



# **APPLICATION OF GEOSPATIAL TECHNOLOGIES FOR EXPLORATION OF GROUNDWATER IN THAR DESERT**

**Presented by:**

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Technology for Water Management, Islamabad, Pakistan**



# Presentation Outline

- Background
- Objectives
- Scope
- Study Area
- Methodology
- Results
- Conclusion

# Background



- Thar Desert, densely populated desert in the world, forms the extreme southeastern part of Pakistan covering about 30,000 Km<sup>2</sup>
- Population of Thar mainly depends on limited agriculture and livestock
- In the absence of surface perennial water and fluctuating rainfall in the region, it is important to explore possibilities of sustainable water resources
- Hunting for alternative water resources and its provision will drastically improve socio economic conditions of the region
- Project Management Office, Sindh Barrages Rehabilitation Project approached SUPARCO for development of GIS as envisioned under this project

# Study Area



- Agriculture solely dependent on rainwater
- Average rainfall significant but inconsistent
- Recurrent drought cycles
- Four zones division, depending upon physiographic features, drainage directions etc.



# Objectives



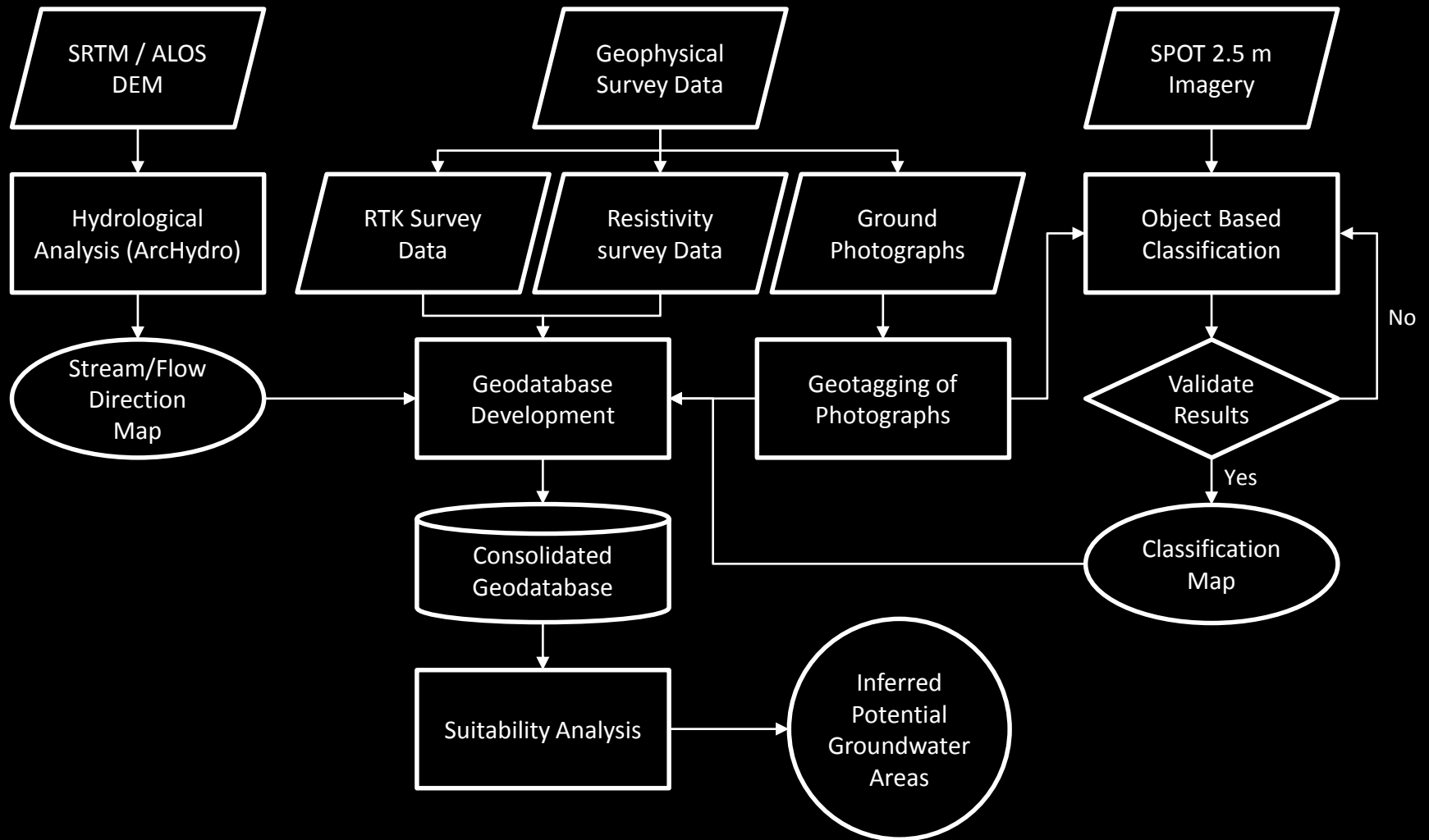
Application of geo-spatial technologies to narrow down potential areas for groundwater for further field investigations

# Scope

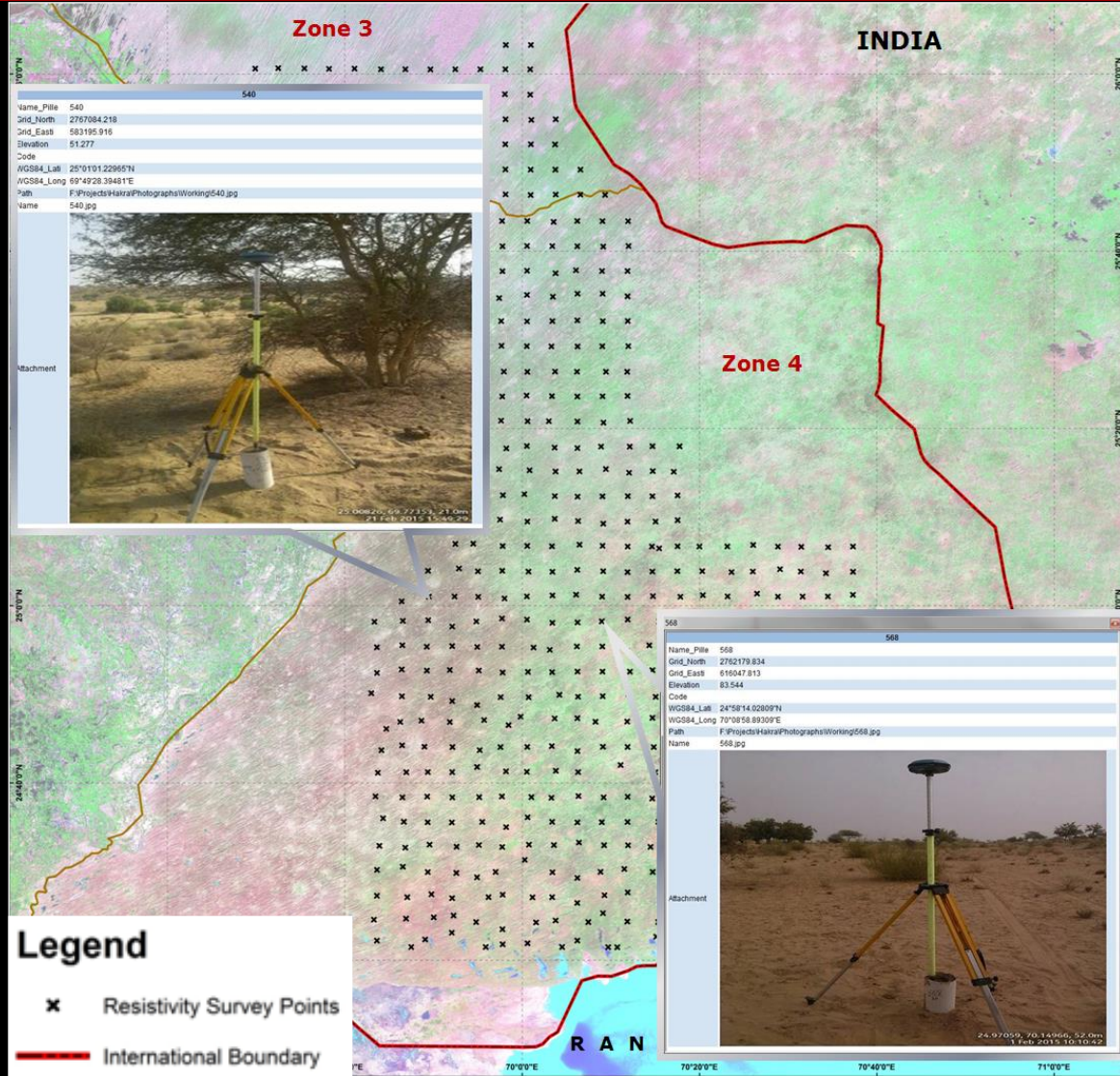
- Preparation of satellite image Landcover classification maps
- Analysis of Digital Elevation Model (DEM) to determine drainage and natural gradients
- Development and analysis of resistivity data in GIS
- Submission of report based on remote sensing and GIS data



