



KINGDOM OF BAHRAIN

National Oil & Gas Authority



# **NOGA's Initiatives for Efficient Water Management to Enhance Climate Resilience in Bahrain**

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# Overview

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# Introduction

1. Petroleum sector in Bahrain like any petroleum sector in the world. It produce and utilize massive a mount of water without control due to absent of regulation.
2. Bahrain enjoy a unique situation as it oil producing counties as well as highly impacted by to climate change phenomena it small island (SIDS) especially on water resources.

# Methodology

1. Defined the national policy/legislations that regulate the water usage in petroleum sector.
2. Defined the negative impact of climate change in water resources & how petroleum sector can help.
3. Studied the potential sources of water in petroleum sector & best practices
4. Defined NOGA's initiatives to address this problem

# National Policy/Legislations Regulate water Usage in Petroleum Sector

## Outcomes:

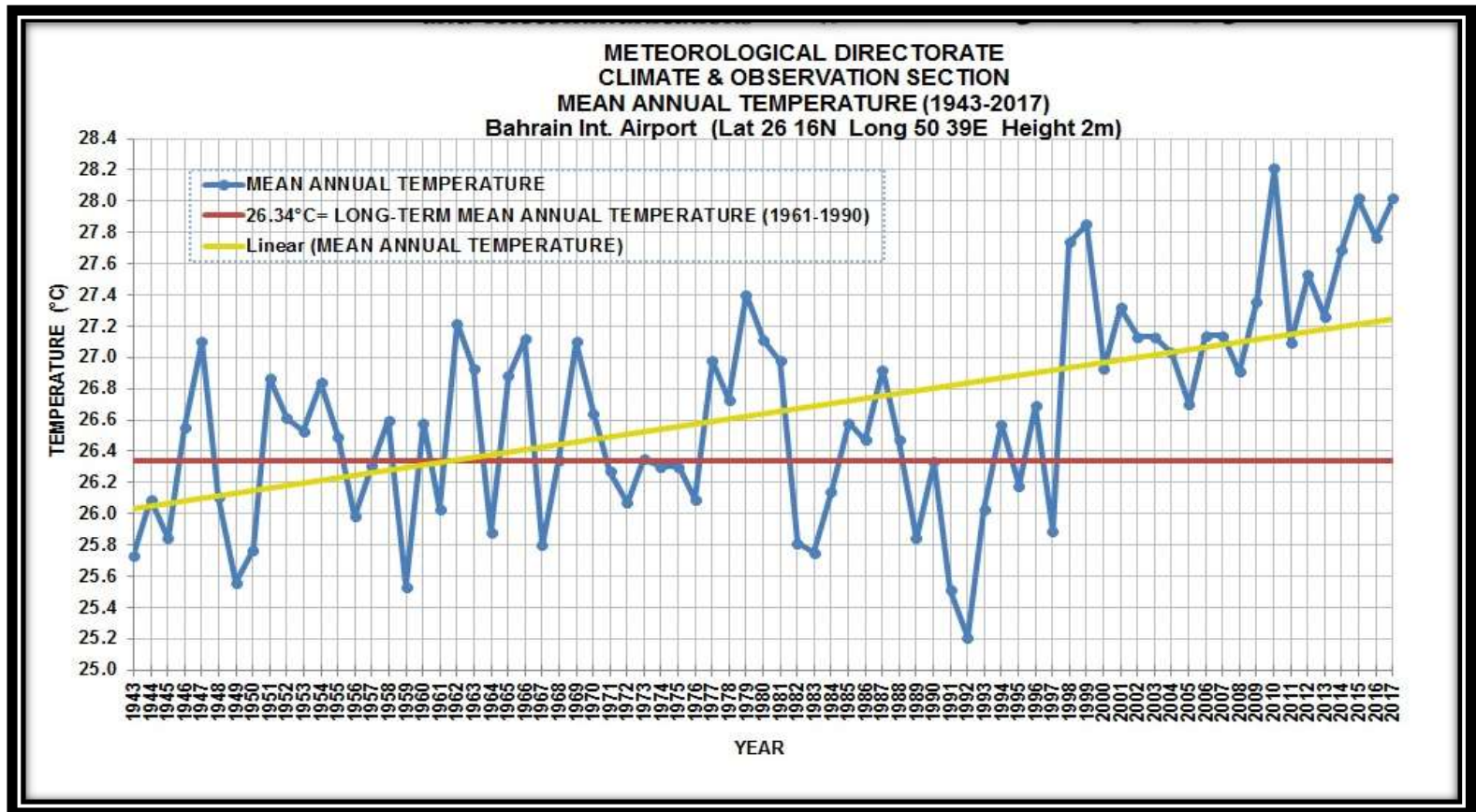
1. NO national policy/legislations regulate the water usage in petroleum sector
2. No incentive or constrains on petroleum companies to rational use water resources

