SUPARCO Headquarters
LIST OF CONTENTS

About SUPARCO ........................................................................................................... 01
Space & Atmospheric Science .................................................................................. 02
Remote Sensing and GIS Applications ....................................................................... 15
Satellite Technology Programme .............................................................................. 20
International Cooperation ....................................................................................... 25
Human Resource Development ............................................................................... 27
LIST OF FIGURES

Fig. 1&2: Variability of foF2 at Karachi & Islamabad during Solar Maximum (1999–2000) & Solar Minimum (2006–07) and its comparison with IRI

Fig. 2: Comparison of foF2 and IRI-2001

Fig. 3: Hourly data of Karachi Vs SSN

Fig. 5: Geomagnetic Observatory at Karachi

Fig. 6: Geomagnetic Observatory at Islamabad

Fig. 7: PALUT, PMCC and RCCs setup

Fig. 8: Classified MODIS Images (28-12-2008)

Fig. 9: Classified MODIS Images (30-12-2008)

Fig. 10: Biomass burning in India near Pakistani border. Red spots show fire (biomass burning) whereas green dots show air trajectory (modeled upon meteorological conditions) depicting transport of air mass from Indian area to Pakistan. A smoke plume is also visible

Fig. 11: ADPRC system block diagram, Lab view and receiving Antennas of LEO & GEO Satellites

Fig. 12: Catchments of Chitral River

Fig. 13: Snow cover deletion curves (2004-06 melting season)

Fig. 14: Glaciers identified in the study area

Fig. 15: Geographical location of study area

Fig. 16: NDVI calculated from AVHRR data for four districts of Sindh

Fig. 17: Annual rainfall intensity in Sindh province during 1986-2006. Red colored horizontal line shows average rainfall in 20 years

Fig. 18: Overall methodology of “Quad S” approach

Fig. 19: Monitoring environmental changes and land degradation due to sea intrusion in southern Sindh

Fig. 20: Satellite Image Map of Thatta & Badin districts, based on SPOT data of Nov 2008

Fig. 21: Waterlogging & salinity thematic map of Thatta & Badin districts, based on SPOT data of Nov 2008

Fig. 22: Study area for mapping of tobacco crop – district Mansehra, NWFP

Fig. 23: Satellite in SAINT bay

Fig. 24: SAINT entrance through air shower

Fig. 25: Integration & functional testing of CFIs of Paksat-1R in progress at SAINT facility

Fig. 26: View of PAKSAT-1

Fig. 27: Stowed Paksat-1R

Fig. 28: Configuration of Paksat-1R in orbit (An artist’s view)
1. About SUPARCO

Introduction

1.1 Space and Upper Atmosphere Research Committee (SUPARCO) Pakistan was established in 1961. It was granted the status of Commission in 1981. SUPARCO, Pakistan’s national space agency has been devoted to R&D work in Space Science Technology, and their applications for the peaceful uses of outer space.

1.2 The major R&D activities of the Commission are:

- Pursue R&D activities in space science, space technology and allied fields for achieving the objective of self-reliance;
- Enhance indigenous capabilities in space science and technology and their applications for peaceful purposes and socio-economic development;
- Prepare and propose short and long-term space programmes to the Govt;
- Develop satellites and satellite launch vehicles;
- Establish satellite ground stations;
- Undertake surveys, investigations and other specialized tasks;
- Advise the Government in all space-related matters;
- Liaise with national and international agencies.
- Operate Mission Control Center (MCC) and Local User Terminal (LUT) of the COSPAS-SARSAT international satellite-aided search and rescue programme providing services to user agencies.

COSPAR National Committee Members

- Engr Raza Hussain   Associate Member
- Dr Sajid Mirza   Associate Member
- Dr Muhammad Riaz Suddle   Associate Member
- Mr Imran Iqbal   Associate Member
- Mr Ayaz Aziz   Associate Member
- Mr Arshad Hussain Siraj   Associate Member
- Mr Badar Munir Khan Ghauri   Associate Member
- Mr Jawed Ali   Associate Member
- Ms Rizla Zareen   Associate Member
- Mr Shafatullah Khan   COSPAR National Report Administrator
Space & Atmospheric Science
2. Space & Atmospheric Science

Introduction

2.1 Pakistan’s space programme encompasses diverse scientific and technological fields and includes research in atmospheric and space sciences using satellites and sounding rockets, satellite meteorology, atmospheric research, environmental monitoring, climate change studies, ionospheric and geomagnetic monitoring and research studies.

2.2 The major activities relating to Space and Atmospheric Sciences are as follows:

- Exploit the potentials of space technology for environmental and pollution monitoring;
- Develop indigenous capabilities in Space Science and its applications;
- Initial environmental examination and environmental impact assessment;
- Aerosols characterization and source apportionment;
- Source evaluation of dense winter fog in north-eastern Pakistan (trans-boundary air pollution impact analysis);
- Risk assessment due to snow, flood and drought;
- Climate change studies;
- Round the clock monitoring of the ionosphere & preparation of charts for the prediction of MUFs and FOT for optimum HF radio communications;
- Round the clock monitoring of geomagnetic field;
- Promotion of relevant scientific activities in the country;
- Marketing of space science value-added products and services to public and private sector agencies;
- Create awareness about latest technologies and embark upon human resource development Programme.

2.3 Major R&D facilities include fixed and mobile Air Pollution Monitoring facilities, Environmental Testing Laboratory, Analytical Chemistry Lab, National Ionospheric Sounding facilities at Karachi, Multan and Islamabad as well as Geomagnetic Field Monitoring facilities at Sonniani and Islamabad. Progress achieved during 2008-09 is given in the succeeding paragraphs:
Space Weather Monitoring

Ionospheric Research and Radio Wave Propagation

2.4 SUPARCO is carrying out ionospheric research and related radio wave propagation studies for nearly last three decades. Using local ionospheric data, various ionospheric phenomena affecting High Frequency (HF) radio communications have been studied using a network of three digital vertical ionospheric sounders one each at Karachi, Multan and Islamabad.