# Methodology



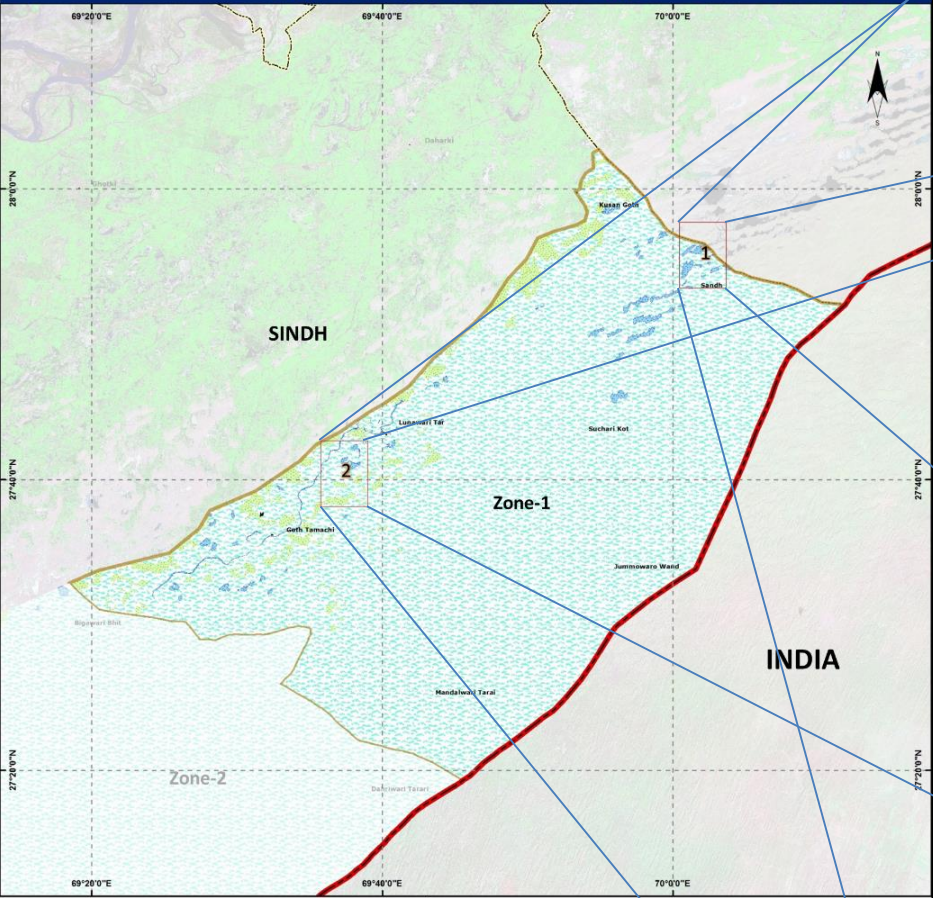
# Incorporating RTK Survey Data into GIS





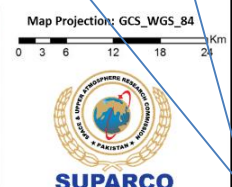
# Landuse / Landcover Classification

Landuse / Landcover Map – Zone 1



Legend & Statistics		
	Provincial Boundary	
	International Boundary	
	High Resolution Satellite Image Blow-up Footprints	
Land Cover	Area (Km <sup>2</sup> )	Area (%)
	Agricultural Land	116.50 / 4.05
	Migrating Sand Dunes	- / -
	Interdunal Plains	- / -
	Hill Outcrop	- / -
	Salt Marsh	- / -
	Sand Dunes with Shrubs	2726.23 / 94.82
	Settlements	0.333 / 0.012
	Trees	- / -
	Water Bodies	32.15 / 1.12

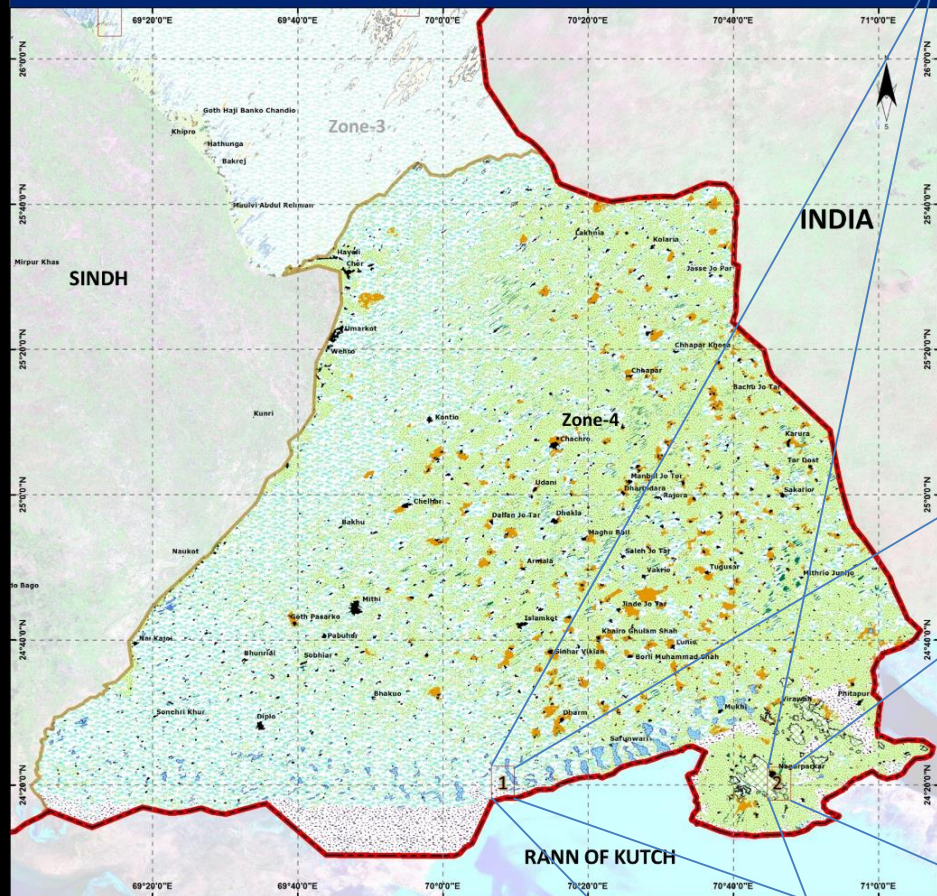
**Note:-** About 95% area of Zone-1 consists of Sand Dunes with Shrubs. Agriculture is practiced over 4% of the area. Another peculiar feature of the Zone-1 is water bodies that consists of around 1% of the total area of Zone-1. Blow-ups of high resolution satellite imagery are shown to give an insight of the landcover classes particularly water bodies. Water bodies are important feature because these originally disjoint water bodies are artificially connected with each other to support agriculture.