# Negative Impact of Climate Change in Water Resources in Kingdom of Bahrain

## Bahrain Enjoy a Unique Situation



Bahrain and Trinidad and Tobago, are the only SIDS and Oil Producer Counties.



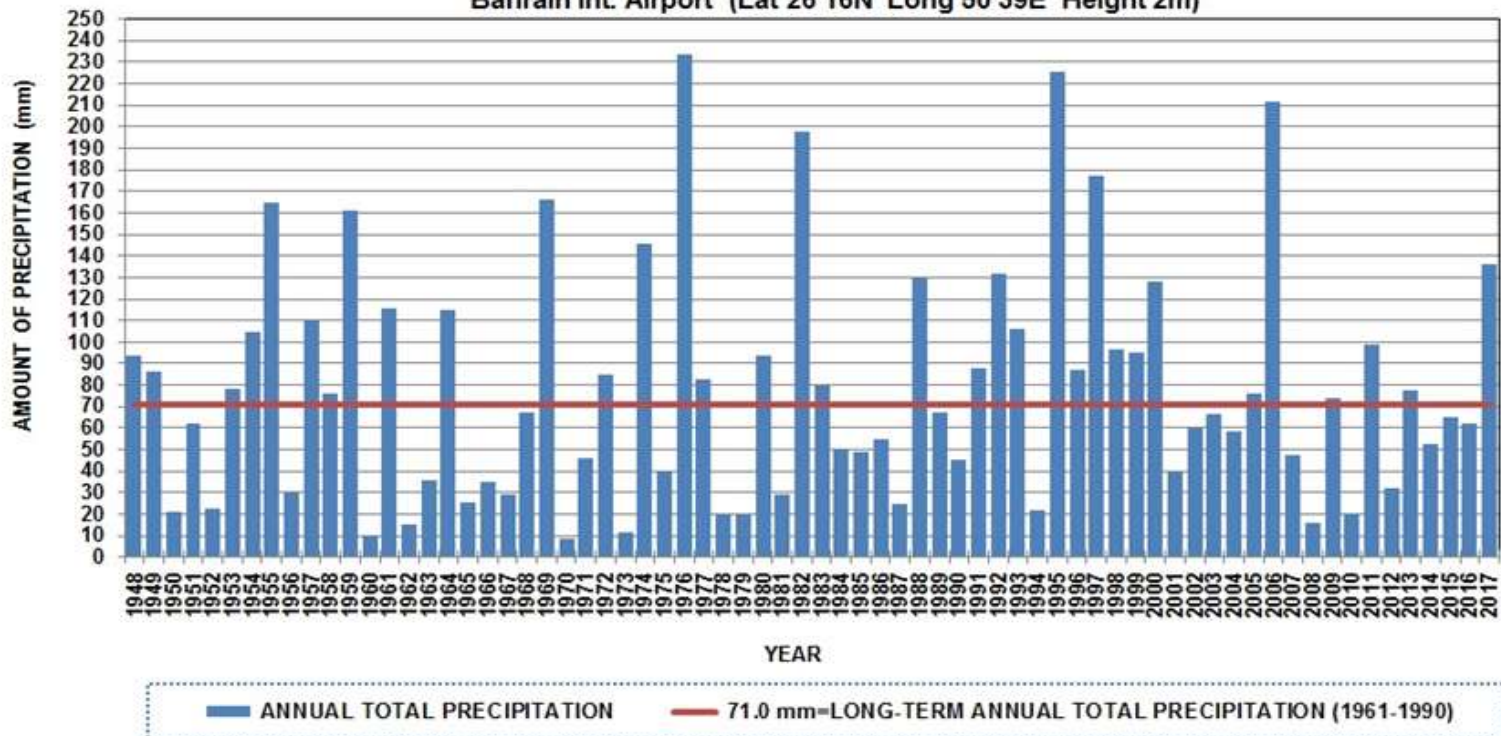
**Climate:**

Over the last six decades, Bahrain has experienced increasing mean, minimum and maximum temperatures. During the period 1943–2016, for example, average air temperatures increased by ~2 °C, with a rate of warming of more than 0.4 °C per decade experienced in the last 20 years



