Public Water Policy Knowledge in the American West

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Misalignment between crop production and the volume of water necessary to maintain abundant food yields is becoming more pronounced in the Western US. As the West continues to struggle with water availability, periods of drought offer poignant opportunities to engage the public with education campaigns about water and could provide a salient policy window to advance water conservation policies, as research shows that increasing public water knowledge may be beneficial to gain public support for water conservation policies.

environmental values public water knowledge water literacy water conservation water policy

1. Introduction

The Western United States has made significant contributions to agricultural products both domestically and internationally. As the Western U.S. continues to grapple with water scarcity and extended periods of drought, the evidence of misalignment between crop production and the volume of water necessary to maintain abundant food yields is becoming more pronounced. There are several policy nudges and mitigation strategies that can be employed to bring water availability and crop selection into alignment. Whether there is public support for these policies, or knowledge of how policies could impact water use in agriculture, it is important to understand what those preferences are and how people weigh tradeoffs between developing agriculture and water use.

The significance of public's policy knowledge for successful democratic governance cannot be overstated. Popular control of public policy is a central principle of democratic theory, and therefore, the quality of the democratic character of a regime is often gauged by the level of public participation and the responsiveness of policymaking institutions to public policy preferences . However, when it comes to complex policy areas such as water resource management, the level of public awareness does not often commensurate with the complexity of the respective issues. Adequate policy-relevant knowledge is vital for citizens to assess policy alternatives, as the lack thereof is likely to culminate in the choice of unwarranted solutions to problems as studies show that when public views diverge from that of the experts, policymakers tend to go along with popular opinion [1][2]. Given that most scientists argue that human-caused greenhouse gas emissions are the main source of climate change and that climate change is leading to increased drought and water shortages in many areas of the world, especially in the U.S. West, it is important to assess the scope of public knowledge concerning water resources and to identify the link between water literacy and support for various water management policies.

Increasing public water knowledge may be beneficial to gaining public support for water conservation policies [3]. As the West continues to struggle with water availability, periods of drought offer poignant opportunities to engage the public with education campaigns about water and could provide a salient policy window to advance water conservation policies. Further, for policymakers, continuing to combine water conservation policy with incentives to large-scale water users to reduce water use through employing water-saving strategies and technologies would mitigate the financial impacts on irrigators and respond to the public's desire for positive incentives for water conservation [3]. States in the West already utilize these incentives, with Oregon irrigators using the Clean Water State Revolving Fund (CWSRF) loans to improve upon water delivery and efficiency to reduce overall water use [4]. Funding for these programs could potentially increase with a more water-literate public actively supporting water conservation policies.

2. Background

Traditional freshwater sources are drastically suffering from climate change and overuse [5], with both population growth and climate variability significantly impacting water availability around the world [6]. Around 70% of the world's freshwater is allocated for irrigation [7]. On average, in the United States, 80% of the total water consumption per year is associated with agricultural use [7], with agriculture in the Western states accounting for 90% of total water consumption [7]. Historical water use in the region spurred the development of Western cities and was also the foundation of the development of the agricultural industry, with the region now providing a significant amount of agricultural products both domestically and internationally. Securing a dependable water supply for agriculture and irrigation is crucial for both crop production and the economies of the West, but also to minimize the impact of water scarcity on other water uses (e.g., ecological, industrial, residential, recreational, etc.).

In the summer of 2021, the first-ever water shortage was declared for the Colorado River, leaving Arizona farmers unable to irrigate their crops for the summer season [8]. In Oregon, the Klamath Basin drought resulted in an irrigation water shut-off, causing significant negative financial impacts to the agriculturally dependent region. After years of drought conditions, some of the most critical reservoirs in the American West, such as Lake Mead, are running low leading to temporary, but unsustainable, water transfers to mitigate the worst of the drought impacts [9]. The lack of water in the summer of 2021 was so significant that over 90 percent of the American West was deemed to be in a drought. Fall conditions did not impact the drought conditions in the West, with several regions in December 2021 still considered in "extreme" or "exceptional" drought [10]. The persistence of drought conditions suggests that this may be the new norm, and current "solutions" more likely focus on emergency reallocation of water instead of long-term solutions to mitigate water scarcity.

