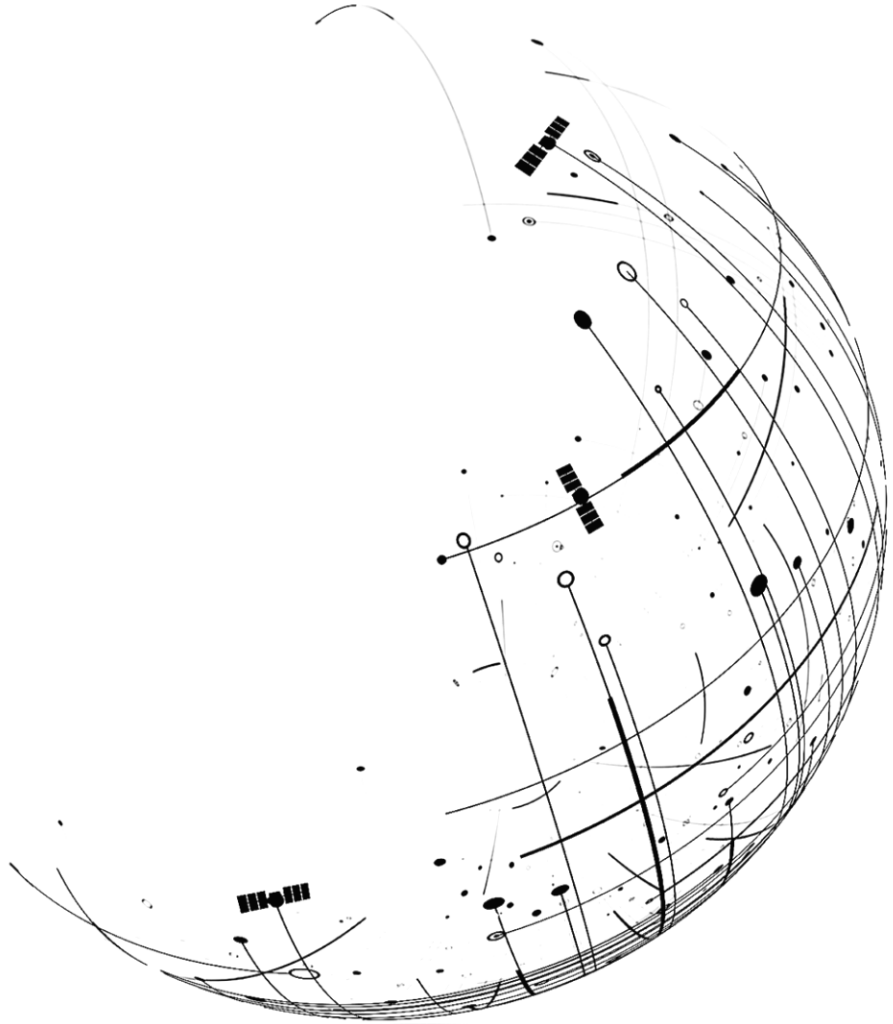
The GNSS Landscape in Pakistan

SUPARCO

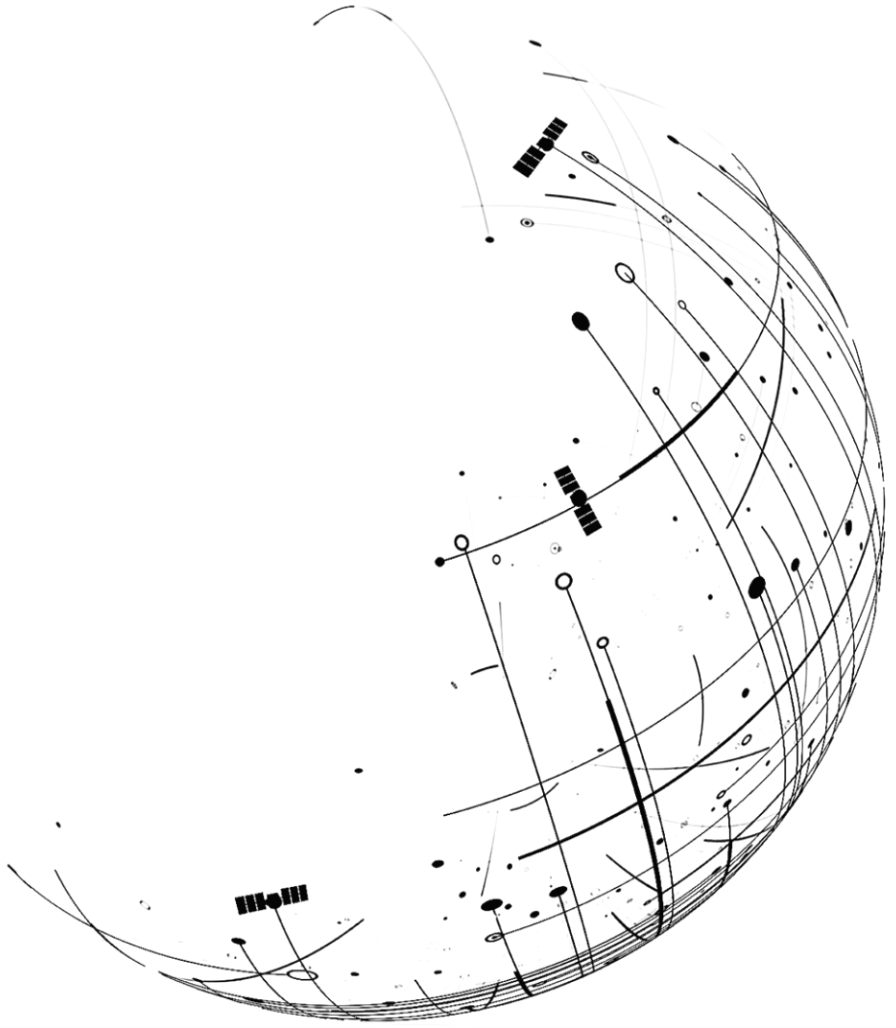
Pakistan Space & Upper Atmosphere Research Commission

Scope of Presentation

- Introduction
- GNSS National Landscape
- GNSS Applications
- GNSS Systems
- Conclusion

