WHAT ARE RESEARCH SCIENTISTS' RESPONSIBILITIES WHEN CONSIDERING CALIFORNIA'S WATER SCARCITY PROBLEM?

California needs more water. The governor of California says high temperatures, low rainfall, and a growing population have created a water crisis. A third of the state is in extreme drought, and if there is another dry season, the state faces a potential catastrophe (*Issues in Science and Technology*). California is the most populous state in the U.S. at 37 million people and has the fastest recorded growth rate (14% from 1990-2000). California is the world's eighth largest economy and generates 13% of U.S. wealth. The state also leads the nation in total water usage followed by Texas, Illinois and Florida. The water in rivers and aquifers of California are over allocated (*Issues in Science and Technology*). Therefore, the state faces increasing pressure for solutions to diversify its freshwater supplies portfolio and people are starting to look to the Pacific Ocean as a next potential freshwater source.

The argument in this paper focuses on the debate over desalination, the process of transforming seawater into drinkable water, versus increasing water conservation and efficiency in the State of California. The specific issue that will be argued is that research scientists have the obligation to promote the public good. Consequently, what role should researchers play in debates between water conservation and water efficiency or development of coastal desalination facilities? That is, what should researchers do when there are questions about where the public good lays? For instance, there are the options of increasing resources (development of desalination plants) in a resource-deficient area or increasing the efficient use of existing resources (water conservation) in inefficient areas. The paper will first address the development of desalination plants, then consider water efficiency and conservation, and lastly discuss what the scientists' obligations and responsibilities are to promote the greater public good in cases where there is scientific uncertainty.

The construction of 20 seawater desalination plants are proposed in California, which could provide 10% of the fresh drinking water to the state (CA Coastal Commission 2004). The developments sound appealing since the desalination of saltwater to drinking water would benefit hundreds of thousands of people. The water supplied by desalination plant could also help relieve some of the over-allocation of aquifers and surface waters in California by reducing demand from these systems. These desalination facilities could also help desalinate brackish groundwater into freshwater for municipal use. By utilizing desalination, annual drought conditions could be alleviated and inconsistent water supplies that depend on natural water systems would be more dependable (The Pacific Institute 2006).

However, coastal desalination facilities raise substantial and complex concerns about cumulative impacts. "Cumulative impacts refers to two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts" (CEQA Section 15355). Different desalination plants can contribute to different types of cumulative impacts associated with the full range of coastal resources, such as environmental, visual or aesthetic, public access and many others. For example, the cumulative impact of the development of desalination plants in relation to water quality as well as marine, estuary, and coastal ecosystems would most likely increase with the coastal desalination facilities due to the existing levels of degradation of these systems (CA Coastal Commission 2004). Because the coastal areas are already slightly degraded, the development of desalination plants will have even greater cumulative impacts on ecosystem health and water quality. Despite this, desalination plants are considered a "new option" compared to dams (because the impacts of dams are known and the cost of these impacts are often greater than the benefits from dams), because the cumulative effects and impacts on the environment are uncertain.

For the sake of the argument, these cumulative impacts addressed above would not promote the public good. Even if the developers can implement the "newest" technology to decrease the negative effect on the environment to a minimum, there is still another cumulative impact issue to consider, the increase in energy consumption. Most desalination facilities will use reverse osmosis (water molecules are forced through semi-permeable membranes at high pressure) to desalinate seawater. The interest in using reverse osmosis is due in large part to recent improvements in technology (e.g. semi-permeable membranes), which can reduce the cost of desalination significantly. However, this technology still requires a lot of energy, resources, and money (one acre-foot of desalinated water costs $1300-$2200/acre foot compared to $15-$30/acre foot for tap water) (The Pacific Institute 2006). The Pacific Institute (2006) states that "more energy is required to produce water from desalination than for many other water-supplies or demand management options in California". The amount of power required to produce the desalinated water will most likely create cumulative substantial demands on local power sources and resulting in additional air or water pollution. Lastly and most importantly, the future cost of desalinated water will be more sensitive to changes in energy prices than will other sources of water (The Pacific Institute 2006).

As with any social choice, the determination to implement desalination facilities should be compared with alternatives. These alternatives include treating low-quality local water sources, encouraging regional water transfers, improving conservation and efficiency, accelerating wastewater recycling and reuse, and implementing well-addressed land-use planning. Of these alternatives, increasing water conservation and water efficiency remains the most cost effective options for the supply of water (Pacific Institute 2006). For example, while not yet widespread, some areas use reclaimed water for irrigation or for injection into groundwater aquifers (reducing the negative impacts from overdrawn aquifers and/or reserving this water for potable uses in the future). The extensive implementation of water reclamation (*e.g.* using reverse osmosis) could dramatically reduce the amount of partially-treated or untreated wastewater being discharged into the ocean.

Some researchers have suggested that water conservation and efficiency efforts should be primarily directed at farmers, in light of the fact that crop irrigation accounts for 70% of the world's fresh water use (Brady and Weil 2008). In California, the agricultural sector has economic importance, and water subsidies in the state are common. Subsidizing water makes irrigation relatively inexpensive and therefore prevents most farmers from investing in more efficient irrigation systems. For example, surface irrigation, by channeling or flooding, is one of the least expensive systems to irrigate land but extremely inefficient in terms of water usage. On the other hand, drip irrigation is the most expensive and least-used type, but offers the best results in delivering water to plant roots with minimal losses. Irrigated agriculture is in competition with urban and recreational water use, as well as with the pressing need to retain enough water in streams and wetlands to preserve ecosystem function. In order for farmers to be more water efficient, it is believed that charging fees for access to water will provide incentives to conserve the resource (Brady and Weil 2008).