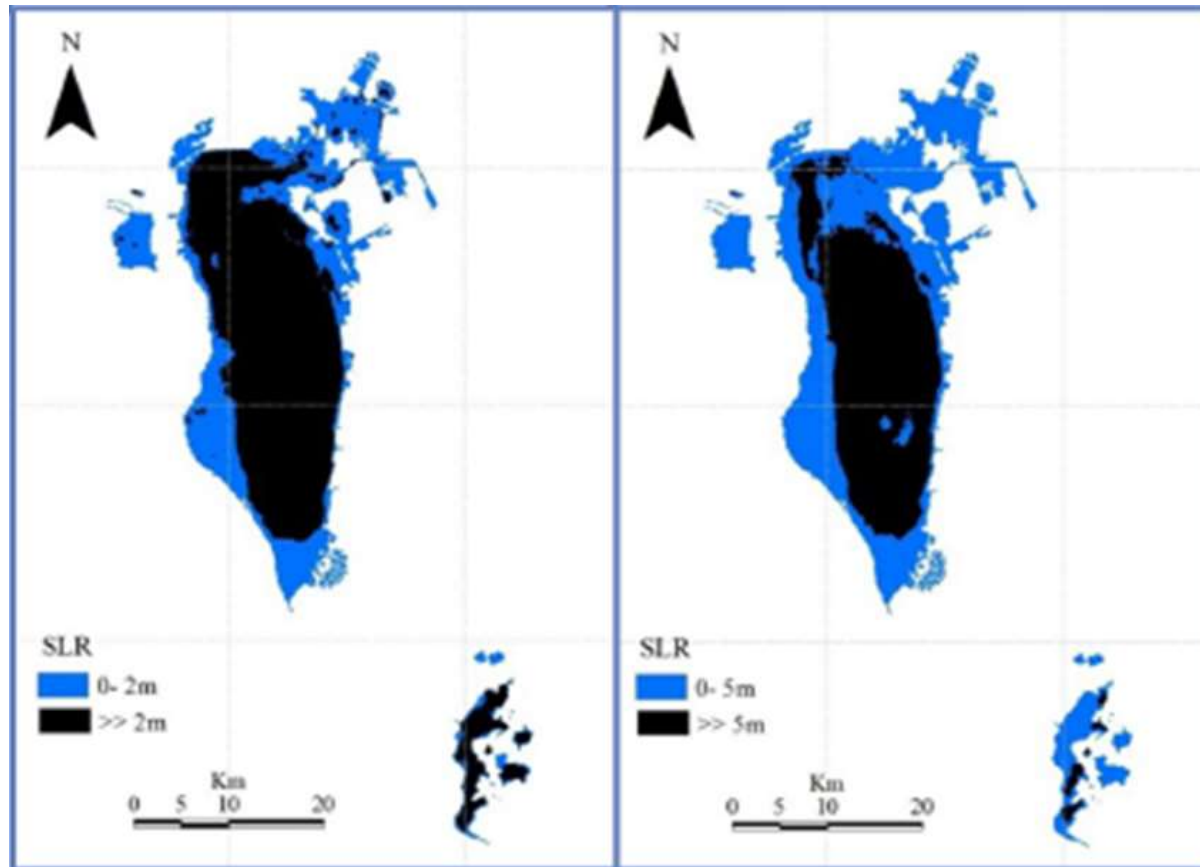


METEOROLOGICAL DIRECTORATE  
 CLIMATE & OBSERVATION SECTION  
 ANNUAL TOTAL PRECEPITATION (1948-2017)  
 Bahrain Int. Airport (Lat 26 16N Long 50 39E Height 2m)