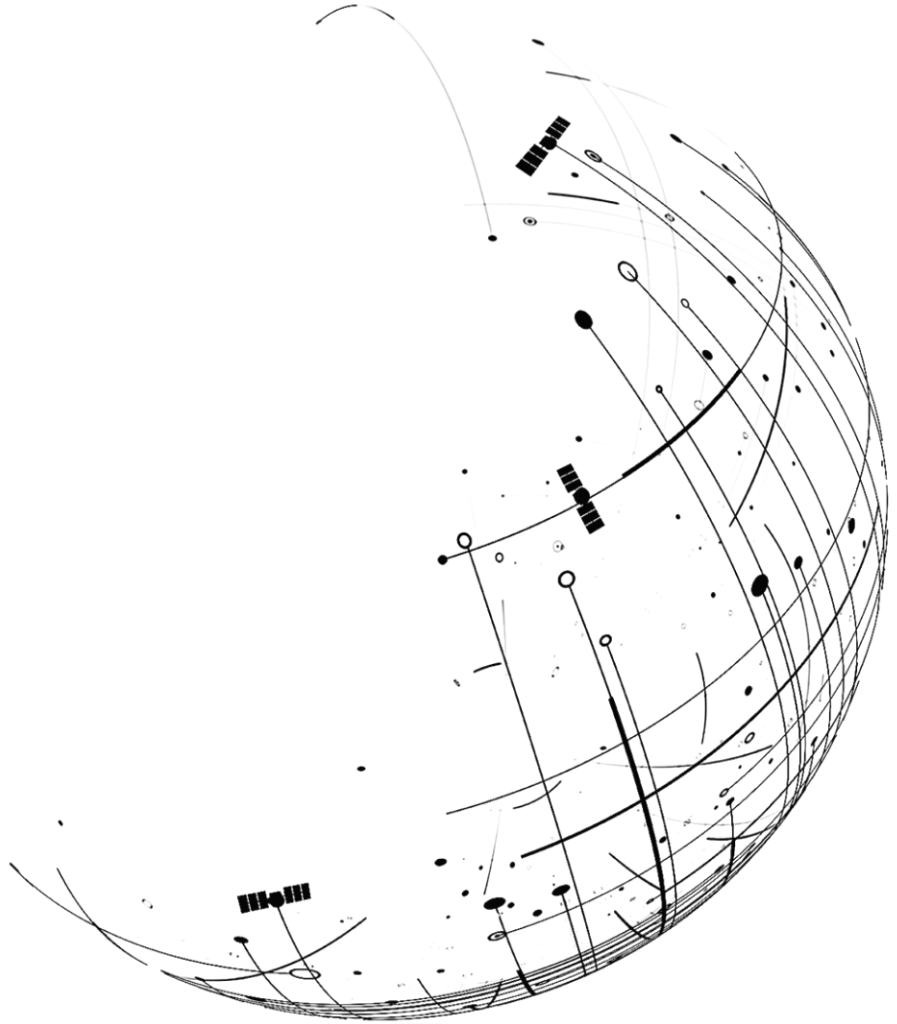


Introduction

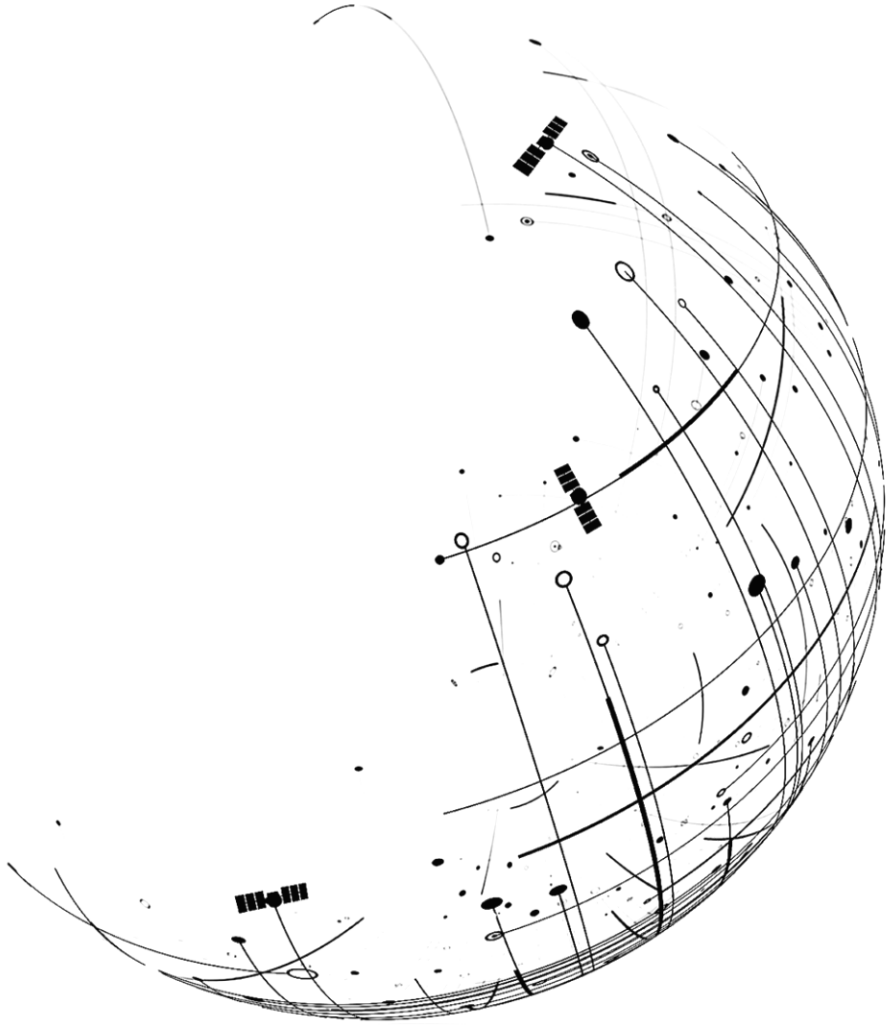


Introduction

- Pakistan is pursuing space program through its National Space Agency SUPARCO (Space and Upper Atmosphere Research Commission) for:
  - Socio-economic development of the country
  - Introduction and promotion of space applications in the country
  - Development of a complete eco-system for provision of GNSS infrastructure, technology and end-to-end solutions



