Ministry of Climate Change & Environmental Coordination
Government of Pakistan

YEAR BOOK
2022-23
Climate Resilient Pakistan

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Foreword

The Year Book 2022-23 of the Ministry of Climate Change & Environmental Coordination (MoCC & EC) offers a comprehensive overview of our continued efforts towards building a climate-resilient Pakistan. Over the past year, Pakistan has faced unprecedented environmental challenges, from extreme weather events to escalating vulnerabilities due to climate change. These challenges underscore the urgent need for coordinated actions and sustainable development policies that address both the current and future risks posed by a changing climate.

This year, our Ministry has strengthened its focus on formulating and implementing policies that align with Pakistan's Nationally Determined Contributions (NDCs) under the Paris Agreement. We have continued to advance our work in areas such as climate adaptation, renewable energy promotion, sustainable urban development, forest management, and biodiversity conservation. Our aim remains to ensure that Pakistan is well-prepared to mitigate and adapt to the impacts of climate change while fostering economic growth and improving the quality of life for all citizens.

The Year Book highlights our key achievements, initiatives, and strategic plans. It outlines the work of the Ministry's various wings and details the contributions of our attached departments and autonomous bodies. Each section reflects our commitment to achieving sustainable development goals and our dedication to promoting a greener, more resilient Pakistan.

I extend my sincere appreciation to the dedicated professionals, partners, and stakeholders who have worked tirelessly to help us achieve our objectives this year. As we continue on this path, I am confident that, with the support of our government, international partners, and civil society, we can make meaningful progress toward a sustainable and climate-resilient future for Pakistan.

We invite you to explore this yearbook to gain deeper insights into our efforts, accomplishments, and aspirations. Let us work together to create a more sustainable, prosperous, and resilient Pakistan.

(Aisha Humera Ch.)
Secretary
Ministry of Climate Change
& Environmental
Coordination

1. FUNCTIONS OF THE MINISTRY (UNDER RULES OF BUSINESS, 1973)

Under the Rules of Business, 1973, the Ministry of Climate Change and Environmental Coordination is assigned the following functions:

- National policy, plans, strategies, and programs with regard to disaster management including environmental protection, preservation, pollution, ecology, forestry, wildlife, biodiversity, climate change, and desertification
- Coordination, monitoring, and implementation of environmental agreements with other countries, international agencies, and forums
- Policy formulation, coordination, and reporting of human settlements including urban water supply, sewerage, and drainage
- Pakistan Climate Change Council
- Pakistan Environmental Protection Agency
- Global Environmental Impact Study Centre, Islamabad
- Islamabad Wildlife Management Board
- Zoological Survey of Pakistan

2. ORGANIZATIONAL SETUP

Business allocated to the Ministry of Climate Change & Environmental Coordination has been distributed amongst the following Wings:

- Administration Wing
- Development Wing
- Environment & Climate Change Wing
- Forestry Wing
- International Cooperation Wing

2.1. Administration Wing

It is a continuous challenge for Pakistan to achieve environmentally sound development. The main objective of the climate change policies is to ensure that climate change is mainstreamed in economically and socially vulnerable sectors of the economy and to steer Pakistan towards climate resilient development.

The Administration Wing is headed by the Senior Joint Secretary (Admn) to supervise the affairs of Human Resources of the Ministry of Climate Change & Environmental Coordination (MoCC & EC). Admn Wing is also supported by the Deputy Secretary (Admn) and Deputy Secretary (B & C). The total strength of the Ministry of Climate Change & Environmental Coordination (MoCC & EC) during the fiscal year 2022-23 under report is 193 employees (52 officers and 141 staff members). The Following Sections are working in the Administration Wing:

i. Admin-I Section
ii. Admin-II Section
iii. Autonomous Organizations Section
iv. Law Section
v. General Section
vi. F & A Section
vii. Budget and Cash Section
viii. Media Section

Responsibilities

- Personnel administration of the officers/officials of the Ministry
- Personnel administration of officers of the attached departments/organizations
- Coordination between wings/ attached departments/organizations of this Ministry and with other Ministries/Divisions
- Matters relating to hiring of residential accommodation of officers/officials
- Reimbursement of medical charges to the serving/retired officers/officials
- Maintenance of Performance Evaluation Reports (PERs) record of all employees of this Ministry and maintenance of annual declaration of assets possessed by the officers/officials of this Ministry
- Processing promotion, pay and pension cases of the officers/officials of the Ministry
- Nominations of officers/officials for the foreign and local trainings
- Preparation of Budget, Technical Supplementary Grant (TSG), and budgetary re-appropriation of the main Ministry and its attached departments/autonomous Organizations
- Preparation of pay bills, contingent bills advance bills etc., on daily basis
- Preparation of Pension Bills
- Appropriation of Accounts Reconciliation of Expenditure of each month with AGPR
- Contribution to international agencies
- Internal Audit/External Audit
- Purchase of stationery/petty items through tender.
- Repair/maintenance of official vehicles of MoCC & EC