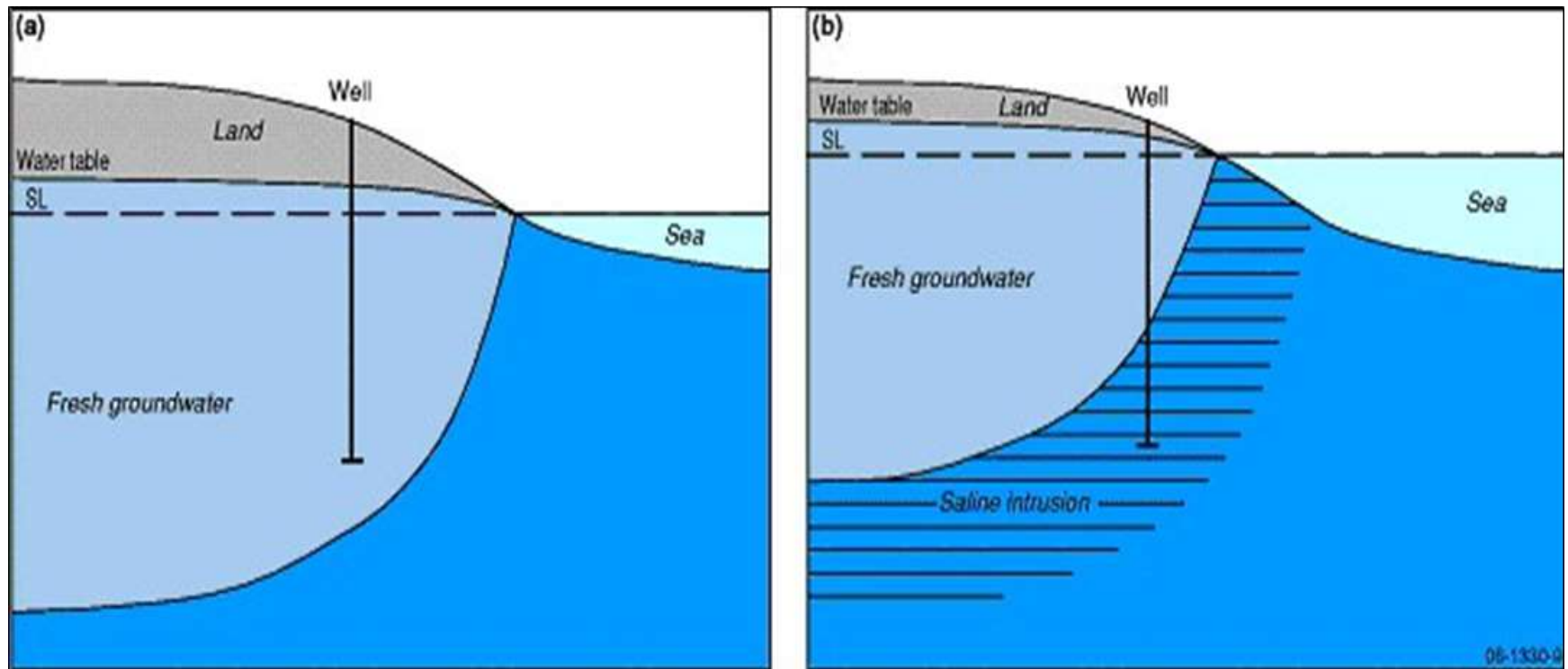
# Predicted Sea-Level Rise in Bahrain under the “No accelerated Deglaciation” and “Extreme Deglaciation Rate” for both 2050 and 2100



