Global Essay Competition 2024

Title: **Crossroads of Crisis and Opportunity: Navigating the Global Water Crisis in the 21st Century**

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Essay:

"As we stand at the half-way point of implementation of the 2030 Agenda and of the Water Action Decade, some 2 billion people do not have equitable access to safe and affordable drinking water, and 3.6 billion do not have access to adequate and equitable sanitation."

– **Opening statement to the UN 2023 Water Conference**

Suddenly, it has become unmistakably clear that the world is running out of freshwater supplies. This realization dawned as world leaders, research organizations, nonprofit organizations, delegates from around the globe, and environmental activists gathered in New York in March 2023 for the UN Water Conference. The gravity of the opening statement, filled with startling figures, not only underscores the challenges that lie ahead but also acts as a clarion call to action for policymakers, communities, and individuals alike. Among the various announcements made at this rare UN summit, the first of its kind in the 21st century and the first major UN water conference since 1977, the report shared by Mazzucato et al. (2023) garnered significant headlines in major news channels. Mazzucato and colleagues (2023) warn that by 2030, due to the mismanagement of freshwater resources, the world may face a shortfall in meeting its freshwater needs by as much as 40% compared to the available supply. The grim future scenario outlined in the reports illustrates a textbook case of a domino effect, triggered by decades of mismanagement and overuse of one of Earth's most critical natural resources: water. This essay traces the origins of this issue from the 1960s through case studies in both the Global South (the least developed and developing countries) and the Global North (developed countries). It aims to unravel a critical question: faced with an imminent water scarcity, should our focus lie in augmenting our water reserves, or might we better serve our future by innovating to live within our means?

Case Study 1- The Thirsty Land: Punjab's Battle for the Last Drop [*Groundwater Depletion in Northwestern India*]

India, home to 1.4 billion people, is grappling with the challenges of ensuring water and food security and promoting sustainable agricultural practices. At the heart of this challenge lies Punjab, a state that, despite covering only 1.53% of the nation's land area, has emerged as the cornerstone of India's food security, contributing 29% of the country's rice and 38% of its wheat production (Punjab Economic Survey, 2017). This remarkable feat is attributed to the Green Revolution of the 1960s, which transformed Punjab into India's breadbasket by introducing high-yielding varieties of wheat and rice, alongside advanced irrigation and fertilization techniques (Dhanagare, 1987; Eliazer Nelson et al., 2019; Fujita, 2012; Parayil, 1992). The legacy of the Green Revolution can still be felt today; as of 2020, Punjab's gross cropped area is dominated by the rice-wheat dual cropping system, accounting for more than 80% (Downing et al., 2022). Although this rice-wheat monopoly, a hallmark of the Green Revolution, has been a boon for farmers by increasing their income, it has proven to be a bane for Punjab's water table. Crops such as paddy are highly water-intensive and not conducive to the state's semi-arid climate (Dutta, 2012). Compounding this issue was the policy of free or subsidized electricity for agriculture in Punjab. While financially aiding the farmers, this policy inadvertently encouraged the rampant installation of tube wells for irrigation. From a mere 0.192 million tube wells in 1970-71, Punjab experienced a dramatic rise to 1.38 million by 2011-2012 (Baweja et al., 2017). The majority of these tube wells, driven by subsidized power, have contributed to an unsustainable drawdown of groundwater (Kaur & Sharma, 2012; Singh, 2009).

The environmental impact of these practices is stark. From 1998 to 2012, Punjab's average water table experienced a precipitous decline from 7.32 meters to 12.79 meters, with an average annual drop of 41.6 cm (Baweja et al., 2017). This decline in the water table has been most severe in Punjab's central zone, leading to the development of groundwater depression cones and a reversal in the natural flow of groundwater. Such overextraction, with groundwater withdrawals exceeding the natural recharge rate, has led to dire predictions that the state's per capita surface water availability is expected to plummet from 2309 m^3 in 1991 to 1191 m^3 by 2050 (Baweja et al., 2017).

This crisis extends beyond just water scarcity and food production. The agricultural practices in Punjab, particularly the management of paddy straw, have broader environmental implications. The prevalent practice of burning paddy straw, an aftermath of intensive rice cultivation, contributes significantly to air pollution in northern India (John & Babu, 2021). This practice, often adopted for the quick clearing of fields, releases large amounts of harmful pollutants including particulate matter, carbon monoxide, and nitrogen oxides, which have adverse effects on human health and the environment (Singh, 2018). The resulting smog and poor air quality not only affect local populations but also travel far beyond state borders, impacting the air quality of major northern cities, including the national capital, New Delhi (Singh, 2018).

The interlinked challenges of water scarcity, food security, and environmental degradation present a complex scenario for both Punjab and India. The state's struggle with groundwater depletion is not merely an agricultural issue but a national concern with far-reaching implications for food stability, public health, and environmental quality. As Punjab stands at this critical crossroads, the need for integrated and sustainable solutions has become more pressing than ever. Should Punjab run out of water, the ripple effect would be felt nationwide, potentially leading to a significant shortfall in the production of essential food grains.