- Repair/cleanliness of the building/bathrooms/stairs/reception of MoCC & EC
- Security of the building of MoCC & EC
- Media Coverage of Minister, MOS and different wings of MoCC & EC, publication of advertisements relating to MoCC & EC /Attached Depts./Development Projects etc.
- Social media coverage/uploads of Ministry, attached departments/organizations, and Development Projects on social media, i.e. Facebook, Twitter, and Instagram, in coordination with the Prime Minister's office. Arranging the Press Conferences of the Federal Minister, media coverage of seminars/capacity building events in coordination with Press Information Department (PID)
- Legal matters/cases of Climate Change Division/ Attached departments, including service matters pending in different Courts/Federal Services Tribunal (FST)

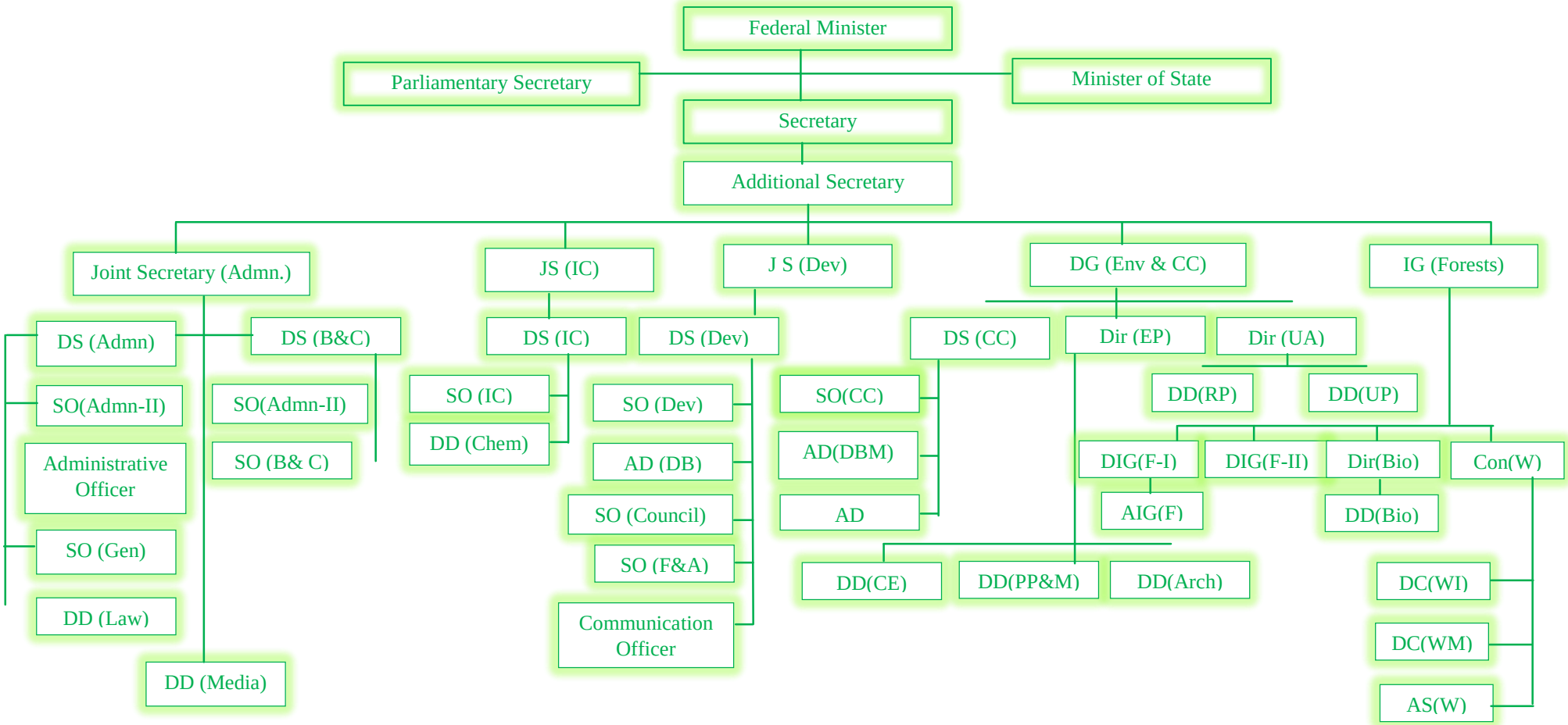
Achievements

- MoCC & EC is effectively implementing E-office application in the main Ministry with the support of M/o IT
- Networking infrastructure has been deployed and all wings of the Ministry are using E-Office to bring efficiency, effectiveness, and transparency
- One officer has been promoted to the Director General (Environment and Climate Change) (BS-20)
- Recruitment to the vacant positions of Ministerial staff was made by this Ministry during FY 2022-23
- Several officers were nominated for local and international trainings, conferences, seminars, and visits abroad to enhance the capacity of the officers in the fields of climate change, on the recommendations of the Foreign Visit Committee
- The Media and Communication Section of the MoCC carried out various public awareness and media outreach activities during the fiscal year 2023 regarding issues related to climate change, environmental degradation, water conservation, floods, clean and environmental-friendly brick kilns, clean air, hazardous solid waste, plastic pollution and the ban on single-use plastics in the Federal Capital. Media awareness activities were also conducted for the Living Indus Initiative, Recharge Pakistan Initiative, Carbon Credit Report (draft), and Blue Carbon national media
- Various activities of MoCC & EC including events, and meetings of the Federal Minister with national and international delegations and country representatives were also publicized in national media through press releases issued by the Ministry's Media and Communication Section
- The news about such events and meetings published in the media included International Conference on Climate Resilient Pakistan, Strengthening Climate Adaptation and Resilience (SAR) project in Pakistan jointly launched by the German Corporation and the MoCC & EC, World Environment Day (June 5), Meeting of Swiss Foreign Ministry with MoCC & EC Minister for joint cooperation, approval of the National Adaptation Plan 2023-2030 by the Federal Cabinet, Hazardous Waste and Challenges of Pakistan, the 7th Green Climate Fund (GCF) Board Pakistan Meeting, Pakistan Draft Carbon Credits Trading Report, Role of MoCC & EC in Operationalization of Global Loss and Damage

