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**Re-establishment of Geodetic Networks at General Commission for Survey
Saudi Arabia**


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Outline

- Introduction
- General Commission for Survey
- History of Geodetic Networks in the Kingdom of Saudi Arabia
- Re-establishing the National Vertical Geodetic Network
- National Tide Gauge Network
- National Gravity Control Network
- KSA Continuously Operating Reference Stations Network
- Conclusion

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Kingdom of Saudi Arabia

- Situated: in the southwest of Asia
- Bordered with Jordan (745 km), Iraq (812 km), Kuwait (222 km), Qatar (86 km), UAE (686 km), Oman (657 km), and Yemen (1327 km).
- Area of 2 million sq. km



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General Commission for Survey (GCS)

- Established in 2006.
- GCS vision is to be the benchmark national organization for survey, mapping, charting, geographic information and hydrographic survey in the Kingdom of Saudi Arabia.
- The Geodetic & Land Survey department's mission is to develop and maintain an accurate and seamless Saudi Arabian National Spatial Reference System, and provide access to it for use in all survey and mapping activities over the of the Kingdom.
- GCS aims to re establish, maintain, monitor and control the National Geodetic Reference Systems, The National Vertical Geodetic Networks, The National Tide Gauge Network and conduct National Earth Gravity Network measurements as needed in the Kingdom of Saudi Arabia.



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History of Geodetic Networks in the Kingdom of Saudi Arabia

Earliest Geodetic Survey started back in the 1930s during the 1st oil exploration by Aramco.

First gravity base stations were reported to be established in late 1950s.

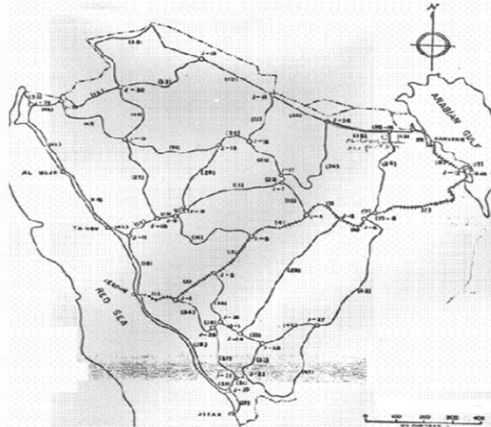
First Geodetic Leveling Network of the Kingdom was established between 1966 and 1971

number of benchmarks : 2,668.

Length of the network: 14,954 km.

Established: Along the major high ways.

Currently, 85% of the network is destroyed.



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Re-establishing the National Vertical Geodetic Network

- GCS is re-establishing the Geodetic Leveling Network in four phases with Second Order/Class I (NGS) accuracy , keeping the quality and density of the original network suitable to serve as the basic reference for future developments within the Kingdom of Saudi Arabia.
- The first three phases has been observed, corrected and adjusted. The fourth phases is presently on-going.
- This network will be used to define a new vertical datum for the Kingdom of Saudi Arabia.



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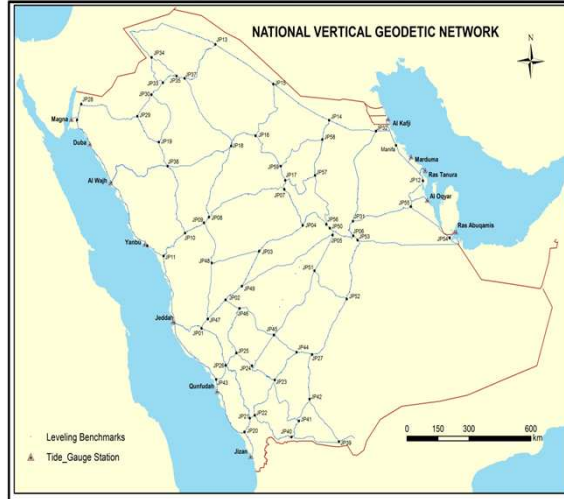




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- **Features of the Vertical Geodetic network include:**
 - Method used to establish the Network: **Precise Geodetic Leveling**
 - Accuracy: **2nd Order/Class 1**
 - number of benchmarks established: **3,552**
 - Length of the network: **20,443 km**
 - distance between the benchmarks: **<6 km**
 - number of lines: **87**
 - **All lines are double run.**
 - Completed: **14,900 km of the 20,443 km**
(Preliminary corrections & adjustment completed)



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National Tide Gauge Network

- **GCS established a network of 12 acoustic wave Tide Gauges in 2011.**
 - 7 sites along the Red Sea
 - 5 sites along the Arabian Gulf
- **Four tidal benchmarks installed in the vicinity of each tide gauge to measure its stability.**
- **1st Order Class 2 precise levelling was used to level the tidal benchmarks.**



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12 Tide Gauge Stations across the Kingdom

- The tide gauge comprises of the following features
 - Accuracy: ≤ 1 cm.
 - Data transmission: **In Real-Time.**
 - Recording interval: **1 minute.**



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National Gravity Control Network

- The gravity network establishment at GCS was defined in two phases
 - **Absolute Gravity Network:** completed
 - **Relative Gravity Network:** on-going project
- **KSA Absolute Gravity Network (KSA-AGN)**
 - Network consists of **41 sites** distributed across the kingdom
 - Each site comprises of two stations; an **indoor** and an **outdoor station**
 - **Both stations** were occupied by **A10 gravimeter** (accuracy: $< \pm 10 \mu\text{Gal}$)
 - **7 of the sites** were collocated by **FG5 gravimeter** (accuracy $< \pm 3 \mu\text{Gal}$).
 - 2 CG5 gravimeters were used for measurement of vertical gradients at both inside and outside stations and to tie them at each site.



