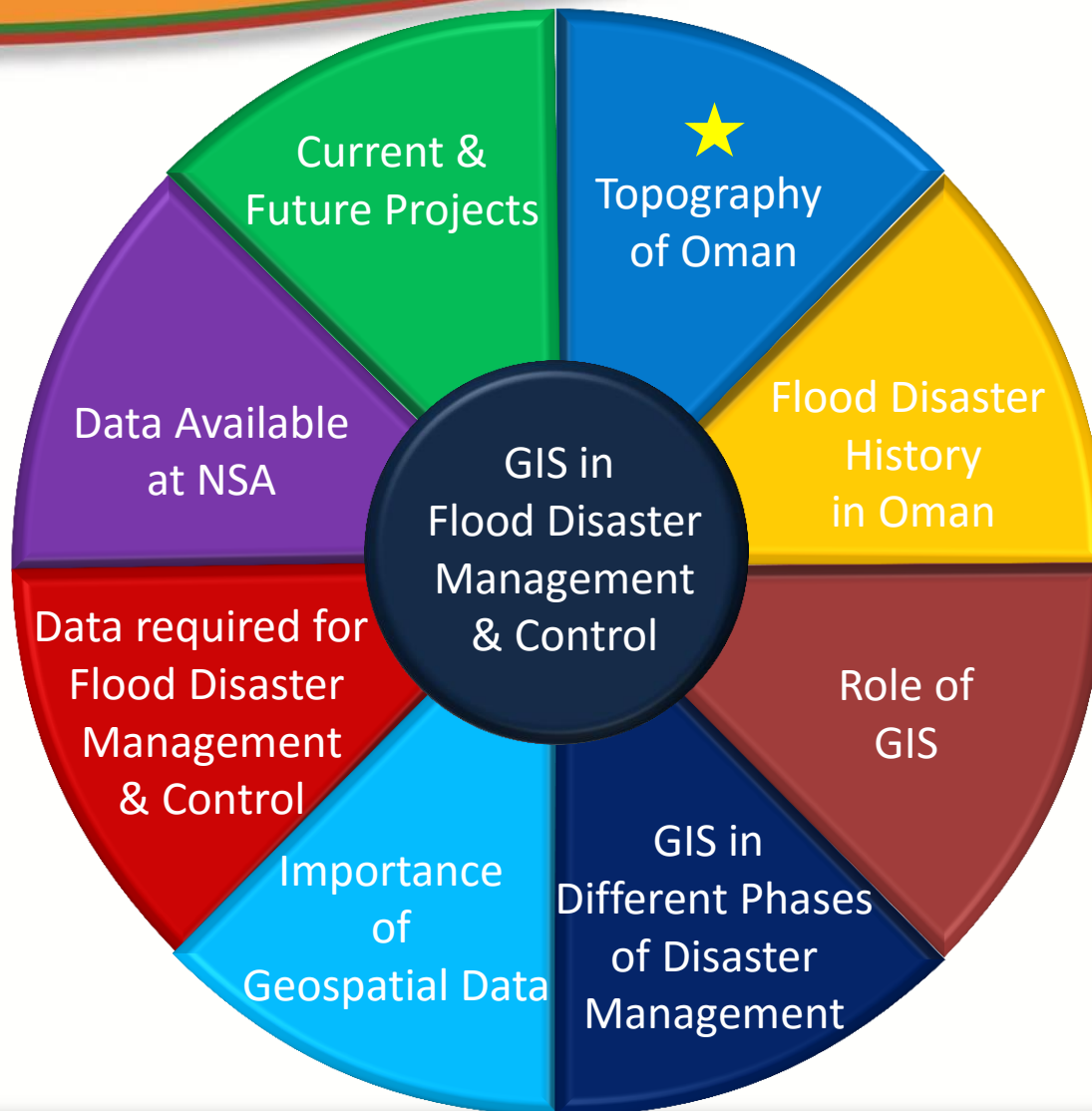




Sultanate of Oman  
Ministry of Defence  
National Survey Authority

# Role of GIS in Flood Disaster Management & Control and Geospatial Data in NSA

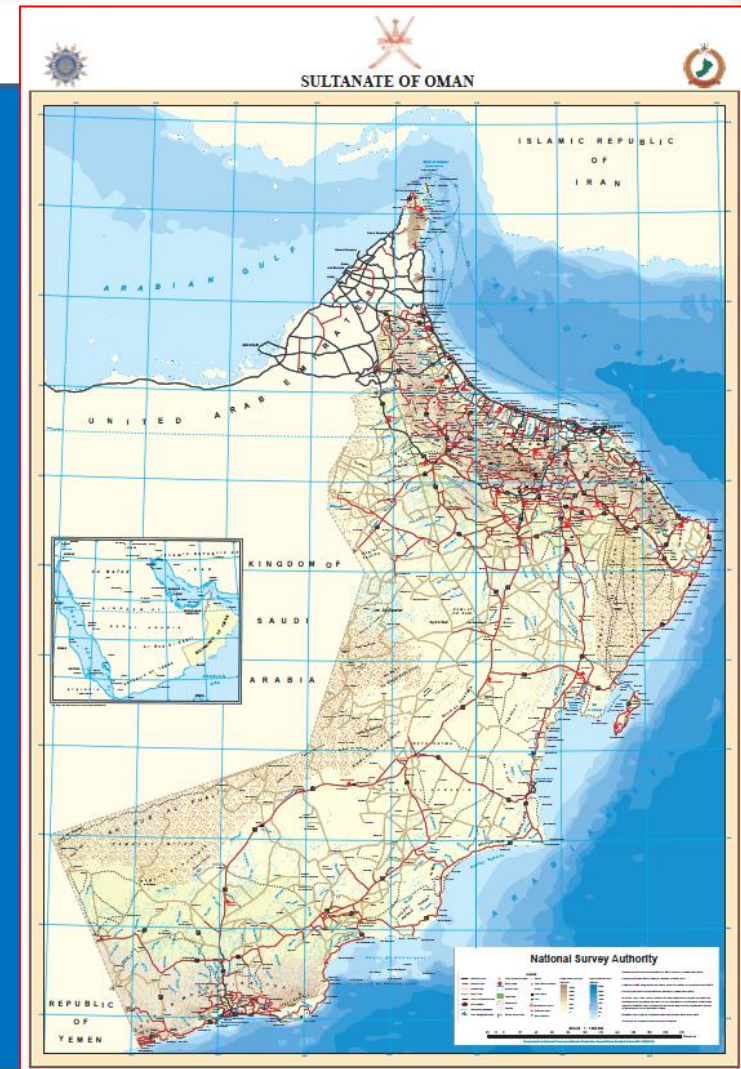
**Amol G. Deshmukh**  
**Geomatics Specialist**

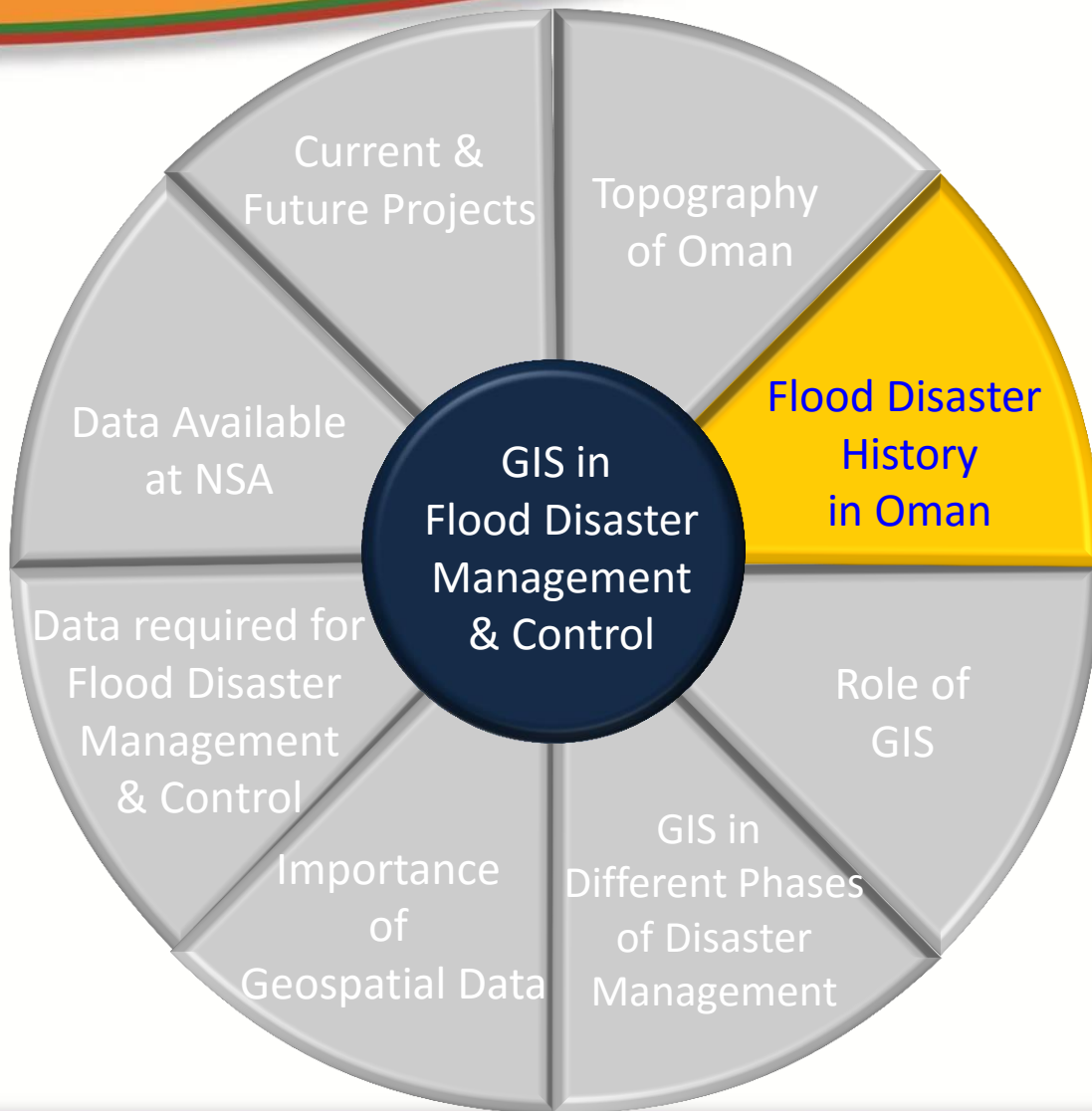






- Located in the SE Corner of Arabian Peninsula
- Total Geographic Area of 310K SqKm (Approx.)
- 15% Mountains, 85% Desert & dry river beds
- Overlooks 3 Major water bodies – Arabian Gulf, Sea of Oman, Arabian Sea
- Approx. Coastal line of 3165 Kms
- Mountains are steep & rocky, allows less infiltration thus causing high runoff and flash floods