GNSS National Landscape



National Landscape

Key Stakeholders

Planning & Execution

Ministry of Planning Development & Reforms

SUPARCO

Survey of Pakistan

Public Sector Users

Pakistan Civil Aviation Authority

National Highway Authority

Pakistan Maritime Security Agency

Commercial / Industry

Local presence of OEMs

Local startups of GNSS Services

Academia

Institute of Space Technology

Institute of Business Administration

National University of Science & Technology

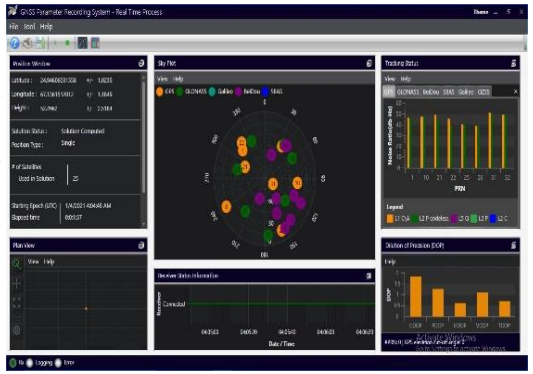
National Landscape

Facilities

iGMA Stations

- iGMAS (iGMA System) at Karachi city
- iGMA Station at Multan city

GNSS Signal Monitoring Station



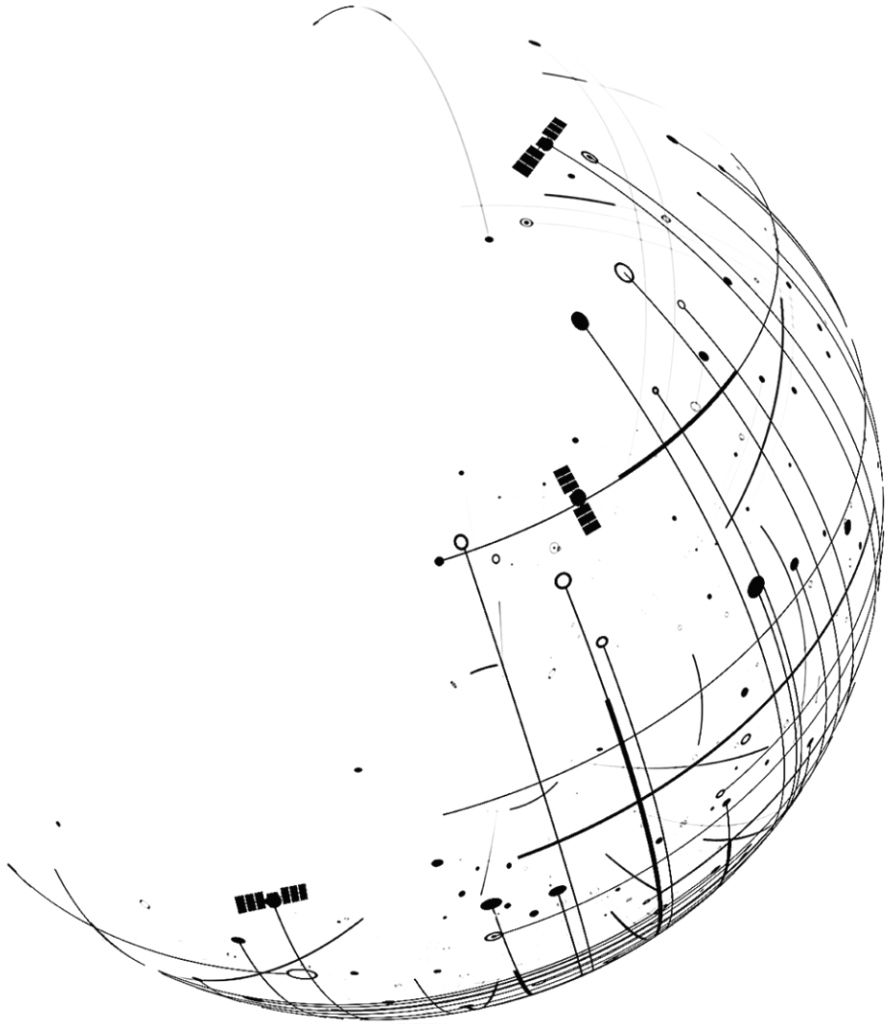
GNSS Integrity Monitoring Analysis

GBAS (Pilot Project)

- NRTK based system covering Karachi city
- Positioning accuracy of H ≤ 04 cm, V ≤ 08 cm

Service Coverage

GNSS Applications



GNSS Applications

Surveying & Mapping

Transportation

Climate Change

Forestry

Agriculture

Wild Life Protection

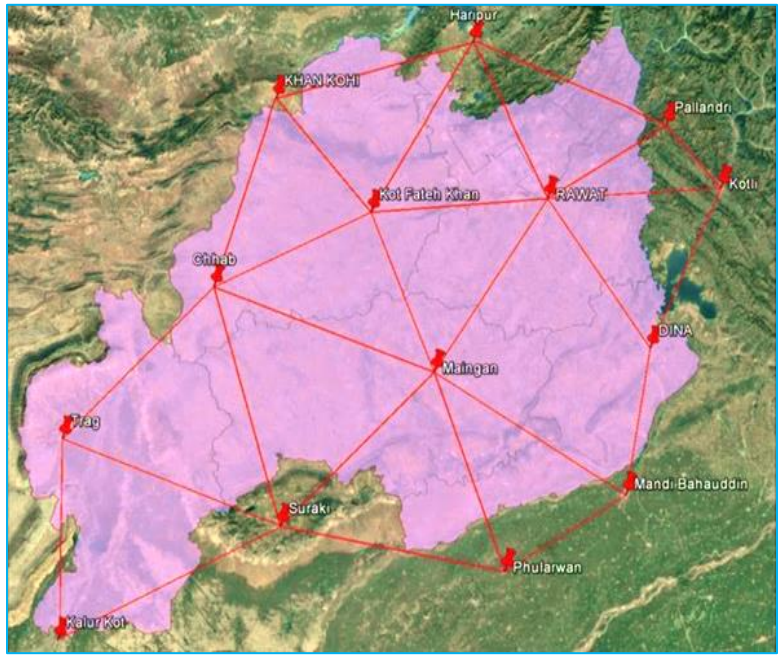
Governance

Disaster Management

Surveying & Mapping

Integrated Solutions for Managing and Conserving Water Resources

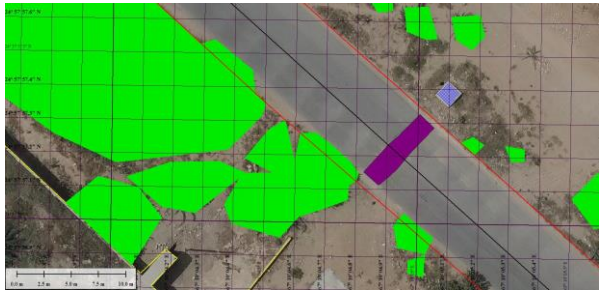
- RTK based GCP collection for accuracy enhancement of Satellite imagery generated DEM
- Identification of potential sites (approx ~8000) for construction of small dams (rain water harvesting)
- Economizing on the cost of surveys and the time required to undertake multi-criteria feasibility analysis