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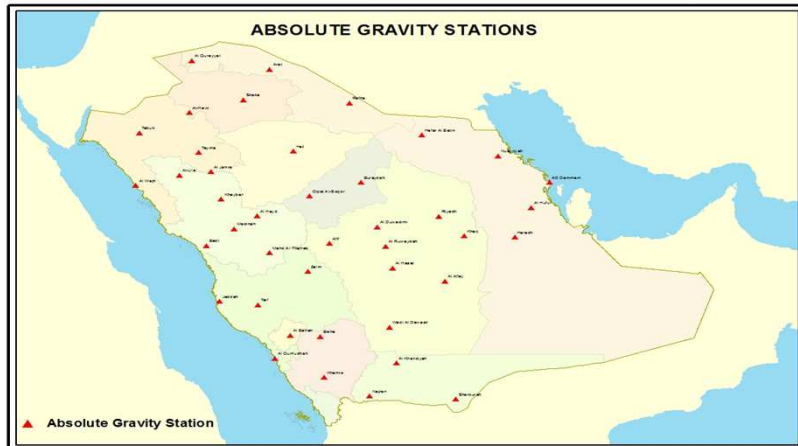




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41 Absolute Gravity Network



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Result from Absolute Gravity Network

- **FG5 and A10 absolute gravity values are coincident at the inside stations while their differences at the outside stations need further study.**
- **The total uncertainties of about ± 2 and ± 6 μGal obtained at the FG5 and A10 stations, respectively, are enough to provide the gravity standard (gravity datum) and scale (calibration) for gravity surveys in the kingdom. A10 tie differences, having minimum -1.96 μGal and maximum 1.03 μGal , indicate slight site dependence.**
- **Considering provided total uncertainty at the sites, the KSA-AGN can be classified as the first-order/class 2.**



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Relative Gravity Network

- Established in order to enable the accurate determination of the geoid surface and to support satellite data providers with elevations and gravity values.
- This project is confined to establish a well standardized and scaled gravity network which serves to satisfy the requirements of Geodetic Level Network, geoid computation and unification of gravity data available in the kingdom.
- The project is divided into 3 phases:
 - Gravity Calibration Baseline .
 - Primary Gravity Network.
 - Vertical Network.



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KSA Continuously Operating Reference Stations Network (KSA CORS)

- GCS is currently deploying a network of 426 Continuously Operating Reference Stations (CORS) across the Kingdom of Saudi Arabia.
- The primary goal of establishing KSA CORS:
 - To define, deploy and maintain the KSA Reference Frame (KSAREF)
 - To provide the Kingdom with wide range of positioning services simultaneously to the user community with access to KSAREF
 - Access to RINEX files from the CORS sites
 - Network Real-Time Kinematic (NRTK)- cm level accuracy at densely populated areas
 - Real Time Network Differential GNSS, decimeter accuracy level at any location within the kingdom



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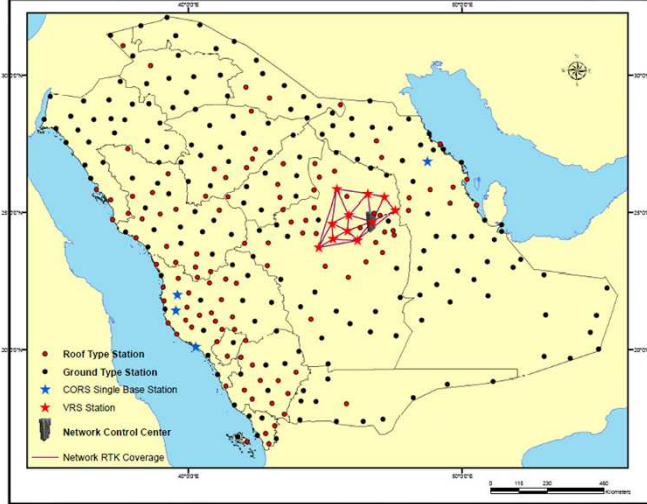


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KSA CORS Coverage Map

- The 15 presently active stations transfer data to the main server where all data are stored, processed in various ways and distributed as needed.
- Recently, a Network RTK was established with a network of 11 active reference stations around AR-Riyadh province.
- Generated corrections are calculated for where the roving receiver is thereby referencing to a Virtual station.
- Network RTK will not be confined to Riyadh alone, it will cover major cities across the KSA as the project progresses.



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Conclusions

- GCS aims to re establish, maintain, monitor and control the national geodetic reference systems, the national vertical geodetic networks, the national tide gauge network and to conduct national earth gravity network measurements as needed in the Kingdom of Saudi Arabia.
- Completed Projects
 - Establishment of an Absolute Gravity Network.
 - Establishment of 12 National Tide Gauge network.
- On-Going Projects
 - Re-establishment of a new vertical geodetic network (86% completed).
 - Establishment of Relative Gravity and the Observations of the Gravity Calibration Baseline.
 - Establishment of a new network of Continuously Operating Reference Stations.
- Future Projects
 - Airborne Gravity measurements within the Kingdom of Saudi Arabia.
 - Establish GPS leveling observation to an improved regional geoid model over the Kingdom with an accuracy better than 5cm.



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THANK YOU FOR YOUR TIME!

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