Bahrain's Second National  
Communication 2012

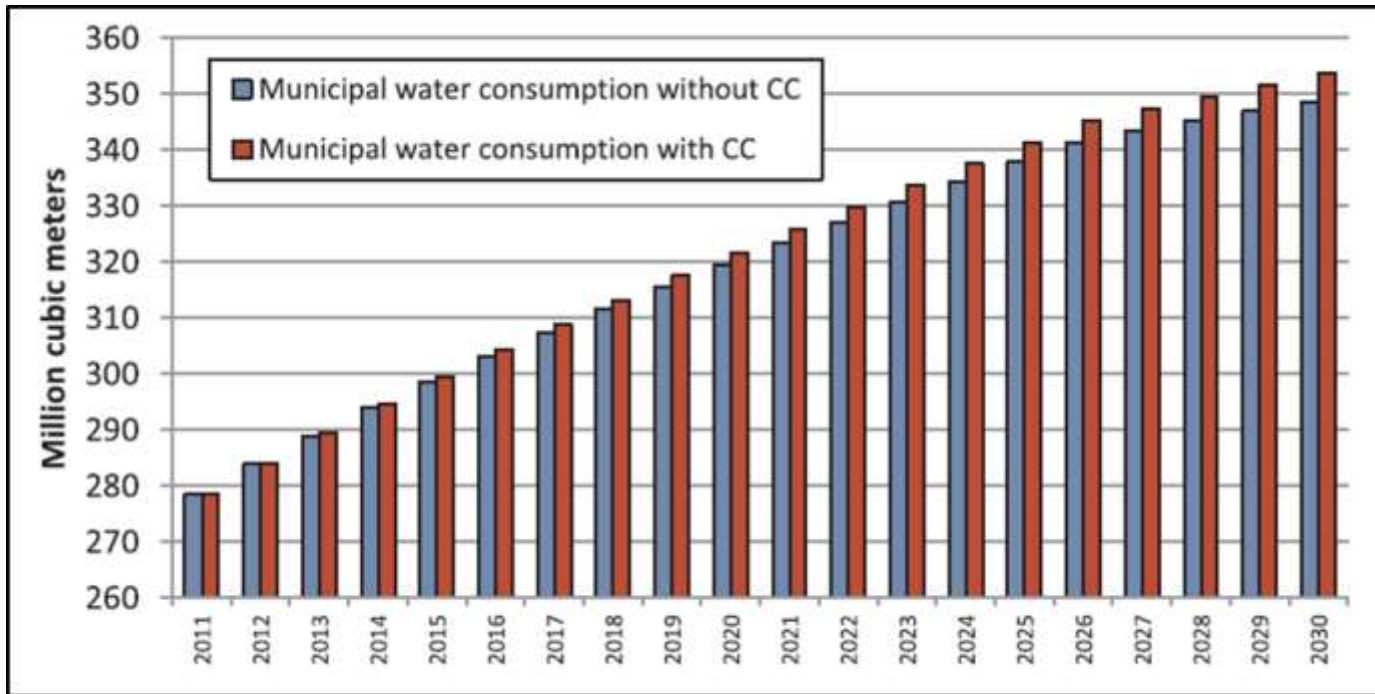
## Reduced Recharge & Saline Intrusion into Aquifers

~11% of Bahrain's land mass would be inundated by a 0.3 m increase in sea-level rise leading to salt water intrusion



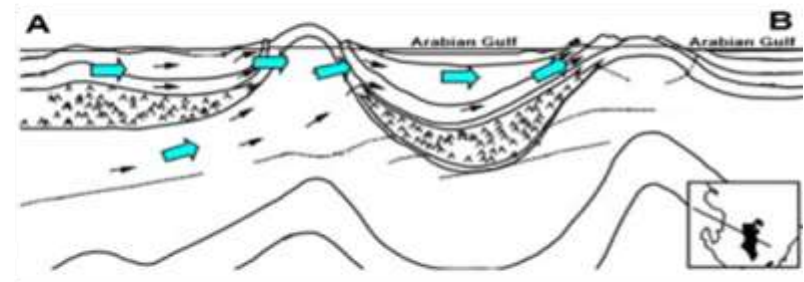
The effect of sea level rise on fresh water aquifers. (a) The baseline situation, where the bottom of a well is in fresh groundwater. (b) The impact of sea level rise, resulting in the bottom of the well being in saline water.