Legend	
	Agricultural Land
	Sand Dunes with Shrubs
	Water Bodies

# Landuse / Landcover Classification

Landuse / Landcover Map – Zone 4

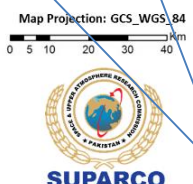


4.2



Legend & Statistics		
	Provincial Boundary	
	International Boundary	
	High Resolution Satellite Image Blow-up Footprints	
Land Cover	Area (Km <sup>2</sup> )	Area (%)
	Agricultural Land	9561 / 42.3
	Migrating Sand Dunes	10 / 0.04
	Interdunal Plains	582 / 2.58
	Hill Outcrop	153 / 0.68
	Salt Marsh	993 / 4.4
	Sand Dunes with Shrubs	10535 / 46.6
	Settlements	318 / 1.4
	Trees	293 / 1.3
	Water Bodies	160 / 0.7

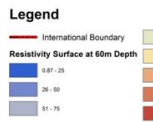
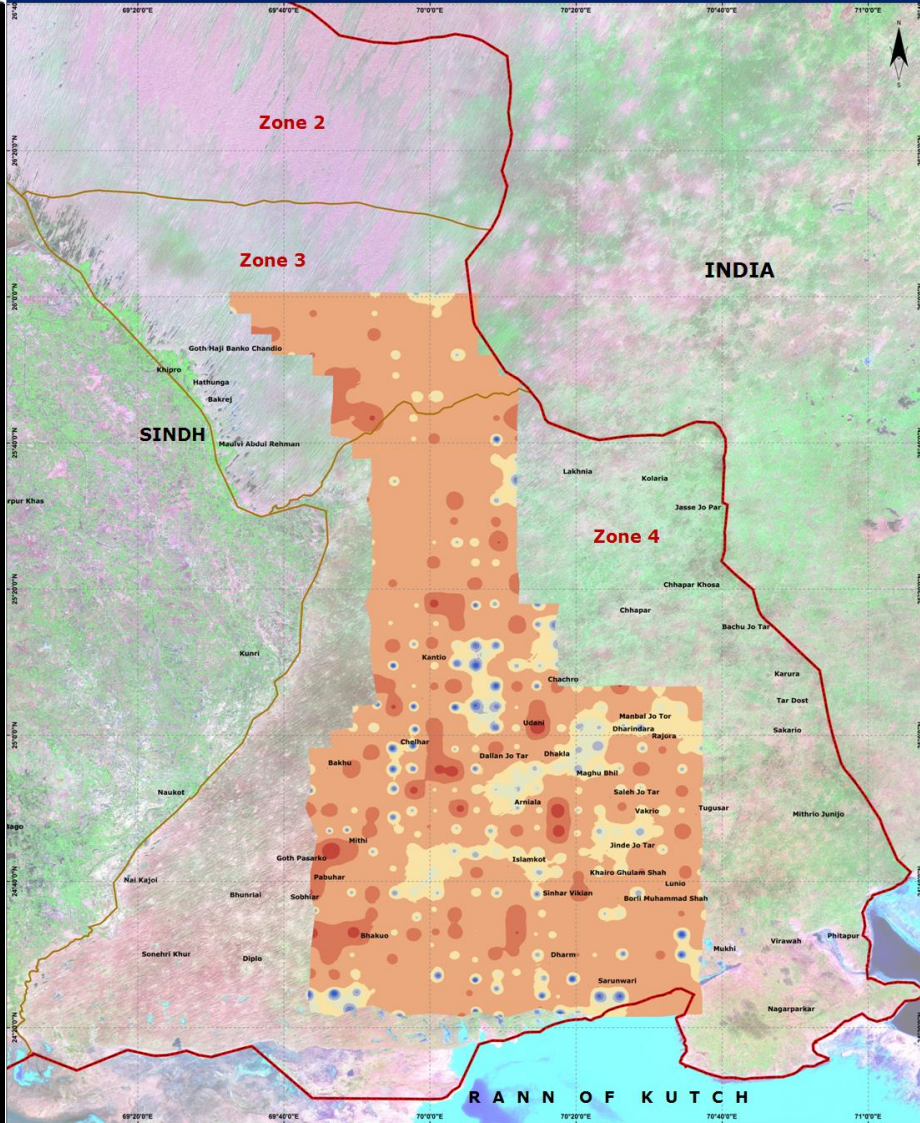
**Note:-** Zone-4 is comparatively the largest populous area of the Thar Desert. Agriculture is practiced over 42% of the area and is the major source of living. A limited number of Migrating Sand Dunes exist in the Zone. A significant number of areas with deep rooted trees are observable. Most of the water bodies exist at the southern border of the zone. There is abundance of Salt Marsh area in the zone as compared to other zones. Hill Outcrop is the peculiar feature of the zone present around Nagarparkar. Based on deep rooted trees and other favorable landuse, potential groundwater areas have been identified.



Legend	
	Agricultural Land
	Hill Outcrop
	Interdunal Flat Plains
	Sand Dunes with Shrubs
	Settlements
	Trees

# Incorporating Resistivity Survey Data

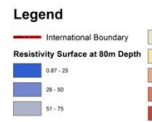
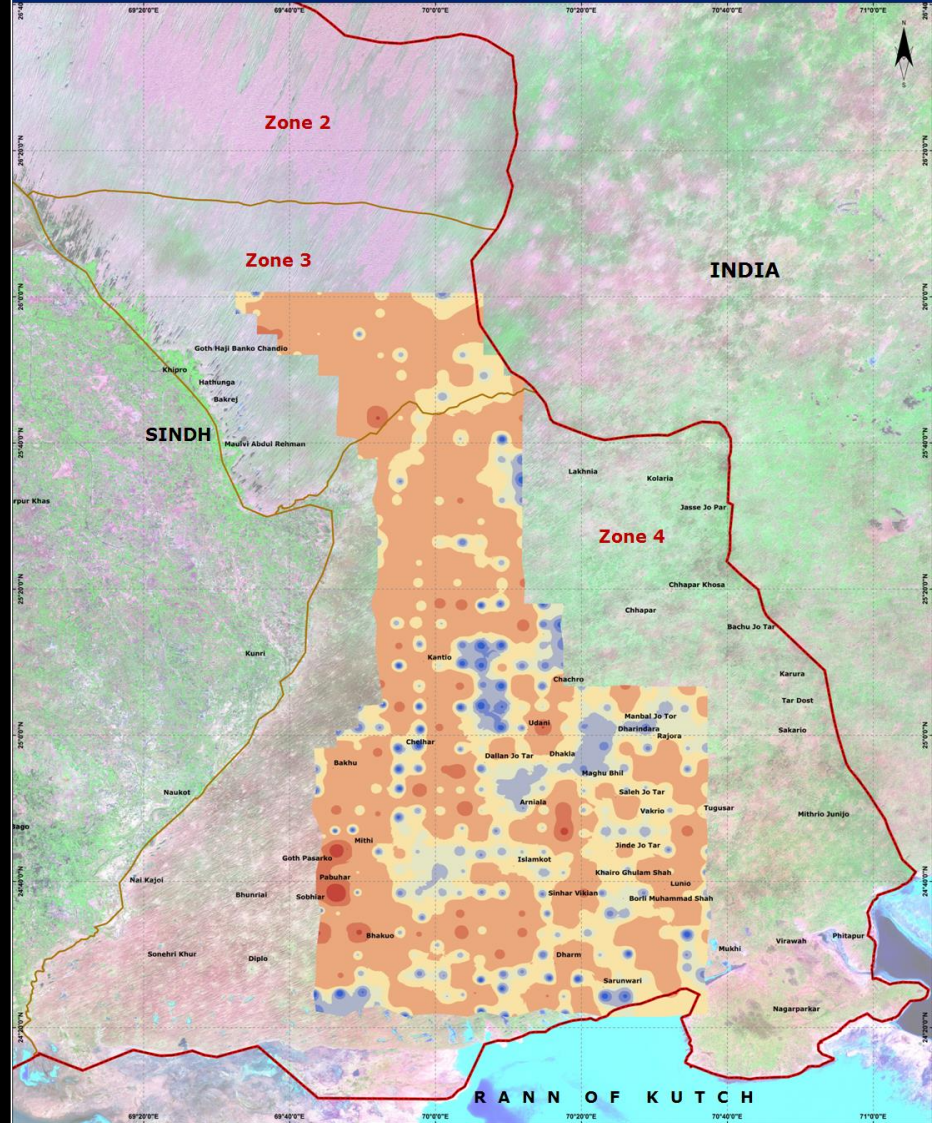
Resistivity Surface Map – 60 m Depth



