Team predicts environmental effects of increased desalination and climate change in the Gulf region through 2050

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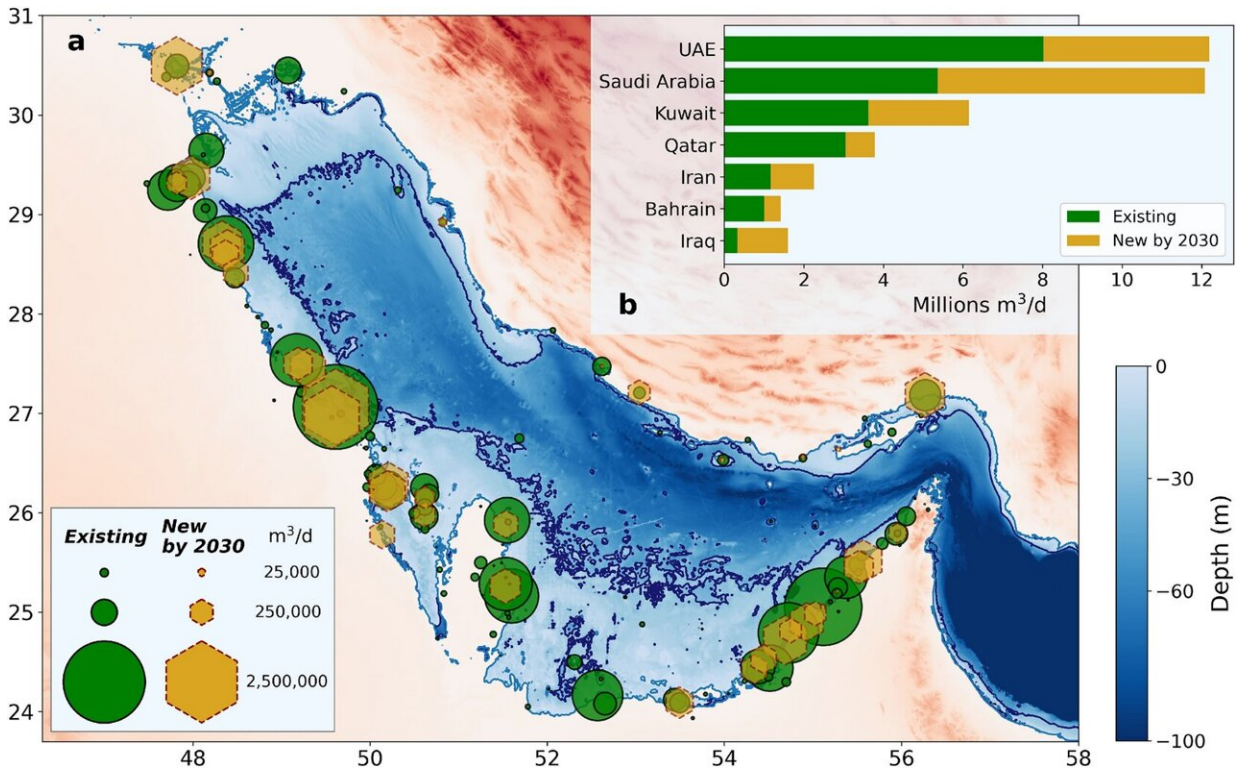

(a) Bathymetry of the Gulf region according to the GEBCO 2021 dataset. Elevation zero is marked in light blue, the −30 m isobath in dark blue. Existing and future (in construction, approved and planned by 2030) desalination plants impinging on the Gulf are marked, respectively by circles and hexagon markers. The marker area is proportional to the plant desalination capacity. Plants closer than ~10 km are represented as a single plant with the combined capacity. (b) Existing and future desalination capacity per country. Oman has been omitted because its desalination capacity in the Gulf amounts to only 5150 m^3 day^{-1}, with

no plans for expansion. Data from2. Map produced with Python 3.10.6: https://www.python.org/. Credit: *Scientific Reports* (2022). DOI: 10.1038/s41598-022-25167-5

A team of researchers from NYU Abu Dhabi's Arabian Center for Climate and Environmental ScienceS (ACCESS) and Water Research Center have studied how increased use of desalination technologies in combination with projected climate change will affect Gulf-wide salinity in the coming decades.

The nations bordering the Arabian Gulf are the world's largest users of desalination technologies to meet their freshwater needs. Growing desalination will result in larger amounts of hypersaline (high-salt) brine being released into the Gulf, and it has been unclear what effect this will have on the Gulf's marine ecosystems and fisheries.

In the paper titled "Long-term, basin-scale salinity impacts from desalination in the Arabian/Persian Gulf," published in *Scientific Reports*, the researchers found that, even under a worst-case climate change and projected desalination scenario, salinity increases will be well within the range of natural salinity variation due to evaporation. These minor salinity changes are therefore not expected to have environmental effects at the Gulf scale, as marine life has adapted to the high and variable natural salinity.

A key finding was that any increase in salinity would drive a corresponding increase into the flux through the Hormuz strait, resulting in a more rapid renewal of the Gulf waters. As a consequence, even in extreme-case scenarios, basin-scale salinity increases are not projected to exceed a level that will have a significant impact on the Gulf's marine life, such as flora and fauna, as these levels of salinity increase are well

within the natural range of variability that organisms in the Gulf are already exposed to.

The occurrence of hypoxia, low or depleted oxygen levels in a body of water, appear to pose a larger threat to marine life in both the deepest part of the Gulf, as well as in the shallow reefs, as documented in earlier papers from these authors and others at NYUAD, conditions that are not related to desalination brine discharge.

While other modeling studies have attempted to estimate the increase of salinity at basin-wide scales due to desalination, this is the first model of its kind to also consider the possible future effects of climate change. As the Gulf region is home to the biggest desalination plant complexes in the world and 45% of global freshwater desalination production, it is important to consider the long-term effects of this industry. The data gathered regarding the anticipated levels of salinity in the Gulf coastal waters can guide the future study of the other effects of widespread desalination, such as the economic impacts of changes to the fishing industry.

"Our team's research provides valuable, new insights into the impacts of this critical industry for the Gulf region," said Francesco Paparella, Principal Investigator at the NYUAD Arabian Center for Climate and Environmental Sciences. "We have developed a reliable model that has allowed us to predict changes in salinity over the next few decades, advancing the ability of our team and the greater scientific community to determine ways to protect our ecosystems better."

"The Gulf is a naturally extreme marine system, and we have been utilizing a growing fraction of its waters for desalination purposes. This raises concerns about whether this may have ecological consequences, particularly in this era of a rapidly changing climate," said John Burt, Co-Principal Investigator at the NYUAD Water Research Center and the

Arabian Center for Climate and Environmental Sciences.

Dr. Burt added, "the results of this work show that salinity increases under even the worst-case climate projections and increased desalination in coming decades are likely to have only negligible impacts on salinity at the Gulf-wide scale, and well within the normal seasonal variation in salinity that organisms here are already exposed to. While we need further research on processes occurring at more localized scales around desalination plants, these results suggest that there is little cause for concern of salinity increases at the Gulf-wide scale."

More information: Francesco Paparella et al, Long-term, basin-scale salinity impacts from desalination in the Arabian/Persian Gulf, *Scientific Reports* (2022). DOI: 10.1038/s41598-022-25167-5

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