As stated earlier, construction of desalination facilities is being considered to provide a reliable source of drinking water. Because the cumulative effects and impacts on the environment are uncertain, the “potential benefits of ocean desalination are great, but the economic, cultural, and environmental costs of wide commercialization remain high” (Pacific

Institute 2007). The state of California has limited experience with large-scale seawater desalination and there are many uncertainties about how such facilities may affect coastal resources. This is because relatively little information is available on many aspects of desalination due to the absence of a large body of research and/or scientific information (CA Coastal Commission 2004). Because of scientific uncertainty regarding the impacts of saltwater desalination, what are the research scientists' obligations and responsibilities to promote the public good?

Shrader-Frechette in <u>Ethics of Scientific Research</u> (1994) strongly voices that research scientists have the obligation to promote the public good. She argues that researchers' primary duties must be to the long-term public good in a case of conflict between two values. In this case the two options are: development of desalination plants or increase of water conservation and efficiency. Further, the author states that researchers have to support preservation and conservation over development since "technologies or developments with questionable environmental impacts have at least the potential to cause economic harm und reduce public welfare (Shrader-Frechette pg.126)."

Shrader-Frechette also asserts that scientists face an ethical dilemma between advocacy and objectivity, between promoting environmental welfare and admitting objectively that certain desalination plants may, or may not, provide a net benefit to the public. "Researchers might believe development and its associated impacts may produce a net benefit for the public. The general ethical question" that researchers' beliefs "raises is how great the human benefits must be to offset seriously harmful environmental impacts and associated development" (Shrader-Frechette pg. 124). Some desalination proposals may be environmentally benign or may even provide environmental benefits, while others may cause significant adverse impacts. Because each proposed facility will have a different design and location, each will also raise different issues of concern and likely be subject to the different Coastal Act policies (CA Coastal Commission 2004). Therefore, each desalination proposal will require a case-by-case review. This requires comprehensive, detailed, and specific analysis to ensure that faculties meet applicable policies and allow the state to maintain and protect its costal resources (CA Coastal Commission 2004).

Scientists have ethical obligation to be unbiased and objective. They should not have to take a position for either side, development of desalination plant or water conservation, rather the research scientists have the obligation and ethical responsibility to promote the public good by accurately analyzing and documenting the likely outcomes and risks for both sides. “Scientists have special obligations to society due to their ability to make a difference” (Shrader-Frechette pg.67). This is because their research results and communication of these results can “lead to desirable or undesirable consequences for the public and the environment, particularly if they are misinterpreted” (Shrader-Frechette pg.120).

“Policymakers tend to ignore the economic effect of harmful environmental impacts. Also cost-benefit analyses often misrepresent environmental goods as free goods; developments that are uneconomical over the long-term are often represented as economical over the short term” (Shrader-Frechette pg.128). In this case, the possible misrepresentation of short-term versus long-term effects is especially apparent when considering desalination. With regard to the cost of energy, the future cost of desalinated water will synchronically change with energy prices. Researchers without the responsibility to provide the public with information relevant to the common good would open the door to political manipulation. Some political leaders might claim whatever they wished about research matters relevant to public welfare (Shrader-Frechette pg. 65).

Therefore, scientists should realize the importance and the need of transparency of their scientific results and interpretation. The transparency of the large body of research and/or scientific information becomes vital, for economic and police decisions, since each desalination facility has to be reviewed on a case-by case basin. The uncertainties of cumulative unknown environmental impact convey a great responsibility for truthfully analyzing the likely economic and environmental outcomes when proposing the construction of a desalination plant. "Research scientists have duties to the public and its interests because they, as professional with economic, political, and intellectual power, control much of what happens in society" (Shrader-Frechette pg.65). This means that scientists play a crucial role in adding scientific information and to assure the transparency of information because of their influence on political discussion and in the decision-making processes.

This paper finds that research scientists should inform the decision makers and the general public that there could be potential benefits of certain desalination facilities but the risks of the cumulative outcomes are extremely high as well as very difficulty to mitigate once they have occurred. In contrast, the improvement of water conservation and efficiency has a very small uncertainty compared to development. The risks that are involved in water conservation would be much less severe in regards to the environment and to the general public.

Scientific researchers have an ethical responsibility to society as well as objectivity (Shrader-Frechette pg. 63) and when realizing that water conservation and increased water efficiency benefits everybody, present and future, whereas development of desalination facilities primarily benefits present developers and the current public, it appears that a greater number of people gain from water conservation (Shrader-Frechette pg. 124). Although, this does not mean that research scientists have to be against development and all developments have negative impacts on the greater public good. In this case, one rather should recognize the importance of first improving, investing and developing in water efficiency and conservation practices before considering expensive development whose impacts are uncertain. When no more improvements can be made in water conservation and efficiency use then the development of desalination facilities and other alternatives should be considered.

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