Surveying & Mapping

Highways

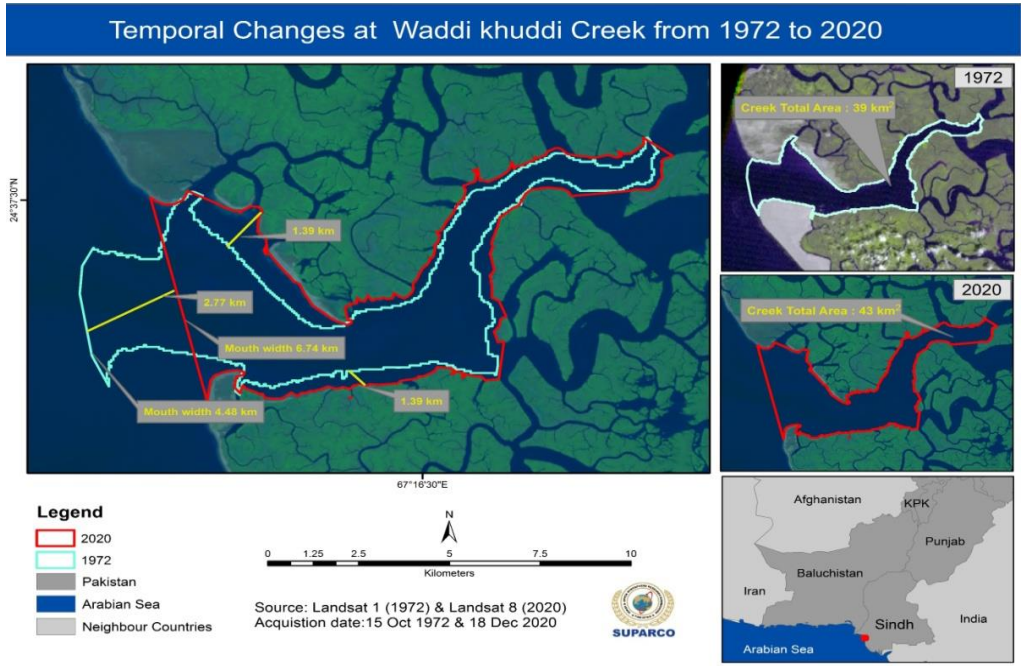
- GNSS drone based high resolution data acquisition for monitoring of national highways/ roads infrastructure with special focus on:
  - *Encroachments (natural, man made)*
  - *Road condition*
- Geo referenced aerial images later incorporated with satellite imagery for development of GSTA (Geo Spatial Temporal Analysis) portal for planning and development



Surveying & Mapping

Monitoring Sea Water Intrusion and Land subsidence

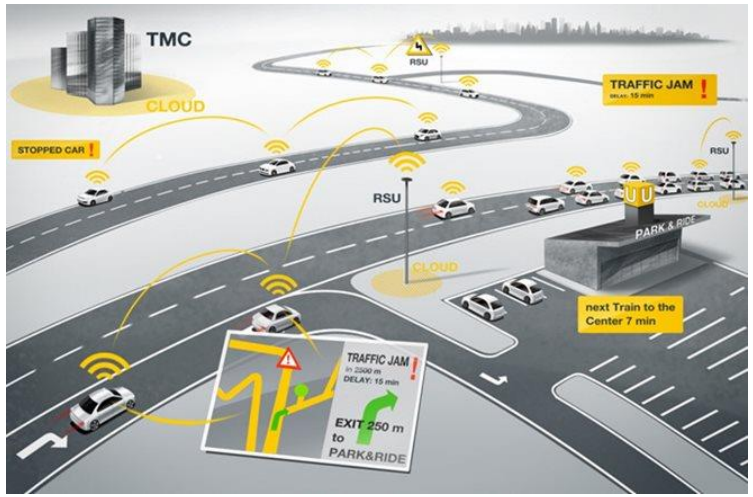
- National Institute of Oceanography, SUPARCO and Pakistan Council of Research on Water Resources are conducting research on Sea Water Intrusion and Land Subsidence along the Coastline
  - Dev of GNSS aided high precision Digital elevation model for selected sites along coastline
  - Installation of GNSS based stations for monitoring land subsidence (vertical shifting of land) along coastline



Transportation

Roads

- Govt. of Pakistan has undertaken development of Intelligent Transportation System (ITS) to reduce the congestions and CO_2 emissions on roads (https://nha.gov.pk/)
- User Services
  - Traveller Information
  - Traffic Management & Operation
  - Law Enforcement & Personal Safety
  - Emergency & Disaster Response Management
  - Electric Toll Collection System Conditions Monitoring



Transportation

Vehicle Tracking

- Private companies provide GPS based vehicle/ fleet tracking/ management solutions

  (https://uniquetrack.com.pk)

- Some companies provide solutions for safety alerts, rough driving alerts, geo-fencing alerts

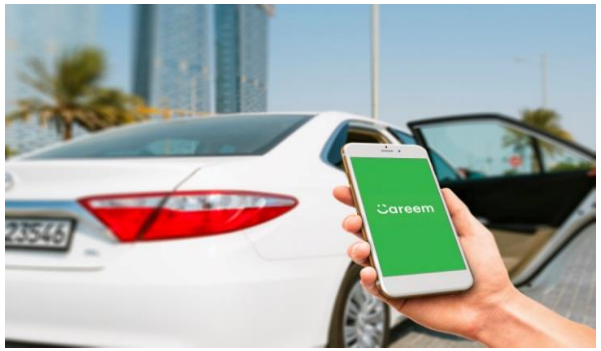
  (https://etracking.pk)

Transportation

Location Based Services

- Location based services are utilized to enable advanced transportation system such as peer-to-peer ridesharing, ride service hailing, grocery/ food deliveries, etc.

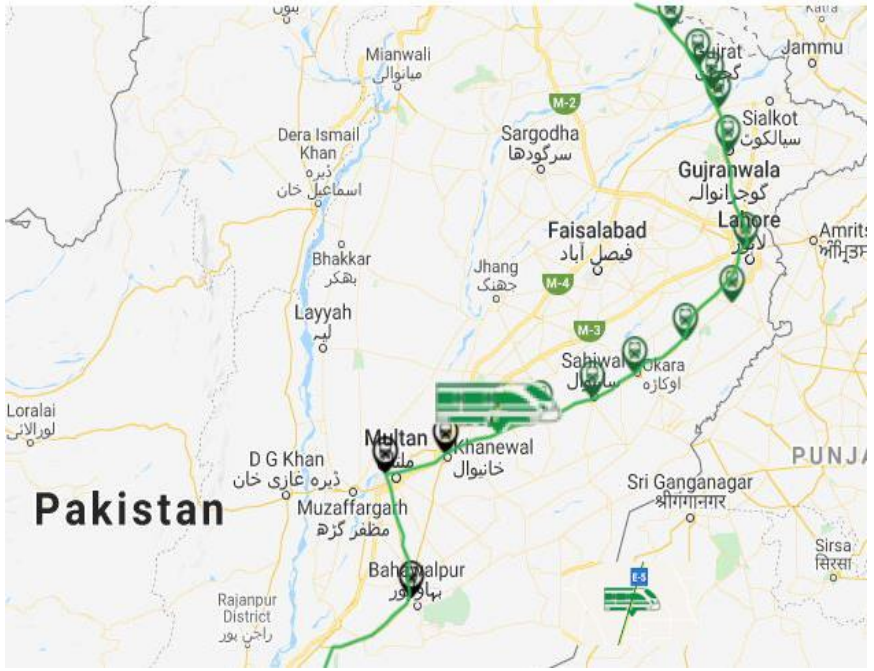
  (https://www.uber.com/pk/en/, https://www.careem.com/ https://www.airliftexpress.com, https://keryana.pk/, https://dawaai.pk/)