# Increased Water Demand



Al-Zubari, W.K., El-Sadek, A.A., Al-Aradi, M.J. and Al-Mahal, H.A., 2018

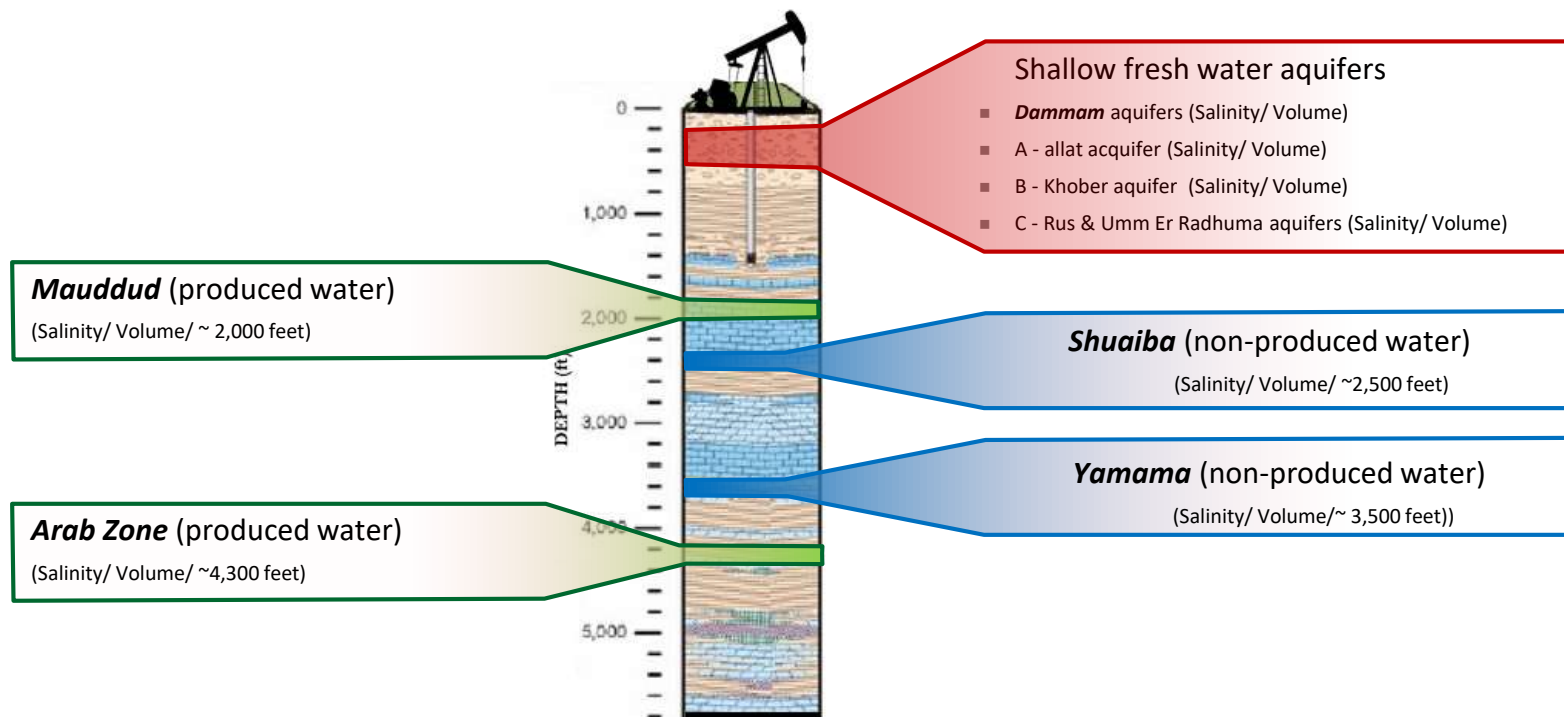
Climate change impacts are expected to reduce Bahrain's freshwater supplies by at least 50 to 100 million m<sup>3</sup> of water per year in the short-term, while water demand in the municipal, industrial and agricultural sectors is expected to rise by ~10 million m<sup>3</sup>/year by 2030





# Potential Source of Water in Petroleum Sector & Best Practices

# Water in Bahrain Field



# Water in Bahrain Petroleum Sector

1. Bapco
  - Sea Water
  - Well Water
  - STP Water
  - Water of Air Conditioning (Awali)
  - Grey Water
2. Banagas
  - Grid Water
  - Well Water
3. Tatweer Company
  - Produced Water
  - Well Water
  - Grid Water
4. GPIC
  - Grid Water



# Defined Opportunities

STP Water

- Planting Mangrove

Water of Air  
Conditioning  
(Awali)

- Agriculture and Planting  
Awali Area

Produced Water

- Multiple Uses

# STP Water

Launching Bapco's Mangrove Model Nursery: 28<sup>th</sup> February 2018



# Water of Air Conditioning (Awali)



- In Awali City, we have 550 houses
- In summer, each house produce 1000 liter water from air conditioning
- Alwali's Engineer has considered a new system for air condition in order to benefit from this water in agriculture.
- We are working on replacing the old system in existing houses with new one to benefit from water

# Produced Water & Possible Use

Drinking Water Supply

Petroleum Industry

GPIC

Refinery

Tatweer (steam injection)

Banagas (Water feed?)

