Sea Level Activities in the Kingdom of Saudi Arabia

A Report Submitted to Twelfth Session of the Intergovernmental Oceanographic Commission (IOC) Group of Experts of the Global Sea Level Observing System (GLOSS)

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I. Overview:

This report gives a brief overview of the sea level activities in the Kingdom of Saudi Arabia. The first tide gauge deployments were occurred nearly half a century ago. Local and regional efforts to measure water levels are sporadic, except Saudi ARAMCO Oil Company, and have not been linked directly or indirectly against international standards.

Regional organizations, which include the Kingdom of Saudi Arabia, have plans to developed frame work for the conservation and management of the coastal and marine resources of the Arabian (Persian) Gulf and the Red Sea, with little or no interest for monitoring sea level.

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II. Introduction:

Saudi Arabia has a long coastline along its western and eastern borders. The stretch of the coast is about 2572 km out of which 73% is along the Red Sea and the remaining 27% is along the Arabian (Persian) Gulf (Figure 1). Over the last few decades the Kingdom of Saudi Arabia has made parallel progress in programs for socio–economic development, more than 50% of the population of Saudi Arabia lives within 100 km of the Saudi coastline.

Modern studies of climate change have identified the mean sea level as an important indicator of change and of the associated processes. Different studies require and recommend a well distributed global sea level network and proper international collaboration in defining observational standards, data collection and processing.

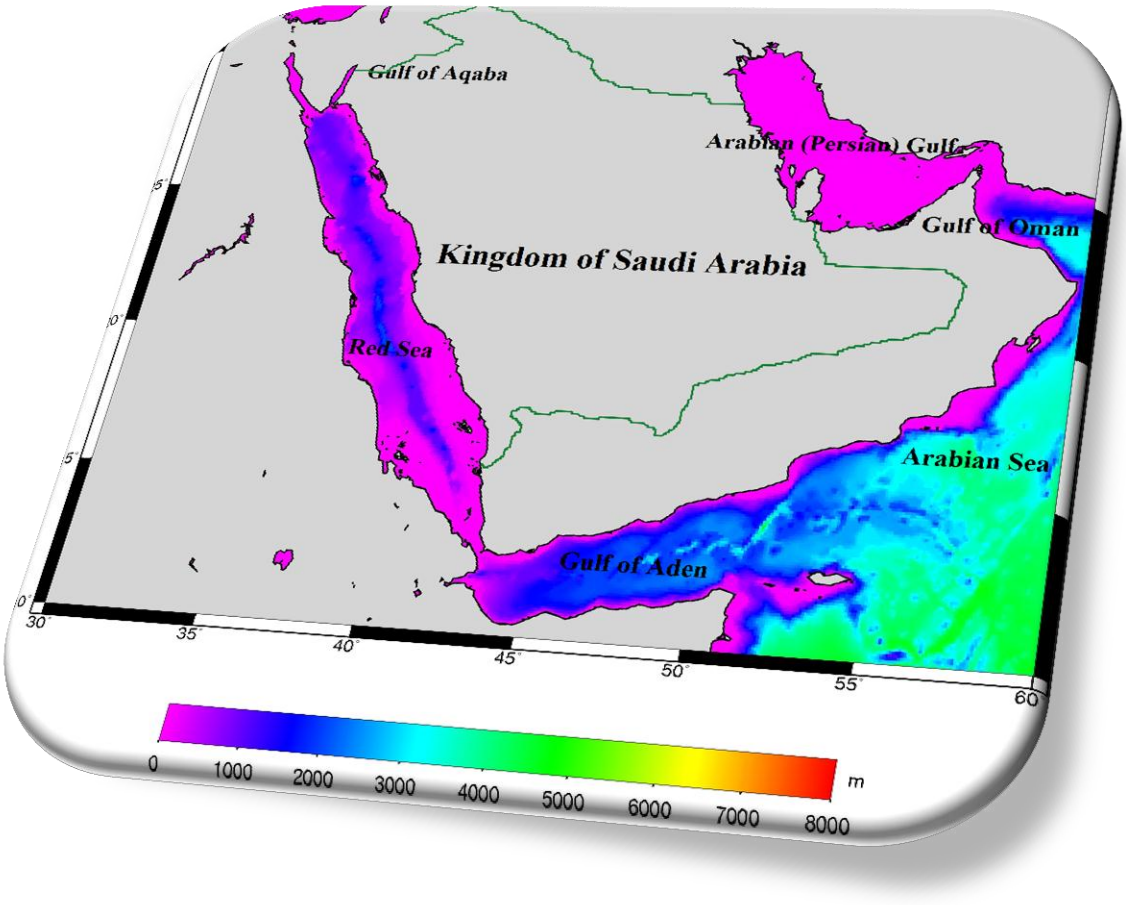

Fig. 1: A map showing the Red Sea, Arabian (Persian) Gulf and Gulf of Aqaba surrounding the Kingdom of Saudi Arabia.