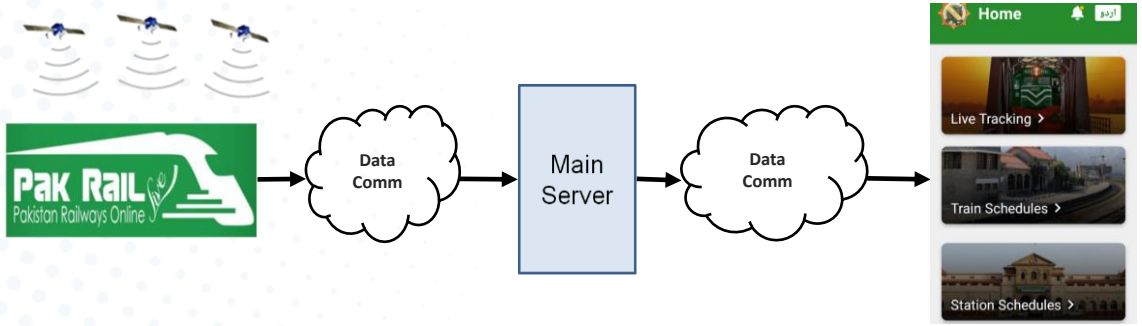


Transportation

Railways

- Pakistan Railways “Pak Rail Live” mobile application provides train tracking, arrival & schedule updates
- The data includes latitude, longitude and velocity of the trains
- GIS functions include Integration of the spatial data, Display the attribute data in a user-chosen format, and make digitized files





Transportation

Marine

- Pakistan Maritime Security Agency (PMSA) manages GNSS based Vessel Monitoring System (VMS) that enables round the clock real time monitoring of deep sea fishing vessels
- VMS is used by fisheries authorities, and coastguards for surveillance, search & rescue and resource management

(http://pmsa.gov.pk)

Transportation

Aviation

- Performance Based Navigation (GNSS based) Instrument Approach Procedures for instrument runaways completed by Pakistan Civil Aviation Authority (PCAA) for airports
- Aviation System block Upgrade through SBAS and GBAS planned for future

(https://www.caapakistan.com.pk)

Climate change

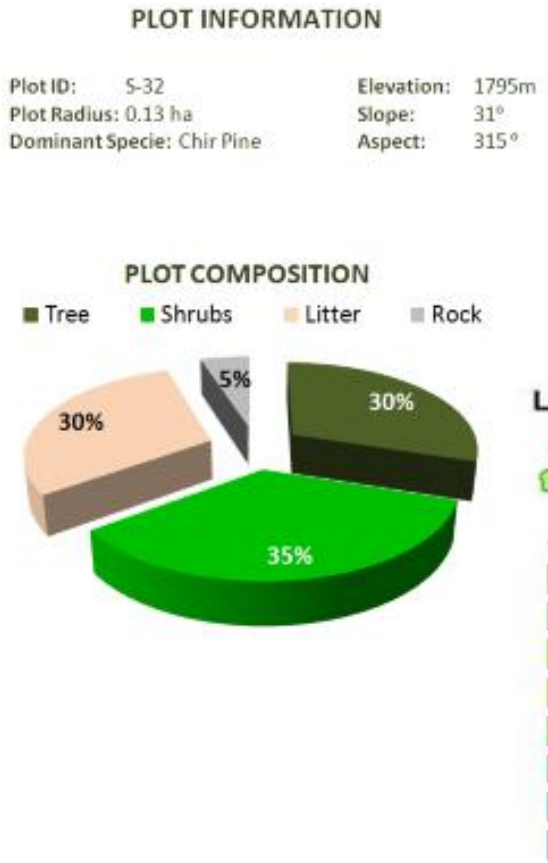
Glacier Inventory

- The ‘Third Pole’ i.e. the Hindu Kush-Karakoram-Himalayan (HKKH) Region now a key concern for climate change
- A GNSS based study was undertaken for identifying glacier inventory (location, size and number) of the part of the ‘third Pole’ located in Pakistan

Climate change

Survey for Carbon Stock Assessment

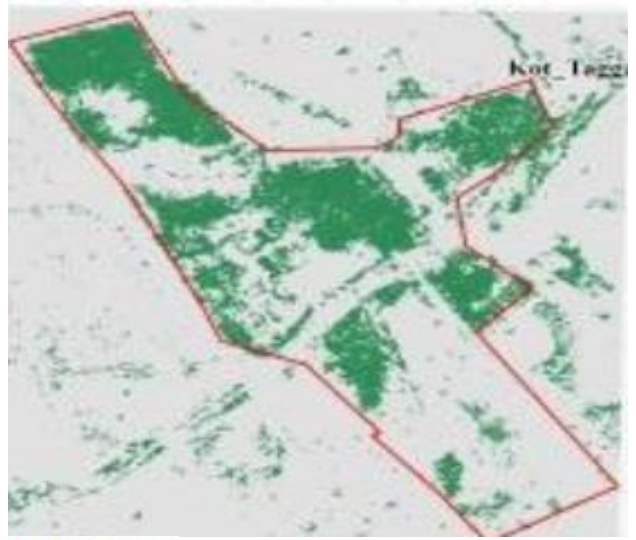
- GNSS aided Aerial Imaging for Carbon Stock Assessment and forest health monitoring in Northern Areas of Pakistan
- SUPARCO conducted an International project to augment the present capacity and capability in handling advanced sensors data for forest carbon stock assessment

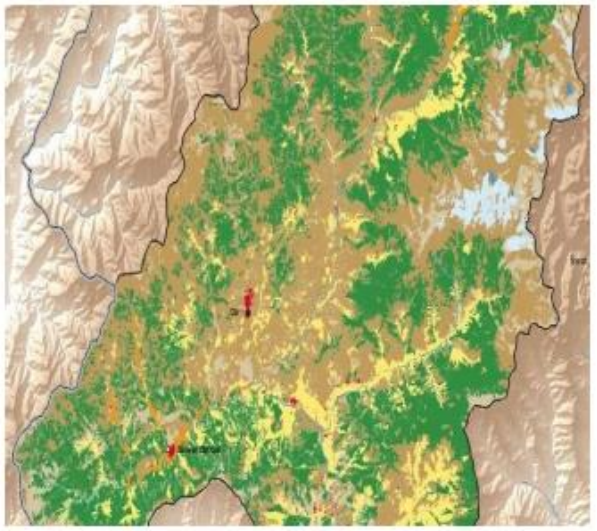


Forestry

National Forest Monitoring System (NFMS)

- Sustainable forest management by monitoring, reporting & verification using:
  - Satellite land monitoring system (SLMS)
  - National forest inventory (NFI)
  - National greenhouse gas inventory (GHG-I)
- GNSS technology is extensively utilized for:
  - Delineation/demarcation of forest compartment boundaries
  - Establishment of Ground Controls Points (GCPs) for covering the range of forest to be surveyed (http://mocc.gov.pk)