Improved Scaling Techniques

2.5 Monitoring the local ionosphere and scaling of the data acquired from digital ionospheric sounder at Islamabad, Multan and Karachi at 15-minute interval are carried out using Standard Archival Output (SAO) software. Value-added products are being used to prepare monthly bulletins of Pakistan Ionospheric Data in standard format and issued to user agencies such as Pakistan International Airlines (PIA), Pakistan Broadcasting Corporation (PBC) and Library of Congress.

Research Studies


2.6 The monthly hourly medians of maximum electron density, NmF2 of Karachi (geog. coord. 24.95°N, 67.14°E) and Islamabad (geog. coord 33.75°N, 72.87°E) have been determined for solar minimum (1996) and solar maximum (2000) and compared with IRI.

2.7 The study concluded that:

- The monthly hourly medians of NmF2 at Karachi in the afternoon are considerably greater than those at Islamabad during the periods from March to October of the year 1996.
- During all the year 2000, the medians of NmF2 at Karachi in the afternoon are greater than those at Islamabad.
- During solar minimum (1996) and solar maximum (2000), the maximum value of monthly hourly median of NmF2 occurred in April at Karachi and Islamabad.
- During solar minimum (1996), the minimum value of monthly hourly median of NmF2 occurred at Karachi in January, whereas at Islamabad the minimum value occurred in February. During solar maximum (2000), the minimum value of monthly hourly median of NmF2 occurred in January at Karachi and Islamabad.
- The maximum monthly values of NmF2 show a semi-annual variation at Karachi and Islamabad both during 1996 and 2000.
The variability of $f_0F_2$ was examined in the data acquired from Digisonde DGS-256 at Karachi (low latitude) and Islamabad (near mid latitude) during 1999–2000 (solar maximum) and 2006–07 (solar minimum). The %variability ($V$) was observed 3% greater during solar maximum for both stations with higher values at nighttime. The comparison of $f_0F_2$ values with IRI-2001 showed the same seasonal trend with overestimation.

This study revealed that:

- At Karachi (URSI code KA225) and Islamabad (URSI code IS233), the %Variability ($\%V$) is higher in winter (D-months) and equinoxes (E-months) during solar maximum but in summer (J-months) it is higher during solar minimum.
- At KA225 the daytime $\%V$ is lower except in D & J-months of solar minimum, whereas the $\%V$ remained low during daytime at IS233 for all the seasons of both solar activity periods.
- The lowest and highest $\%D$ ($\%$Deviation) values at KA225 have been observed during E-months, whereas at IS233 these extremities exist during D-months of both solar activity periods.
- In general IRI subroutine model CCIR showed good to reasonable agreement with $f_0F_2$ whereas IRI subroutine model URSI showed reasonable to poor agreement except in D-months of solar minimum for both stations. It is seen that CCIR and URSI curves are close to each other with a prominent diversity during solar minimum at IS233.
- The model has overestimated the observed values in general while underestimation has been observed at pre sunrise (showing the sunrise anomaly) and/or sunset.
Study of Climatology of Ionosphere over Pakistan for Solar Cycle 22

2.10 The day to day variability of ionosphere was investigated by using Digisonde-256 daily hourly data at Karachi (24.95N, 67.14E) during the period of solar cycle 22 i.e. 1986 - 1996.

2.11 The climatology of ionosphere at Karachi during solar cycle 22 concludes that:

- Maximum percentage disturbances occur during solar cycle 22 in years which have low sunspot numbers i.e., % disturbances are high during ascending and descending phase while low in maximum phase of the cycle.
- The maximum percentage disturbances occur in Feb and Nov while lowest disturbances occur in summer months i.e., Jun, Jul & Aug during the whole cycle.
- Night time lower and upper deciles graphs show that variations are high during winter (Nov, Dec, Jan, Feb) and equinox (Mar, Apr, Sep, Oct) months and lower during summer months (May, Jun, Jul, Aug).
- Day time upper deciles graph show that variations are high during summer and equinox months while lower deciles show that the variations on average remains same in all months.

HF Prediction Services

2.12 Monthly / Quarterly / Seasonal bulletins of MUF / FOT predictions are regularly prepared and provided to several national data users viz. Pakistan Broadcasting Corporation (PBC), Pakistan International Airlines (PIA) etc. These bulletins of HF prediction contain hourly MUF / FOT predictions.

Geomagnetic Field Monitoring and Associated Work

2.13 SUPARCO is operating a geomagnetic observatory at Islamabad and another one at Sonmiani acquiring geomagnetic data round the clock using Fluxgate Magnetometers. Monthly bulletins are prepared and supplied Survey of Pakistan, World Data Centre Colorado, etc. Information on the occurrence of the ‘sfe’ (Solar Flare Effects) and severe SC (Sudden Commencement) magnetic storms is provided to national users for HF communication. The geomagnetic data are also used for research/studies by the scientists of SUPARCO.
Establishment of Geomagnetic Observatories

2.14 A geomagnetic observatory was established at Karachi in 1983. A new observatory has been established at Islamabad in 2008. There are plans to establish another observatory in the middle part of Pakistan.

Fig. 5: Geomagnetic Observatory at Karachi

Fig. 6: Geomagnetic Observatory at Islamabad

2.15 SUPARCO intends to offer geomagnetic services to the scientific and socio-economic sectors of the country. Different departments will be approached to provide them with geomagnetic data and on-site measurements. Repeat station work will be started in collaboration with Institute of Royal Meteorology (IRM), Belgium.

Space Communication

Up-gradation of COSPAS-SARSAT Search and Rescue System in Pakistan

2.16 SUPARCO is participating in international COSPAS-SARSAT programme since 1990. The ground segment of Pakistan Mission Control Center (PMCC) and Pakistan Local User Terminal (PALUT) has recently been upgraded for providing real time alert and location data to national agencies tasked for undertaking search and rescue operations. Two Rescue Coordination Centers (RCCs) have been established for search and rescue operations.

Fig. 7: PALUT, PMCC and RCCs setup
Environmental Studies

Fog Aerosol Characterization, Source Apportionment and Impact Study, Lahore

2.17 Environment of Lahore and adjoining area is badly affected by regional winter fog and haze. The government of Pakistan approved a project to investigate the fog / haze, aerosol and environmental impacts of regional dimming.

