On-Land Filtration of Seawater: A Water-Based Solution to Global Challenges

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Editorial

Climate change's 'surplus' of oceanic water presents an unparalleled chance to address a variety of global challenges through a very practical process: diverting extra water from the oceans to land. The desalination of very large amounts of saltwater in an international network of enormous desalination plants, we argue, could help to minimize sea-level rise. Desalinated water might be kept on land in the form of crops, wetlands, or new forests to effectively offset sea-level rise. The cost of mitigating current sea-level rise by water desalination exceeds US$ 23 trillion in investment and US$ 4 trillion per year in operation costs, based on a US$ 500 million price for a single mega desalination plant built with current technology. The economic, environmental, and health benefits, on the other hand, would be enormous, and might help to solve a variety of global concerns such as sea-level rise, food security, biodiversity loss, and climate change. Because these challenges are so closely linked, remedies should try to solve them all at the same time and on a global basis [1].

Although the effects of climate change on the oceans are more difficult to perceive than receding glaciers, individuals living on low-lying oceanic islands can already notice the rise in sea level and its economic and social repercussions. Between 1993 and 2010, sea levels rose an average of 3.2 2.8 mm to 3.6 mm per year due to thermal expansion of seawater and melting of glaciers and polar icecaps. Rising waters result in the loss or inhabitability of coastal land6, resulting in millions of "climate change migrants" as well as significant economic and environmental harm in the near future. This 'surplus' of water, on the other hand, presents an unparalleled chance to address a variety of global challenges through a very practical process: diverting excess water from the ocean. The desalination of very large amounts of saltwater in an international network of enormous desalination plants, we argue, could help to minimize sea-level rise. The economic, environmental, and health benefits would be substantial as a result [2]. Desalinated seawater could be utilized to grow crops in decertified and drought-prone locations, directly contributing to greater food security in countries with limited water resources for agriculture through stable local food production. Water is also required to replenish lakes and river systems that have dried up due to human use and rising temperatures, like the Jordan River in Israel has already done.

Desalinized water could be utilized to compensate for groundwater depletion and keep existing levels stable. Desalinated water might also be 'caught' in the form of restored wetland plants and new wooded areas to ensure long-term 'storage' on land. Wetlands provide crucial ecological services, which are especially important in a changing climate; however since 1700 AD, 87% of wetland areas have been lost. Not only will novel forests catch and store water, but they will also operate as significant carbon sinks. As a result, current woods, which may have reached saturation, will be supplemented, and climate change will be mitigated. These repaired or freshly constructed habitats will also help to conserve biodiversity that is particularly vulnerable and diminishing, addressing yet another critical global challenge. Desalination plants today are primarily geared to provide potable water for human consumption, but they also support agricultural activities [3]. The number and capacity of these facilities are quickly expanding as freshwater resources become more unreliable in many parts of the world. The world's largest desalination plant was recently completed in Saudi Arabia. It will be capable of generating 1,025,000 m^3 of desalinated water per day once fully operational. The Sorek desalination plant in Israel, which reached full capacity in 2015 and now produces up to 624,000 m^3 of desalinized seawater per day, providing potable water to 20% of Israeli households, is another example of a mega plant [4]. The ongoing processing expenses of sea water must also be considered, in addition to the expenditures of erecting desalination mega plants. Reverse osmosis (RO), a procedure with excellent energy efficiency that is currently employed in 65% of desalination facilities throughout the world, is the approach used in Sorek and most modern desalination facilities. To counteract the osmotic pressure of seawater, seawater is pumped through semi-permeable membranes at 27 times atmospheric pressure during the RO process. To achieve this, RO still necessitates a significant amount of energy, which accounts for 30%-60% of the cost of desalinated water production on average. In Sorek, the price of producing 1 m^3 of drinkable water is presently $0.58.