## History of Tropical Cyclones causing torrential rains leading to flash floods

- Major countrywide flood in 1977, killing 105 people and affecting 5000
- Salalah floods in 2003, claimed 30 lives
- Cyclone Gonu in 2007, first National Level Disaster
- Cyclone Phet in 2010, killing 24 people and affecting 10000 others

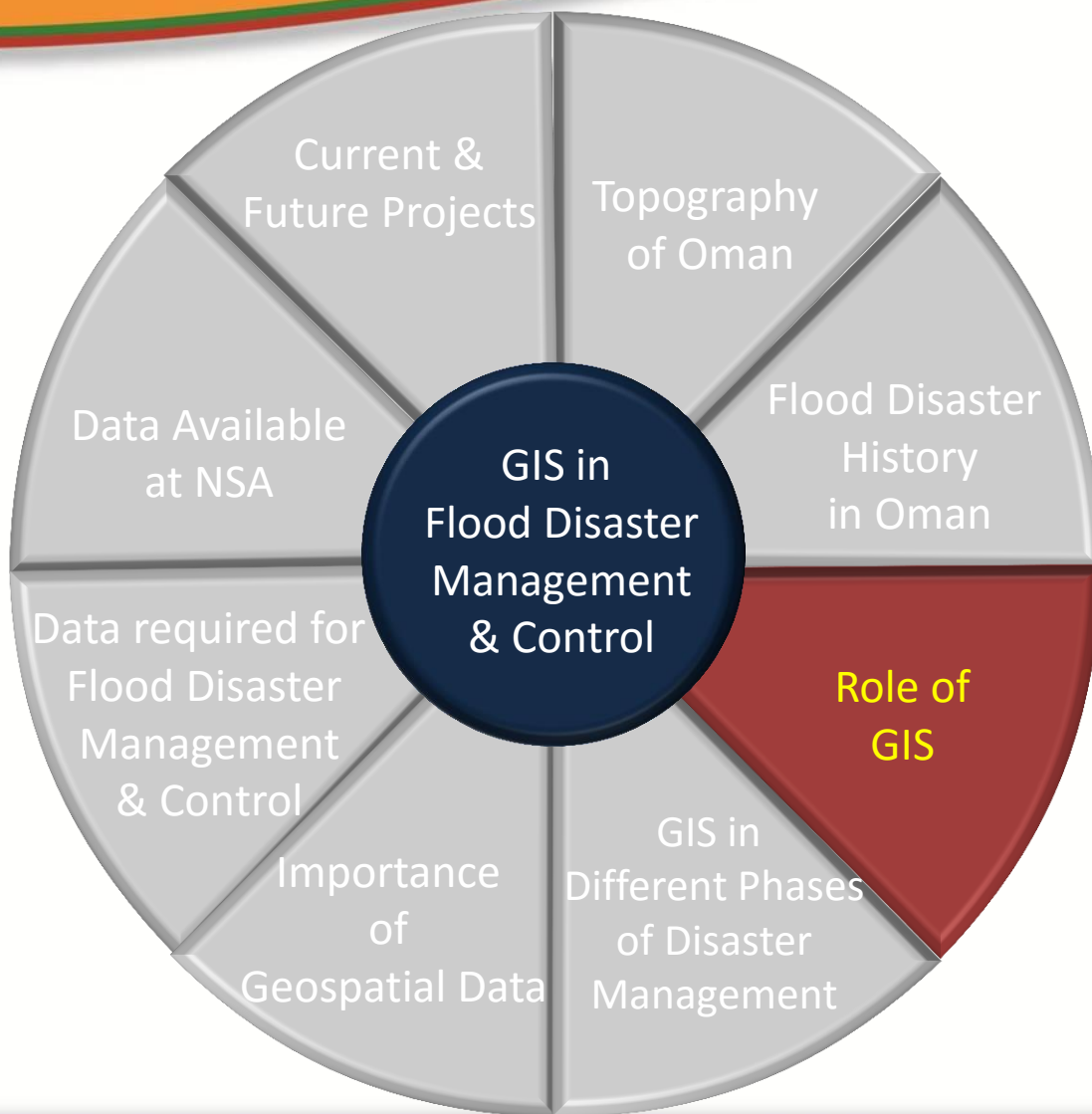
## Reasons for Flash Floods

- Topography of the area
- Poor Drainage system
- Unplanned infrastructure

## Effects of Flash Floods

- Loss of life (avg 70/yr), Infrastructure, electricity & water disruption







GIS effectively stores and retrieves magnanimous amount of spatial and attribute data

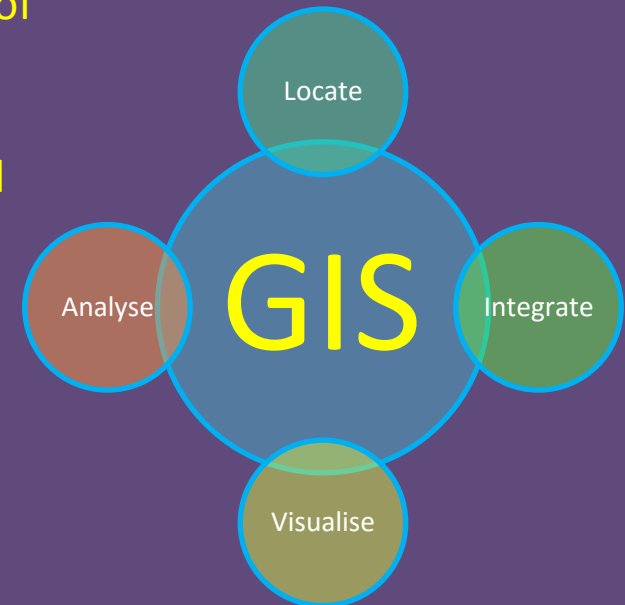
GIS enables effective planning and management of infrastructure

GIS Integrates data from various sources for flood management

Spatial Analysis allows to identify high & low risk areas for damage

Visualisation of terrain in 3D

Create What-if scenarios to analyze trends and phenomenon based on time related data







## GIS in Water Utility Mapping/Management

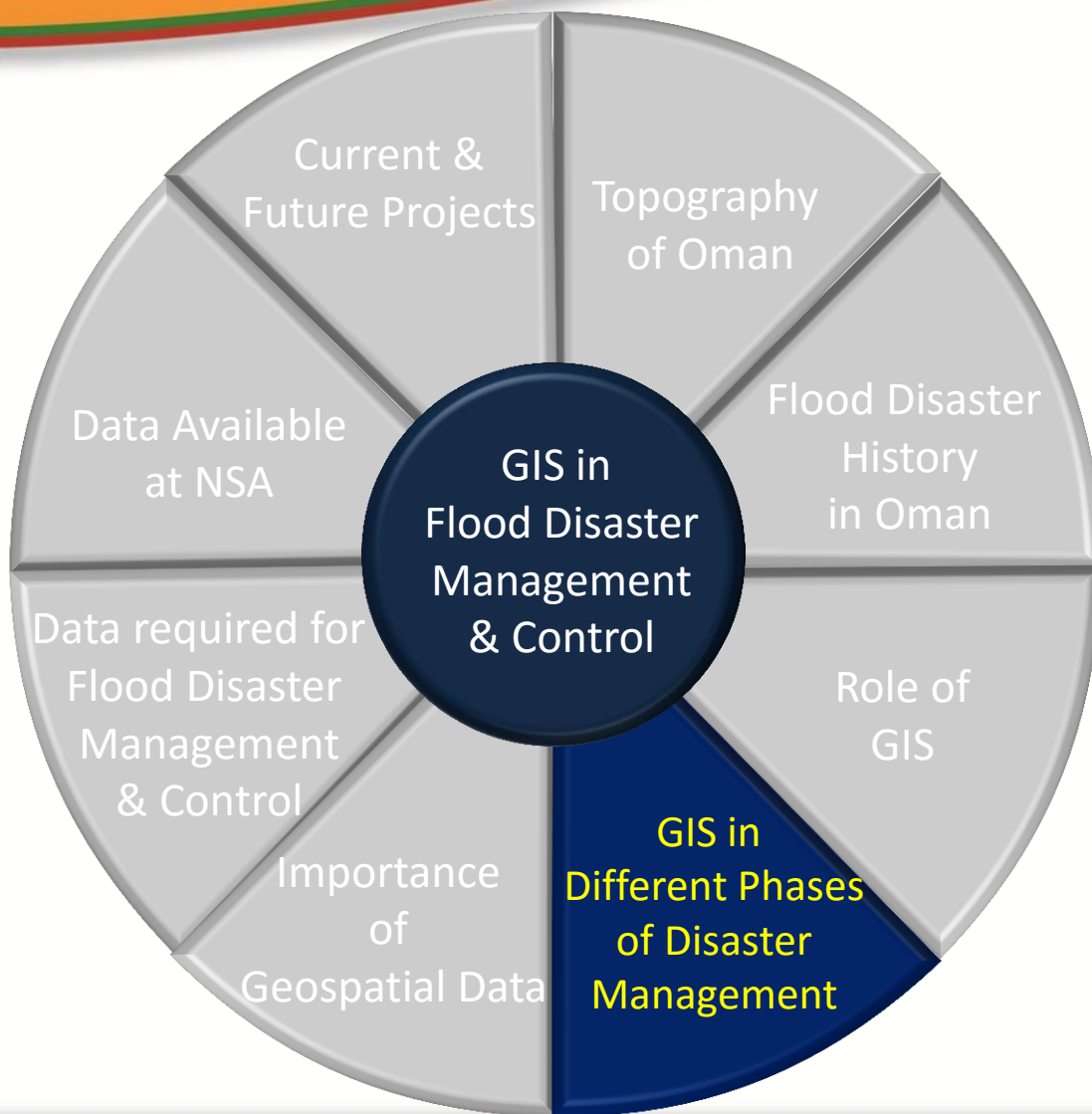
- Utilities are laid geographically over large areas
- GIS supports asset survey, mapping and database creation, Improved decision making, better tracking and managing assets
- GIS offers a collective platform to access data, update utility network information, incorporate work orders, find customer information and prepare reports
- AM/FM Technology  
Graphical Component & Database Component



Khoula Hospital

Al Nahdha Hospital







## Planning

- Using a GIS, hazards can be spatially identified and consequences can be evaluated to assess potential emergencies or disasters



- Visualizing the hazards with the data of roads, pipelines, buildings, residential areas, power and communication infrastructure etc. helps officials to formulate mitigation, preparedness, response, and possible recovery plans as well as to create awareness among the citizens.
- GIS facilitates an effective emergency management by providing a platform for thorough analysis and planning, and also by allowing the agencies to view the various scenarios generated by combinations of spatial data.