Fund at UN's COP-28th session of the Global Climate Conference, participation of Pakistan Delegation in the 28th Session of the UN Climate Conference in Dubai (COP28), Annual Review and Planning Workshop (2023-24) as a part of the Upscaling Green Pakistan Program - Phase-1 in Islamabad, the Joint UNDP-MoCC & EC's National Multi-Stakeholders' Consultation Recognition and Selection of Pakistan's Living Indus Project as the World Restoration Flagship of the United Nations Decade on Ecosystem Restoration

- Journalists from print and electronic media organizations were also engaged to cover and report on various activities including raids in various parts of the ICT to discourage use of the single-use plastic bags. On-site awareness campaigns in this regard were also carried out with the support of officials of the MoCC & EC, Pak-EPA Islamabad, and the ICT Administration
- Print and electronic media journalists were also engaged to conduct interviews of the Federal Minister for Climate Change and Environmental Coordination on various programmes and projects-related activities, particularly forests, climate change, environmental protection, smog, air pollution, climate-resilient urbanization, climate-smart agriculture, natural disasters, glacial melting, etc. These interviews helped project various initiatives of the Ministry in mainstream national print and electronic media
- Besides, ten (10) different advertisements of job vacancies, tender notices, and public notices of this Ministry and its attached departments were published in various newspapers during the fiscal year 2023 through the Press Information Department (PID), Government of Pakistan

Organogram of the Ministry of Climate Change & Environmental Coordination (2022-23)



2.2. Development Wing

The Development of the Ministry is mandated to perform the following functions:

i. All policy, administrative, and budgetary matters of PSDP projects
ii. Senate and National Assembly business
iii. Coordination with all wings and departments of the Ministry, Implementation of the Cabinet Decisions

The following projects are currently under execution:

2.2.1. Climate Resilient Urban Human Settlements Unit

Introduction

Pakistan has the highest rate of urbanization in South Asia at 3% per annum with aggregated 36.4% of the population residing in urban areas. Moreover, projections show that the urban population will surge up to 50% by 2025 indicating a significant and hostile transformation of Pakistan's urban landscape (UN-Habitat). Pakistan's urbanization is majorly driven by rural-urban migration and fueled by other factors like population growth, industrialization, and various job opportunities. The uncontrolled urbanization costly impacts on cities' basic services, infrastructure, housing, human livelihoods, and health. Furthermore, urbanization increases the usage of energy and transportation, causing air pollution and GHG emissions. United Nations Environmental Program (UNEP) suggests that cities are liable for 75% of global CO2 emissions, with transport and buildings among the largest contributors.

The Federal and Provincial Governments of Pakistan are facing major challenges in controlling the unplanned and haphazard growth of urban settlements coupled with the occurrences of climate change-induced disasters. These challenges include a lack of coordinated approach in urban Planning and Development (P&D) and weak control of the growth of human settlements, limited implementation and management capacity of municipal administration, absence of an efficient institutional mechanism to manage urban development, and priority conflicts among development authorities.

A coordinated approach and action at the national, provincial, and local levels is required to make cities an integral part of the solution in fighting climate change. To address this burgeoning issue, the Ministry of Climate Change and Environmental Coordination (MoCC & EC) established 'Climate Resilient Urban Human Settlements Unit (CRUHS–Unit)' in 2019 to execute the policy measure of National Climate Change Policy (2012 – 2021) which intends to introduce changes in urban planning and building systems to adapt to the impacts of climate change, conduct in-depth policy and planning research to identify the urbanization challenges and propose timely measures for making the cities climate resilient, coordinate the Government of Pakistan's endeavors regarding environmentally sustainable urban development and human settlements at the Federal level and to establish the ministerial level mechanism to regularly report the sectoral progress and facilitate the provincial action plans related to urbanization.

Goals and Targets

The 'Climate Resilient Urban Human Settlements Unit (CRUHS–Unit)' is established to implement harmonized action plans for climate resilient safe and sustainable cities, launch community-based

urbanization initiatives and facilitate their access to external funding, and strengthen the capacity of city administration to meet urban development challenges and following targets:

- To plan and implement the harmonized Action Plans for developing "Climate Resilient Safe & Sustainable Cities", in collaboration with the Pakistan Urban Planning & Policy Centre at the Ministry of PD&SI (Planning, Development& Special Initiatives); along with the UN-Habitat (Pakistan); all Provincial Urban Units; and the Line Departments of P&D; Local Governments; Housing & Urban Development of the Governments of Gilgit Baltistan and the AJK
- To facilitate Provincial Urban Units in launching community-motivated urbanization initiatives and in implementing urban projects; to facilitate their access to external funding with development partners and set aside international funds for adopting actions in developing Climate Resilient Cities, like the Adaptation Fund; Global Environment Facility and Green Climate Fund in addition to the increased Government's budgetary allocation
- To assist Pakistan Urban P&P Centre in the Ministry of PD&R; in implementing Pakistan Vision 2025 strategic initiatives for transforming all urban human settlements into economic growth hubs and eco-friendly sustainable cities through improved governance, effective urban planning, efficient mobility infrastructure, better security and community participation in collaboration with city governments
- To develop and strengthen the capacity of city administrations to assess the emission targets and adopt low-carbon energy-efficient comprehensive Action Plans to convert their urban-heat islands into "Climate Resilient Cities", towards fulfilling international commitments of the federal government through the focal Ministry of Climate Change & Environmental Coordination
- To strengthen the city governments' capacity in engaging the line departments and agencies and also the non-state actors to effectively meet the urban development challenges throughout Pakistan, as per the international obligations of the Federal Government to meet the UNEP; UNFCCC & UN-Habitat targets under Rio+20 Declaration; New Urban Agenda; and SDGs
- To strengthen the institutional capacity of Provincial Urban Units; GB & AJK by augmenting their technical knowledge and integrating their working mechanism to streamline future urbanization throughout Pakistan; thus enabling them to develop people-centered "Cities for Life", through efficient service-delivery based on information from an integrated Web-Net Databank of all human settlements scenario including the SDGs (i.e. rural-urban migration and demographics; urban poverty & land-use, GHG emissions& temperatures; informal slums, etc.)
- To hold policy dialogues, media roundtables, and conferences/workshops on urban development; besides promoting think tank(s)of scholars and civil society for short- and long-term measures, both at provincial and local levels, for developing productive cities, equipped to effectively control the future of urban growth

Activities

The following are the activities of 'Climate Resilient Urban Human Settlements Unit (CRUHS–Unit) 2022-23:

- Approval of Draft 'Pakistan Resilient Urban Policy Framework' from the competent forum and coordination with provinces to mainstream the framework by inclusion in master planning and land use planning etc. of cities
- Research report on "Assessment of Spatio-Temporal Changes of Land Use Land Cover (LULC) and Associated Impact on Urban Heat Island in Eight Metropolitan Cities: Islamabad, Lahore, Muzaffarabad and Multan Using Geospatial Technologies"
- Two training sessions on "Assessment of greenhouse gases emissions" were conducted in Lahore and Islamabad during 2022-23
- Initiation and execution of activities under the Adaptation Fund Project "Enhanced community local and national level urban climate change resilience to scarcity, caused by floods and droughts in Rawalpindi and Nowshehra"
- Formulation of urban development monitoring and reporting mechanism against indicators stated in PC-I through a web-based data bank for metropolitan cities of Pakistan. (Indicators included: urban population profile, conditions of shelter, water crises, wastes disposal, congestion, pollution, and growth)

Achievements

The following are the achievements of 'Climate Resilient Urban Human Settlements Unit (CRUHS–Unit):

- Formulated "Pakistan Resilient Urban Policy Framework" in consultation with all relevant stakeholders from federal and provincial governments
- Formulated "Green Building Guidelines" for Naya Pakistan Housing Programme (NPHP).
- Secured Adaptation Fund Project titled "Enhanced community local and national level urban climate change resilience to scarcity, caused by floods and droughts in Rawalpindi and Nowshehra" from Adaptation Fund Board, Washington DC in 2020
- The User interface of the web portal for urban development monitoring and reporting mechanism has been developed/Live (Cruhs.gov.pk) and data is collected against the indicators i.e., Population, Precipitation, temperature, and Waste generation.
- Research study on "Assessment of Spatio-Temporal Changes of LULC and associated impact on Urban Heat Island in four metropolitan cities: Lahore, Multan, Islamabad, and Muzaffarabad of Pakistan Using Geospatial Technologies"
- Training sessions on "Assessment of greenhouse gases emissions" are conducted in Lahore and Islamabad during FY 2022-23

2.2.2. Capacity Building on Water Quality Monitoring and SDG 6(6.1) Reporting

Introduction

The safely managed water under SDGs comprises of; water accessible at premises, available when needed, and free from contamination. About 89% population in Pakistan has access to improved water sources. This largely comprises of motorized pumps, hand pumps, piped water, and closed wells. Only 1/4th of the population in Pakistan has access to piped water (26%). High reliance of drinking water in the form of hand pumps or motor pumps shows that groundwater extraction is unregulated, so self-

provision is leading primarily in Punjab and Sindh provinces as compared to Baluchistan and KPK provinces where high reliance is on piped or surface water.

In Pakistan due to huge urbanization and environmental changes, there was a dire need to focus on the drinking water quality in the country. Moreover, growing population further accelerates demand and supply of safe drinking water and also raises a need for addressing this issue on an urgent basis. In addition to this, a proper platform was needed to play a vital role in reporting and tracking the progress of SDG 6.1. Further to provide support to fill in the gaps in the implementation of interventions around access to safe drinking water, a separate PC-1 titled ''Capacity Building On Water Quality Monitoring and SDG 6 (6.1) Reporting'' under the KOICA grant is being developed in alignment with the PC-1 of WASH Strategic Unit to strengthen the capacities for reporting, monitoring and surveillance of drinking water both at Federal and Provincial level.

