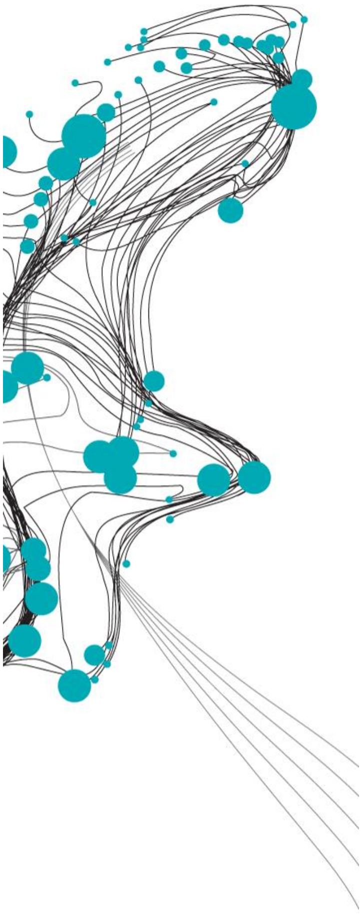

Impact of Desalination and Climate Change on Salinity in the Arabian Gulf.

In the Gulf region, growth of population and wealth are expected to continue for the coming decades. This will contribute to the future demand for fresh water, which can't be met with the limited amount of runoff water in the arid region. The operational capacity of desalination of seawater from the Arabian Gulf is expanding at an increasing rate, to meet the increasing fresh water demand. Desalination extracts fresh water and feeds salty brine water back into the Arabian Gulf. The impact of large increase in desalination capacity, combined with the impact of climate change on salinities in the Arabian Gulf is the focus of this research.

Numerical experiments were conducted to identify the combined future impact of increasing desalination capacity and climate change on salinity in the Arabian Gulf. Increased atmospheric temperatures (accompanied with oceanic temperature rise) and desalination capacity were found to have little effect on the Gulf-wide salinity, see Table 1. Locally, at shallow and sheltered locations, salinity increases of more than one PSU were found. Figures 1 and 2 show scatterplots salinity deviations due to desalination capacity increase and climate change at locations of economic and ecological importance. In general the Figures show that extreme salinities tend to become more extreme due to desalination capacity increase and climate change, while the same climate and desalination scenarios cause salinity drops at specific locations.

Seasonal salinity extremes increase with typically double the year averaged salinity increase. It was found that Indian ocean water temperature is very influential to the exchange rate between the Arabian Gulf and the Gulf of Oman, by affecting the density gradient in the Strait of Hormuz. Weekly variations show light increase. Wind climate dominates evaporation and internal transport patterns in the Arabian Gulf and strongly affects the salinity distribution. Wind velocity increased by 50% provides an increase of evaporation of the same order as evaporation rate increase induced by air temperature rise of 4.5 ^{o}C. The uncertain development of the future wind climate introduces uncertainties in the simulations of future salinity distribution.

Table 1: Simulated results of combined climate change and desalination capacity increase.

Scenario:	Reference (2016)	Extreme 2050	Mild 2050	Extreme 2080	Mild 2080
Evaporation rate [m/year]	*2.03*	*2.38*	*2.20*	*2.58*	*2.20*
Average salinity [PSU]	*41.2*	*41.2*	*41.2*	*41.3*	*41.3*
Relative gross inflow volume [m/year]	-	*6.86*	*2.59*	*11.28*	*3.68*

Felix Dols

Graduation Date:
3 July, 2019

Graduation committee:
University of Twente
Prof. dr. K.M. Wijnberg
Dr. ir. G.H.P. Campmans

Deltares
Ir. R. Morelissen
Ir. R. Hoekstra
Ir. R. Vlijm

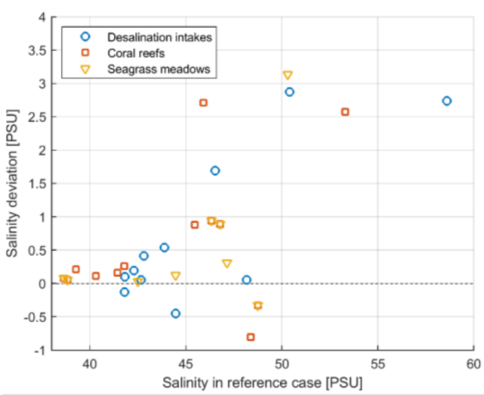

Figure 1: Scatterplot of impact of desalination capacity increase by ten times reference capacity.

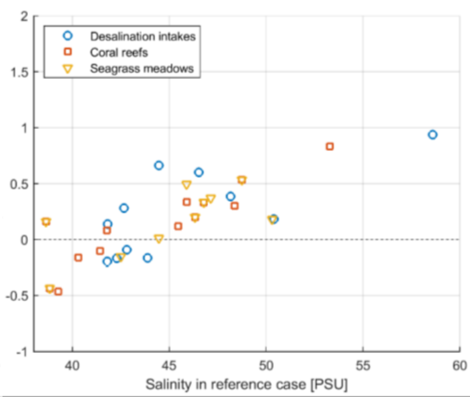

Figure 2: Scatterplot of impact of climate change by 4.5 ^{o}C, relative to the reference case.

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