3. Water Profiles of California, Idaho, Oregon, and Washington

The American West requires vast sums of water to meet irrigation needs as it produces a significant amount of the nation's agricultural products. In 2015, total water withdrawal for irrigation purposes amounted to approximately

74% of California's water withdrawal, 86% of Idaho's, 78% of Oregon's, and 59% of Washington's with each state utilizing a significant, if not majority, of both surface and groundwater withdrawals for irrigation [11]. Water use contributes directly to all four states' agricultural production and economies. In 2019, estimated agricultural revenue in California was USD 49.9 billion, USD 8 billion in Idaho, USD 5 billion in Oregon, and USD 9.3 billion in Washington [12]. Washington, Oregon, and Idaho collectively are the top producer of 22 principal agricultural products [13], while California produces over one-third of the nation's vegetables and two-thirds of its fruits and nuts [14]. While increasing water scarcity threatens crop management and abundance, water efficiency for agriculture has not necessarily led to less water use; rather in some cases, it has led to increasing the crop size since more water is available [15]. With the significance of irrigated crops in CA, WA, OR, and ID, on both food production and regional economies, addressing water use and management is critical to maintaining economic and production stability.

As many surface waters have been over-allocated and unable to meet demand, the reallocation of groundwater has been used either to supplement insufficient surface water or become the primary water source. This dependence on groundwater aquifers in the American West is causing substantial groundwater depletion and raising concerns about the ability of groundwater aquifers to recharge water supply fast enough for demand. Further, in the most extreme cases, over-pumping of groundwater from aquifers is causing land subsistence. In some regions of the Central Valley in California, land subsistence is occurring at more than 1 foot per year [16], which in the worst case could result in the inability of the aquifer to act as a future water bank for freshwater.

As a finite resource, there are limited options to mitigate water scarcity. Large-scale infrastructural dam and pipeline projects are becoming an anachronism of an era when water was considered abundant and necessary for the expansion and development of the West. The remnants of these projects are currently evident in the misalignment between crop production and the volume of water necessary to maintain abundant food yields, water shut-offs in agricultural regions, as well as more prevalent water restrictions in urban areas. A greater push toward water conservation is apparent with more households planting xeriscaped yards, ubiquitous household installations and purchasing of water-efficient appliances and devices, and agricultural producers utilizing more water-efficient irrigation and growing less water-intensive crops [9]. Additionally, technological innovations have expanded the definition of "fresh" water with desalination plants converting saltwater to potable water and more recycled water being employed not only for irrigation but other residential and industrial uses.

4. Public Knowledge and Water Policy

4.1. Public Knowledge and Policy Preference Connection

Electing delegates to act on behalf of citizens in policymaking institutions does not mark the end of citizens' participation in representative democracies. The ideal of democratic governance demands that citizens should be able to actively speak out on government actions and effectively steer policy development [17][18]. However, when it comes to complex policy areas such as water resource management, scholars have been especially concerned about the democracy and technical information quandary; that is, how does one legitimately push for public

involvement in policy areas where the level of public awareness does not commensurate with the complexity of the respective issues [19][20]. The impression that the public does not always have adequate knowledge about policy issues has led some to even question the value of public participation in policymaking. From the Platonic notion of 'philosopher king' to Lippmann's 'phantom public' in the early 20th century, the calls for the rule of experts have stemmed from the concern that the public generally lacks policy-relevant knowledge [21]. Even in the 21st century, some well-known climate researchers and environmentalists, frustrated by the lack of action, have endorsed authoritarianism as an answer to climate change [22][23]. However, as Stehr puts it, what we really need is more democracy but with enhanced "knowledgeability of individuals, groups, and movements who work on environmental issues" [24] (p. 44).