## Mitigation



- As potential disasters are identified, mitigation measures can be planned and prioritized.
- Utilizing existing socioeconomic and other databases linked to geographic features, help in identifying the variations in vulnerability of the affected region and in planning of the mitigation measures accordingly.



## Preparedness

ARE YOU  
PREPARED?

- GIS can help locating emergency infrastructure like firefighting stations, fire hydrants, hospitals etc. in minimum response time.
- GIS can be used for integration of satellite data with other relevant data in the design of disaster warning systems and to display real-time monitoring of climatic and other conditions for early warning.
- GIS can also be used for the planning of evacuation routes, design of emergency operation centers etc.



## Relief



- GIS in combination with Global Positioning System is extremely useful in search and rescue operations in the devastated areas where it is difficult to locate.
- GIS also supports planning for the relocating requirements and logistics for emergency supply chain management.
- GIS can also model the event in order to warn people and position public safety resources for immediate deployment.
- GIS is also used to analyze vulnerable populations for secondary health effects from a disaster, implementing preventive treatments, and positioning medical teams and medical supplies in locations to optimize preventive treatments.



## Rehabilitation



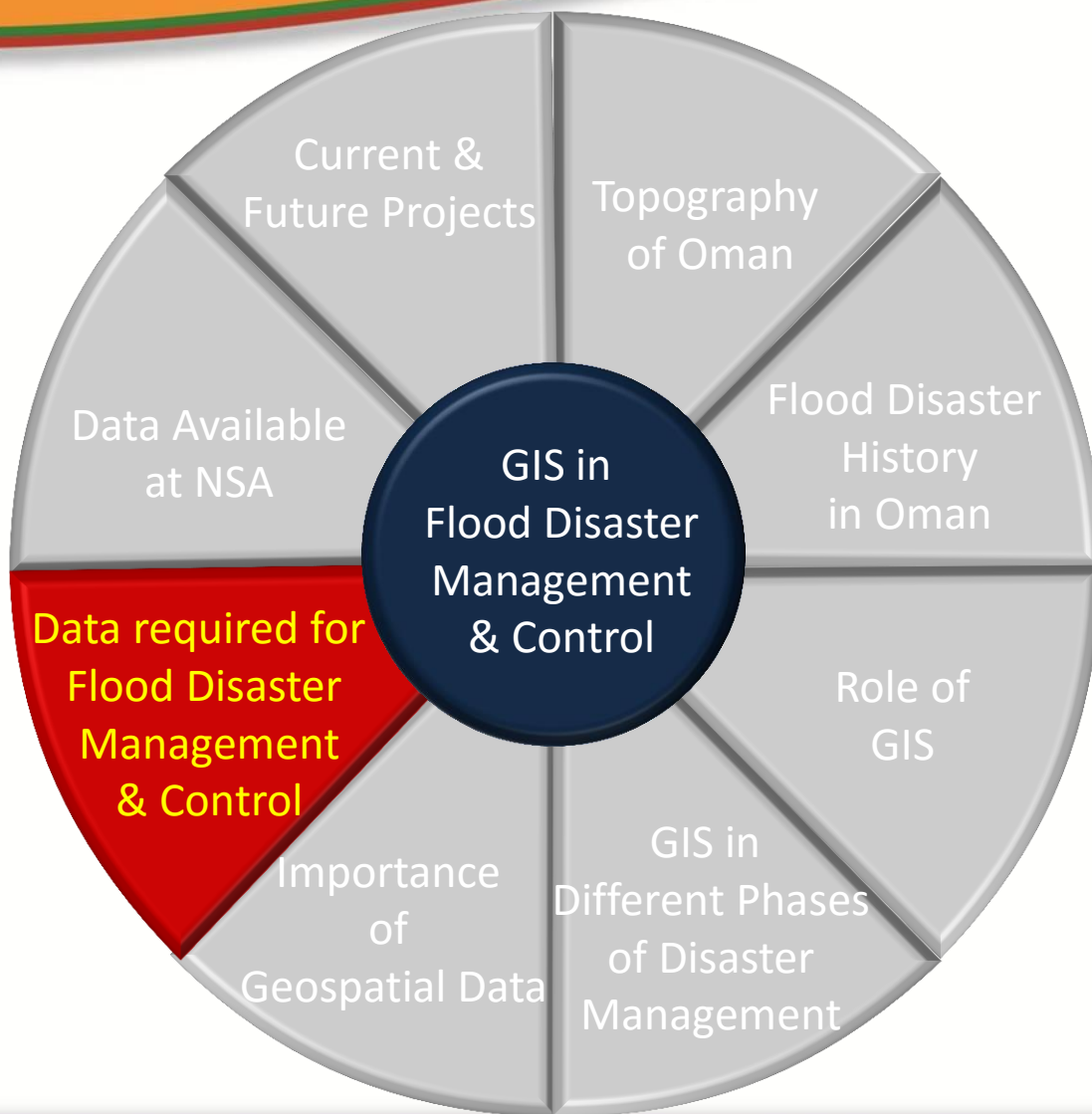
- In the disaster rehabilitation phase, the damage caused can be assessed using satellite imageries.
- Customized applications can be developed on GIS to calculate the damage
- GIS is also used to organize the damage information and the post disaster information, and in the evaluation of sites for reconstruction, compensation etc.

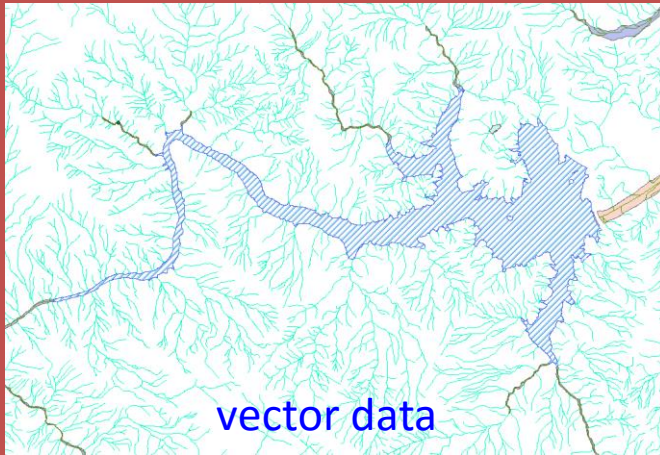




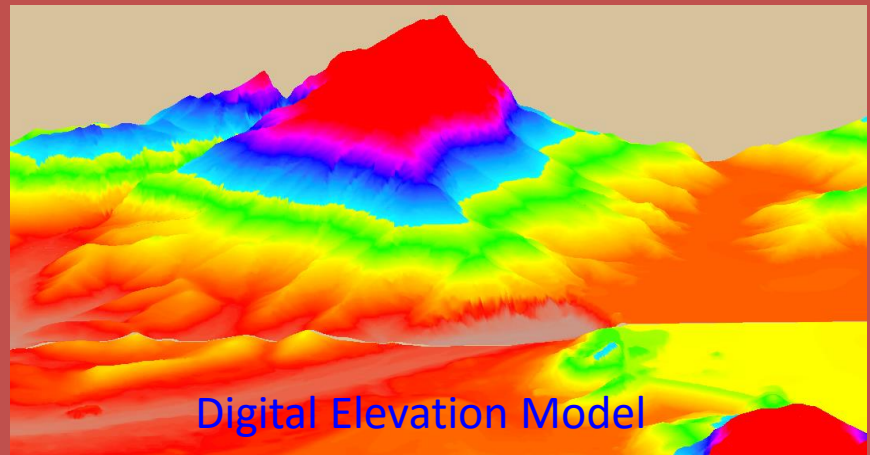


- Soil, Landuse and Topographic data provides the basis for determining how much runoff we can expect (ex: SCS-CN Method)
- Digital Elevation Models (DEM) is used to study the elevation and slope pattern
- Remotely sensed data can be used to study the landuse pattern and identify the changes in the area