Map Projection: GCS\_WGS\_84  
 Resistivity Survey Data Source: Project Management Office, Sindh Barrages Rehabilitation Project Irrigation Department, GoS



Resistivity Surface Map – 80 m Depth

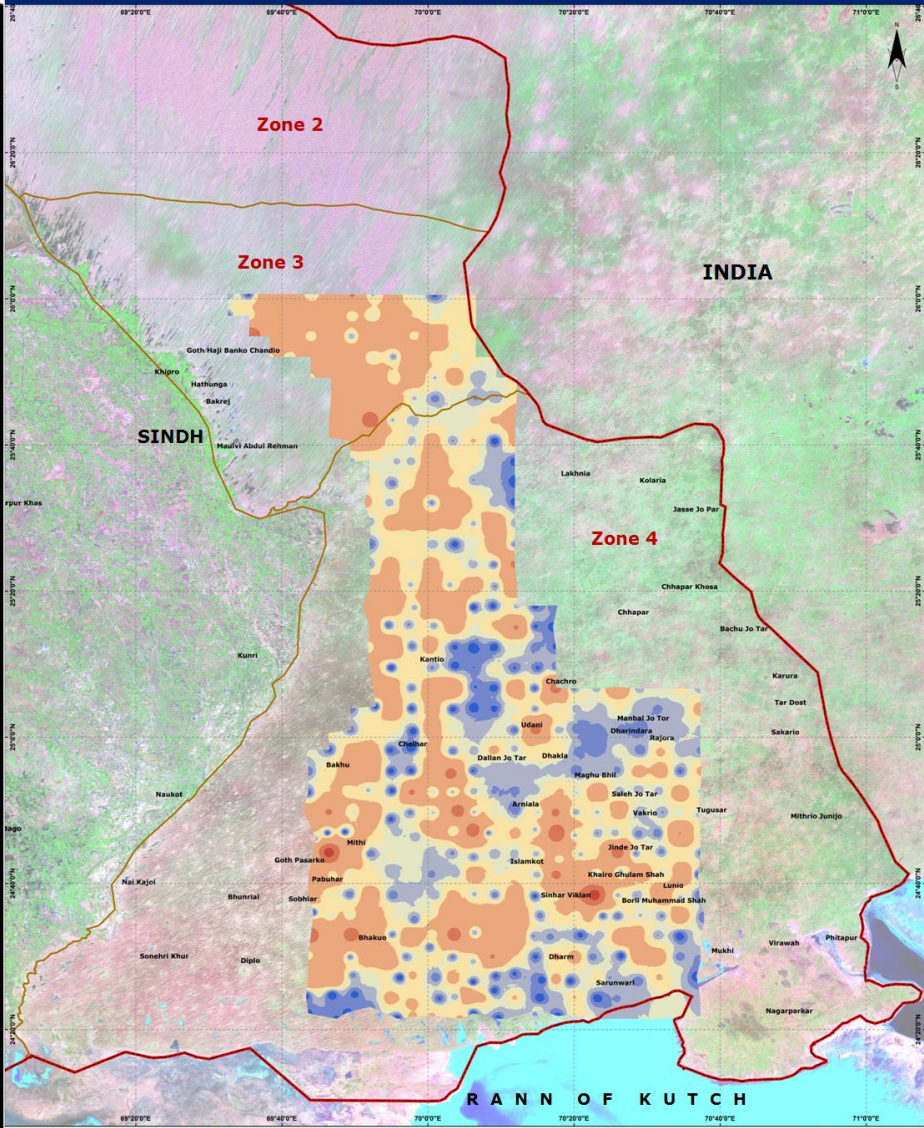


Map Projection: GCS\_WGS\_84  
 Resistivity Survey Data Source: Project Management Office, Sindh Barrages Rehabilitation Project Irrigation Department, GoS

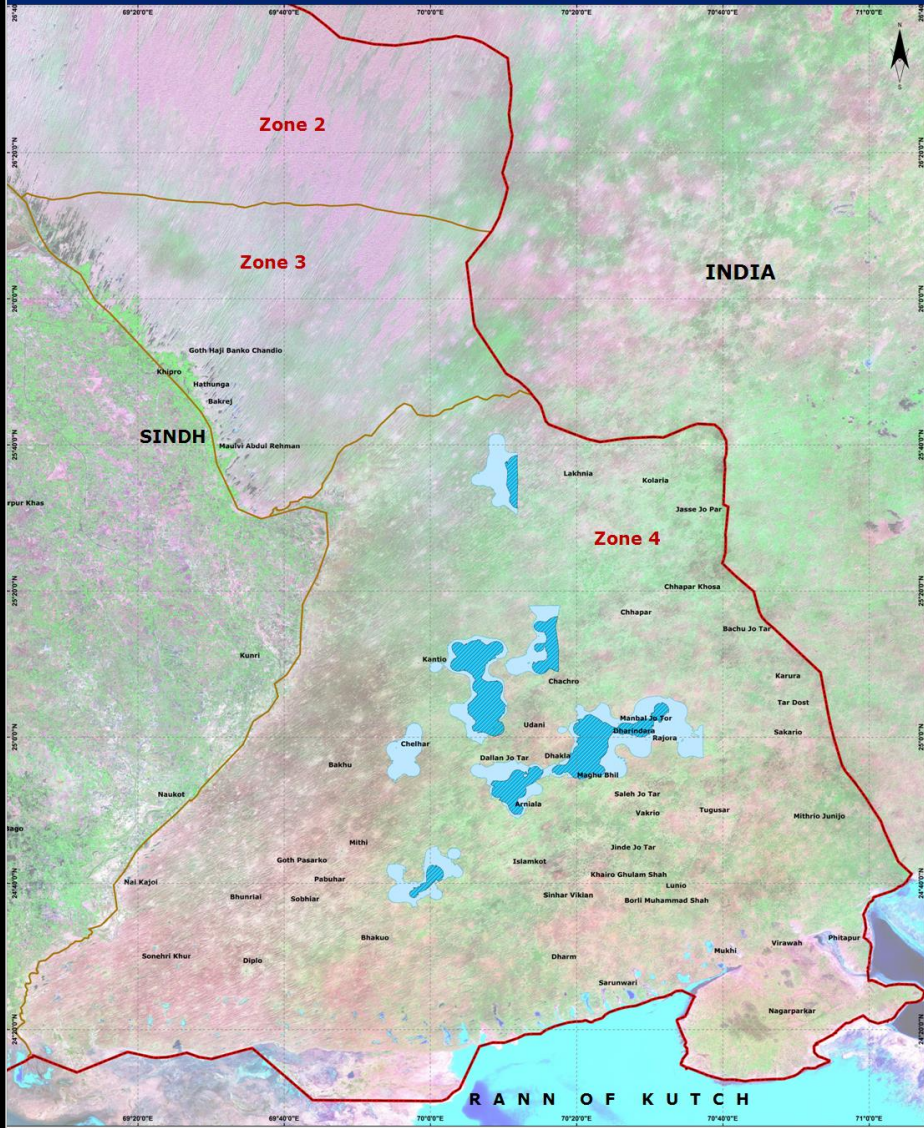


# Resistivity based Inferred Potential Areas

Resistivity Surface Map – 100 m Depth



Resistivity Based Inferred Potential Groundwater Areas



**Legend**

- International Boundary
- Resistivity Surface at 100m Depth
- 0.87-1.05
- 1.10-1.50
- 1.50-2.00
- 2.00-3.00
- 3.00-4.00
- 70-100
- 100-150
- 160-300
- 310-1,000
- 1,100-2,400

