

## **Risk Assessment, Remediation, and Sustainable Rehabilitation in Jeddah City, Saudi Arabia**

**Tom Øyvind Jahren** (tom.jahren@ramboll.no), Eivind Dypvik, Aud Helland, and Hanne Vidgren  
(Ramboll, Oslo, Norway)  
Suhair Majdalawi (Ramboll, Abu Dhabi, United Arabian Emirates)  
Richard J. Wenning (Ramboll, Portland ME, USA)  
Victor S. Magar (Ramboll, Chicago, USA)

**Background/Objectives.** Jeddah is an urban city situated in Saudi Arabia, at the East Coast of the Red Sea. In recent years, due to the city's rapid expansion, the amount of waste water and other types of pollution generated from household, industrial, and commercial facilities have seen a significant increase. Untreated waste water discharges to sea and ambient air transport can lead to unacceptable environmental risks, including impacts to fish and wildlife, and adverse effects to human health. This has been especially significant in constricted water bodies which see increasing levels of contaminants (pollutants) and deteriorating environment due to increased biological and chemical oxygen demands (BOD / COD) and low dissolved oxygen (DO), as well as the increased deposit of solids and presence of algae. This has been prominent across three marine lagoons in the Red Sea, in Jeddah – Al Salam, Al Shabab, and Al Arbaeen. As part of the *Saudi Arabian Vision 2030*, the General Authority of Meteorology and Environmental Protection (GAMEP) has initiated a large rehabilitation project to restore the environmental quality of the three lagoons and the surrounding marine environment.

**Approach/Activities.** Ramboll has been hired by GAMEP to conduct a comprehensive study of the environmental status of the project area, culminating in a risk assessment of the environmental state, and to develop a concept design and action plan for remediating the marine environment. Ramboll conducted an environmental risk assessment of the water body and sediments in the Al Arbaeen, Al Salam and Al Shabab lagoons, as well as in areas outside these lagoons, between the Islamic Port of Jeddah and the western tip of the Royal Palace property.

**Results/Lessons Learned.** The findings of the study have revealed unacceptable risks associated with organic and inorganic contaminants and high-BOD/COD waste in the lagoon sediments. Work is being initiated on land, to address ongoing upland sources before remediating contaminated sediments. An action plan is being developed to address the sediment contaminants, to determine whether to remediate contaminated areas via dredging, capping, or other available technologies. This talk will focus on the characterization, risk assessment and remedy planning for marine sediments in Jeddah, Saudi Arabia, and how we have leveraged science. We will focus on lessons learned, planning exercises to educate GAMEP and stakeholders on the science of risk assessment and remedy technologies for contaminated sediments and surface water. We will discuss our experience communicating our understanding of the nature and extent, risk, and remedy alternatives to GAMEP through a series of workshops that form the basis for their decisions on how to meet the goals of *Saudi Arabian Vision 2030*.