Citizens' policy preferences are intendedly rational; however, their rationality is bounded by the knowledge they possess about respective policy issues [25][26][27][28][29]. Consequently, fallacious knowledge claims are likely to culminate in a choice of unwarranted solutions to problems [30][31], especially in dealing with complex problems where individuals often heavily rely on heuristics [32]. Adequate policy-relevant knowledge is vital for citizens to not only assess policy alternatives but also to enable them to discern their real interests and influence policymaking accordingly [33][34]; as Janicke argues, "without knowledge, there is no (perceived) problem, no public awareness, and consequently no policy process…" [35] (p. 7). At the policymaking level, policy process theories incorporate the vital role of knowledge by assuming boundedly rational policymakers who are bounded by beliefs in decision making [36][37] and by time and attention to agenda setting [38][39].

Prior research has identified a knowledge gap between experts and the public [40][41][42], which can culminate in bad policies, as studies show that when public views diverge from that of the experts, policymakers tend to go along with popular opinion [1][2]. This knowledge gap dovetailed with Americans' ideologically charged and divergent views about the existence and severity of climate change [43] makes it vital to study water literacy and its links with public policy preferences. Given that most scientists argue that human-caused greenhouse gas emissions are the main source of climate change and that climate change is leading to increased drought and water shortages in many areas of the world, especially in the U.S. west, it is important to assess the scope of public knowledge concerning water resources and to identify the link between knowledge and support for various water management policies. By more clearly specifying the connection between knowledge levels and the impact—if any—on beliefs about water policy preferences, one can better understand how information dissemination efforts may be designed to more effectively engage the public in water management issues and to assist the public in understanding policy discussions that concern water. Science communication experiments in the U.S., Canada, Europe, Asia, and Africa have shown encouraging findings that individuals' policy preferences are likely to change when they are equipped with relevant knowledge through effective communication and public deliberations [44][45][46][47][48][49].

4.2. Public Water Knowledge in American West

Earlier studies indicate that water literacy among the U.S. population has generally been at a very low level. The majority of the citizens have not been found well informed about water-related terms or issues concerning water

resources management [50][51][52][53][54]. McCarroll and Hamann have recently reviewed two streams of studies related to water literacy, one focusing on students and the other on adults (18 years and above). They have found that knowledge gaps and misconceptions related to water resources among the students are carried through to adulthood [55]. Studies in educational research have shown that students often struggle to understand water-related concepts [56][57][58][59], and the trend persists in the general public that exhibits a limited understanding of water-related policy issues [50][51][52][53][54][55][60][61].

A recent national survey of U.S. adults found that a majority (53%) were knowledgeable of the connectivity between water and food production [62], recognizing the trade-offs and water concerns in agricultural food production. While the U.S. public has some water knowledge pertaining to agricultural use and concern about abundance, there is potentially a lack of knowledge pertaining to water resources themselves. A 2018 study of Texas residents found that a vast majority (between 79% and 95% of mail and online respondents, respectively) expressed the belief that groundwater is an abundant resource that "is plentiful and will always be available for human use" [63].

However, recent water restrictions to several Western cities and other regions have helped to create an awareness of water scarcity, potentially making water policy salient to the public. A 2019 poll by Colorado College found that a majority of residents in the American West had high levels of concern for water scarcity [5]. The Pew Research Center found that 76% of residents in the Pacific states recognized the impacts of climate change on periods of "drought or water shortages" [6].

4.3. Factors influencing Water Public knowledge

Several studies on the correlates of policy-relevant knowledge have identified a knowledge gap between people of higher and lower socioeconomic status (SES) [33][34][64][65]. Individuals with higher SES have not only been found to exhibit higher levels of knowledge holding but also tend to more quickly respond to efforts to increase public knowledge compared with those with lower SES [66][67]. Education and income are typically found to be positively associated with water literacy [3][68][69] and public knowledge related to policy issues in general [64][65][70]. However, a recent study of water literacy among the urban residents of China reveals a negative relationship between income and water-related knowledge [69].

While age is generally found to be positively related to knowledge holding [34], younger people were found to be more knowledgeable than older cohorts in the case of water-related knowledge [3]. However, Dean et al., found age to be positively related to water literacy [68]. Several studies found male respondents to be better informed than females about policy-related issues in general [64] as well as about issues specifically related to water resources [3][68][71]. However, female respondents were found to be more knowledgeable in several policy issues than males in Turkey, Palestine, and Taiwan [33].