**SUPARCO**  
 Map Projection: GCS\_WGS\_84  
 Resistivity Survey Data Source: Project Management Office, Sindh Barrages Rehabilitation Project Irrigation Department, GoS

**Legend**

- International Boundary
- Potential Groundwater Areas at 80 m Depth
- Potential Groundwater Areas at 100 m Depth

**SUPARCO**  
 Map Projection: GCS\_WGS\_84  
 Resistivity Survey Data Source: Project Management Office, Sindh Barrages Rehabilitation Project Irrigation Department, GoS

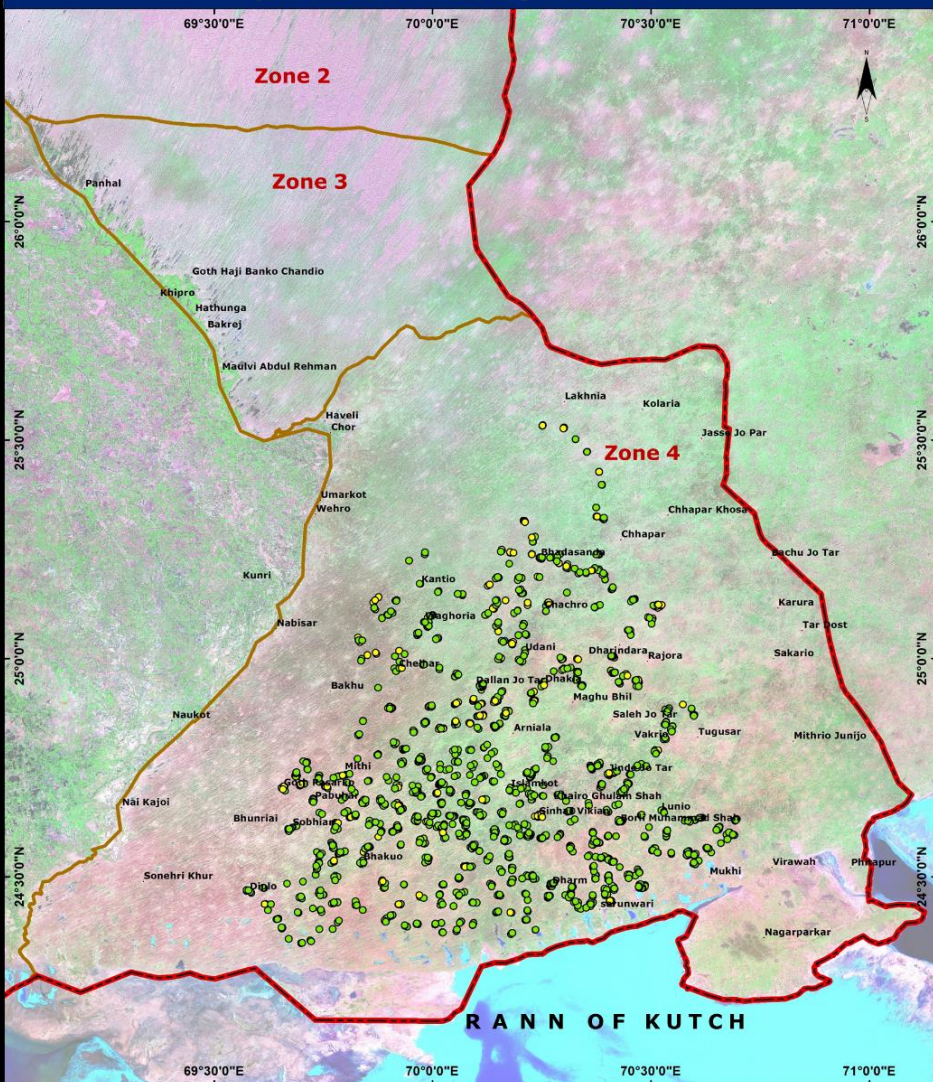


# National Standards for Drinking Water

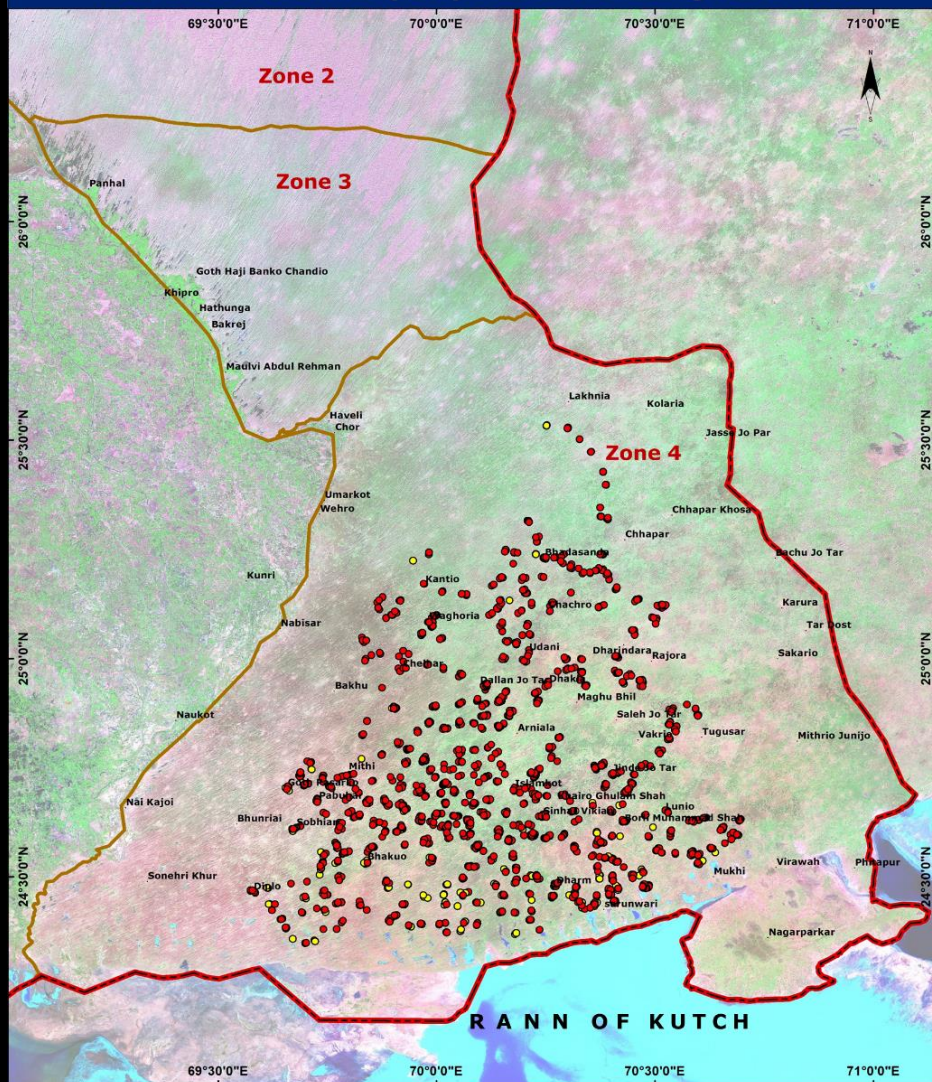
Properties / Parameters	Standard Values for Pakistan	WHO Guidelines	Remarks
Total hardness as CaCO <sub>3</sub>	< 500 mg/l	---	
TDS	< 1000	< 1000	
pH	6.5 – 8.5	6.5 – 8.5	
Arsenic (As)	< 0.05 (P)	0.01	Standard for Pakistan similar to most Asian developing countries
Chloride (Cl)	<250 mg/l	<250 mg/l	
Fluoride (F)	<1.5 mg/l	<1.5 mg/l	
Nitrate (NO <sub>3</sub> )	<50 mg/l	<50 mg/l	