Case Study 2- Combatting Agricultural Pollution to Protect the Great Lakes' Legacy

The North American region, specifically Canada and the United States, holds a privileged status in terms of freshwater resources, thanks in large part to the Great Lakes. These lakes, which are shared between the two countries, account for 20% of the world's surface freshwater reserves, highlighting their global significance (Cable et al., 2017; Steinman et al., 2017). The reliance of approximately 45 million people in the surrounding basin on the Great Lakes for drinking water and other vital needs further emphasizes the urgency of protecting these extensive water resources (Maghrebi et al., 2015). Despite their invaluable significance, the environmental integrity of the Great Lakes has faced increasing threats from various pollution sources since the 1960s, posing a significant challenge (Bilder, 1972). A principal factor contributing to the deterioration of freshwater quality is agricultural pollution, as highlighted in an Environment and Climate Change (2023) report. This issue is particularly acute in the Midwest United States, where the excessive application of fertilizers, rich in nitrogen and phosphorus to boost crop yields, disrupts aquatic ecosystems. These nutrients, while essential for crop growth, are scarce in aquatic environments and usually act as a limiting factor for algal growth. Excessive runoff of these nutrients from agricultural lands into water bodies disturbs this delicate balance, leading to uncontrolled algal and cyanobacteria blooms (Kleinman et al., 2011). Such blooms can produce toxins, deplete oxygen levels, disrupt aquatic life, and create dead zones where most aquatic organisms cannot survive (Breitburg et al., 2009; Dodds, 2006; King et al., 2015; Scavia et al., 2003). A striking instance of this issue was in 2014 in Toledo, Ohio, when harmful algae blooms in Lake Erie's western basin left half a million residents without safe drinking water for two days, highlighting the grave consequences of nutrient pollution (Jetoo et al., 2015; Steffen et al., 2017).

Confronting the Future: Steering towards sustainability

Although the case studies highlight a significant difference, one portrays the Global South, which often lacks the resources to address challenges associated with economic constraints and large population burdens. In contrast, the other scenario focuses on the Global North, or the so-called first world, endowed with abundant resources and high human development indices. However, they share a concerning similarity: the bleak future of water resources across both regions. It does not matter whether countries like Canada and the US have historically enjoyed water abundance, or India, which faces a large population with lower per capita water availability. The drive for increased agricultural production has compromised water quality in the US and Canada and diminished water quantity in India.

Therefore, the urgency for integrated and sustainable solutions has never been greater. My initial approach to address this issue involves leveraging computer modeling and AI technology to predict optimal management practices, rather than relying on long-term field experiments. At first glance, this might seem like a concept from science fiction. However, field-scale simulations for nitrogen reduction are already widespread in the US. The challenge lies in the absence of a practical model that can accurately forecast management strategies to minimize phosphorus loss through fields, as phosphorus movement is significantly more complex (Radcliffe et al., 2015). Nonetheless, recent advancements in AI are poised to enhance the accuracy of models in predicting the best management practices. If implemented in the fields, these practices could lead to a notable decrease in agricultural pollution in the Great Lakes. Similarly, in countries like India, there is a pressing need for extensive research into complex weather phenomena such as El Niño and La Niña, which are influenced by climate change. These phenomena have profound impacts, including altering rainfall distribution, which can lead to increased occurrences of extreme weather events like droughts and floods. Such variations in rainfall directly impact groundwater recharge rates in regions like Punjab. The year 2023 has presented significant challenges for Punjab, with floods causing widespread agricultural damage. Despite this, a research gap still exists in understanding the exact effects of changing weather patterns, particularly El Niño and La Niña, on Punjab’s groundwater reserves. Developing a comprehensive understanding of these impacts is vital for creating effective strategies to manage the state's water resources efficiently.

My second take is that the concept of a 'free lunch' should not exist in countries like India either. It is essential to reassess the policy of providing free electricity to farmers in Punjab. Initiated in 1997, this policy aimed to offer economic support to farmers at a time when their financial stability was more precarious. However, the context has significantly changed since then, particularly concerning groundwater reserves. Presently, farmers are generally in a better economic position than they were in the 1990s, which was the primary motivation behind the policy.

One potential solution the government could explore is the establishment of large-scale biomass power plants in India. This would not only provide a viable alternative to paddy straw burning – a practice banned by the Supreme Court – but also create a productive use for this agricultural by-product. Effective solutions require attractive alternatives; without feasible options for utilizing paddy straw, farmers are unlikely to move away from the traditional practice of burning it.

Moreover, crop diversification is an essential strategy that needs to be vigorously pursued. The government should consider offering minimum support prices (MSP) for alternative crops like maize and millets. While it is understood that crops like maize may not fetch the same market price as rice, providing an MSP could incentivize farmers to consider crop diversification. Although initially, this might place a significant financial burden on the state's exchequer, gradually increasing the MSP each year could ease this burden. More importantly, it would provide farmers with a tangible incentive to transition to less water-intensive crops, thereby contributing to the sustainable management of India’s water resources.

Conclusion

While the world faces the imminent threat of freshwater scarcity, the UN Water Conference in 2023 represents a highly welcomed initiative, turning a crisis into an opportunity by sparking global awareness about water issues. I firmly believe that human needs can be met with the resources currently available on Earth, and that greed remains insatiable, even if we exploit everything the planet has to offer. Through systematic scientific approaches such as computer modelling, a deeper understanding of climate change, the implementation of prudent welfare policies, and the development of alternative economic models, a balance can be achieved for the sustainable future of our planet.

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