

Geographical Information System Sector

“Knowing where things are, and why, is essential to rational decision making.”

Jack Dangermond



The Geographical Information System (GIS) is a framework to collect, store, manage, manipulate, analyse and visualise spatial data. GIS enables to store information in layers and retrieve data to identify unique patterns, solve complex problems, automate processes and build decision support systems.

The GIS has the potential to be used in virtually every field. The application of GIS includes urban planning, transportation planning, environmental risk analysis, climate change, flood forecasting and damage estimation, disaster management and mitigation, emergency response, hydro-informatics, irrigation water management, reservoir site selection, wetlands mapping, natural resources management, wildlife management, landslide hazard zonation, soil mapping, mineral exploration, modelling renewable energy, agriculture, land information system, public health, waste management, crime analysis and utilities mapping.

At NESPAK, the GIS Sector continues to grow exponentially in the engineering and environmental domains. NESPAK is the pioneer in the GIS Sector in Pakistan and its industry leadership extends over three decades. The Company's vast experience in diverse disciplines has increased its portfolio of GIS projects manifold. So far, more than 70 projects have been undertaken in this sector for local and international clients in addition to providing in-house services for the Company. NESPAK possesses a strong team of GIS experts having excellent technical knowledge and broad experience to ensure successful and timely completion of projects.

NESPAK scope of services and experience in the GIS Sector are given below:

SCOPE OF SERVICES

Real-time Crop Water Monitoring using Satellites: Identification of crop types, development of Normalised Difference Vegetation Indexes (NDVIs), generation of NDVI time-series using Fourier components (magnitude and phase), calculation of evapotranspiration and calculation of crop water requirements.

DSM and DTM Generation from Drone Imaging: Production of extremely high-resolution Ortho-mosaics (less than 10cm), Digital Surface Models (DSM) and Digital Terrain Models (DTM) from Unmanned Aerial Vehicle (UAV) or Drone imaging. Geo-rectification by state-of-the-art Differential Global Positioning Systems (DGPS) for survey grade accuracy results.

Photogrammetry: Aerial triangulation, stereo compilation, bundle block adjustments, digital surface modelling, digital terrain modeling, ortho-rectification, ortho-mosaicking and feature collection (topographic/planimetric maps)

Remote Sensing: Information extraction from passive and active remotely sensed data (e.g., multi-spectral radiometer, Radar, Lidar), digital image processing, pattern recognition, automated classification of land covers, supervised classification, unsupervised classification, Geographic Object-based Image Analysis (GEOBIA) and change detection.

Web GIS Application: Development of browser-based GIS application on both Environmental Systems Research Institute (ESRI) and open source platform. Online spatial querying, overlay and buffer analysis and other geo-processing tasks. Dynamic development of thematic maps, based on



the outputs of hydrological and hydraulic models.

GIS Database and Model Development:

Development of geo database consisting of thematic map layers e.g., land use, soils, elevation, geology, slope, watersheds, floodplain map layers and their integration with hydrologic, groundwater, evapotranspiration, watershed and river flow models.

Geographical Data Analysis: GIS data analysis includes querying, reclassification, retrieval, map generalisation, map abstraction, map sheet manipulations, buffer generation, polygon overlay and dissolve, measurements, digital terrain analysis (hydrology, topography etc.), cut/fill volume calculations, network analysis and overlay analysis.

GIS Field Data Collection and Verification:

Data collection through field surveys, topographic survey, etc., being applied to all types of features such as roads, rivers, dams.

Map Production: Map production as per ESRI cartographic standards.

EXPERIENCE

NESPAK offers a broad spectrum of GIS services in near real-time monitoring of flood, reservoirs, crop conditions, forest disturbances e.t.c., using very high-resolution satellite imagery, extremely high-resolution digital surface models produced from drone imaging. Development of Web GIS applications and its integration with engineering models and customised GIS applications as per client requirements. To date, NESPAK has developed GIS database and models for urban development, utilities mapping, flood forecasting, watershed management, irrigation and dam engineering.