Forestry

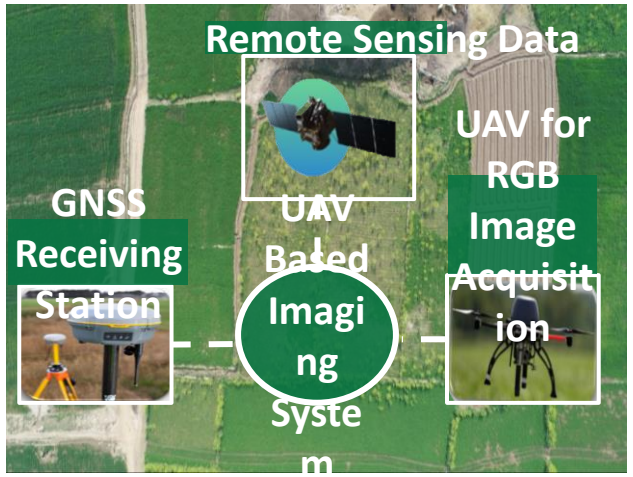
Tree Plantation Campaign

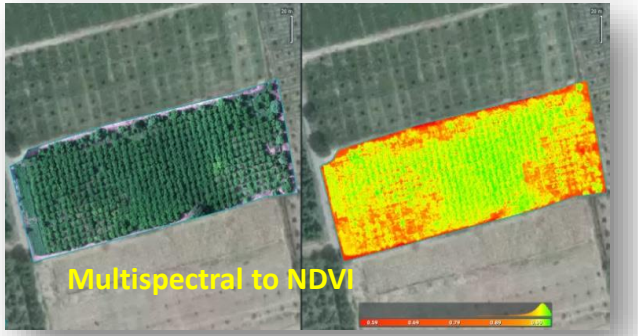
- A Provincial Government (KPK) implemented tree plantation campaign in 2015 in Chinar area to counter climate change challenges
- GNSS technology was utilized for calculation of the campaign area, ensure proper growth of saplings and tracing illicit cutting of trees

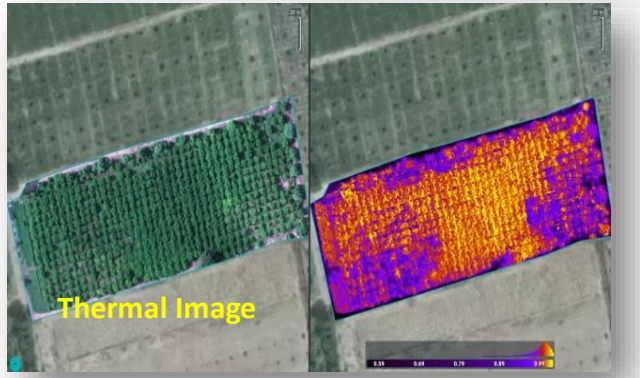
Agriculture

Data Driven Smart Decision Platform for Increased Agriculture Productivity

- GNSS aided High Resolution Aerial Imaging at Farms level (Multi-Spectral, Thermal, LIDAR, Hyper-spectral) for Acquisition of Actionable Intelligence for VRT based Agricultural Inputs (Seeding, Fertilization, Irrigation, etc)
- A collaborative project between SUPARCO and an Agricultural University





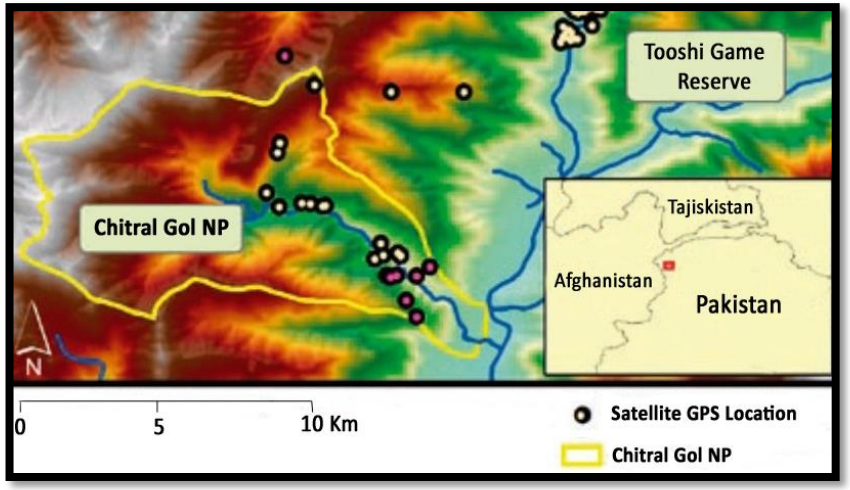


Wild Life Protection

WWF-Pakistan Project for Snow Leopards Protection in Pakistan

- Utilization of GNSS technology in leopard's movements and habitat use
- The collar programmed to take GPS fixes 03 times/day & uplink data via Argos Satellite System once every two weeks

(https://wwf.panda.org)



Wild Life Protection

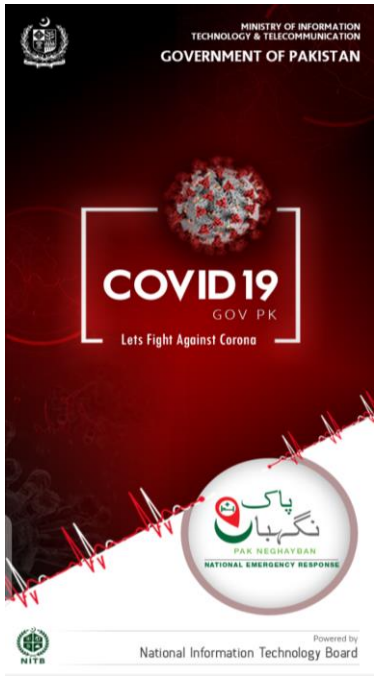
Spatial Monitoring & Reporting Tool (SMART)

- To assist wildlife conservators and national park managers in patrolling and monitoring large areas
- GPS based SMART application uses geographical data collected by community for patrolling routes, and traces of animals
- SMART system implemented in Khunjerab, Central Karakorum & Margalla Hills National Parks

Governance

COVID-19 Emergency Response

- ‘Pak Neghayban’ mobile application allows users to locate hospitals with available beds and ventilators and find out labs conducting corona virus tests (https://ncoc.gov.pk/govt-initiatives.php)
- Multiple features to assist people in pandemic such as:
  - Hospitals Locations
  - Laboratories Locations
  - Corona Zones



Governance

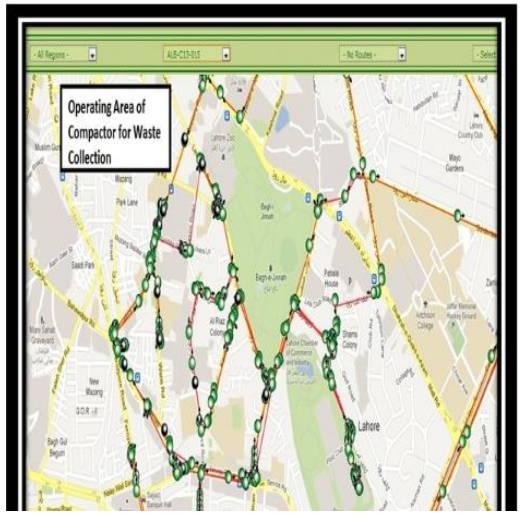
Safe City Projects

- Utilization of GNSS technology for resource location and emergency response management in Safe City Projects (https://psca.gop.pk/)
- Punjab Police has initiated Integrated Command, Control and Communication Center program which utilizes GNSS coupled with latest technology to improve operational efficiency