# Incorporating Geophysical Survey Data

**pH Values of Existing Tube Wells**



**Total Dissolved Solids (TDS) Values of Existing Tube Wells**




**Legend**



- International Boundary

**pH Value**

- 4.41 - 6.49
- 6.50 - 8.50
- 8.51 - 11.36



Map Projection: GCS\_WGS\_84





**Legend**



- International Boundary

**TDS Value**

- 109.0 - 1000.0
- 1000.1 - 69504.0



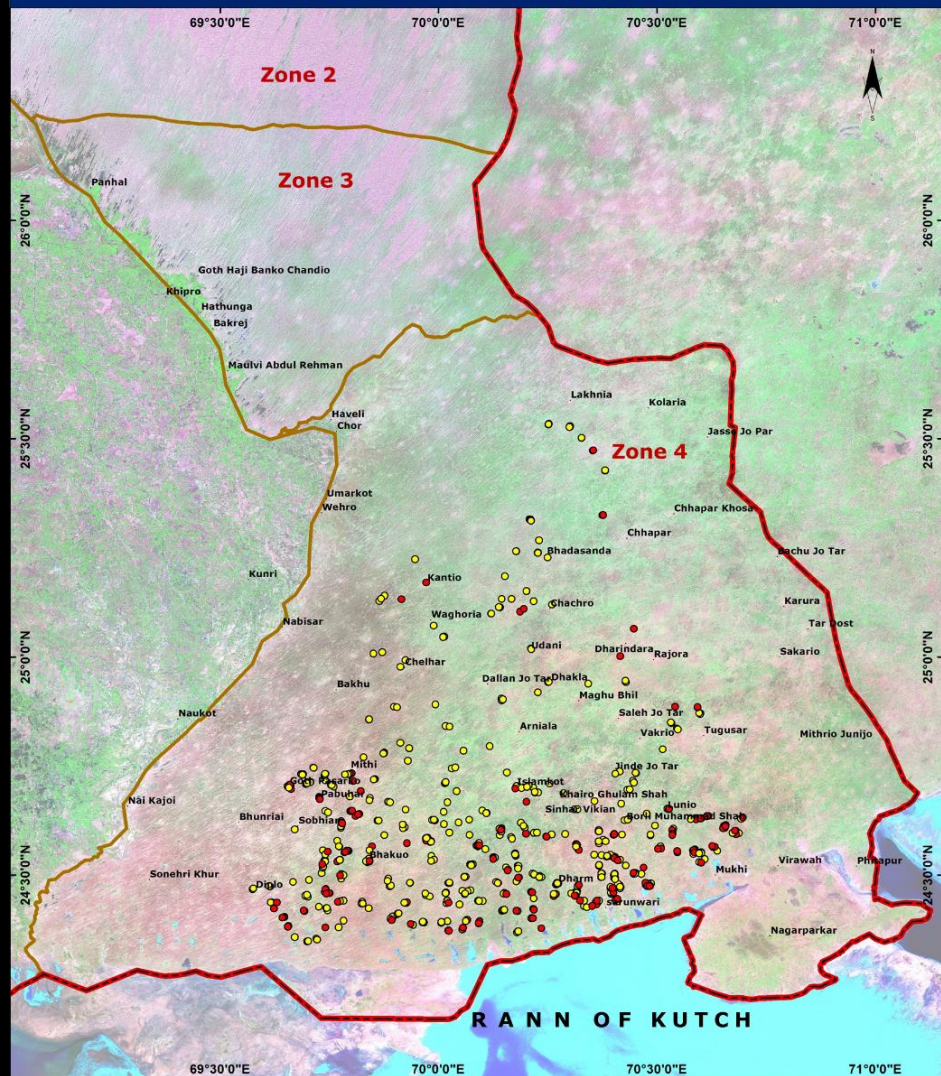
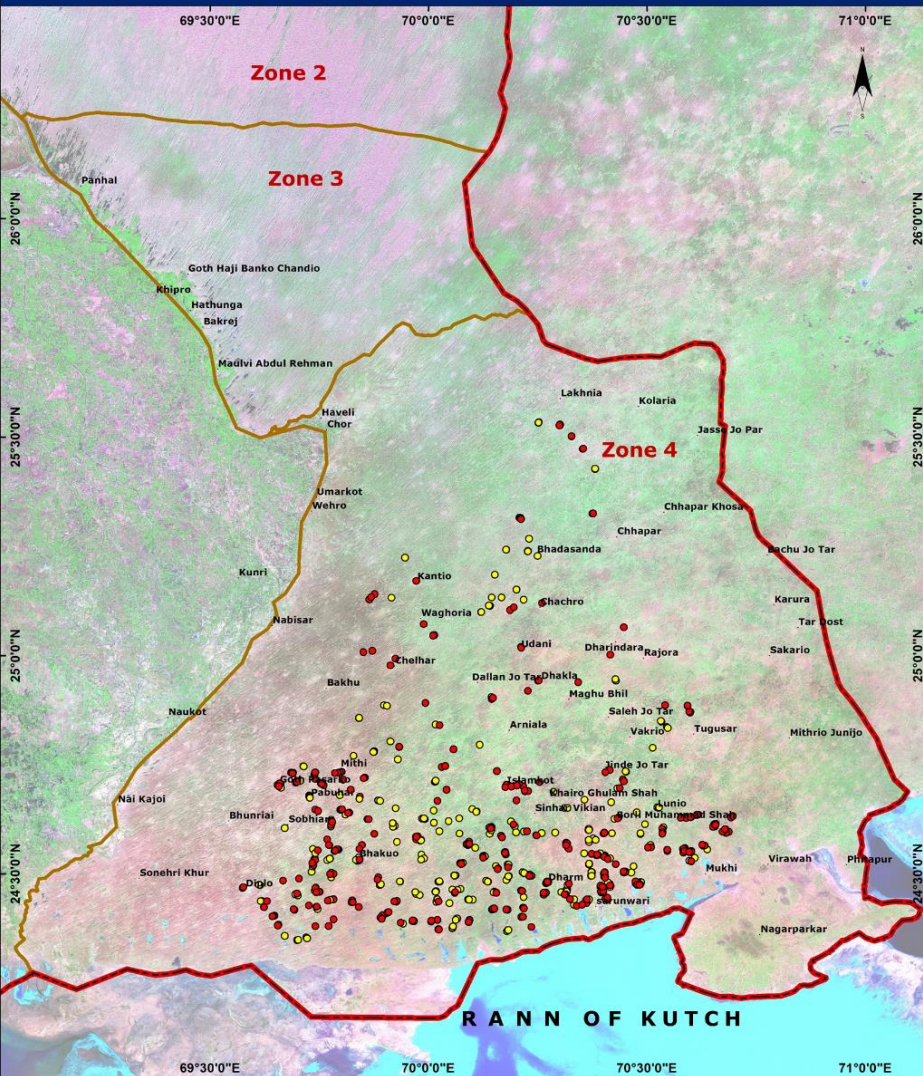
Map Projection: GCS\_WGS\_84