All the interventions and activities designed for the project were conceived in consultation with the provincial stakeholders over a period of two years. An extensive process of consultations and review of data was undertaken by MoCC & EC and KOICA experts to ensure that there is no duplication of activities. The project will aid and facilitate the process, preparation, implementation, and monitoring of KOICA grant funds. This will also facilitate the Provincial departments and governments to receive the next phase of the KOICA grant to support the equipment and infrastructure uplift of water quality testing labs/systems.

Roles and Functions

- To develop and establish a national/ provincial drinking water quality monitoring and surveillance management system and strengthen the capacity of WASH cell and PHEDs to track the progress of SDG-6.1
- To strengthen the coordination capacity of WASH Cell on drinking water issues with provincial governments
- To build capacity of human resources on water quality testing, monitoring, and provision of necessary equipment

Goals and Targets

- Effective water quality monitoring, surveillance, and management systems are in place
- Institutional and policy arrangements for water quality monitoring
- A periodic IT-based reporting mechanism on water quality monitoring is established
- Capacity for water quality monitoring and testing is developed for the identified stakeholders.

Activities

- Development of National & Provincial Water Quality Monitoring and Management Framework
- Review of drinking water policy and development of a national guideline on drinking water that covers the water quality monitoring and management system
- Finalization of Water Quality Reporting Indicators
- Organization of quarterly coordination meetings
- Organization of one national workshop (Joint Sector Review) for the annual review of water quality components

- Establishment of MIS System for water quality monitoring and surveillance
- Development of MIS System (water quality) and interfacing it with Clean Green Pakistan Index Dashboard
- Development of annual report on drinking water quality statistics and analysis of data on water quality twice a year
- Capacity building (trainings) for water policy, master trainer, and water quality lab operation
- International courses/ training sessions to be organized in Korea
- National trainings in Pakistan
- Strengthening of water quality testing labs by providing the water quality testing equipment and necessary infrastructure uplift
- Project Implementation at the National and Provincial level
- Development of SOP and operational guidelines for water quality testing labs and staff

Achievements

- A baseline for water quality laboratories under, KP, Punjab and Federal EPAs has been developed
- A tender for the purchase of equipment for 36 labs in Punjab and 8 labs in KP has been done. Delivery completed and installation in process
- Training/capacity-building Consisting of Mid-level officials from stakeholders has been conducted on Date: 18th August – 6th September 2022 (20 days) Participant: Nine (9) working-level officials (MoCC, PEPA, PCRWR, HUD & PHED in Punjab, LG & CDD in Punjab and PHED in KP) completed
- Development of MIS for water quality reporting and tracking of operational activities of water quality is completed
- Purchase of IT equipment, establishment and repair/maintenance of water and Sanitation Hygiene Cell in MoCC has been accomplished
- Invitational Training Program in KOREA including Master Training Program for 90 days is under process with KOICA for setting the schedule and the course has been completed on 9th June 2023
- Development of SOP (Standard Operating Procedures) for Laboratory for 45 laboratories of PCRWR, PEPA, and PHED in Punjab and KP in coordination with KOICA is completed and is in the process of review
- Training/capacity-building Consisting of high-level officials from stakeholders for (07 days) Participant: high-level officials (MoCC, PEPA, PCRWR, HUD & PHED in Punjab, LG & CDD in Punjab and PHED in KP) from 7th-14th July 2023 has been completed

Way forward

- Local trainings of Laboratories staff for the equipment are in process from August 2023 till February 2024. The first batch was completed on 30th September 2023 and 2nd Batch is in process and will be completed by December 2023
- Water policy/ Legal system Administrative Statistic Report Development
- Development of status and database report on Water quality in Islamabad

2.2.3. Upscaling of Green Pakistan Programme (UGPP)

Ministry of Climate Change and Environmental Coordination (MoCC & EC) initiated the implementation of Upscaling of the Green Pakistan Programme (UGPP) in 2019 with a total cost of 125.1843 billion for four years (2019-23) with the primary objective of reviewing forestry and wildlife resources across the country. The programme is sponsored through the federal government with 50% cost sharing from the provinces except for AJ&K and Gilgit Baltistan. Out of the total target of planting 3.296 billion in the current phase of the project from afforestation, reforestation, plant distribution, and regeneration, the provinces and federal territories reported 227.09 million plants during 2022-23. This makes the total accumulative achievement of 2068.86 million plants restoring 0.716 million hectares of land over the past four years (2019-23). In addition, the programme also provided 167,511 man-months green job opportunities to the local communities during the reporting year. The independent third-party consortium of IUCN, WWF, and FAO revealed an average survival range of 72-93% of the plantation/regeneration.

On the other hand, the programme has helped notify two Man and Biosphere Reserves (MAB), established two information desks at the airport and check post to arrest illegal wildlife traffic, and developed several management plans, extended watch, and ward support for wildlife activities across the country. Collectively, the programme has been able to help the provincial governments notify 97 PAs of various categories in the country.

Due to the efforts of the government, the programme is now rated among the very few highly successful initiatives across the globe and has attracted the attention of the national and international conservation communities as well as the media. MoCC &EC is in the process of designing the revised phase of the programme (July2024-June 2028) to fulfil its commitment to enhancing and maintaining forestry cover in the country through nationwide forest digitization/ scientific forestry resource assessment, plantation/regeneration, and getting registry in the carbon market for earning carbon credits.