Study of Fog / Haze using Satellite Data

2.18 Wide spatial coverage of satellites makes the use of satellite data very important in studying large area phenomena such as fog, haze and clouds. SUPARCO is using MODIS level 1B data to estimate cover of Fog, Haze and Clouds over the region as well as their classification with respect to density. Effect of Clouds and Haze layers on the density and persistence of fog (radiation fog) directly under them is also part of the study. Satellite imagery is further processed to differentiate fog, smoke, haze and clouds and classify them with respect to their density and nature. Satellite-based data showed that the fog covered area in Pakistan ranged from 67,384 Km² to 160,900 Km² during winter (2008-2009) season. During this period, there was thick fog on 10 days, heavy haze on 25 days and visible smoke on 6 days.

2.19 MODIS fire (thermal anomaly) data were used to assess large scale burning and spread of pollutants. Large scale biomass burning was most commonly observed in the months of September, October and November in Pakistan and India where the farmers clear their fields for next harvesting by burning.

2.20 MODIS Level 3 data were used to make a comparison of satellite based pollutant levels with ground based observations and measurements. METEOSAT-7 IODC data were also used to observe near real-time (half hourly) variation in spatial coverage, density and movement of fog and clouds.
Air Pollution and Dimming (Fog/Haze) Impact on Human Health

2.21  To estimate health impact of fog / haze on human health, air pollution data of related diseases were acquired from two hospitals in Lahore. Increased respiratory illnesses especially asthma related to the environment have been observed. Similarly, there was an increased trend in contact dermatitis in three years data. It was also observed that PM2.5 levels correlate directly with the incidents of asthma in Lahore. Both, PM2.5 levels and asthma cases increase in winter. Men of age group 16 to 45 have been found more affected by the air pollution related diseases.

Air Pollution and Dimming (Fog/Haze) Impact on Agricultural Crops

2.22  Decrease in visibility due to haze/smoke was observed in Lahore and adjoining areas of Punjab especially in Oct – Feb every year. The data of agricultural yield and various parameters possibly affecting were collected from different sources and modeled using statistical software. In addition, field surveys were also carried out to collect information directly from farmers. The study revealed that the formation of haze and fog causes negative impacts on wheat yield. As per reference studies, a loss of Rs. 26,320 million and Rs. 6370 million for wheat and rice respectively over the last 10 years has been estimated.

Monthly Variation in PM2.5 Concentration at Suburban Area of Karachi

2.23  The study of suspended particulate matter and their size as well as their composition are of importance in determining the health of our urban and rural atmosphere. Up-to-date knowledge of anthropogenic air-borne species of concern,
their prevailing levels and their contributing sources is imperative to devise a control strategy. The existing levels of air pollutants would help in assessing the impacts on human health, development of abatement tactics and control regulations, judging compliance with and or progress made toward meeting ambient air quality standards, guidance of future land use and transportation planning and environmental management. To achieve these objectives, SUPARCO has collected samples of PM2.5 at Karachi City and analytical work for determining the composition and concentration of pollutants is under progress.

Research Studies

Black Carbon Aerosols in Urban Air in South Asia

Incomplete combustion of fossil fuels or bio-fuels produces soot in the form of element or black carbon, and numerous organic carbon (OC) species. Carbonaceous aerosols in South Asia has recently received increased attention due to its rapidly rising emissions. In less than two decades, South Asia has become one of the most polluted areas in the world. Fossil fuel and biomass are the major energy sources in this area. With its many low-tech industries and poorly controlled combustion, huge quantities of pollutants are exhausted into the air. Rapid industrialization has produced exceedingly high emissions in South Asia. To assess the regional and global climate change caused by aerosols in South Asia, detailed information is required on the atmospheric concentrations of carbonaceous aerosols in the region.

Report based on the data from a year long (2006–2007) study of black carbon (BC) concentrations acquired at 5-min intervals with an Aethalometer in Karachi, Pakistan. Daily mean of BC varied from about 1 - 15 µgm⁻³. However, short-term spikes exceeding 40 µgm⁻³ were common, occurred primarily during the morning and evening rush-hour period. The BC values were highest during Nov - Feb i.e. 10 µgm⁻³; and lowest during June – Sept i.e.2 µgm⁻³. It is demonstrated that these trends are strongly affected by meteorological conditions. A simple expression is applied to the concentration profiles to separate the effects of meteorological conditions and elucidate the underlying emissions patterns. Daily emissions varied from 14,000 to 22,000 kg of BC. When integrated over the year, emissions for Karachi city were estimated at 6.7 kilometric tons per year and emissions for greater Karachi were 17.5 kilometric tons per year. Folding in populations of each area yields BC emissions of 0.74 and 1.1 kg per person per year, respectively. Applying the model to previously collected data of BC emissions at Lahore for three months from Nov–Jan that came out to be around a factor of two higher than those in Karachi. Annual estimates of emissions were not attempted because the BC measurements in Lahore covered only three months. Due to the large populations of these cities, the local health impact from PM alone is expected to be severe and because of the high BC emissions the impact on the global climate may be equally significant.
Space Science Applications in Natural Resource Management

Atmospheric Data Receiving & Processing Center (ADRPC) - A Facility for Receiving & Processing Satellite Data

2.25 Atmospheric Data Receiving & Processing Center (ADRPC) at SUPARCO is equipped with real time data acquisition and processing facility for Moderate Resolution Imaging Spectrometer (MODIS) onboard Aqua and Terra Satellites, Advance Very High Resolution Radiometer (AVHRR) onboard NOAA, FengYun1D, FengYun2E and Meteosat-7 satellites. Processing of ALOS, SPOT and Landsat data are also carried out using ADRPC.