III. Tide Gauges along the Coast of Saudi Arabia; Past and Present:

The Pacific Aero Survey Company (PASCO) installed the first tide gauges in the Kingdom nearly half a century ago. Saudi ARAMCO Oil Company has the major effort for monitoring the sea level in the Kingdom and the data output is presented in periodical tide tables. Presidency of Meteorology and Environment (PME) has provided a sporadic monthly mean sea level data. Two universities in the Kingdom are planning to monitor the sea level along the Red Sea. General Commission of Survey (GCS) has laid a comprehensive plan to establish tide gauges network to monitor the sea level.

Regional organizations such as the Protection of the Marine Environment of the Arabian Gulf (ROPME) and the regional organization for the conservation of the environment of the Red Sea and Gulf of Aden (PERSGA) have plans to develop frame work for the conservation and management of the coastal and marine resources of the Arabian (Persian) Gulf and the Red Sea respectively.

In this section an overview history of sea level measurement activities will be described in more detail below:-

1) The Pacific Aero Survey Company (PASCO):

In the spring of 1960, The Pacific Aero Survey Company (PASCO) installed four tide gauges in the Red Sea at Alwajh, Yanbu, Jeddah and Jazan and two in the Arabian Gulf at Manifah and Ras Tannura. These tide gauges were operated only for one year; from 1st of April 1969 to March 1970 (PASCO, 1970). FUESS Tide Gauges LFT-III floating devices fitted in stilling well were used and the movements of the float with time were documented on a chart.

2) Saudi ARAMCO Oil Company:

ARAMCO Oil Company has a continuous monitoring monthly means of sea level in the Kingdom and provided to the permanent commission for mean sea level (PSMSL). The company has been operating 12 tide gauges in the Arabian Gulf at Quarriyah, Ras Tanura, Juaymah, Abu Safah, Abu Ali, Arabiyah Island, Lawnah, Tanajib, Marjan, Safaniya Pier, Zuluf, Safaniyah (ARAMCO, 2008a and 2008b). Five of these twelve have been operational since 1980, while the

rest of the stations were operated since mid-eighties. After 1993, the float type tide gauges were replaced with acoustic tide gauges in GLOSS standard (Sammari, 2004).

In the 1998, ARAMCO operated 5 primary tide gauges along the Red Sea at Jeddah, Rabigh, Yanbo, Jazan and Duba. These tide gauges are British brand tide gauges (Sonar Research Ltd), data at Red Sea stations are transmitted in real-time to Ras Tannura office, where they are archived and processed (Sammari, 2004).

3) Presidency of Meteorology and Environment (PME):

Meteorological and Environmental Protection Agency (MEPA) is now called Presidency of Meteorology and Environment (PME); installed four tide gauges using Sutron 9000 with Aquatrak acoustic sensors and telephone modems for data retrieval for only one year from 1992 to 1993 at Haql, Alwajh, Jeddah and Jazan along the coast of Red Sea. The data were transmitted to the PSMSL (IOC 2002). The MEPA/PME sites are coincident almost with the ARAMCO sites (General Directorate of Military Survey, 2008).

Unfortunately, the tide gauge at Jeddah station had been removed due to construction at the Coastguard and the gauge at Alwajh Coastguard harbor was in bad shape and needed more attention. By April of 2000, the tide gauges at Jazan Sea Port and Haql Coastguard station were still in operation but had non-operational telephone lines for data retrieval according to Sammari, 2004.

4) General Commission of Survey (GCS):

General Commission of Survey (GCS) has placed a broad plan to establish tide gauges network to monitor the sea level in the Red Sea and the Arabian (Persian) Gulf (Table 1) and (Figure 2). Six stations will be deployed along the Red Sea and one station in the Gulf of Aqaba. Five locations are selected in the east coast of the Kingdom along the Arabian (Persian) Gulf. Ultrasonic acoustic tide gauges without sounding tubes were recommended for the twelve locations at the three basins. A future data center is recommended in the plan.

Site Name	Long			Lat		
Jazan	42°	34´	39”	16°	56´	36”
Qunfuthah	41	4	20	19	7	20
Jeddah	39	9	8	21	32	29
Yanbu	38	4	7	24	6	43
Alwajh	36	31	15	26	14	15
Duba	35	43	36	27	19	49
Magana, Gulf of Aqaba	34	45	57	28	27	27
Safaniya-Ras Meshaab	48	44	29	27	58	27
Ras Aghaar	49	11	51	27	30	16
Rhema	50	2	28	26	40	21
Aloqyar	50	18	29	25	32	23
Ras Aboqamis	24	26	49	51	19	4

Table 1: Twelve (12) site names and approximate locations (after Moammar and Chaudhry, 2010).