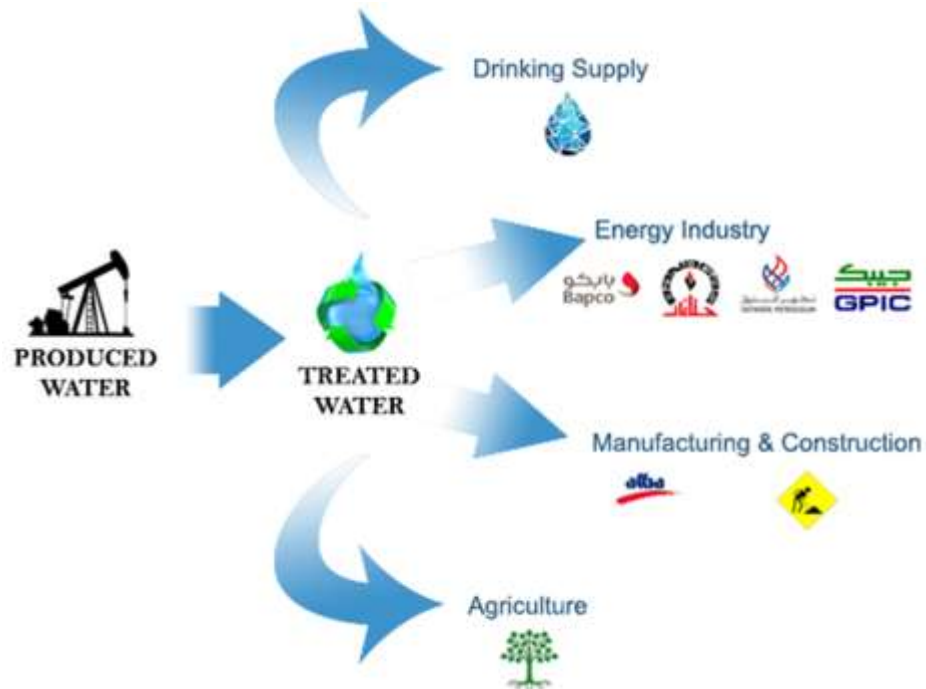
Alba

Coolants?

Construction

Agriculture

Irrigation, livestock, etc.





# NOGA Contracted Wetland Water Treatment Project (Change Treatment Methodology)

- The 110 ha Constructed Wetlands are a natural water treatment system
- This project will help improve the resilience of Bahrain's water sector to climate change by using new innovative technologies to treat ~80,000 m<sup>3</sup> wastewater
- This natural based project will avoid emitting ~100,000 tonnes CO<sub>2</sub>eq per year caused by injection processes of water into deep wells.
- According to biologist and scientist, more than 64 bird species feed or roost in the reed beds; of which at least 13 species breed in this wetlands or around it.