# Incorporating Geophysical Survey Data

Chloride Values of Existing Tube Wells

Hardness Values of Existing Tube Wells



**Legend**

- International Boundary

**Chloride (mg/Litre)**

- 3.5 - 250.0
- 250.1 - 1091.0

**SUPARCO**

Map Projection: GCS\_WGS\_84

Index Map

**Legend**

- International Boundary

**Hardness (mg/Litre)**

- 15.0 - 500.0
- 500.1 - 1420.0

**SUPARCO**

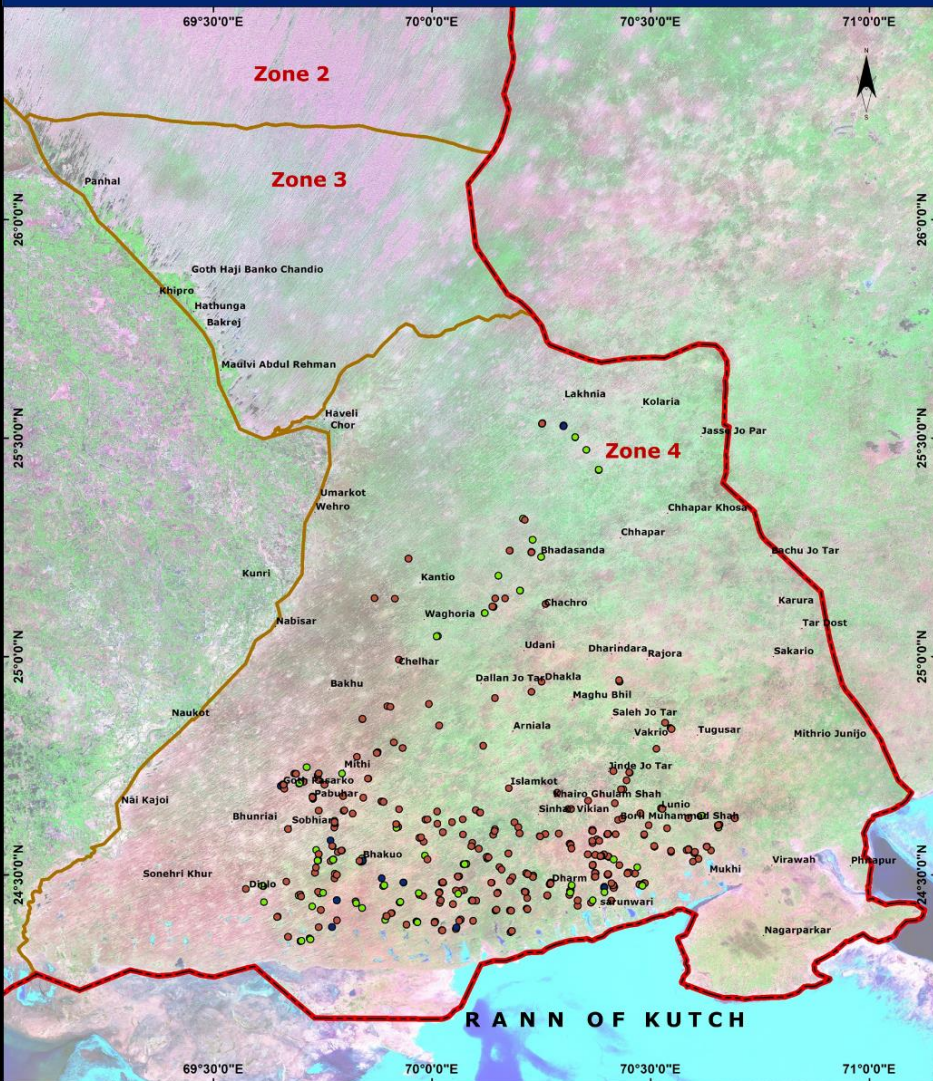
Map Projection: GCS\_WGS\_84

Index Map

# Incorporating Geophysical Survey Data

Nitrate Values of Existing Tube Wells

Arsenic Values of Existing Tube Wells




**Legend**


— International Boundary

**Nitrate (mg/Litre)**

- 0.0 - 10.0
- 10.1 - 20.0
- 20.1 - 33.3



Map Projection: GCS\_WGS\_84





Index Map

**Legend**


— International Boundary

**Arsenic (mg/Litre)**

- 0.001 - 0.010
- 0.011 - 0.050
- 0.051 - 0.250



Map Projection: GCS\_WGS\_84



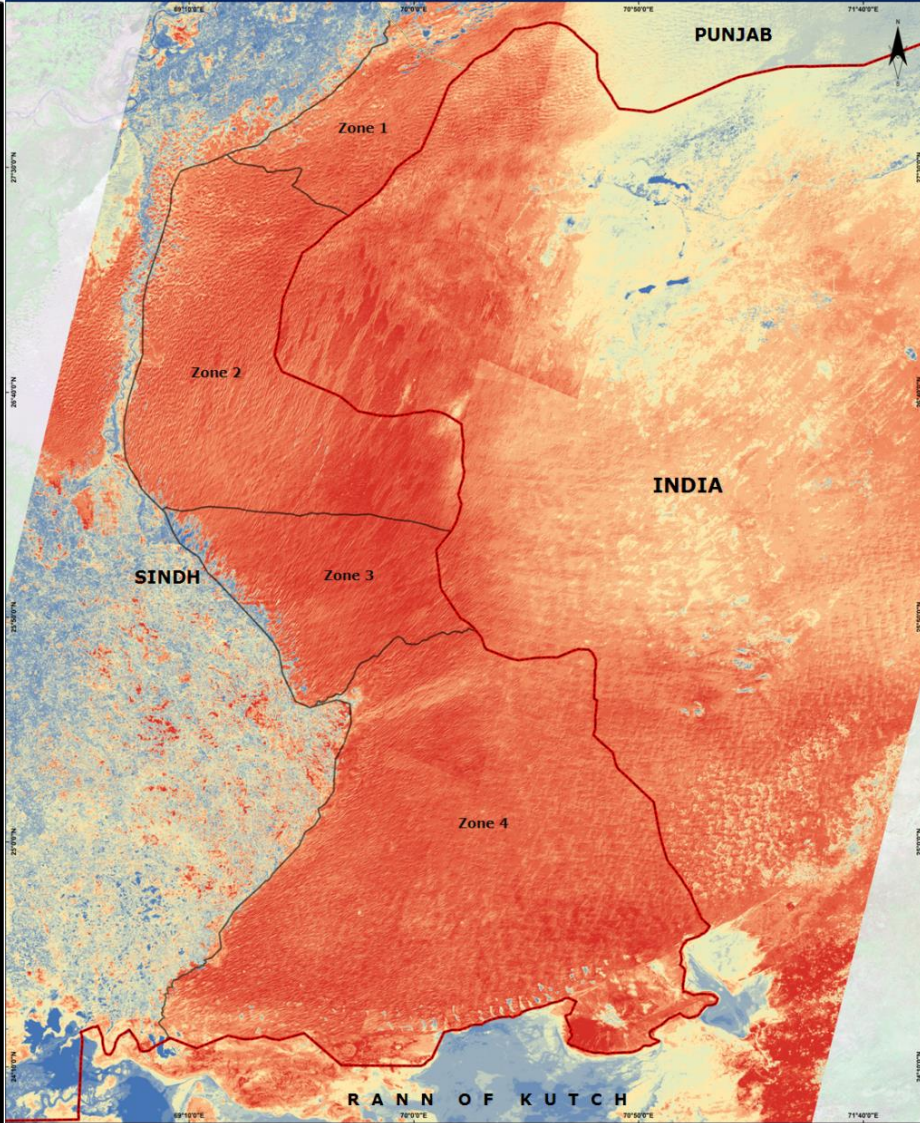

Index Map



# LST Maps



Land Surface Temperature Map of Landsat-TM