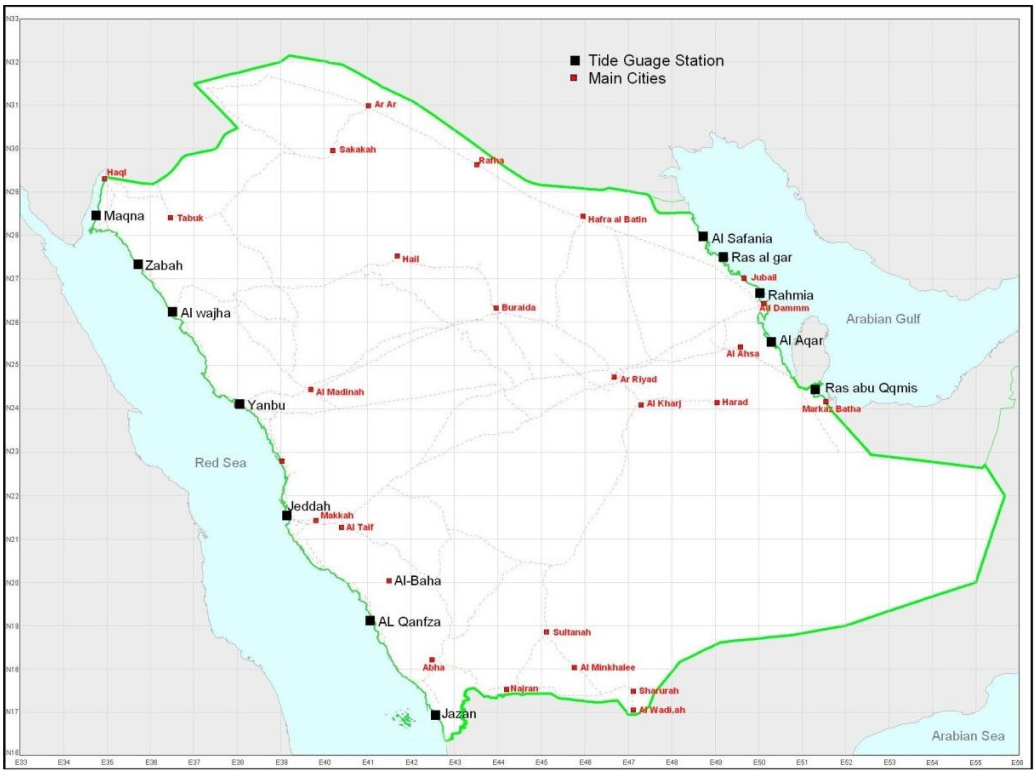

Fig. 2: A map showing the GCS proposed locations for the tide gauges network to monitor the sea level in the Red Sea, the Arabian (Persian) Gulf and Gulf of Aqaba(after Moammar and Chaudhry, 2010).

5) Saudi Universities:

The Faculty of Marine Science at King Abdulaziz University (KAU) in Jeddah has formed an intensive cooperation with the Research and Technology Centre of the University of Kiel (FTZ Büsum, CAU); one of the subprojects is the development and application of a Coastal Monitoring System (CMS) for Jeddah coastal areas. By April 2011, three separately ultrasonic acoustic tide gauges with meteorological sensors were installed at the Coast Guard Stations of Obhur (northern side of Jeddah), Gahaz (Jeddah) and Saroom (southern side of Jeddah) for monitoring of water levels and winds were completed (Figure 3). Data from the three stations is currently being transferred and is available in real time both in Jeddah and Kiel. A future plan to deploy two more tide gauges at Jazan and Duba are currently under discussion (Mayerle and Al-Subhi, 2011).