In addition to the core objective of landscape restoration and conservation, it is estimated that the program will generate around 148.76 mtCO2e over the next 10 years (ref. Pakistan NDC report), which may earn around US$ 2.528 billion for the local economy through the marketing of carbon credits in the international market. Negotiations for marketing Carbon Credits have already been initiated by the provincial/territorial government with the international carbon credit buying companies.

2.3. Environment & Climate Change Wing

Climate Change and Environment Wing of the Ministry is mandated to perform the following functions:

- Implementation of National Climate Change Policy and its implementation framework;
- United Nations Framework Convention on Climate Change (UNFCCC), Inter-Governmental Panel on Climate Change (IPCC), Economic Cooperation Organization (SCO), United Nations Environment Programme, Natural Capital Accounting, CAREC Vision 2030

The Environment & Climate Change Wing has undertaken the following initiatives to respond to environmental degradation and climate change:

International Cooperation

Ministry of Climate Change and Environmental Coordination (MoCC&EC) has experienced a notable surge in its performance, both on the national and international fronts. Domestically, the Ministry has spearheaded initiatives like institutional strengthening and climate action through policy and project level interventions. Internationally, MoCC&EC has amplified its engagement, playing a pivotal role in global climate discussions and negotiations. A brief description of the achievements is as follows:

i. Pakistan's noteworthy achievement includes the signing of a Memorandum of Understanding (MoU) with the United Arab Emirates (UAE) to facilitate the mobilization of foreign direct investment in wastewater treatment
ii. Pakistan has signed a strategic agreement with Kuwait, fostering investment in the promotion, protection, and rehabilitation of mangrove forests through responsible forestry practices and carbon credits
iii. Pakistan played a crucial role in the operationalization of the L&D Fund under the UN Framework Convention on Climate Change (UNFCCC), amassing pledges exceeding USD 792 million
iv. Pakistan was elected to the L&D Fund Board, showcasing its commitment to addressing climate-induced loss and damage
v. Pakistan achieved significant recognition by being elected to key bodies within UNFCCC, including a Board Member position on the Loss and Damage Fund, membership in Technology Executive Committee (TEC), Paris Committee on Capacity Building (PCCB), the Advisory Board of the Santiago network, and Standing Committee on Climate Finance (SCF). This highlights Pakistan's proactive role in global climate governance
vi. Pakistan achieved a significant milestone with the inauguration of Recharge Pakistan by the Prime Minister. This transformative initiative, funded by the Green Climate Fund with a grant of $77 million, aims to revolutionize flood and water resource management in the Indus Basin, implementing ecosystems-based adaptation and green infrastructure interventions to enhance resilience to climate-induced challenges

Pakistan is considered one of the low global greenhouse gases (GHG) emitter. Presently, Pakistan’s GHG emission accounts for less than one percent however, the country is considered extremely vulnerable to the impacts of climate change. Being a responsible member of the global community, Pakistan has responded with a well-articulated climate change agenda, consisting of the following initiatives:

2.3.1. 27th Session of United Nations Climate Change Conference (COP-27)

The 27th Session of United Nations Climate Change Conference (COP-27) of the United Nations Framework Convention on Climate Change was held from 6 November until 20 November 2022 in Sharm el- Sheikh, Egypt. It took place under the presidency of Egyptian Minister of Foreign Affairs with more than 100 heads of state and governments and an estimated 45,000 representatives/ delegates, from 190 countries attended. A high-level delegation under the leadership of Mian Muhammad

Shahbaz Sharif, the Prime Minister of Pakistan attended the COP 27 and participated in a number of events. The delegates discussed issues such as climate change mitigation, adaptation, Loss & Damage and financing to support developing countries in their efforts to move away from fossil fuels and become more resilient to the impacts of climate change. It is pertinent to mention that after vigorous efforts of Pakistan being Chair of G-77 & China, the Loss & Damage issue came up on the agenda of COP 27.

As a result of effective participation and diplomatic efforts, Pakistan has been able to perform a key role in COP 27 and raise issues for countries most adversely impacted by climate change. An overview of key achievements is presented below:

- Pakistan chaired the G-77 & China group and through extensive efforts, got the L&D Fund placed on the agenda for COP 27, and later on pushed for a consensus agreement on it, which was successfully adopted. The establishment of the fund reflects Pakistan's ability to not only speak and deliver for itself, but also led the voices of developing countries at the international level. Pakistan's representation as the Chair of the G- 77 & China has marked the country's important position at the international negotiations and Pakistan's presence at COP 27 was greatly recognized and appreciated
- A Global Shield initiative receiving funding from the G-7 countries are set to mobilize funds to the V-20 countries and Pakistan will be amongst the first recipients, due to its climate vulnerable position and due to the recent heatwaves and floods. It aims to provide climate vulnerable countries with rapid access to insurance and disaster protection funding after floods or drought
- The Global Fertilizer Challenge Ministerial announced $135 million of funding for fertilizer efficiency projects, with the US funding to focus on Brazil, Colombia, Pakistan and Vietnam. Germany will also support the challenge with an additional €13.6 million, mostly centered on Sub-Saharan Africa and will focus on efficiency and productivity
- The demand for the establishment of the Global Goal on Adaptation Framework was echoed by the G-77 & China subgroups. Pakistan presented a very strong case given the catastrophic situation it is facing after the devastating floods
- The agreement reached on establishing an Advisory Board of the Santiago Network on L&D (SNLD) as part of the Warsaw International Mechanism (WIM) on L&D. Pakistan had continuously pushed for WIM for the past two years and was successful to keep developing countries united to galvanize this support

2.3.2. Living River Initiative

Living River initiative for restoration of River Indus for climate resilient future was launched by Government of Pakistan. The initiative is aimed at improving water quality and quantity, while also restoring the health of the Indus Basin. The Living Indus initiative aims to restore and repair the natural resources and ecosystems of the basin to ensure that they are resilient to climate change.