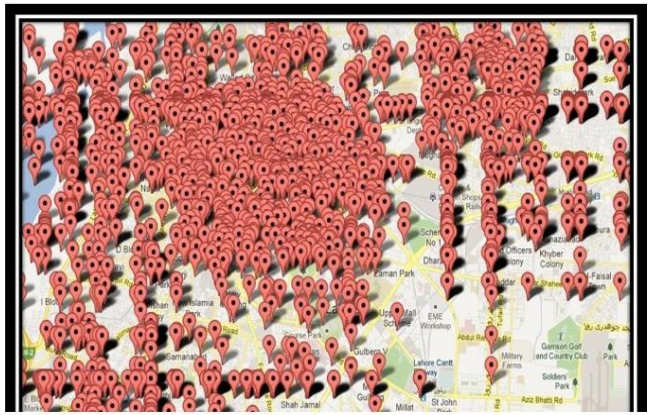
Governance

Waste Management

- A Provincial Government (Punjab) company uses GNSS enabled tablets operated by its field operators to indicate garbage location by providing real time geo-referenced images
- Central Control Station then directs nearest garbage collection vehicle to collect the garbage
- The field observer later transmits cleared area image to the Central Control Station



Vehicle Tracking System

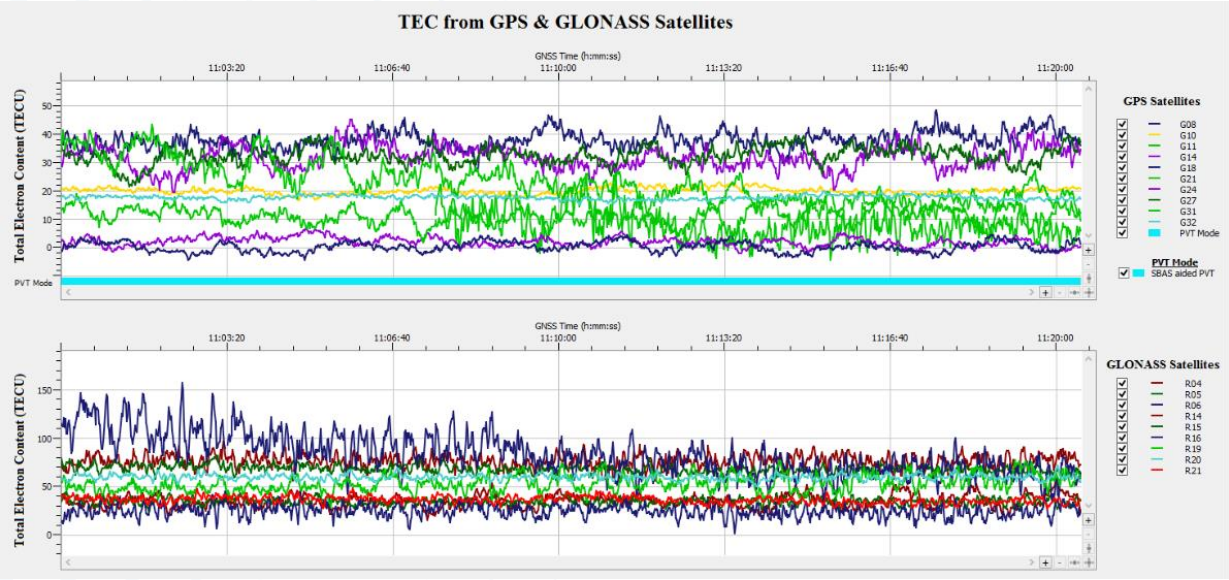


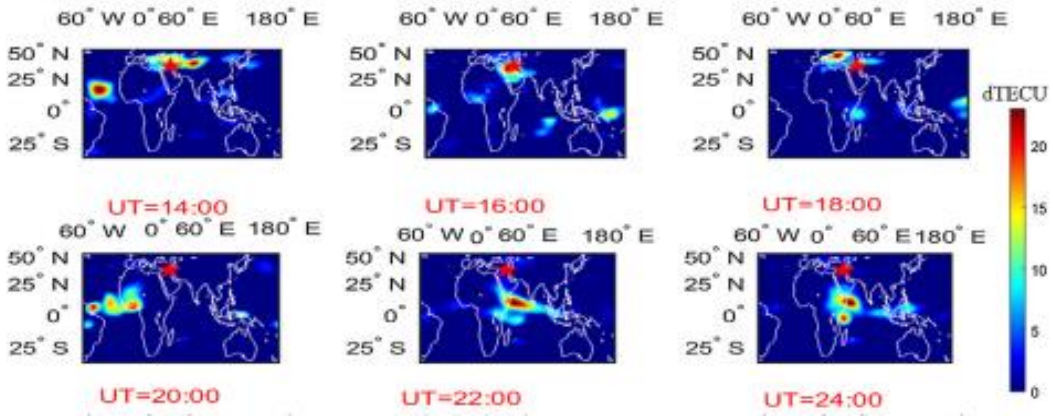
Android App based monitoring

Disaster Management

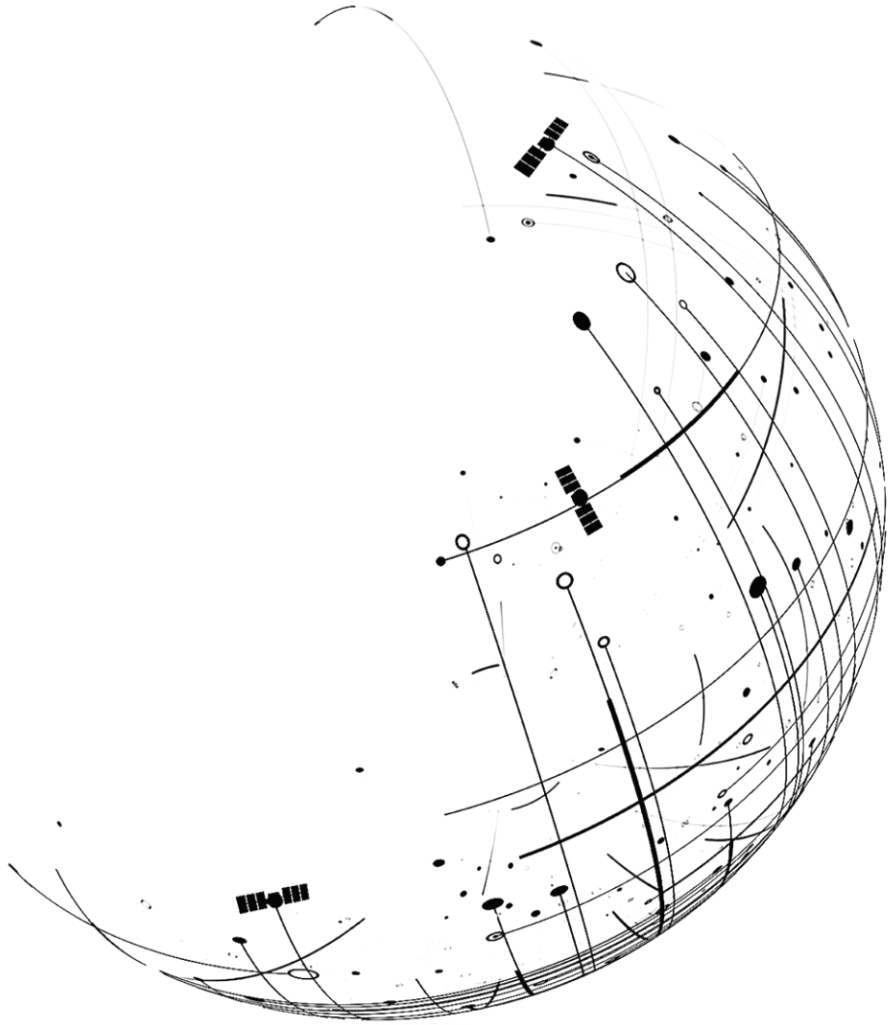
Earthquake Precursor

- GNSS based Ionospheric Stations established by Centre for Earthquake studies (CES) monitor the Total Electron Content (TEC) for potential earthquake precursor (https://www.ncp.edu.pk)





GNSS Systems



GNSS Systems

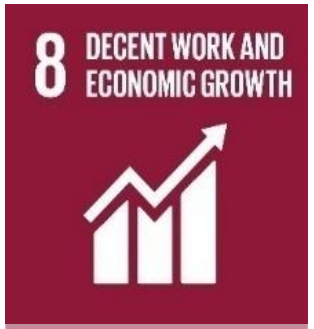
Vision

- To develop GNSS Systems targeted for:
  - Socio-economic development
  - Safety of Life (SoL) services
  - Sustainable Development Goals (SDGs) achievement
- To promote GNSS applications in the country in every sphere of life
- To enhance national capacity building in GNSS research & development
- To foster international/ regional cooperation in GNSS development, operation and utilization
- To join and actively participate in the proceedings of International and Regional GNSS forums

GNSS Systems