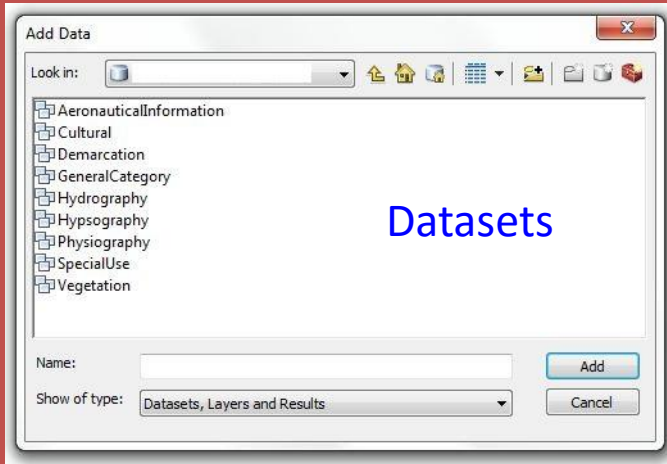
vector data



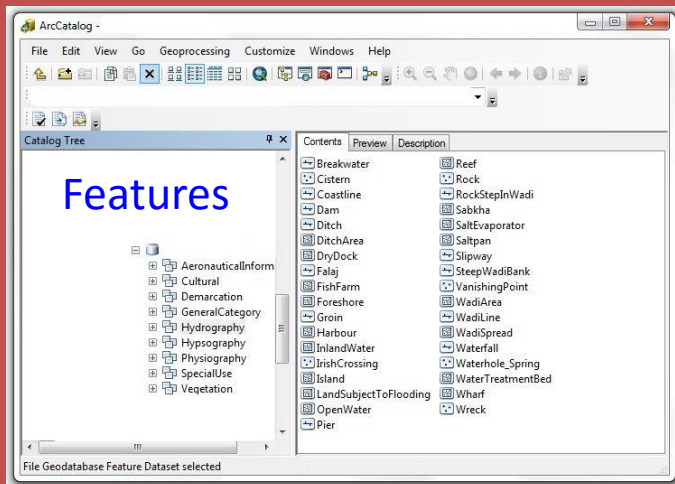
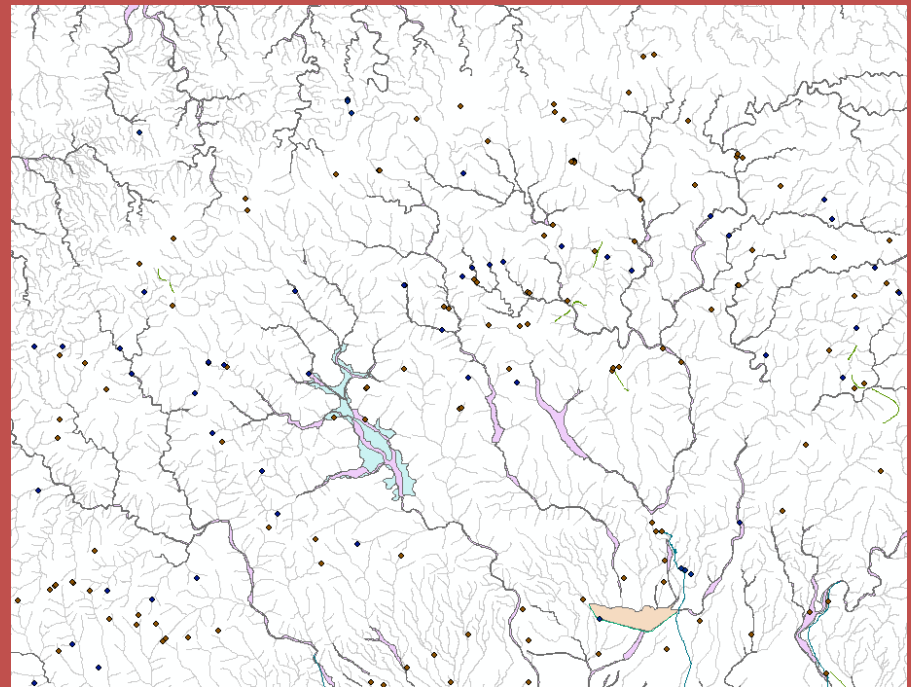
Digital Elevation Model



Terrain Information



## 1:50,000 Vector Data (Hydrography)





Images of different acquisition  
year to identify Change in  
Terrain





## Hydrology toolset from ArcGIS Spatial Analyst

DTM 5m

Orthophoto  
0.5m

Vector Data  
such as  
buildings,  
streams etc.

Fill Sink

Generate Flow  
Direction

Calculate Flow  
Accumulation

Decide Snap  
Pour Point

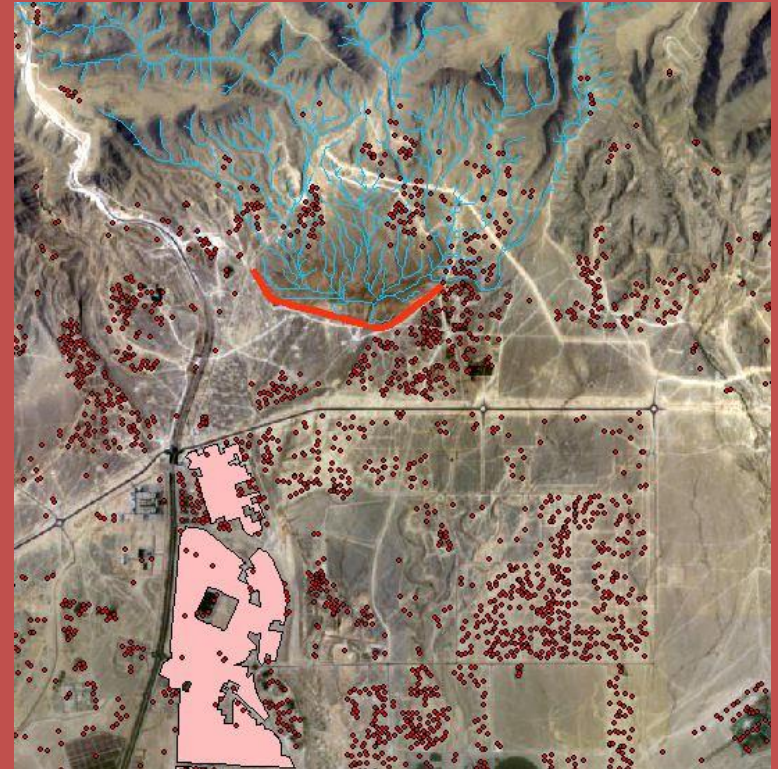
Generate  
Watershed

Analysis to find out the area contributing runoff to a particular point of Interest

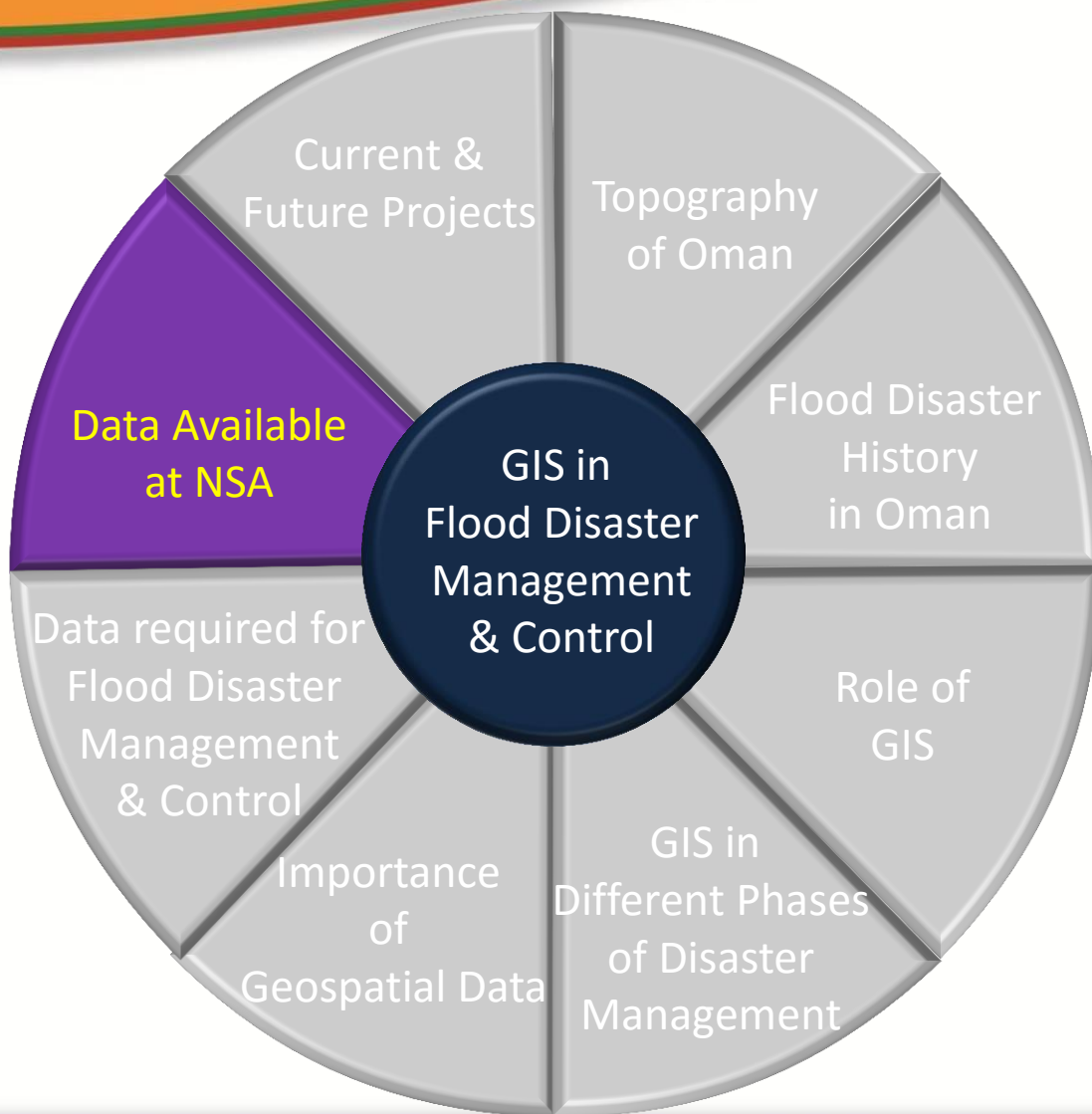


Analysis to find out the Area affected by coastal Flooding if sea level rises to 5m





Identifying areas of high importance, Deciding the location of Flood Protection Dams





### Maps

- Topographic Maps (50K & 100K – New edition)
- Tourist Maps
- Air Charts, Range Maps, Exercise Maps, Border Maps