Fig. 11: ADRPC system block diagram, Lab view and receiving Antennas of LEO & GEO Satellites

2.26 The MODIS/AVHRR data received and processed by ADRPC are being used for:

- Calculating daily Normalized Difference Vegetative Index (NDVI)
- Crop yield estimation model for project titled “Monitoring of Crop through Satellite Technology”
- Snow cover estimation as well as assessment of water for hydro power projects
- Glacier Retreat / Advance and Glacial Lake Outburst Flood Monitoring (GLOF)
- Sea Surface Temperature (SST) and NDVI for the assessment of phytoplankton in marine fisheries studies
- Calculating aerosol & cloud optical properties, temperature & moisture profile for atmospheric studies
- Analysis of fog situation for project titled “Fog and Aerosol Characterization and Source Apportionment”
• Natural and Industrial Hazards monitoring and risk mapping

2.27 The following Ministries / Govt organizations are being benefited from the value-added products of ADPRC:

- National Disaster Management Authority (NDMA)
- National Institute of Oceanography (NIO)
- Water & Power Development Authority (WAPDA)
- Ministry of Environment/Federal & provincial Environment Protection Agencies (EPAs)
- Pakistan Council for Research in Water Resource (PCRWR)
- Other public & private sector agencies / Universities

**Snow Mapping in Chitral District for Hydroelectric Power Project**

2.28 SUPARCO has recently completed a Hydroelectric Power project of mapping snow cover during snow melting seasons (April - August) in the district of Chitral. Snow, composed of small ice particles, is a great source of water as it acts as natural reservoir for many water supply systems. Snow cover is the most important input variable for water resource estimation. Its aerial extent gradually decreases during a snowmelt season (April-August). Also, precipitation can be of different forms, such as rain, freezing rain, hail, sleet, and snow.

![Fig. 12: Catchments of Chitral River](image1)

![Fig. 13: Snow cover deletion curves (2004-06 melting season)](image2)

2.29 Snow cover has been mapped using images of MODIS sensor onboard Aqua and Terra satellites. False color composite image of MODIS with band combination 721 has been used for snow discrimination from other cover types. In this color composite image vegetation appears bright green and bare soil red, and water appears dark black, leaving snow in light blue color. Snow depletion curves for melting seasons of 2004, 2005 and 2006 indicate that the aerial extent of snow was large in 2005 as compared to 2004 and 2006.
Inventory of Glaciers

2.30 With the development of new techniques/methods over the last three decades, capabilities to observe glaciers in detail by means of remote sensing satellites have greatly improved. These techniques now provide an opportunity to observe glaciers in the most remote regions in a shortest possible time with little or no logistical effort. SPOT and Landsat, TM and ETM+ images have been incorporated in this study.

2.31 Emphasis in this study has been made on valley glaciers, also called mountain or alpine glacier, found in mountain regions all around the world. Valley glaciers are a thick body of solid ice that flows like a very slow river under its own weight.

2.32 In Pakistan, a huge area is covered by glaciers. A digital repository of valuable knowledge on glaciers and rivers feed by these glaciers is essential for water management and dam’s construction. In Pakistan where irrigation network and power generation is heavily dependent on the snow melt in summer, such information can provide a basis for future planning of water resources and flood hazards monitoring in the country. To date, 76 valley glaciers have been identified.

Determination of Potential Fishing Zones in Exclusive Economic Zone of Pakistan

2.33 Fisheries is an important sector of Pakistan’s economy which provides direct employment to about 3.8 M fishermen and 4.0 M people in ancillary industries. Fisheries sector has domestic consumption potential of 1mmt and export of 1 billion US$ annually. Data from remote sensing satellites, which have a synoptic view of the oceanic area, provides information on distribution and abundance of fishes. Satellite-based Potential Fishing Zone (PFZ) forecast helps in deep-sea fishing which is 12 to 35 nautical miles from the coastal areas within EEZ. The incorporation of advanced satellite based methods for fish catch could be helpful in increasing the fish catch rate and decrease the amount spends on vain trips. SUPARCO has conducted pilot study to map marine resources using satellite images of coast near Karachi and analyzed to assess mangroves in the area.

Fig. 14: Glaciers identified in the study area
Research Studies

Glaciers Variation Study

2.34 The use of satellite images due to their wide/regional and repetitive coverage allow monitoring and mapping of glaciers. Glaciers serve as natural regulator of regional water supplies. These glaciers are enormous reservoirs of fresh water and their melt water is an important resource which feed rivers all around the world. SUPARCO has conducted satellite-based studies for the assessment of snow cover the northern areas of Pakistan such as Batura, Biafo, Yazghil, Jutmau, Ghulkin and Passu Glaciers. Comparison of temporal satellite data from Landsat, TM & ETM+ and ALOS, AVNIR revealed that all of these glaciers have retreated.

<table>
<thead>
<tr>
<th>Name of Glacier</th>
<th>Depleted Area (km²) (% loss)</th>
<th>Study Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batura</td>
<td>17 (15%)</td>
<td>1992-2001</td>
</tr>
<tr>
<td>Biafo</td>
<td>8.5 (9%)</td>
<td>1992-2000</td>
</tr>
<tr>
<td>Yazghil</td>
<td>1.2 (5%)</td>
<td>1992-2007</td>
</tr>
<tr>
<td>Jutmau</td>
<td>6 (28%)</td>
<td>1992-2007</td>
</tr>
<tr>
<td>Passu</td>
<td>3.2 (7%)</td>
<td>1992-2008</td>
</tr>
<tr>
<td>Ghulkin</td>
<td>0.5 (12%)</td>
<td>1992-2008</td>
</tr>
</tbody>
</table>

Table-1: Depleted area of the Glaciers during study period

Drought Study — Sindh Province of Pakistan

2.35 Pakistan has suffered several times from drought conditions. It is one often underestimated for two reasons: a) have a slow onset and; b) have less visual impact on us. However, the long term outcome of a drought can be wide spread and devastating. Analysis of the drought conditions made in this study for the areas of Sindh province of Pakistan particularly along River Indus. The study is based on calculation of Normalized Difference Vegetation Index (NDVI) and DEVNDVI using Advanced Very High Resolution Radiometer (AVHRR) data on board National Oceanic and Atmospheric Administration (NOAA) series of satellites. Analysis of data for the months of February and October (1996-2006) and deviation of rainfall from its mean for the period 1986-2006 was carried out. The aim of this study was to integrate Satellite Remote Sensing data and long term precipitation data to delineate drought conditions in Sindh province of Pakistan. This would help to evolve a continuous system for the monitoring of drought conditions in the country. Results showed strong relationship among NDVI, DEVNDVI, variation in precipitation and drought conditions. Study of NDVI and DEVNDVI calculated for monitoring drought condition in major parts of Sindh reveal that these indices may be continuously studied for other drought prone area in Pakistan for early prediction of drought conditions.
Fig. 16: NDVI calculated from AVHRR data for four districts of Sindh.