Targeted SDGs

Agricultural Productivity



GDP Growth

Infrastructure Mapping

Urban Planning

Disaster Management

GNSS Systems

Development Phase

- New Generation National Geodetic Datum
- Space Based Augmentation System (SBAS)

Planning Phase

- Ground Based Augmentation System (GBAS)
- Regional Navigation Satellite System (RNSS)

GNSS Systems

SBAS

- Kick off — Aug 2021
- Space Segment — Paksat-MM1R (2024)
  Paksat-2R (2026)
- Constellations — GPS, BeiDou (planned)
  Galileo, Glonass (under consideration)
- Protocols — RTCA, DFMC, PPP
- Services — Public, Authorized

12 x RIMS

Ground Uplink Station

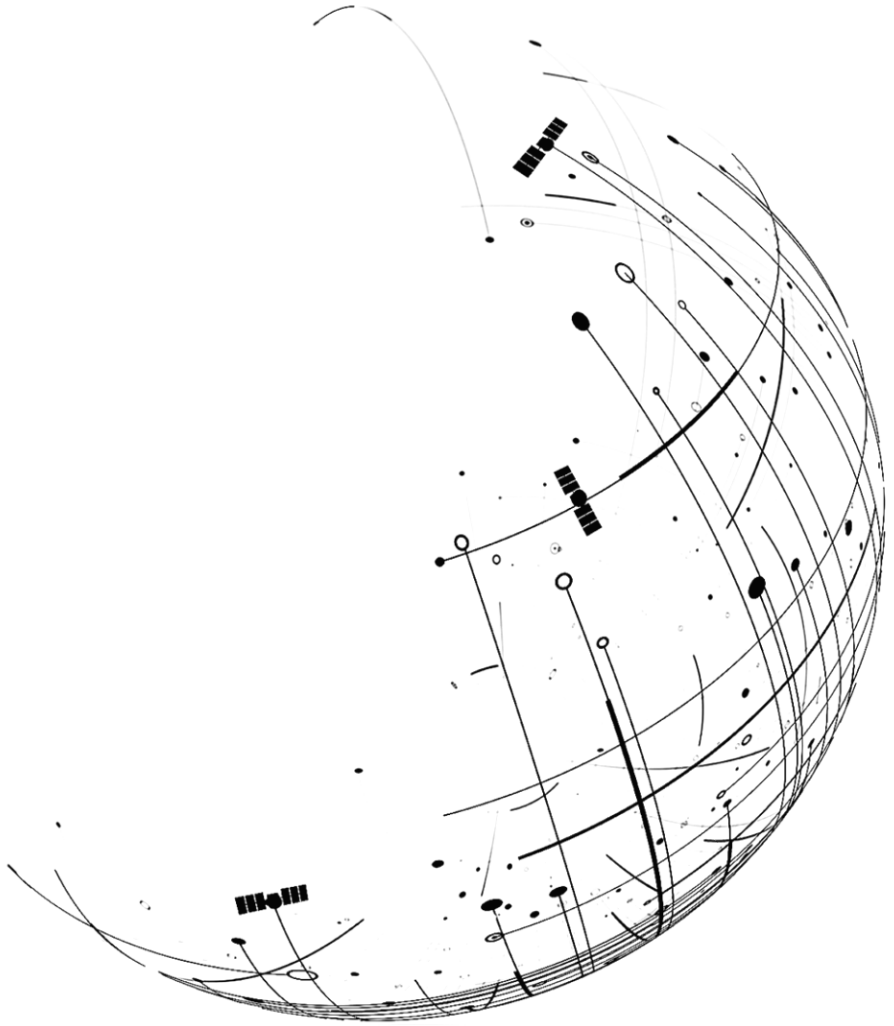
Data Processing Center

GNSS Systems

National Geodetic Datum

- Contract finalization in progress:
  - Horizontal Datum (16 GNSS CORS, 200 points first-class GNSS control network)
  - Vertical Datum (01 long-term tide gauge station, 01 leveling origin point)
  - Gravity Datum (10 absolute gravity station, 10 First Geodetic Leveling (FGL) stations)
  - Geodetic Datum Data Centre

Conclusion



Conclusion

- GNSS is indispensable for socio-economic development
- Pakistan’s GNSS landscape is vibrant and poised to grow in future
- Pakistan is promoting and adopting the utilization of GNSS technology services and applications in the country
- Pakistan is striving to remain abreast with the GNSS technology spectrum and be part of the international forums shaping its future

Thank You