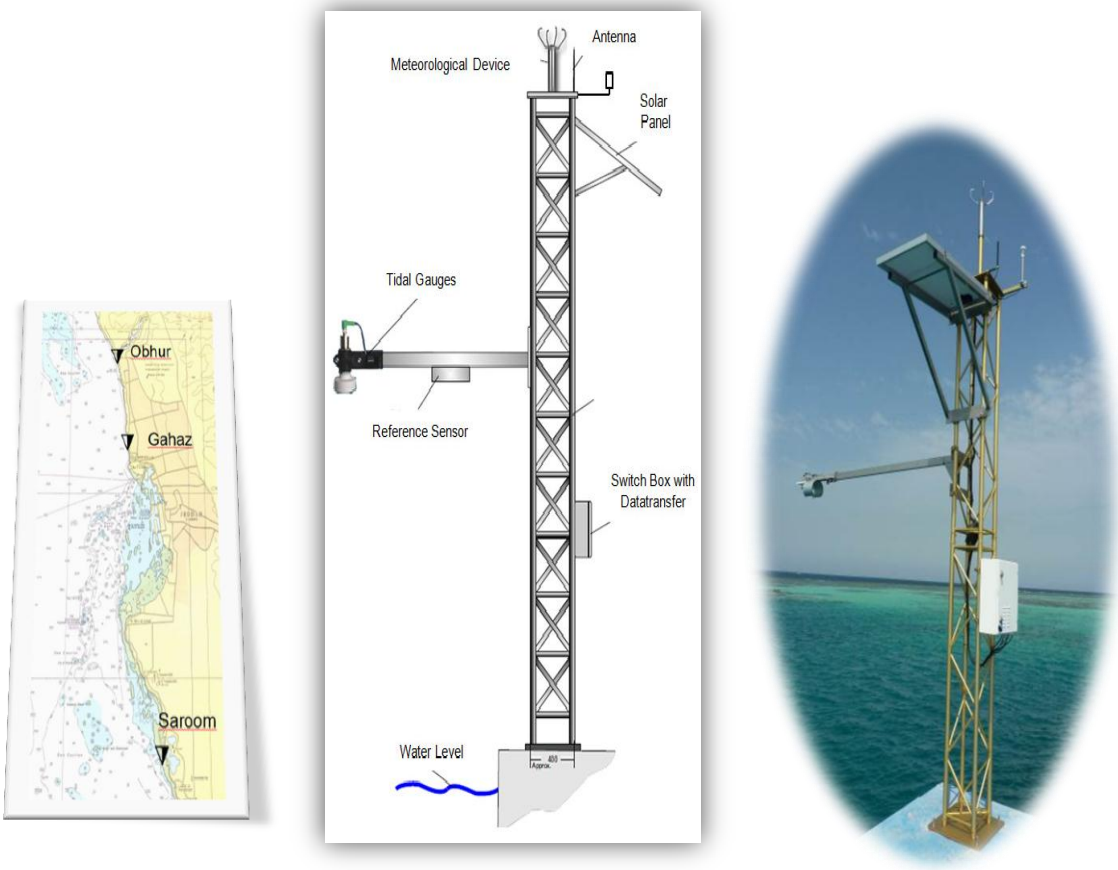

Fig. 3: Location of the tide gauge stations; Obhur (northern side of Jeddah), Gahaz (Jeddah) and Saroom (southern side of Jeddah) (left), technical details (centre) and tidal gauge at the Saroom Coast Guard (right) (After Mayerle and Al-Subhi, 2011).

King Abdullah University of Science and Technology (KAUST) in Thuwal, which established on September 2011 and is located ~100km north of Jeddah, had an initial plan to observe the sea level in the Red Sea. However, since there are several activities by other local groups, this plan was changed and a communications were launched with these groups to exchange the benefits.

6) Regional Organizations for the Protection of the Marine Environment of the Arabian (PERSIAN) Gulf (ROPME):

Regional convention was held at Kuwait in 1978, which included the surrounding eight countries: Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates. An action plan for the region was adopted covering activities related to, oil pollution, industrial waste, sewage and marine resources. The member countries are dedicated to the conservation of the marine environment of the Arabian (Persian) Gulf; in 1979 the regional organization for the protection of the Marine Environment (ROPME) was established. No actual plan was set for monitoring sea level.

7) Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA):

This is an intergovernmental organization working to conserve the coastal and marine environments in the region, which include the surrounding seven countries: Saudi Arabia, Yemen, Djibouti, Sudan, Somalia, Egypt and Jordan. The PERSGA headquarter is located at Jeddah (Saudi Arabia). The organization is implementing the strategic action program (SAP) for the Red Sea and Gulf of Aden, the plan was prepared based on regional environmental issues and has been permitted by the PERSGA Council of Ministers. PERSGA took the initiative during the execution of the SAP to consider the importance of conserving regional habitats and biodiversity.

In 1998, PERSGA has provided a tide gauge (SML-2B) and was installed by a British expert at the Harbor of Sudan, disappointingly was never functional despite a second visit in 2000. It appears that a manufacturing fault is at the origin of this breakdown (Sammari, 2004).

Recently, PERSGA has no tangible plan for sea level network in the Red Sea and Gulf of Aden.

IV. Data Quality:

Data quality depends on the leveling process and calibration; these procedures are used in ARAMCO stations beside the quality control. Periodicals prints made by ARAMCO, which including tidal tables are prepared based on these data and they are accessible upon request. However Tide Gauge Bench Marks (TGBMs) are not connected to a geodetic datum, calibration and leveling operations are carried out regularly and the time series from the stations are analyzed (Harmonic analysis and tide forecasts); data outputs are exclusively used for safe navigation (Moammar and Chaudhry, 2010).

General Commission of Survey (GCS) is proposing to follow the major requirements for GLOSS-quality tide gauge station (IOC, 1997). Data collections are in accordance to the standards set by International Council for the Exploration of the Sea (ICES).

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