Knowledge is not just influenced by demographics and socioeconomic status but also by values, perceptions, personal interests, and life experiences that contribute to associative learning. Research shows that liberals are

significantly different in their orientation toward science than those who identify themselves as conservatives—the former believing scientists and science to be objective. Liberals, therefore, have a higher level of motivation to acquire scientific knowledge, and as a corollary, are more likely to exhibit a higher level of knowledge in complex policy domains such as water resource management. A recent study has found that the environmental efficacy and climate change beliefs significantly positively associated with knowledge related to recycled water and water use in crop irrigation. The respondents who believe the Earth is getting warmer due to human-caused activities were 86 percent more likely than those who do not believe in human-caused climate change to respond correctly to statement related to recycled water and food, and 42 percent more likely to respond correctly to water use in crop irrigation statement [3].

Even though recycled water benefits the environment, economy, industry, and agricultural communities, it is still considered a controversial topic with public acceptance of recycled water dropping “with increasing human contact” [72]. Thus, many industries that could use recycled water do not at this time due to lack of acceptance or availability [5]. Negative perceptions reflect human health concerns and food safety [5], as well as the “yuck” factor [73] with people imagining sewage water turned to drinking water or other potable uses, thus finding it an unsavory conservation option. Even during periods of drought, public acceptance of recycled water remained unaffected [74], suggesting that there is a significant lack of knowledge about the safety and cleanliness of recycled water.

Research exploring variables affecting the acceptance of recycled water illustrates variation among demographic groups. Regarding age, older consumers are less likely to accept the use of recycled water than younger ones [7] [74]. The intuition behind these findings is that older people are more concerned with health risks given their increased health concerns as older adults [7]. Conversely, research has revealed that educated and environmentally conscious people are more willing to use and accept recycled water. Gender has also been found important with men more likely to support recycled water use compared with women [72][74]. In a meta-study conducted by Fielding, Dolnicar, and Schultz (2019), higher income levels were consistently correlated with higher levels of acceptance of recycled water [72]. Cost is also significant in encouraging the usage of recycled water; more specifically, the price should reflect the price of freshwater used for irrigation during water scarcity, and not cost more. Further, a study by Glick et al. (2019) examined policy-relevant knowledge and support for recycled water, finding a correlation between increased knowledge and support for recycled water use [74].

4.4. Water Knowledge influences Water Policy Preferences

A recent study provides convincing evidence of the relationship between water knowledge and policy support for supply-side and demand-side water policies. The study found that those who correctly answered questions pertaining to the safe use of recycled water to grow food and that irrigation is the largest user of groundwater in the U.S. were much more supportive of conservation policies to address the management of water resources and less supportive of building dams and reservoirs or pipelines [3]. Further, of the four conservation policies that water knowledgeable people supported, two were incentive-based, suggesting that policies aimed at water conservation should focus on positive incentives to engage the public and garner support for water conservation policy [75]. These findings align with the reality that there is no more water to be stored or piped to other water-deprived

regions. Therefore, it was expected that those with accurate water knowledge would support policies seeking to conserve existing water for multiple uses and needs. These findings substantiate prior research that found significant correlations between water knowledge and water conservation [68].

5. Concluding Remarks

The lack of water in the West is not a problem that will go away on its own. Active management of water resources is now required to meet current water needs as well as actively planning how to maintain water uses in the future without further exacerbating limited resources. Policies to encourage water efficiency and conservation will require an active engagement with a knowledgeable public and the participation of all water users. Policymakers engaged in managing scarce water resources would potentially benefit from continued efforts to increase public water knowledge. Building on existing awareness and concern, particularly in times of drought where impacts are more tangible to the public could prove effective in developing water knowledge and engaging the public in creating more impactful and sustainable water conservation policies, particularly policies that are incentives-based. Beyond large-scale water conservation policies, this could also engage the public in broader water conservation efforts, particularly those who feel that their actions can have a positive impact on water conservation.[3]

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