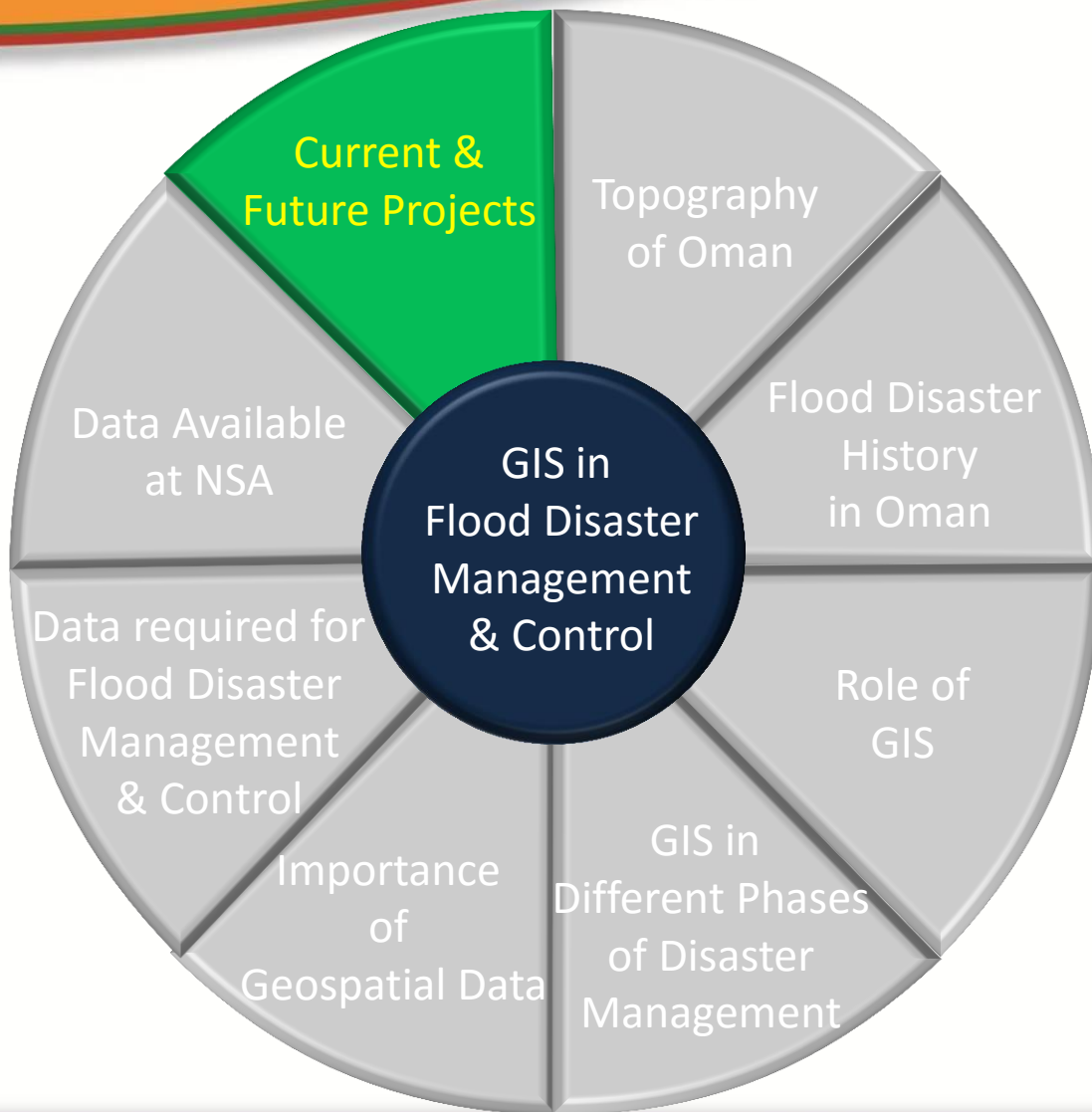
### Raster Data

- Satellite Images
- Aerial Photographs
- Orthophotos
- Digital Elevation Models



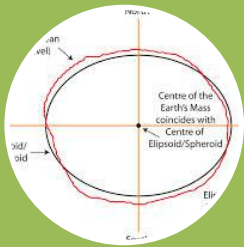
### Vector Data

- 50K data in seamless ArcSDE managed Oracle Spatial
- 5K Data (Transport & Hydrography) ArcGIS Format
- 1.3 Milion, Wilayat, Niyabat, Royal Camps, Control Points, Airfields, VoBs, GPNs





## NSA's Nationwide Geospatial Footprint



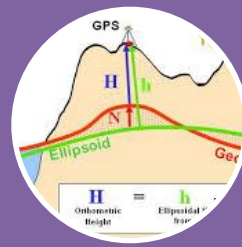
### ONGD-14

Localised Datum for accurate Surveys



### ONCN

Offers GPS data with cm level accuracy



### ONGM

Geoid Model enables Orthometric Heights



### TOPO50K & 100K

Orthophoto, Seamless Vector data & Topographic Maps



### Oman Geospatial Manual

Standards, & Policies

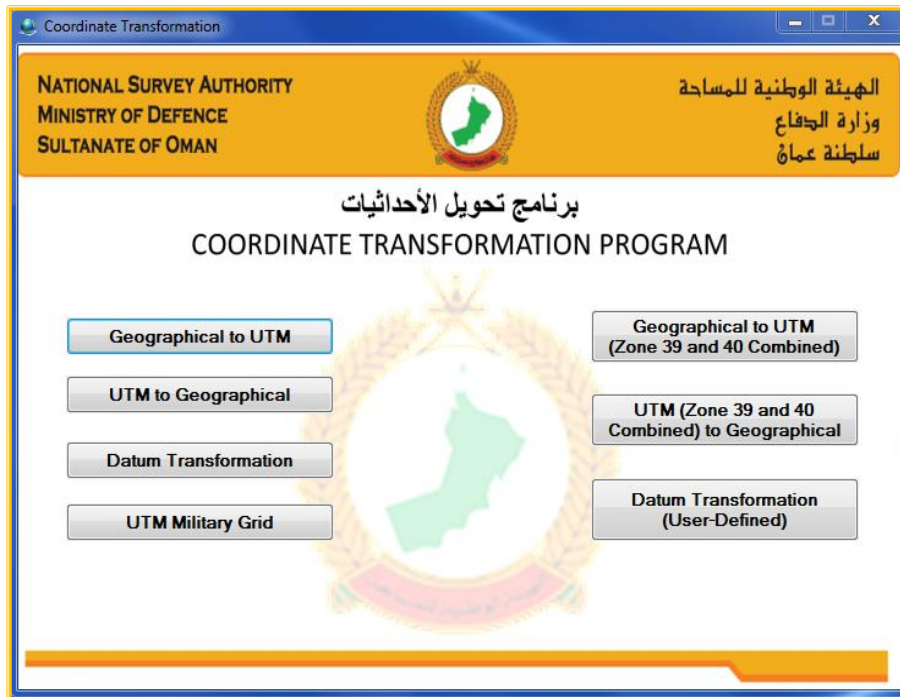
**Backbone for any Geospatial Activity / Project**



## Oman National Geodetic Datum 2014 (ONGD-14)

Localised Datum established to enable accurate data measurement

Project Status : Completed in Dec 2013, won award in GWF-2014



### Characteristic Of Geodetic Datum For Oman

FRAMEWORK	WGS84	ONGD14
ECEF CARTESIAN COORDINATE REFERENCE SYSTEM	ITRF89	ITRF2008
REFERENCE ELLIPSOID	WGS84	GRS80
ORIGIN	CENTER OF MASS OF THE EARTH	CENTER OF MASS OF THE EARTH
SEMI-MAJOR AXIS	6378137.000 METER	6378137.000 METER
FLATTENING	1/298.257223563	1/298.257222101
EPOCH (YEAR)	1994	2013



Circumference of Earth =  $2 * \text{Pi} * \text{Radius}$

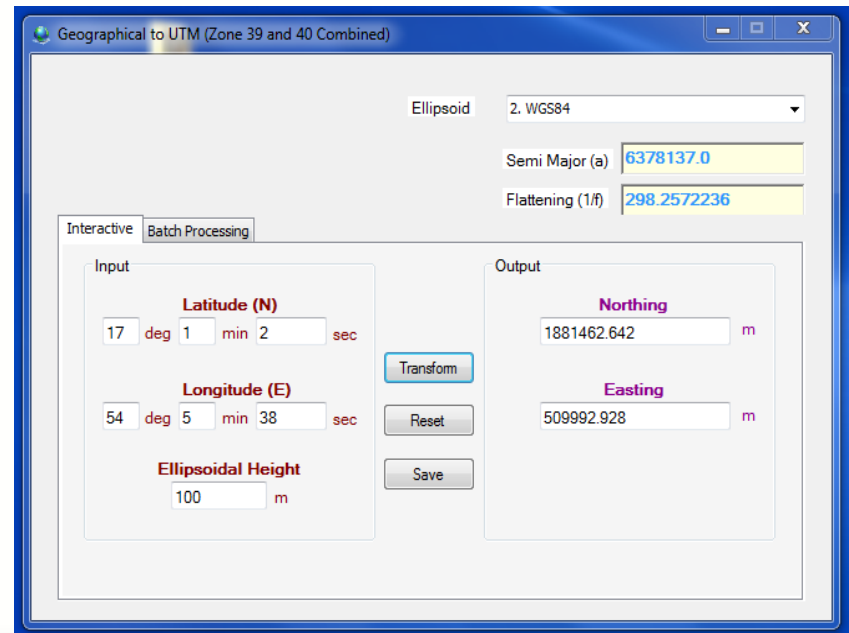
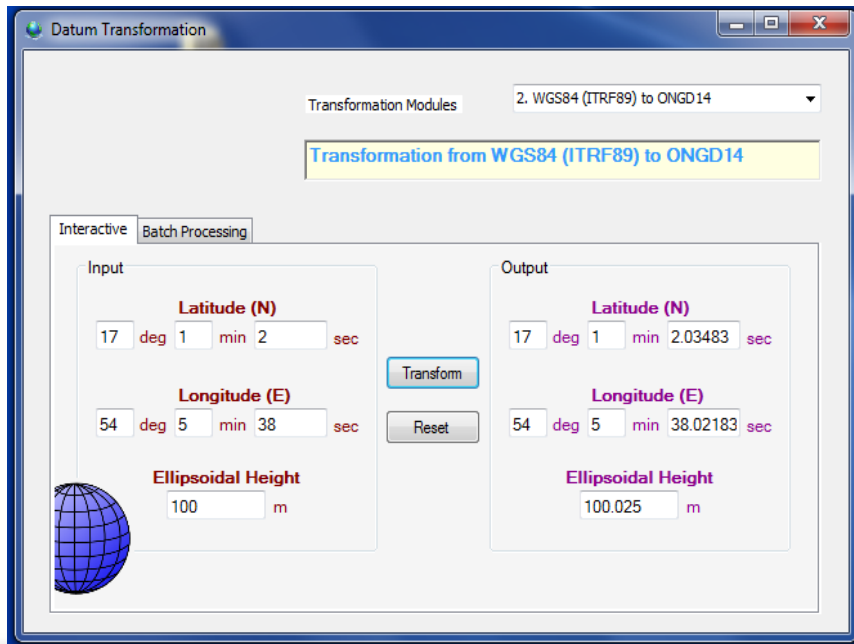
Radius = 6378137 m