Fig. 17: Annual rainfall intensity in Sindh province during 1986-2006. Red colored horizontal line shows average rainfall in 20 years.
Remote Sensing and GIS Applications
3. Remote Sensing and GIS Applications

Monitoring Development in Irrigation Network – A “Quad S” Approach

3.1 Most of the agriculture in Pakistan depends upon canal irrigation system, which comprises rivers, canals, distributaries and watercourses. Watercourses run through the agriculture fields and act as the ultimate source of water to the field crops. Most of the watercourses in the entire irrigation network are unlined resulting in enormous loss of water due to seepage. A study conducted in Pakistan showed that about 40% of water losses take place at watercourse level; about 15% losses are due to seepage, and the remaining due to wastage. To minimize losses due to seepage, watercourses are being lined with bricks or concrete. Regular monitoring of the development work being carried out through a reliable and user-friendly information system is one of the key factors for the success of such a large project. Official record of the entire irrigation network of Pakistan is paper based i.e. index maps and watercourse inventories, which are difficult to handle and analyze. Besides, these maps lack geographic referencing as well as regular updation.

3.2 A remote sensing and GIS based system was developed by SUPARCO for monitoring progress on watercourses lining project in NWFP province. The system involves: a) mapping of irrigation network up to the watercourse level through SPOT 2.5 m pan-sharpened satellite images; b) development of customized GIS solution and Geodatabase and; c) a communication system to transfer data collected at watercourses by field monitoring teams directly to the main server via GPRS using GPS enabled iPAQ. The developed methodology was named “Quad S Approach” derived from four ‘technologies i.e. SRS, GIS, GPS, and GSM. The developed system is capable of: a) collecting and disseminating field data and updating records; b) generating reports and thematic maps to serve day-to-day needs in addition to possible future enhancement that may include incorporation of several other themes as well as attributes such as soil classification maps, cropping pattern in command areas of watercourses etc, in order to address the needs of agricultural activities. The system shown in Fig.18 demonstrates one of the operational application of RS, GIS and associated technologies (GPS and GSM) to water resource management that can be adopted anywhere in the world.
3.3 SUPARCO, having a vast experience and capability in the field of remote sensing and GIS, has contributed in social sector development projects. These projects range from district level to country level. Govt of Sindh in consultation with SUPARCO has initiated various social sector development programs aimed at addressing infrastructure development and poverty alleviation in the Province. These include:

**Monitoring Developmental Work of Khairpur - Larkana Bridge**

3.4 The bridge is under construction on river Indus to connect two cities of Sindh province i.e. Larkana and Khairpur. SUPARCO provided satellite imagery for bridge site location and services for monitoring of construction work through multi-temporal SPOT imagery.

**Assessment of Mangrove Forest Along the Coast of Sindh Province**

3.5 Mangrove forests not only serve as first line of defense in the events of cyclone and tsunamis but also provide the means for livelihood of habitats. A forum on rehabilitation of mangrove forest is under consideration by the Govt of Sindh. Hence on the request of Govt, current as well historical status of mangrove forest in the Indus deltaic region was provided.
Digitization of Karachi Circular Railway (KCR) Line and Delineation of Encroachments on Railway Land

3.6 Karachi Urban Transport Corporation (KUTC) was mandated to upgrade the existing infrastructure of KCR by a modern commuter system in collaboration with JICA. KUTC required a study to formulate a resettlement action plan for compensation of encroachments to be affected due to the upgradation of the rail-track. In this connection, SUPARCO conducted a study using Quick-Bird satellite imagery, GPS ground surveys along with existing KCR maps/drawings to identify and measure encroachments along the said tracks as well as updated the existing outdated maps/drawings prepared in 1945 by British Administration (Fig.19).

![Complete Track of Karachi Circular Railway](image)

**Fig. 19:** Monitoring environmental changes and land degradation due to sea intrusion in southern Sindh

3.7 The Thatta and Badin districts in the Province of Sindh are facing problems of waterlogging & salinity. The major paddy (rice) growing areas are badly affected. A study was therefore undertaken on Monitoring Environmental Changes and Land Degradation due to Waterlogging & Salinity in Thatta and Badin Districts using Satellite Remote Sensing & GIS based Techniques. High resolution SPOT-5 satellite data acquired in November 2008 was employed and Landuse/Landcover maps were prepared to identify Waterlogging & Salinity in these districts (Fig.20) Shortage of fresh water downstream Kotri barrage and the intrusion of sea water into the riverine tract have increased the salinity thereby degrading the vast areas of the districts. Tidal Link drain of LBOD has resulted in the degradation of agricultural lands and increased the waterlogging
& salinity in the area too. It was estimated that the total degraded land in Thatta and Badin districts comes out to be 335,350 hectares out of 2,432,800 hectares.

![Satellite Image Map](image1.png) ![Waterlogging & salinity thematic map](image2.png)

**Fig. 20:** Satellite Image Map of Thatta & Badin districts, based on SPOT data of Nov 2008  
**Fig. 21:** Waterlogging & salinity thematic map of Thatta & Badin districts, based on SPOT data of Nov 2008

**Monitoring of Tobacco Crop through Satellite Technology**

3.8 Tobacco is grown over nearly two percent of the total area under cultivation and Pakistan is the fifth largest tobacco producing country. The share of this crop in GDP is about four percent. Tobacco is grown mostly in NWFP province. Tobacco is the only crop grown in Pakistan whose yield is well above the world average and matches the per hectare yield in the US and other developed countries. Pakistan Tobacco Board (PTB) was interested in Tobacco acreage and yields estimation through Remote Sensing and GIS techniques for many reasons including non-availability of accurate acreage and yield estimates, spatial pattern of crop, distribution of Tobacco Cess collected by Govt of Pakistan for the development of Tobacco growing areas.