**Legend**

- Provincial Boundary
- International Boundary

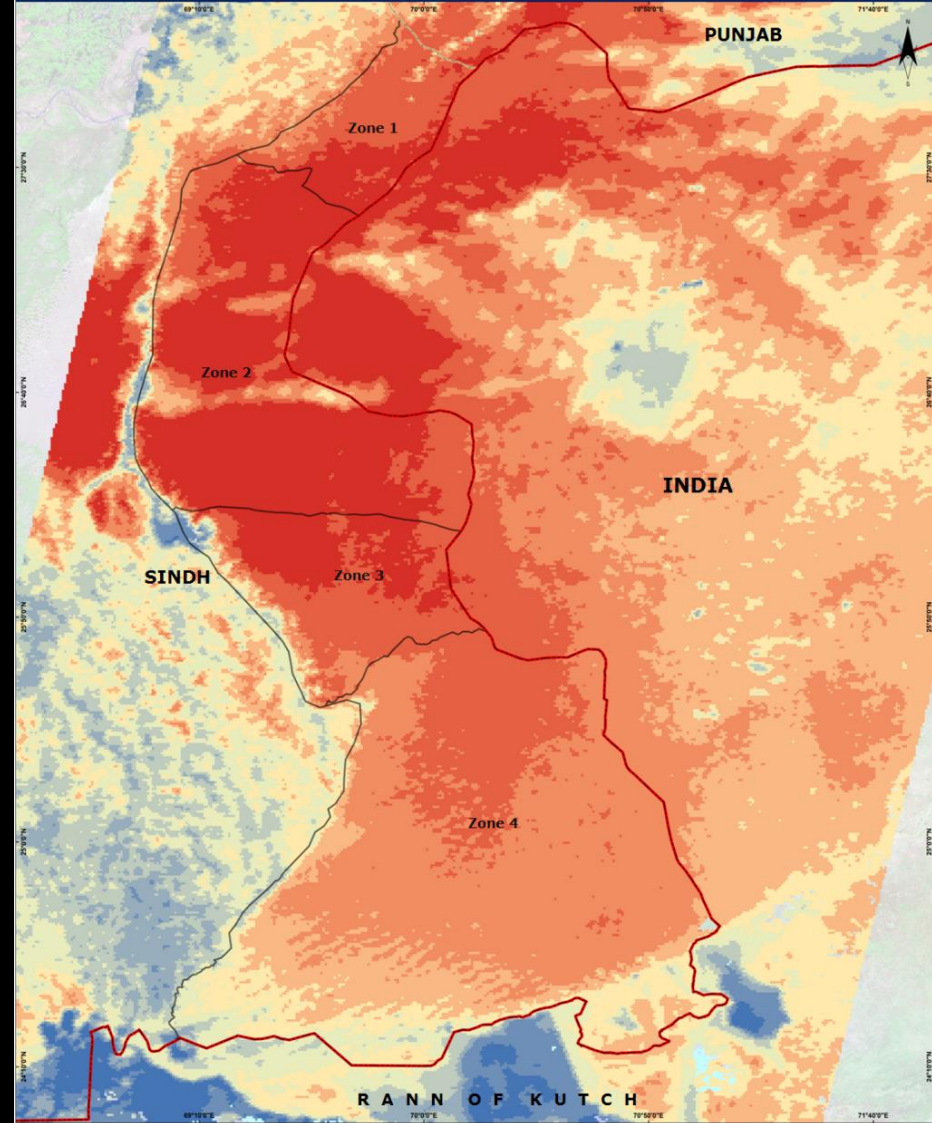
**Land Surface Temperature (Kelvin)**

289 - 297	305 - 307
298 - 301	308 - 309
302 - 304	310 - 311
	312 - 314
	315 - 315
	316 - 317
	318 - 336

**SUPARCO**

Map Projection: GCS\_WGS\_84

Land Surface Temperature Map of MODIS



**Legend**

- Provincial Boundary
- International Boundary

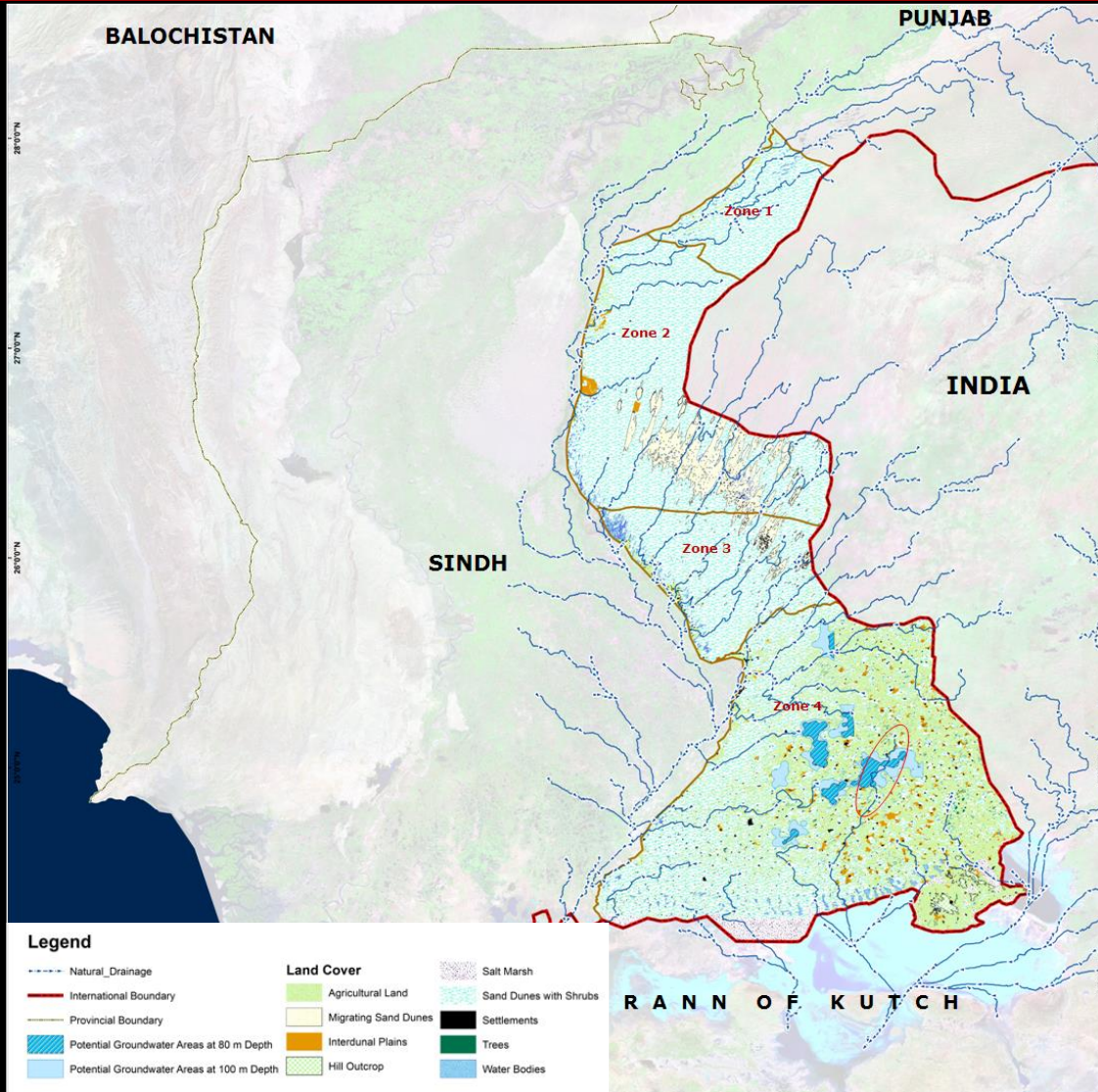
**Land Surface Temperature (Kelvin)**

298 - 305	314 - 315
306 - 309	316 - 318
310 - 313	319 - 320
	321 - 322
	323 - 324
	325 - 327
	328 - 331

**SUPARCO**

Map Projection: GCS\_WGS\_84

# Inferred Potential Groundwater Areas





# Conclusion

- The study demonstrates potential of the applications of geo-spatial techniques in groundwater prospection
- A total of 20 bore holes have been quarried within boundaries of potential groundwater zones
- Sweet groundwater was found in 19 out of 20 bore holes



**Thank You**