360degrees =  $2 * (22/7) * 6378137$

1 degree = 111364 m

1sec =  $111364 / (60 * 60) = 30\text{m}$

Difference =  $0.03 * 30 = 1\text{m}$

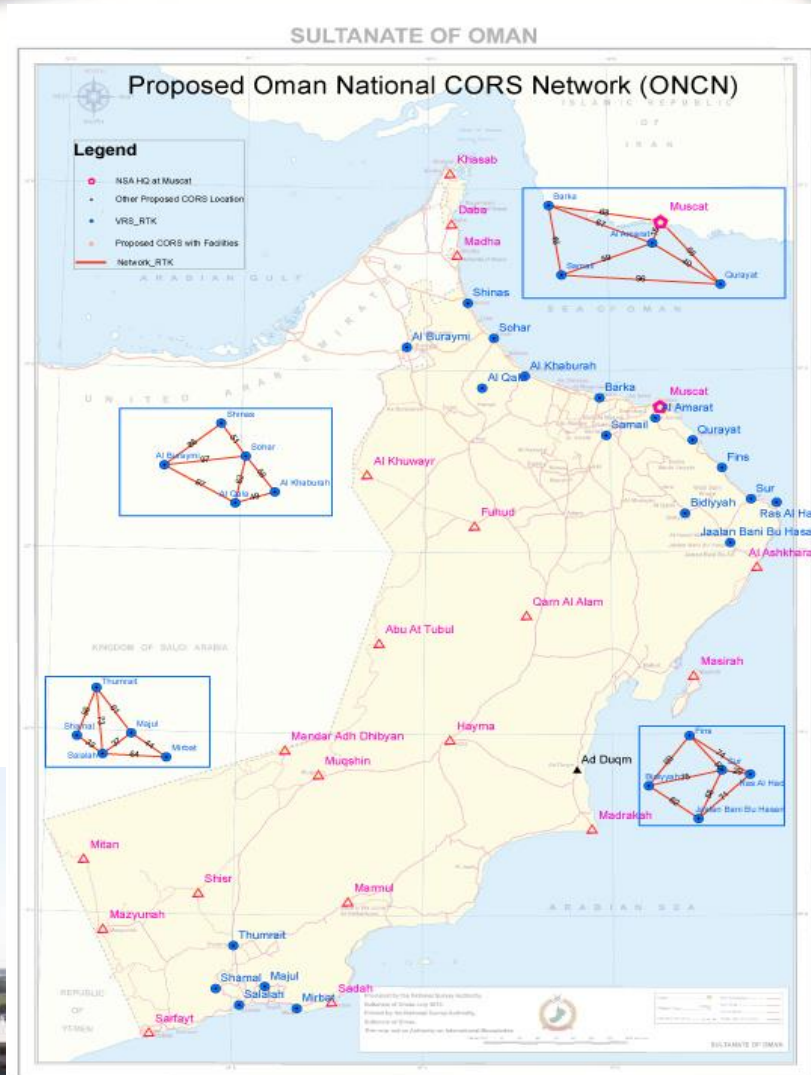
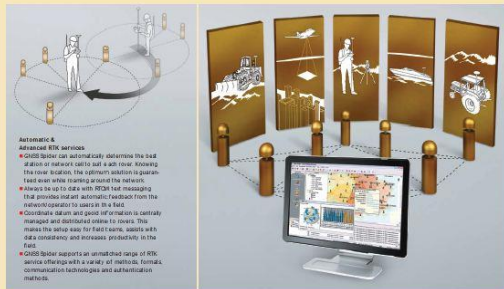




## Oman National CORS Network (ONCN)

A network of Continuous Operating Reference Stations (CORS) that will continuously record Global Positioning System (GPS) signals and provide organizations, within the Sultanate of Oman, real time as well as post-processing positioning capabilities using single GPS receivers (Rover).

Improves the Precision of GPS Collected Data  
This project is now under execution stage.







## ONCN Project – Field Work

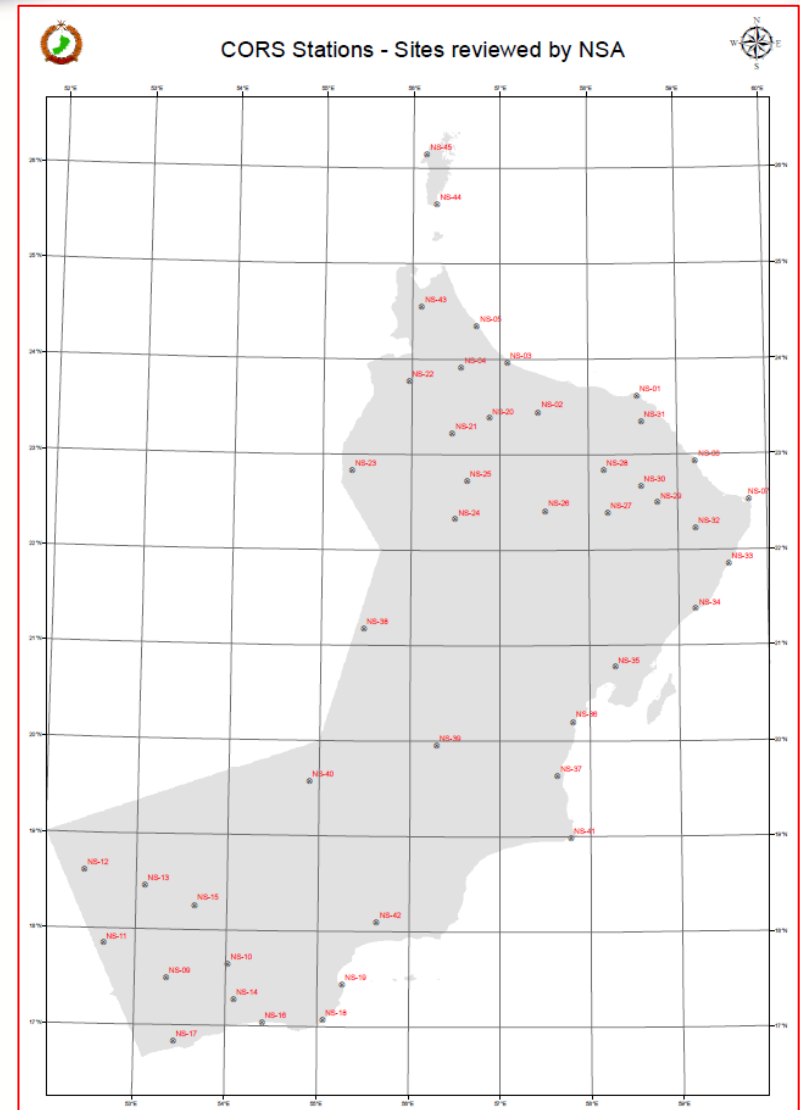




## ONCN Project – Current Status

Site study review for 45 CORS sites has already been completed.

Station	Station_Name	Station	Station_Name
NS-01	NSA HQ MUSCAT	NS-24	FUHUD POLICE STATION
NS-02	RUSTAQ	NS-25	HAMRA AD DURU
NS-03	KHABOORAH	NS-26	ADAM MUNICIPALITY
NS-04	WADI HIBI	NS-27	AL AFLAG
NS-05	SOHAR MUNICIPALITY	NS-28	SAMAD ASH SHAN
NS-06	FINS	NS-29	BIDDIYAH
NS-07	RAS AL HADD	NS-30	IBRA
NS-08	Station DROPPED	NS-31	Dama Wa At Taiyyin
NS-09	MUDAY	NS-32	Al Kamil Wa Al Wafi
NS-10	THUMRAYT	NS-33	Al Ashkharah
NS-11	AL MAZYUNAH	NS-34	Khuwaymah
NS-12	MITAN	NS-35	MUHOOT
NS-13	AL HASHMAN	NS-36	SARAB HOSPITAL
NS-14	ZEEK ROP	NS-37	AD DUQM HOSPITAL
NS-15	SHISR	NS-38	ABU AT TUBUL
NS-16	TAQAH	NS-39	HAYMA SCHOOL
NS-17	HILAL	NS-40	MUQSHIN
NS-18	SADAH	NS-41	RAS MADRAKAH
NS-19	RAS HASIK	NS-42	SHALEEM
NS-20	MAKANIAT	NS-43	AL JUWAYF
NS-21	AL AKHDAR	NS-44	DABA
NS-22	AL SUNAINAH MUNICIPALITY	NS-45	BUKHA
NS-23	AL KHUWAYR		





## Oman National Geoid Model (ONGM)

A height modernization effort by developing a gravity network that will enable all organizations within the Sultanate of Oman to determine accurate orthometric heights.