They calculated that, under optimistic assumptions, the energy expenditures of pumping sea water onto the Antarctic ice shelf might consume 12% of global primary energy supply in 2012. The authors came to the conclusion that creating such a large amount of energy in the Antarctic was a significant technological challenge for their method. Similarly, operating the proposed network of desalination mega plants poses a significant energy issue, not only because of the vast quantity of energy required, but also because the energy must not be produced using fossil fuels, which would result in massive carbon dioxide emissions [5]. As a result, producing renewable energy such as solar, wind, and tide-generated electricity to power desalination facilities is an important field of research and innovation. Facilities being built now are already transitioning to renewable energy sources, and the energetic obstacles indicated above are anticipated to diminish over time as technology progresses. The recent establishment of the Global Clean Water Desalination Alliance at the UN Climate Change Conference in Paris also reflects a political commitment to reducing carbon dioxide emissions from desalination processes. The total cost of desalinated water has decreased rapidly as plant capacity has increased, bringing the cost of desalinated water closer to that of conventional water delivery. However, transporting desalinated sea water remains a big challenge, which could have a considerable impact on the cost and hence feasibility of the suggested proposal. The production and transportation costs of desalinated water would likely remain under $2 per cubic meter if most of it was used within 1000 km of the source and at 500 m of elevation. If such expenses are acceptable when it comes to potable water for human use, they may be less so when the water is used to grow forests or refill wetlands, but they may be justifiable for agriculture in locations where food security is a concern.

Another factor to consider is that desalinated water used in agriculture (and, by extension, natural habitat restoration) does not require the same level of purity as drinking water. Irrigation water must have a salinity of less than 1600 ppm of total dissolved solids, whereas drinking water must have a salinity of less than 400 ppm. As a result, desalination for agriculture or land storage is technically easier and can be much less expensive. The potential environmental impact of sea water desalination is a recurring concern. Reverse osmosis generates a lot of waste in the form of hyper-salinized brine, which is normally dumped in the ocean, and used membranes, which are usually thrown away. In a scenario including the installation of hundreds of big desalination plants, these by-products could cause substantial environmental problems [6]. The primary environmental consequences occur within tens of meters of the discharge site, according to a review by Roberts et al. (2010). To limit the potential negative effects of desalination plants on marine ecosystems, it is critical to carefully select these sites. Another key field of research is the development of innovative, more efficient, and environmentally friendly desalination technology. Because sea-level rise is expected to accelerate, the desalination capacity necessary for the anticipated response is always increasing. The melting of Antarctica's ice shelves, which is expected to become irreversible if global warming exceeds 1.5°C to 2°C above present temperatures, is a vital tipping point. Under the present emission scenario, this point might be reached in less than 50 years. Given the timeframe required to build a global network of major desalination plants, as well as the methods and infrastructures to disperse desalinated water where it is needed, it seems unlikely to be accomplished in the next 50 years.

However, the advantages of following the indicated course will be apparent right away. The effects of starting the building of huge desalination facilities will directly contribute to 9 of the 17 Sustainable Development Goals set forth by the United Nations. The path to these favorable outcomes is a step-by-step process. On a local level, these include the creation of jobs, the development of infrastructure, the drive of innovation in water treatment systems, and the prospect of raising food production in famine-prone areas by providing stable and sustainable irrigation water. These findings should be viewed as motivations to invest in the development of large-scale seawater desalination facilities, especially in locations where freshwater supply is unstable and food security is a concern [7].

Despite its radical nature, the proposed plan is simple in theory, depends on existing and increasing technology, and is scalable in order to minimize sea-level rise and contribute to tackling a variety of global concerns such as food security, climate change, and biodiversity loss. Because these problems are so closely linked, solutions that merely target one of them have a slim chance of succeeding. Proposing and testing more proactive and ambitious strategies to solve many global concerns under one single roof is critical. Significant socioeconomic and environmental benefits are anticipated to outweigh the huge financial investment required to counteract sea level rise by seawater desalination. This viewpoint highlights a number of important issues, including the financing and ownership of thousands of mega desalination plants around the world, the mechanism for delivering desalinated water to agricultural and other uses, and the governance of such a worldwide collaboration [8]. A global political plan to engage in a worldwide coordinated effort to mitigate sea-level rise is the other significant stumbling block.

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