3.9 PTB in collaboration with SUPARCO initiated a pilot project on mapping of Tobacco crop in the district Mansehra of NWFP (Fig.22). The objectives of the project were to estimate acreage and forecast yield. Yield forecasting is a complicated system which is governed by a number of factors. The main factors affecting crop yield are weather variables. Weather plays a dominant role in crop growth and development and hence can be conveniently used as indicator of change in crop yield modelling. The results of the pilot study were very encouraging and therefore a project for the mapping of tobacco crop in NWFP province has been initiated. Multivariate crop models are being developed that use information on agro-met, fertilizer usage and irrigation water supplies in addition to parameters used in bivariate models.
Fig. 22: Study area for mapping of tobacco crop – district Mansehra, NWFP
Satellite Technology Programme
4. Satellite Technology Programme

National Satellite Development Program (NSDP)

4.1 SUPARCO has developed infrastructure and established number of facilities with latest equipment essentially required for realization of National Satellite Development Program. These facilities comprise of the following laboratories to undertake assembly, integration and testing of a small to medium sized satellites:

a. Imaging payload systems Labs
b. RF communication Labs
c. Onboard Data Handling System labs
d. Attitude Control and orbit determination system labs
e. Digital Systems labs
f. System engineering labs
g. Mechanical shops and related facilities
h. Clean Room facility for integration of payload and satellite
i. Vacuum/thermal test chamber

4.2 In the context of the implementation of Paksat-1R Communication Satellite project, SUPARCO has developed some satellite hardware called Customer Furnished Instruments (CFIs) to fly it onboard Paksat-1R.

4.3 Successful integration and functional testing of the CFIs have been completed in the SAINT Facility and their various environmental qualification tests are planned to be carried out in collaboration with the other organizations soon.

Fig. 23: Satellite in SAINT bay  
Fig. 24: SAINT entrance through air shower
4.4 PAKSAT-1 continues to operate at 38°E and provide satellite communication services to its customers through PakSat Int’l. Its in-orbit life is till mid 2011. A strategy is being developed along with Intelsat to operate it beyond its in-orbit life to provide uninterrupted services to the customers until it is replaced by PAKSAT-1R in the later half of 2011.

4.5 For allocation of orbit slot at 38°E and frequency spectrum system filing of PakSat-1 Satellite Network at 38°E was initiated in 1994. It was notified and brought into use in 2003. ITU identified satellite networks of 32 different administrations for frequency coordination of PAKSAT-1 Satellite. After continuous efforts and pursuance of frequency coordination with all identified administrations, PakSat-1 frequency assignments and orbital slot have been registered into MIFR of ITU. This will facilitate launching of follow-up Satellite PakSat-1R ensuring continuation of National Satellite Development Programme.
Communication Satellite (Paksat-1R)

4.6 The contract for the design, manufacturing and launching of Paksat-1R satellite was signed with CGWIC, China in October 2008. The satellite is planned to be launched by mid 2011. Paksat-1R is based on the DFH-4 platform, designed by CAST. The payload consists of 30 transponders: 18 Ku-band and 12 C-band. The satellite program is progressing satisfactorily since its Effective Date of Contract (EDC).

4.7 The contract for the Ground Control Segment (GCS) of Paksat-1R has been signed with CGWIC in Oct 2009. Under this contract two fully redundant Ground Control Stations are being established in Karachi and Lahore to operate and control the satellite. The construction of the technical buildings which would house the GCS equipment is also currently underway.

4.8 SUPARCO’s indigenous contribution towards the Paksat-1R Program is the in-house design and development of the following Customer Furnished Instruments (CFIs):
   - Data Handling Unit
   - Telemetry/Telecommand Remote Terminal Unit
   - Telecommand Receiver
   - Telemetry Transmitter
   - Channel Filter
   - Power Conditioning and Distribution Unit

4.9 The design of the CFIs has been done taking into account the relevant requirements for interfacing and integration in the DFH-4 platform. Interface control document (ICD) has also been developed and finalized. It is pertinent to mention here that CFIs are being developed on international space industry practices. The prototype and Engineering Qualification Models (EQMs) were developed first. The Qualification model is presently under development and then finally the Flight Model (FM) would be developed.

4.10 The implementation of this project, beside meeting Pakistan’s objective of preserving 38°E orbital slot, will not only augment the existing
telecommunication infrastructure of the country, but will also help greatly in promoting the use of satellite communication in the country (especially in remote/hilly areas), particularly for socio-economic development.

**Remote Sensing Satellite System (RSSS)**

4.11 To cater for the national needs of Remote Sensing (RS) data, Feasibility and System Definition Study (FSDS) of National Remote Sensing System was carried out jointly by SUPARCO and M/s Space Engineering SpA, Italy during year 2005-06, which resulted in consolidated Mission Requirements for Remote Sensing Satellite System (RSSS) program.

4.12 FSDS deduced a combination of Optical and SAR based systems to meet the user and mission requirements in totality but due to financial constraints it was decided to first implement the optical system comprising of single satellite with a strong component of Knowhow and technology training.

4.13 A plan for the release of fund was submitted to the Government to develop a system of around 2m PAN in collaboration with a renowned satellite manufacturer within three year time after the formal approval. The program is planned to maximally utilize the local resources both in the development of space and ground segment. RSSS mission requirements were formulated in light of concurrent remote sensing scenario and future trends of Remote sensing satellites. In parallel the capacity building in this respect is underway for a progressive and sustained RSS program.

**Prototype Remote Sensing Satellite (PRSS)**

4.14 A Prototype Remote Sensing Satellite was developed as a part of skill development programme. It is an indigenous effort to enhance capacity and capability in the field of satellite engineering at SUPARCO.

4.15 Top level specifications of the engineering model of PRSS-1 are:

- Imaging Payload with 2.5m resolution (Altitude: 700Km)
- Swath: 35 Km
- Radiometric Resolution: 12 bit
- Imaging Bands: Panchromatic
- Three Axis stabilized platform
- Onboard Storage of 300 image scenes
- Honey Comb structure (1.2m x 1.0m x 1.0m)
- 300 watts Power subsystem
- S-band Transmitter, Receiver for telemetry/ tele-command
- X-band Transmitter for Image transfer
Onboard data handling unit

4.16 Facilities developed/upgraded have been utilized to test and evaluate the satellite responses in various environments such as HELMHOLTZ Coil, Clean Room, Anechoic Chamber and Light Controlled Environment, Satellite Platform Control Unit and Satellite Mission Control Room. Some of the subsystems of PRSS that were indigenously developed are:

- Attitude and Orbital Control System
- On-Board Data Handling System
- RF Transmitter / Receiver
- Reaction Wheel and propellant Tank
- Satellite Electrical Power System
- Imaging Payload System
- Structure and deployment Mechanism
International Cooperation
5. International cooperation

Introduction

5.1 SUPARCO is the permanent member of several international institutions, associations, societies and United Nations bodies and derive benefits through bilateral and multilateral cooperative arrangements aiding further development in space sciences, technology and applications through joint projects, KHTT (know-how technology transfer), short and long term training programmes, participations in the conferences, seminars, symposia and workshops related to the on-going projects and building capacity for socioeconomic development.