GIS in Water Sector: NESPAK has provided extensive GIS services for 28 projects in the Water Sector. Key projects include National Flood Protection Plan-IV, Water Resources Management Information System (WRMIS),

Indus Basin Model Revised (IBMR), Neelum-Jhelum Hydropower Project, Greater Thal Canal Project and Alborz Integrated Land and Water Management. Detail of experience areas is as follows:

- **Flood Forecasting:** In the field of flood forecasting, NESPAK has carried out the National Flood Protection Plan-IV project, wherein previously developed Flood Early Warning System (FEWS) model was updated. Land-use map of Indus River and its major tributaries (Kabul, Swat, Jhelum, Chenab, Ravi and Sutluj) has been developed along with high, medium and low flood risk zones. FEWS predict expected areas of inundation for any part of 3,500 km long Indus Basin. All land-use and risk maps are accessible through a web GIS application developed for stakeholders.
- **Drought Mitigation and Planning:** GIS has been utilised to evaluate the impact of prolonged drought in Pakistan in Rod Malazai and Pishin districts, Balochistan and Soan Valley, District Khushab, Punjab. After an intense resource evaluation based on satellite imageries, potential sites for recharge dams and deep groundwater development were identified. A Disaster Mitigation Plan was prepared with GIS overlays and modelling.

GIS in Dam Engineering: GIS is being used extensively in a number of ongoing hydropower projects. Large-scale topographical mapping, catchment area delineation, geological mapping and resettlement studies have been carried out for the Kalabagh Dam, Diamer-Basha Dam, Mangla Dam Raising and Mirani Dam projects.

GIS in Urban Planning: As many as 15 projects have been carried out in the urban planning sector by NESPAK. The important ones are the Development of GIS Geo-spatial for Five Cities in Punjab, Satellite Imageries of 42 Military Cantonments of Pakistan, Sindh Six Cities Improvement Investment Programme, Rawalpindi



Improvement Project, Integrated Master Plan for Lahore and Integrated Master Plan for Multan.

GIS in Highways Sector: NESPAK offers GIS services for projects pertaining to roads and highways. NESPAK has provided services for Corridor and Alignment Study of Batinah Expressway, Detailed Field Inventory Planning and Preparation of Kookies Along Batinah Coastal Highway, Treatment of Landslides on Kohala-Muzaffarabad Road, Azad Jammu and Kashmir and Sialkot-Lahore Motorway Project.

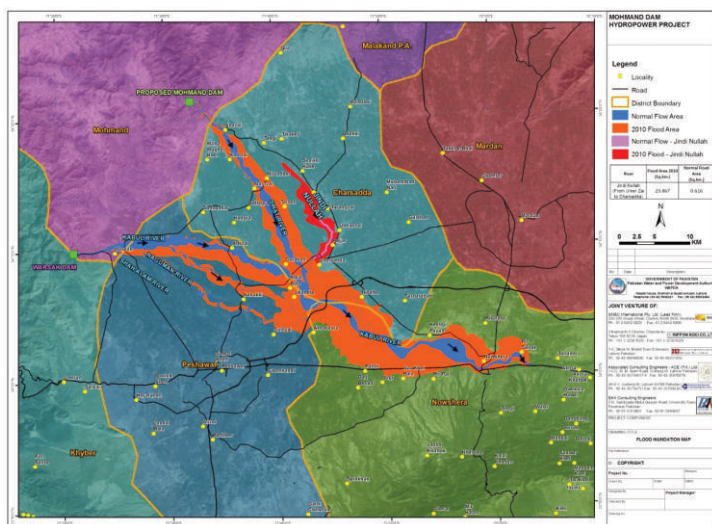
GIS in Utilities Mapping: As many as 16 projects have been carried out in the utility network sector. Details are given below:

- **Power Distribution System Mapping:** NESPAK developed a GIS for 11 kV network of one of the grid stations for the Karachi Electric Supply Company for managing information of the power distribution network from the grid station to the transformers. The conventional database for consumer data management has been linked to the base map to record consumer location. This can be helpful for further analyses to aid power engineers in load balancing and location-based loss statistics.
- **Gas Distribution System Mapping:** A GIS application has been developed for the Sui Northern Gas Pipelines Limited. Complete distribution system of Sui Gas network from SMS (Short Message Service) to consumer has been digitised with the help of existing maps, latest satellite imageries. Eventually, the network will be linked to simulation models.
- **Sanitary Drainage Mapping:** NESPAK has provided complete GIS services for Sanitary Drainage Master Plan for Jeddah City. The entire existing sanitary network was digitized from the existing drawings and overlaid on high resolution satellite imagery. Relevant attribute data was attached with each pipe segment for a total of 1,800 segments. Data for 24,000 manholes
- was prepared. NESPAK also provided GIS services for the Sewerage and Drainage Scheme for Southern Lahore and Multan Master Plan Project.
- **Water Supply System Mapping:** Another NESPAK project in the utilities sector is the Quetta Water Supply and Environmental Improvement Project. Water supply network has been digitised and all the parameters have been incorporated for various nodes and lines in the network. The network has been linked with MIKE Urban Software of the Danish Hydraulic Institute and simulates the flow distribution in the network. NESPAK also provided GIS services for Water Supply System mapping for Multan Master Plan.
- **Corridor Mapping:** NESPAK also renders services in corridor mapping which includes corridor and route selection for a collision-free corridor. Corridor selection comprises identification and mapping of constraints, i.e., environmentally protected areas, steep slope areas, water bodies, built-up areas, prohibited areas and heritage sites within a specific corridor. NESPAK has carried out Iran-Pakistan Gas pipeline 800km route selection and 1,300 km long Power Transmission line from Karachi to the Upcountry using its expert services.

SOFTWARE USE

NESPAK is using ArcGIS program for mapping and serving data through server on the web for its GIS-related projects. ArcGIS has been used on field survey, mapping through web-based Enterprise GIS application for Islamabad Electric Supply Company, Water Resources Management Information System and Decision Support System for Efficient Irrigation Water Management in Punjab, Development of National Flood Protection Plan-IV and Related Studies to Enhance Capacity Building of Federal Flood Commission, GIS/MIS Centre and Decision Support System to Enhance the Capacity of Indus River System Authority.