Geoid is an equipotential surface of the Earth's gravity field

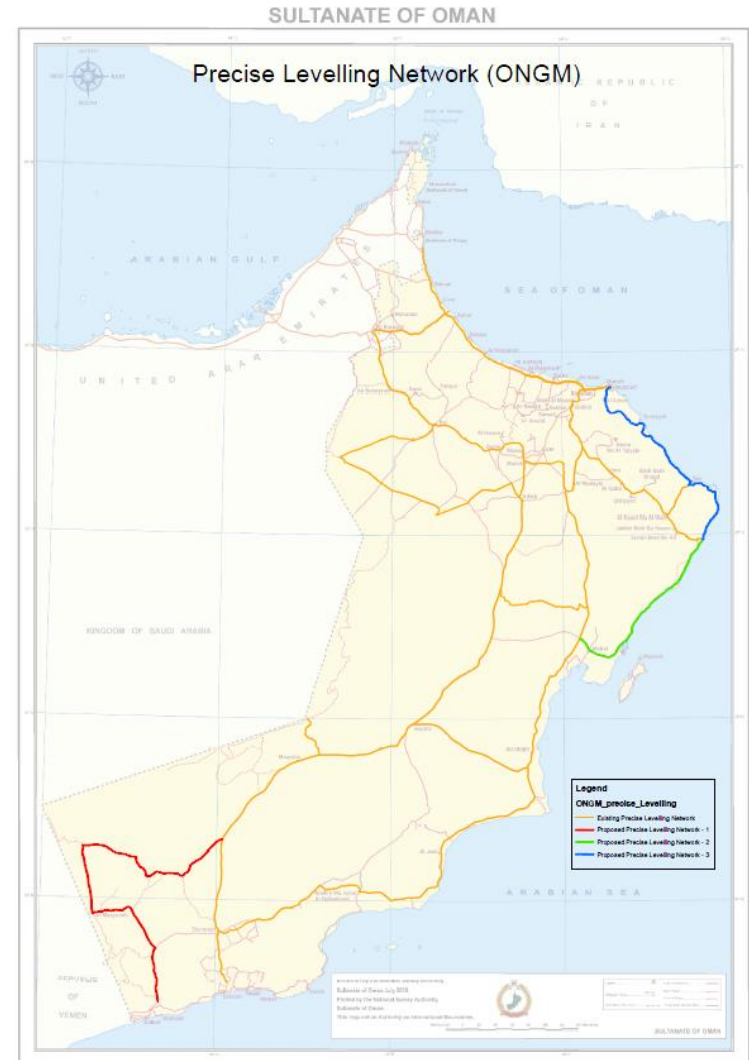
This project is also under execution Stage.





## Precise Levelling Work

- It is the highest order of levelling works
- Used for transferring height to benchmarks
- Approx. 300 benchmarks are used
- These benchmarks are then used for GPS observation to implement GPS – Geoid Fitting process



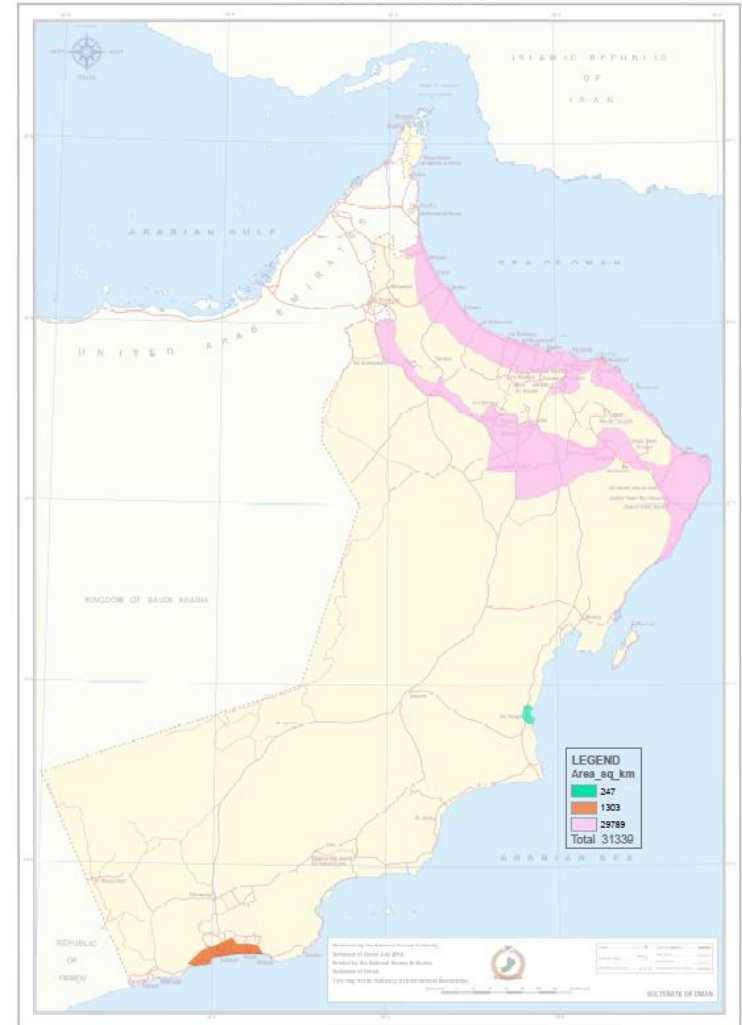


## Ground Gravity Survey Work

To acquire accurate GPS-positioned ground gravity measurements at 2 km spacing over the cities and populated areas of Oman for a total of approximately 6000 gravity data points



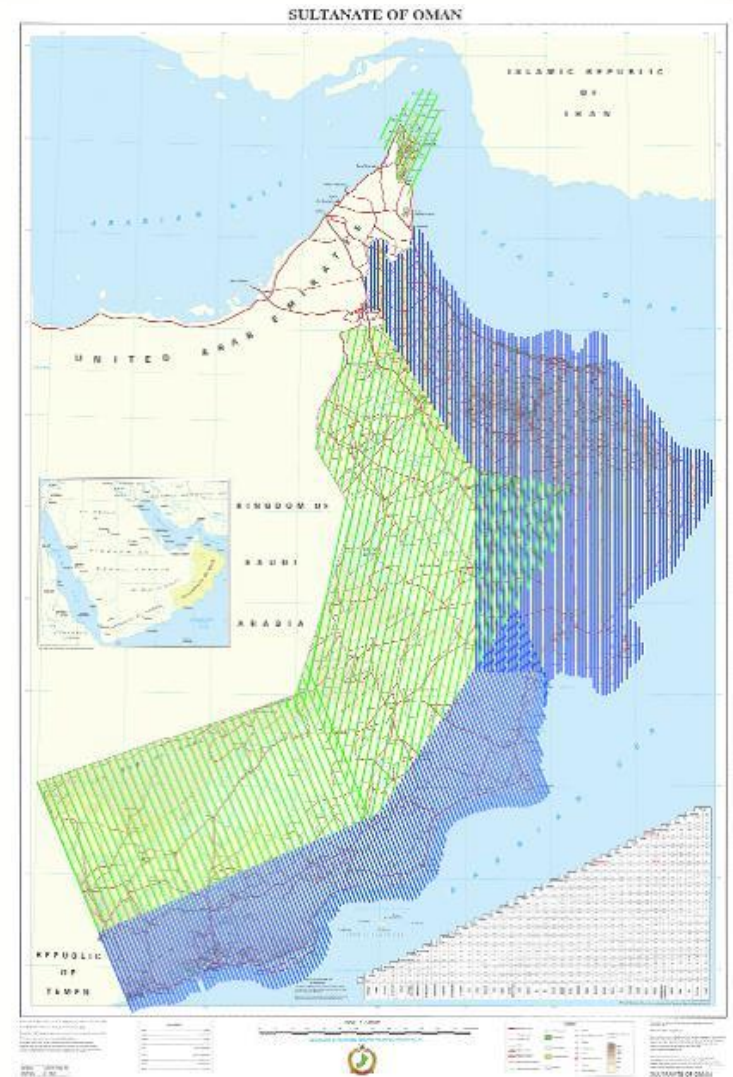
PROPOSED 1-2KM LAND GRAVITY SURVEY (ONGM)  
SULTANATE OF OMAN





## Airborne Gravity Survey Work

To cover the entire country with airborne gravity surveys at 5 km and 10 km spacing including marine area of up to 20 km from the coastline of The Sultanate of Oman for a total of approximately 66,000 line-km including perpendicular control line with spacing of 25 km to 50 km as required





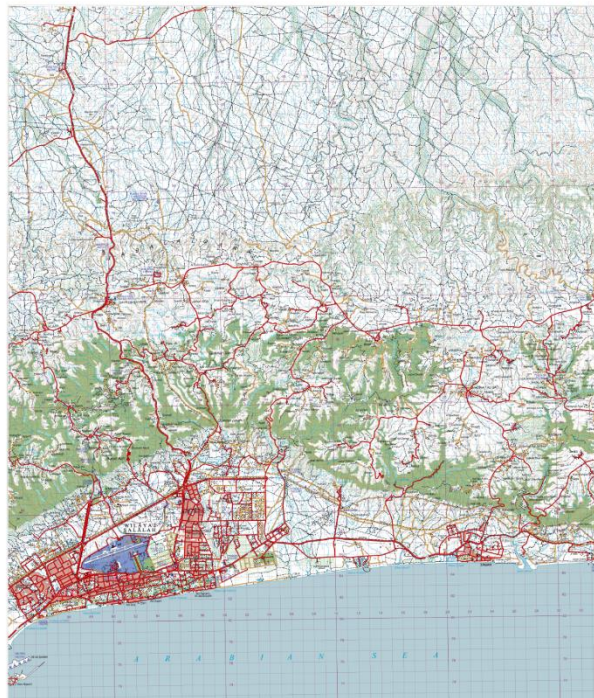
## New 50K & 100K Mapping

Expected Completion by 2015

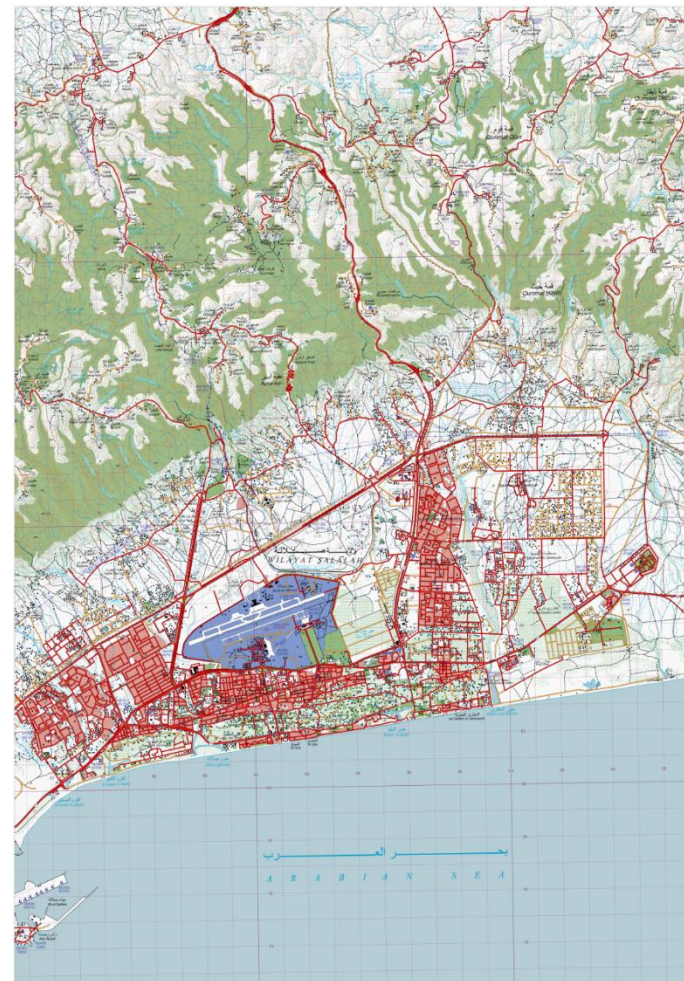
NATO STANAG rating AAOM12, highest rating in terms of currency, horizontal & vertical accuracy