2.3.3. Pakistan's Commitment Towards NDCs Under Paris Agreement

Government of Pakistan (GoP) as a Party to the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC) has performed its role to support the global efforts in combating climate change. GoP had submitted an inclusive updated Nationally Determined Contributions (NDC) which represents national consensus to accelerating the transition towards a climate-resilient economy. The current submission showcases GoP's progress in climate action that ranges from policy and programs on Nature-based Solutions (NbS) to technology-based interventions. Pakistan, recognizing the role of nature in climate adaptation and mitigation, has developed robust natural capital restoration efforts including the Ten Billion Tree Tsunami Program (TBTTP), Protected Areas Initiative (PAI) etc. These programs have also served as a way to enhance livelihood opportunities for the most vulnerable, including women and youth. In addition, Pakistan has introduced several policy actions focused on mitigating greenhouse gas emissions from high-emission sectors like energy and industry. The focus of GoP's climate actions during the decade ahead is decided by the current climate-induced vulnerabilities, aimed at achieving reduced poverty and ensuring a stable economy.

The updated NDC is informed by recent policy developments in the country in the NDC sectors, and some ambitious decisions taken by the pro-climate leadership to enhance Pakistan's resilience and decarbonize the economy. In addition, for enhanced contributions, new sectors, and new gases have also been added to the updated document. Hence, Pakistan intends to set a cumulative ambitious conditional target of an overall 50% reduction of its projected emissions by 2030, with 15% from the country's resources and 35% subject to the provision of international grant finance that would require USD 101 billion just for the energy transition. To reach the target, Pakistan aims to shift to 60% renewable energy, and 30% electric vehicles by 2030 and completely ban imported coal. Moreover, Pakistan seeks to expand nature-based solutions by implementing of TBTTP, Recharge Pakistan, and PAI. Pakistan's emissions as of 2018 are 489.87 MtCO2e; the Billion Trees Afforestation Project (BTAP) and TBTTP will sequester CO2 around 500 Mt CO2 e by 2040 if implemented fully.

2.3.4. National Climate Change Policy (2021)

Mitigating and adaption actions are considered to be the two key ways of combating climate change. The more immediate and pressing task for the country is to prepare itself for adaptation to climate change. This National Climate Change Policy addresses issues in various sectors such as water, agriculture, forestry, coastal areas, biodiversity, and other vulnerable ecosystems. Even though Pakistan's contribution to global greenhouse gas (GHG) emissions is small, its role as a responsible member of the global community in combating climate change is dedicated by giving due importance to mitigation efforts in sectors such as energy, transport, forestry, and agriculture.

The implementation of the National Climate Change Policy has been assessed, which shows landmark achievements gained by the Ministry of Climate Change, and Provincial Line Departments in various development sectors i.e., agriculture, transport, energy, industries, forestry and biodiversity through adaptation and mitigation measures. Several projects have been initiated by the federal government and provincial departments i.e., Ten Billion Tree Tsunami, Clean Green Pakistan Index, Ecosystem

Restoration, WASH, Climate Resilient Urban Development, and Green Building Code are some of the major initiatives in addressing climate change in the country.

In this connection, the meetings of the National Climate Change Policy Implementation Committee are convened to oversee the implementation status of NCCP.

2.3.5. Building Capacity to Advance National Adaptation Plan Process in Pakistan

This Project "Building Capacity to Advance National Adaptation Plan Process in Pakistan" is funded by GCF. United Nations Environment Program (UNEP) is the delivery partner of the project, while the Ministry of Climate Change & Environmental Coordination (MoCC&EC) is the National Designated Authority of the project. The project's overall objectives are:

i. Reducing vulnerability to the adverse impacts of climate change, by building adaptive capacity and resilience, and
ii. Facilitating the integration of climate change adaptation, coherently, into relevant new and existing policies, programs, and activities, in particular development processes and strategies, within all relevant sectors and at different levels

Progress 2022-2023

i. Provided technical and financial support in the finalization and printing of the NAP document in 2023
ii. Report on Pakistan Climate Change Impact Storylines Based on Existing Vulnerability Literature;
iii. Report on the Current status of climate change projections in Pakistan
iv. To research, review, and synthesize available information on the adverse effects of climate change and beneficial coping strategies
v. Report on Outlining gaps and suggesting changes to the current Policy and Legal Framework on climate change adaptation
vi. Organized a high-level consultative workshop in 2022 to lay out a roadmap for the implementation of the NAP process. It was attended by 100 participants
vii. Conducted a mapping exercise to know who does what and with whom NAP Project can make partnerships. For doing the meetings were held with IUCN, WWF, NDRMF, NRSP, KFW, UNDP, WFP, ILO, GIZ, PMD, GCSIC, and consulting firms
viii. Initiated the work on developing the project proposals for the Living Indus Initiative in Pakistan through GCF funding