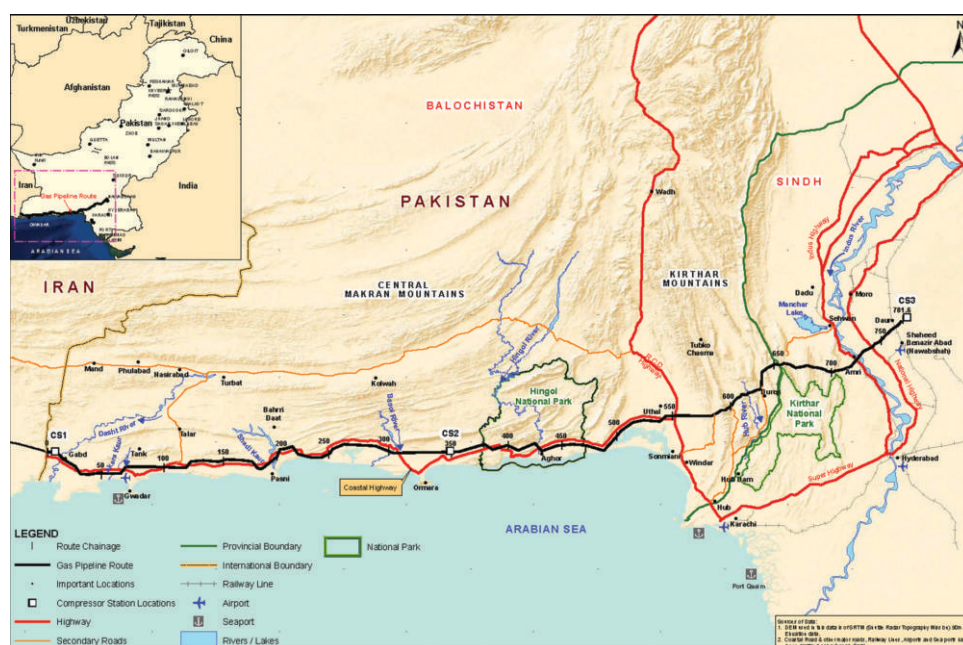


GEOGRAPHICAL INFORMATION SYSTEM SECTOR

Mohmand Dam Hydropower Project

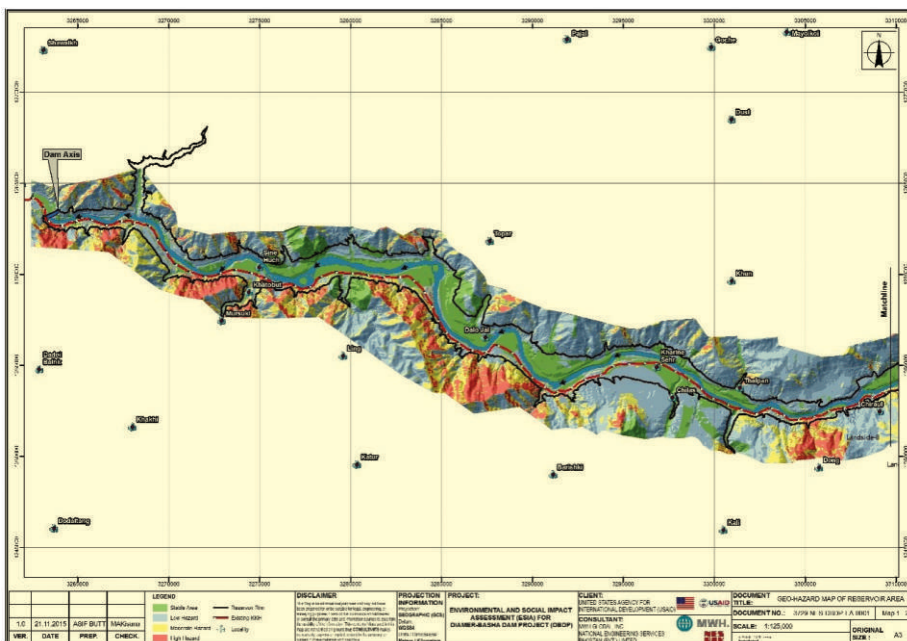
NESPAK conducted flood inundation studies of Swat and Kabul Rivers with historical data of 2010 super-flood during detailed design study of Mohmand Dam Hydropower Project. The flood inundation was computed for both the rivers up to Nowshera Bridge. Quantification of inundated area was also carried out for damage estimation.

Iran-Pakistan Gas Pipeline Project



Under Iran-Pakistan Gas Pipeline Project, GIS database has been developed for land use environmental, hydrological and route constraints marked on 5km wide route corridor with detailed topographical survey of 200m finalised route corridor. A web GIS application on ESRI ArcGIS Server has also been developed to disseminate spatial information to the project stakeholders through a virtual private network.

Diamer-Basha Dam



Geohazard mapping and preparation of geohazard inventory of Diamer Basha Dam reservoir was conducted during the World Bank-funded Environmental and Social Impact Studies for the Diamer-Basha Dam. NESPAK carried out Landslide Susceptibility Mapping study for the Diamer-Basha Dam reservoir, using the Bivariate Statistical Weight of Evidence Method (WofE) Method. Reservoir area was categorised in three classes i.e., high hazard, moderate hazard and low-to-no hazard.



Upgradation of Pakistan Railway's Existing Mainline

The Government of Pakistan under the China-Pakistan Economic Corridor (CPEC) projects assigned Upgradation of Pakistan Railways Existing Karachi-Peshawar Main Line-I Project to the China Railway Eryuan Engineering Group Limited (CREEC). Under this project, CREEC entrusted DGPS-based establishment of (Horizontal and vertical) Geodetic Control along 1800 km long Main Line (ML-I) to NESPAK. NESPAK conducted the fourth order horizontal control and first order vertical control network establishment along the Main Line (ML-I) referenced with the Survey of Pakistan.