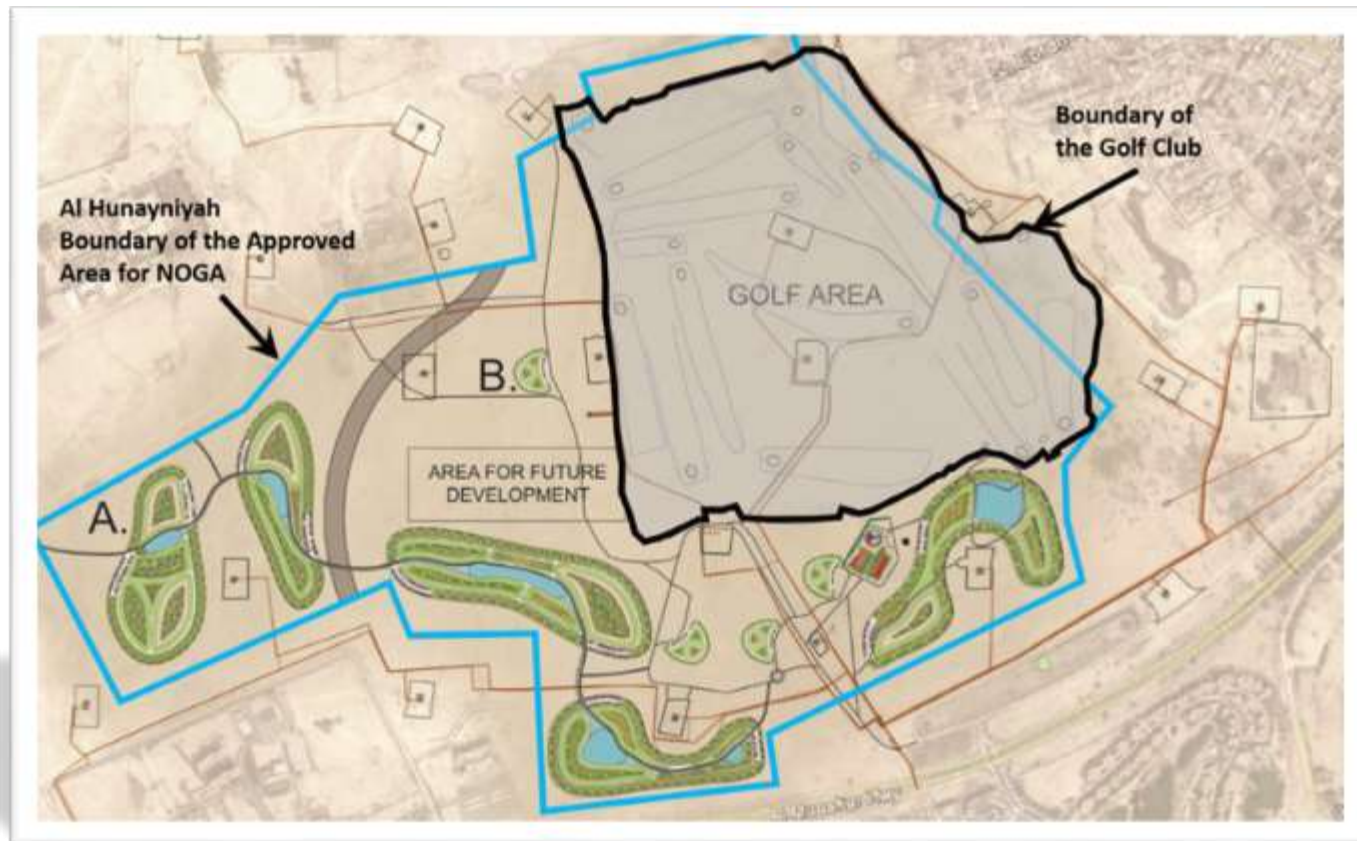
- The wetlands will produce up to 72,000m<sup>3</sup>/ day of treated water that will contain up to 21,000mg/l total dissolved solids & no harmful added chemicals.
- The wetlands will reduce the oil in water (OiW) concentration of the produced water from ~500 ppm to under 5 ppm.
- The treated water will be reinjected to Aquifer C which is a fractured limestone aquifer containing semi-saline water.

# Con't

- The groundwater in Aquifer C is abstracted for drinking water supply by Ras Abu Jajur desalination plant, approximately 11km from the reinjection location.
- Preliminary calculations of travel time have shown that in the worst case scenario water from the reinjection wells will take 19 years to reach RAJ. Dilution, dispersion, adsorption, chemical and biological degradation will act on the oil so that it is attenuated and there is no chance it will reach RAJ



# The Allocated Area for Hunayniya is 4.9 km<sup>2</sup> (Use it for Protected Area)



# Conclusion & Recommendations

1. Petroleum Sector is one of main water supplier & consumer.
2. Climate change become a serious issue for all counties especially SIDS.
3. Petroleum Sector can play a vital role to address the climate change issue & enrich the water resources.
4. Most of water in petroleum sector can treated or uses directly.
5. Natural based solution is the best option to treat the produced water due to the outcome water quality.
6. There is a need for national policy/legislations to regulate the water usage in petroleum sector, this may include some incentives.