Collaboration with CGWIC, China

5.2 Pakistan has signed an agreement for cooperation with China Great Wall Industry Corporation (CGWIC) for the design, manufacturing and testing and launch of a communication satellite including one primary and one backup satellite with control system software as well as Know-How technology transfer.

Collaboration with APSCO

5.3 Pakistan is the founder member of Asia-Pacific Space Cooperation Organization (APSCO) since 2005. A number of collaborative projects have been initiated in cooperation with the Member States. A feasibility study of these projects has been completed and their implementation phase will be started shortly after the approval of APSCO Council.

Collaboration with the Institute of Tibetan Plateau Research (ITP), Chinese Academy of Sciences (CAS)

5.4 The Institute of Tibetan Plateau Research (ITP) is one of the prestigious R & D organizations, founded by Chinese Academy of Sciences (CAS). It deals in Tibetan Plateau research. The objectives of ITP include study of earth structures, environmental gradients, global change, land surface & atmospheric processes and glaciology.

5.5 SUPARCO is in process of signing MoU with ITP-CAS for a collaborative study pertaining to glaciers. ITP-CAS will provide technical assistance in mapping different morphological aspects of glaciers, developing advanced inventory on glaciers, remote sensing and GIS techniques for glacier study and installation of an acquisition workstation on high mountains region for glacier monitoring in the context climate change.
Institute for Computational Earth System Science, University of California, Santa Barbara (UCSB)

5.6 Institute for Computational Earth System Science, University of California, Santa Barbara (UCSB) has a vast experience of research work in modeling of the microwave signature of snow soil and vegetation, image processing & analysis and inversion model development for retrieving physical parameters from remote sensing data. SUPARCO and UCSB have jointly submitted a research proposal on drought study under Pakistan-US Science and Technology Cooperation Program 2009. The aim of this study is to integrate satellite remote sensing in combination with meteorological data for drought monitoring and improving irrigation efficiency so that a continuous system may be developed for drought events and crop health. The proposal is at the stage of approval from the Govt.

European Commission

5.7 SUPARCO is involved in the EnerGEO project titled “Energy Observation for Monitoring and Assessment of the Environmental Impact of Energy Use” headed by European Commission, under Global Earth Observation System of Systems (GEOSS) program. The objective of EnerGEO project is to develop a strategy for a global assessment of the current and future impact of the exploitation of the energy resources on the environment and ecosystem and to demonstrate this strategy for a variety of energy resources worldwide. SUPARCO has been included for execution of pilot study on biomass dynamics and energy resources in Pakistan.

National Coordination Committee (NCC) for COSPAS-SARSAT

5.8 Government of Pakistan has established a National Coordination Committee (NCC) for effective implementation of the satellite-aided search and rescue COSPAS-SARSAT Programme. The complete system has recently been upgraded and operational since June 2009. This programme provides distress alert and position location services through the low-earth orbiting satellites. The NCC also review the effectiveness of various search and rescue organizations in the country and formulate recommendations on Satellite-Aided Search & Rescue (SS&R) operations, ensuring their consistency with the national plan and compatibility with the COSPAS-SARSAT programme.
Human Resource Development
6. Human Resource Development

Training

2008

1. Air Quality Management, organized by IUCN from in Lahore, Pakistan

2. Addressing climate change through better air quality management, organized by Pak EPA in collaboration with Pakistan Clean Air Network, IUCN-Pakistan and Clean Air Initiative for Asian Cities Center at Lahore, Pakistan

3. Regional Atomic Modeling: Plume Dispersion & Photochemistry, organized by PIEAS in Islamabad, Pakistan

4. Geospatial Analysis for Infrastructure Asset Management & Disaster Assessment, NED University of Science and Technology, Karachi Pakistan

5. Satellite Technology Applications in Communications and Remote Sensing, organized by ISNET in Lahore Pakistan

6. Climate Change & Natural Resource Management by SUPARCO at Lahore, Pakistan

7. Satellite Remote Sensing Using Coarse Resolution Data at SUPARCO HQs, Karachi, Pakistan

2009

8. Open Source PostgreSQL Training Workshop, organized by Pakistan Software Export Board, Ministry of IT&T at Sir Syed University of Engineering & Technology, Karachi, Pakistan

9. Training on COSPAS-SARSAT Ground Receiving Station by M/s Techno Sciences Inc, USA

10. Two week on-the-job tainting on Software and Hardware of Satellite Ground Station by M/s Environmental System & Services (ES&S), Melbourne, Australia

11. Solar Radiation & Modern Technologies at SUPARCO, Islamabad, Pakistan

12. Satellite & Ground-based Environmental Monitoring at SUPARCO HQs, Karachi, Pakistan

13. On-the-job training on COSPAS-SARSAT Ground Receiving Station to Maritime Security Agency (MSA) and Civil Aviation Authority (CAA), SUPARCO HQs, Karachi, Pakistan

14. Remote Sensing & GIS Applications in Natural Resource Management at SUPARCO HQs, Karachi, Pakistan

15. On-the-job training on ArcGIS 9.2 software
16. Participated in three months training course on TT&C Station configuration and operation in Beijing China

17. Five months (100 Hrs) training course on “Certified Project Management Professionals” at PIQC and NED Karachi

18. Short training on “Image processing and RS link modeling in Simulink” organized at Institute of Space Technology (IST) Islamabad

19. Short training on “Space Communications” in Tokyo, Japan.

20. 05-days training on “OSLO software” in Singapore.