Orthophoto



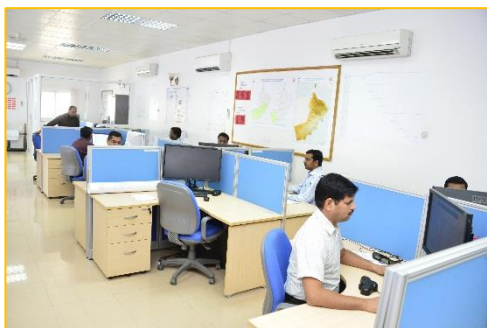
TOPO100K Map



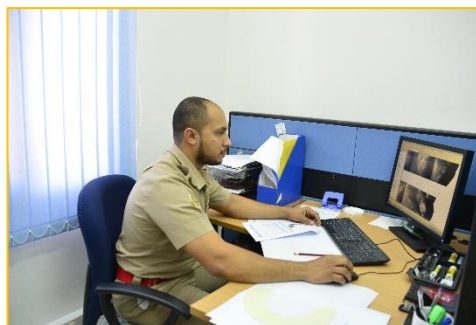
TOPO50K Map



## TOPO Project – Teams



Contractor



Data QC



Vector GDB



Geo PDF



Hardcopy Map QC



Plate Making and Printing





## TOPO50K Current Status

Data	Total Scope	Count	Completion
CAD	498	498	100%
Vector GDB		498	100%
Hardcopy Maps		446	94%



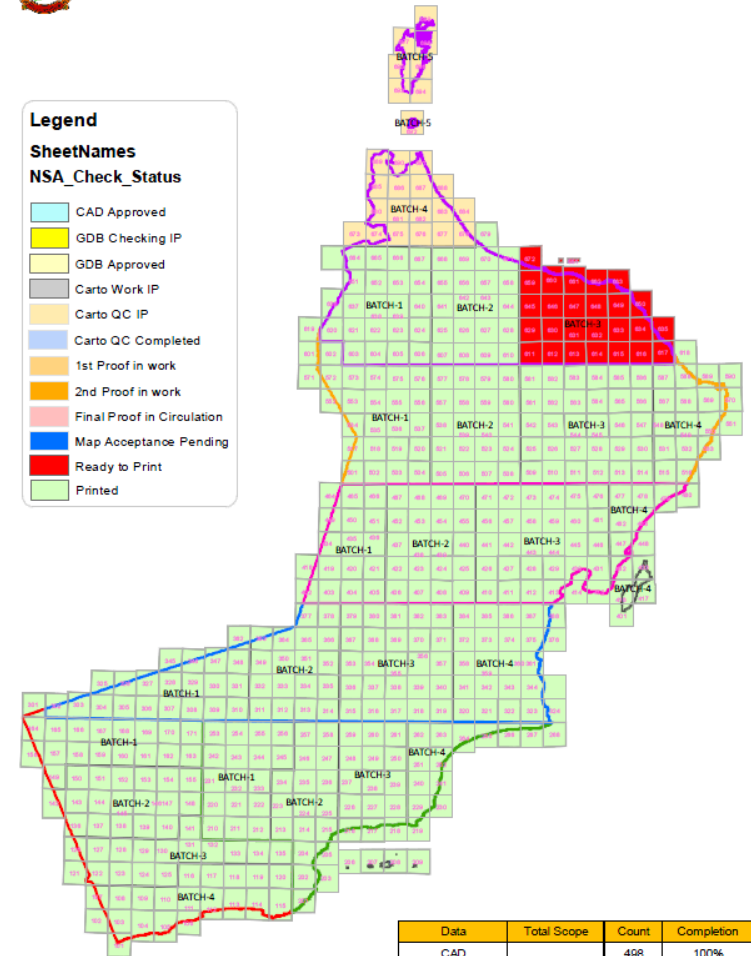
## TOPO50K Project Status - November 2015 (Mid)

**Legend**

**SheetNames**

**NSA\_Check\_Status**

- CAD Approved
- GDB Checking IP
- GDB Approved
- Carto Work IP
- Carto QC IP
- Carto QC Completed
- 1st Proof in work
- 2nd Proof in work
- Final Proof in Circulation
- Map Acceptance Pending
- Ready to Print
- Printed



Data	Total Scope	Count	Completion
CAD	498	498	100%
Vector GDB		498	100%
GeoTiff/PDF		472	95%
Hardcopy Maps		446	90%



## TOPO100K Current Status

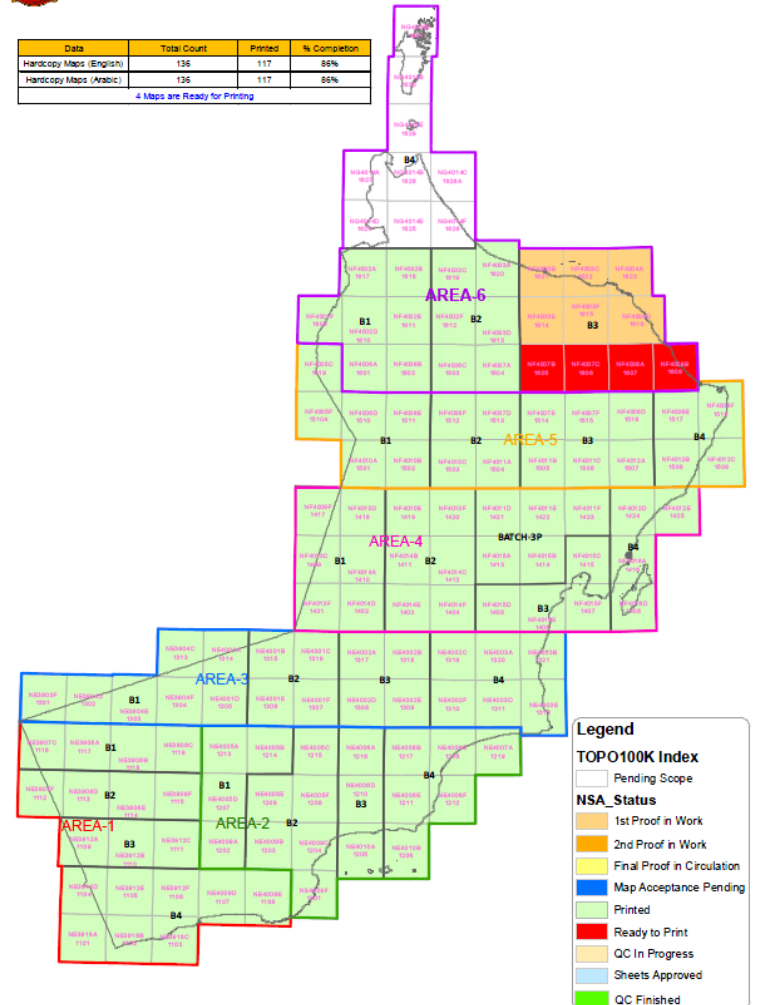
Data	Total Scope	Count	Completion
Hardcopy Maps (English)	136	117	86%
Hardcopy Maps (Arabic)	136	117	86%



## TOPO100K Project Status - November 2015 (Mid)

Data	Total Count	Printed	% Completion
Hardcopy Maps (English)	136	117	86%
Hardcopy Maps (Arabic)	136	117	86%

4 Maps are Ready for Printing





## Oman Geospatial Manual, Expected Completion by Mar 2016

- Creation of agreed content for the Oman National Geospatial Manual, based on current NSA policy, licensing, practices and;
- Build and deliver the technical infrastructure for publishing the Oman National Geospatial Manual to users as defined by NSA which may include: Military, Government, Commercial and Citizens; and
- Provision of advice and recommendations for the development of existing NSA policy, licensing, practices, standards, products and services taking account of NSA's future role and responsibilities.



## Standards for Geospatial Activities at NSA

### Data Model-

- ESRI based data models based on DFDD/FACC codes at various scales such as 5K, 20K, 50K, 100K, 1.3M etc.

### Data Capture Specifications -

- Specifications based on international standards for data capture at 50K scale

### Data Finishing Specifications-

- Specifications based on International standards for map finishing covering aspects like color, pattern, symbols, generalisation etc.

### Field Survey Operations-

- Possess manual based on international standards for field survey activities

### Data Security & Vetting Procedure-

- Supports proper security of data



## Mobile Mapping



## Unmanned Aircraft System (UAS)



## Remote Sensing Satellite Receiving Station



Sultanate of Oman  
Ministry of Defence  
National Survey Authority

# Thank You

Amol G. Deshmukh  
Geomatics Specialist, PMP

National Survey Authority, Ministry of Defence,  
Bait Al Falaj, P.O. Box 113, Muscat, P. C. 100,  
Sultanate of Oman

Tel 968-24312371 · Fax 968-24312443  
Email: [go4amol@outlook.com](mailto:go4amol@outlook.com)