DESALINISATION FACTS AND FIGURES

INCREASING DEMAND

Increasing global population, rising water demands and diminishing water supplies are exacerbating water scarcity around the world. Unconventional water resources, such as desalinated water, are increasingly being looked to reduce the gap between supply and demand.

Globally, there are some 15 906 operational desalination plants producing around 95 million m^3/day (or almost 100 billion litres) of desalinated water for human use, of which almost a 50 % is produced in the Middle East and North Africa region (Jones *et al*., 2019).

Currently, around 40 % of Arabian Peninsula region's freshwater requirement comes from desalinisation but with an ever-increasing population, the demand is constantly increasing.

Across the Arabian Peninsula, there are over 2 240 desalination plants, of which 486 plants accounting for over 14 million m^3/day of capacity that discharge brine and other chemical by-products directly to the Arabian Gulf (AGEDI, 2016).

The demand for desalinisation in the region continues to increase, largely a result of gathering momentum in construction plans in the Middle East, especially for the six Gulf Cooperation Council (GCC) nations: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. However, it is not restricted just to this region.

According to the 2018-2019 *IDA Water Security Handbook*, global desalinisation capacity is growing rapidly with 1.9 million m3/day of seawater capacity contracted in the first half of 2018, up 26 percent over the same period in 2017. With projects in Mexico (378,000-m3/day), UAE (272,760 m3/day), Saudi Arabia (250,000 m3/day and 210,000 m3/day) and elsewhere.

The Problem with Brine Disposal

Almost half of the 100 largest desalination plants in the world are located in the Arabian Gulf, extracting water from the Gulf to make potable water through desalinisation and returning concentrated brine as waste to the marine environment.

Brine (hypersaline concentrate) discharge associated with desalination represents a major challenge due to its potential negative environmental impacts. Global brine production is estimated at around 142 million m^3/day, with over half of the global amount coming from the region. Currently, most of this is returned direct to the marine environment, often at elevated temperatures and also with chemicals such as biocides mixed with it. This hypersaline, hot and sometimes toxic mix, can be extremely damaging to the immediate environment, particularly for critical habitats such as corals and seagrass.

Recent studies by the Abu Dhabi Global Environmental Data Initiative (AGEDI) suggest that the environmental impacts of brine upon the marine environment may also be amplified through the effects of climate change.

IMPACTS OF BRINE

Temperature

One of the main impacts of brine discharge is thermal pollution brought about by discharging hot brine to the marine environment, typically at temperatures around 6°C above ambient for Multi-stage flash (MSF) desalinisation and less for Reverse Osmosis (RO). Depending on the temperature and volumes of brine discharged, as well as the nature of the receiving water (deep, high-energy, *etc.*), the impact can be relatively small and localised or extend for several 100 metres damaging or causing mortality of killing benthic fauna and flora.

The coastal waters of Abu Dhabi are already extremely warm in summer and many species are surviving at the upper threshold of their temperature tolerance, so any further increase may well push them beyond the limit if survivability. Sessile organisms such as sea grass or corals, considered as critical habitat for many other organisms, cannot move out of the way or avoid such impacts and damage to these critical habitats in particular has the potential for knock on impacts on species such as dugong and green turtles that feed on sea grass and hawksbill turtles that forage amongst corals.

Depending on the situation there are possible solutions to mitigate some of the worst impacts of temperature, such as using end-pipe diffusers or allowing brine to adequately cool before being discharged into the marine environment, although given the volumes of brine involved this may not always possible.

Salinity

Brine discharge, since it has a higher specific gravity than seawater sinks towards the seabed as a hypersaline layer with the potential to severely impact marine benthic biota. Changes in salinity can influence the propagation activity of the marine species and that consequentially affect their development and growth rate. Larval stages in particular are impacted by increasing salinity.

Proper diffusion mixing of discharge waters can help to alleviate some of the impact of salinity, although over time there is concern of the cumulative impacts of increasing salinity from desalinisation as well as from climate change.

Dissolve Oxygen

Since the amount of dissolved oxygen is inversely proportional to the salinity level, increasing levels of salinity through brine discharge can result in hypoxia, a serious condition which results from low levels of dissolved oxygen and can cause serious harm to the aquatic organisms.

The solubility of oxygen reduces with increased temperature as well as increased salinity, so hot concentrated brine can be very damaging in this regard. The addition of oxygen consuming anti-corrosion chemicals can also further reduce dissolved oxygen.

Miscellaneous Impacts

Biocides, anti-scaling agents and antifoaming agents, *etc.* contained within discharged brine can lead to chronic toxicity and small-scale alterations to community structure in marine environments, particularly for corals.

REFERENCES

AGEDI. (2016). Final Technical: Regional Desalination and Climate Change. LNRCCP. CCRG/IO.

Jones, E., Qadira, M., van Vliet, M.T.H., Smakhtin, V., Kangac, S. (2019). The state of desalination and brine production: A global outlook. Science of The Total Environment Volume 657, 20 March 2019, Pages 1343-1356.

Global Construction Trends https://idadesal.org/dynamic-growth-for-desalination-and-water-reuse-in-2019/.