21. Training on “PCI Express Analyzer & Exerciser” from Generton Institute, Singapore.

22. Short term training on “PCI Express Analysis System” in Singapore.

23. Short term training on “X-Band Transmitter” from IMT, Italy.

**Participation in Seminars/ Symposia/ Workshops/Conferences/ Meetings**

**2008**

1. ISNET international seminar on “Space Technology & Applications for Sustainable Development” in Tunis, Tunisia

2. BAQ 2008, Better Air Quality Conference, Bangkok, Thailand

3. CLIMA, Final International Conference, Vienna International University, Italy

4. Regional workshop on “Development and Harmonization of Land Cover Classification in the HKH region” organized by FAO-GLCN in collaboration with ICIMOD Kathmandu, Nepal

5. The XXIXth URSI General Assembly, Chicago, USA

6. XIIIth IAGA Workshop on Geomagnetic Observatory Instruments, Data Acquisition and Processing, Colorado, USA


2009

9. The 9th Australian Space Science Conference, Sydney, Australia


11. 2nd International Conference of Aerosol Science and Global Changes, Hang Zhou, China

12. Workshop on Environmental Changes, Glacial and Hydrological Processes and related consequences in the Third Pole Region: Beijing & Lhasa, China

13. Management of Mercury and Mercury Containing Waste in Pakistan, organized by Ministry of Environment in Lahore Pakistan

14. Workshop on World Environment Day-2009, organized by Pakistan Engineering Congress in Lahore, Pakistan

15. Two-day workshop on Sustainable Energy Conversion at NED University of Science & Technology, Karachi, Pakistan

16. UN Workshop on Integrated Spatial Technology to Water Resource Management, Environment Protection and Disaster Vulnerability Mitigation, Jakarta Indonesia


18. 3-days Global Space Technology Conference (GSTC) and exhibition National Exhibition Center (ADNEC) held in Abu Dhabi, UAE.


21. 13th session of the Intergovernmental Consultative Committee on the Regional Space Applications Program for Sustainable Development in Asia & the Pacific, Bangkok, Thailand

22. Expert Group Meeting on ICT and Disaster Risk Reduction in Asia and the Pacific, Bangkok, Thailand

23. EnerGEO Kick off meeting, The Netherlands

24. UNESCAP Meeting of the Regional Group on Drought Disaster Monitoring and Early Warning, Bangkok, Thailand
Publications


13. Farooq, Muhammad, Fabrice Muller, Michel Auguin, Efficient and Optimal Multiprocessor Scheduling for Real Time Tasks at ACM Transactions on Embedded Computing ACM TECS.

14. Farooq, Muhammad, Bhatti M. Khurram, Fabrice Muller, Cecile Belleudy, Michel Auguin, Improving Resource Utilization under EDF-based Mixed
Scheduling at International Conference on *Very Large Scale Integration, Rhodes Island, Greece, Oct 2008*.


17. Farooq, Muhammad, Fabrice Muller, Michel Auguin, Weight bound Limits in Supertasking Approach for Guaranteed Timeline Constraints at *4th International Workshop on Scheduling and Resource Management for Parallel and Distributed Systems, USA, Sep 2008*.

18. Farooq, Muhammad, Bhatti M. Khurram, Fabrice Muller, Michel Auguin, Efficient and Optimal Multiprocessor Scheduling for Real Time Tasks at *GDR National Conference on System on Chip, Paris, France, Jun 2008*.

19. Farooq, Muhammad, Bhatti M. Khurram, Fabrice Muller, Cecile Belleudy, Michel Auguin, Precognitive DVFS: Minimizing Switching Points to Further Reduce the Energy Consumption at *14th IEEE Real Time and Embedded Technology and Applications Symposium, St, Louis MO, USA, Apr 2008*.

20. Farooq, Muhammad, Fabrice Muller, An Embedded Generic and Multiprocessor Hardware Operating System at Conference on Design and Architectures for Signal and Image Processing (Euro DASIP) *Sophia Antipolis, France, Sep 2009*


22. Farooq, Muhammad, Fabrice Muller, Virtual Platform for Hw RTOS – Multiprocessor Hardware RTOS at Design Automation and Test in Europe University (EDA and IEEE), France, Apr 2009.


25. Iftikhar,Usman, Bilal, A., D. Sadarnac, P. Lefranc, C. Karimi, Analysis of Input Filter Interactions in Cascade Buck Converters at *IEEE International


32. Muhammad Rafique, Said Rehman, S.U. Rahman, Shahida jabeen, M. Ikram Shahzad, Mumtaz H. Rathore and Matiullah. Indoor radon concentration measurement in the dwellings of district poonch (Azad Kashmir), Pakistan


35. Muhammad Rafique, Shahida Jabeen, M. Ikram Shahzad, Said Rahman, Shujaht Bukhari and Matiullah. Radiation doses due to indoor radon exposure, before and after 2005-earthquake in the dwellings of Muzaffarabad and Jhelum Valley, Azad Kashmir, Pakistan Indoor and Built Environment 2009 (Accepted for Publication)

36. Matiullah, A. Ahad, Munazza Faheem and Said Rehman. Measurement of radioactivity in vegetation of the Bahawalpur division and Islamabad


42. Said Rehman, Matiullah and Badar Ghauri. Effect of moisture on the radon exhalation rate from soil, sand and brick samples collected From NWFP and FATA, Pakistan. Radiat. Protect. Dosim-2008 Vol 130(2)page 172-177

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44. S. Rehman, Matiullah, S.A. Mujahid and S. Hussain. Assessment of the radiological hazards due to naturally occurring radionuclides in soil samples collected from the North Western areas of Pakistan. Radiat. Protect. Dosim 2008 Vol 128(2) page 191-197


46. Sadiq, M. U., A medium power two stage balanced amplifier with 2.17dB gain for S-band technology, IEEE-IBCAST-2008, Pakistan

47. Usman Iftikhar, Mr. P. Lefranc, Mr. D. Sadarnac, Mr. C. Karimi, Theoretical and Experimental Investigation of Averaged Modeling of Non-ideal PWM DC-DC Converters Operating in DCM at D´epartement Energie - Ecole Sup´erieure d’Electricit´e (Sup´elec), Gif-sur-Yvette, France, Jun 2008.