2.3.6. Introduction of Carbon Pricing Instrument in Pakistan

To strengthen the institutional capacity for developing "carbon trading" and for participating in the international carbon market, the Ministry of Climate Change is formulating carbon policy framework guidelines. Carbon markets are becoming an indispensable tool in the global climate fight, with carbon pricing instruments now covering over 20 percent of global greenhouse gas emissions, generating $53 billion in revenue at the end of 2021, according to the Carbon Pricing Leadership Coalition, a 17

percent increase in revenue from the previous year. Setting up a carbon market is part of efforts by Pakistan, one of the country's worst hit by climate change, to reduce 15 percent greenhouse gasses with the country's resources and 35 percent with the support of international grants by 2030.

2.3.7. Natural Capital Accounting

Natural capital is often undervalued or neglected in decision-making, which contributes to more biodiversity loss, and ultimately impacts human well-being. For example, infrastructure and road development projects have historically been carried out with little to no attention to the short-or long-term impact of these activities on natural ecosystems and biodiversity which sustainable use of the natural capital, which provides the foundation for sustainability of the life on earth and overall socioeconomic development of current and future generations, is vital to its sustainability for generating ecosystem services for the lasting human well-being.

A report on natural Capital Accounting has been prepared with the cooperation of the World Bank which encompasses the conversion of Biophysical capital into economic capital and enables tracking of changes in the natural capital. The study has been conducted in designated areas to make it more specific.

2.3.8. Central Asia Regional Economic Cooperation Program

Climate change affects weather and climate conditions regionally and therefore requires strengthening national data collection and analysis and creating regional centres of weather and climate observations and prediction, regionally coordinated risk management, planning, and action CAREC is an important regional convener. It offers great opportunities to operationalize the climate agenda in its five operational clusters and promote DMCs' and DPs' active and sustained participation at policy and project levels, including supporting cross-cutting priorities. Given the regional interconnectedness of CAREC countries in many climate issues, the strong commitment of the countries to work together and use the CAREC platform to identify linkages and possible regional solutions for climate change issues are needed in the operational clusters providing overall cross-cluster guidance, coordination, and monitoring.

2.3.9. Climate Change Dashboard

Pakistan achieved a milestone by inaugurating the Climate Change Dashboard, a comprehensive platform, featuring modules for climate data tools, NDCs achievement tracking, and playing a crucial role in building resilience against climate change impacts.

2.3.10. Mitigation and Adaptation Projects

Pakistan's share in the United Nations' Green Climate Fund (GCF) grants portfolio has surged from $129 million to $221 million. Furthermore, the Ministry of Climate Change & Environmental Coordination (MoCC & EC) has approved additional climate change mitigation and adaptation projects, totaling around $200 million for GCF financing, bringing the total number of endorsed projects to 11. Alongside issuing no-objection letters for these projects, MoCC & EC has also endorsed public and private sector entities for accreditation with the GCF.

2.3.11. Engagement with The Shanghai Cooperation Organization (SCO)

The Shanghai Cooperation Organization (SCO) is a Nine-member inter-governmental trans-regional organization comprising of Pakistan, Russia, China, India, Iran, Tajikistan, Uzbekistan, Kazakhstan and Kyrgyzstan. It was established in Shanghai on 15 June 2001. SCO has 3 Observers - Mongolia, Belarus and Afghanistan; and 14 Dialogue Partners -Azerbaijan, Armenia, Cambodia, Nepal, Turkey, Sri Lanka, Egypt, Qatar, Saudi Arabia, Kuwait, Bahrain, Maldives, Myanmar and UAE.

SCO membership includes four nuclear states and two permanent members of the UN Security Council. As the main trans-regional organization in the Eurasian heartland, SCO brings together phenomenal natural resources including oil and gas reserves, minerals, precious metals, food grains and technologically advanced human resource. Altogether, SCO is home to 41% of the world population and brings together 23% of the global GDP.

SCO is based on the Shanghai Spirit which stands for mutual trust and respect, equality, respect for diverse civilizations, and pursuit of shared development. All SCO decisions are taken by consensus and the focus is on possible areas of cooperation rather than confrontation and point-scoring. It also excludes discussions on areas of bilateral dispute between member states.

SCO comprises two permanent bodies: the SCO Secretariat based in Beijing and the SCO Regional Anti-Terrorism Structure (RATS) based in Tashkent. China and Russia are the driving force behind SCO. They have a common interest in maintaining peace and stability and fighting terrorism and extremism. But they also have their specific interests to pursue. SCO as an organization is different to other multilateral organizations with a different ethos. Russian and Chinese are the two official languages of SCO. All discussions and negotiations take place in Russian language. For non-Russian speaking members like Pakistan and India, this poses a significant challenge.

- **Initiatives under discussion with SCO and Response of Ministry of Climate Change & Environmental Coordination**

i. **Plan of Action for the SCO Year of Ecology:** The main objective is to organize different activates regarding Environment/Climate Change/Forestry to be held during the Year of Ecology in the SCO in 2024.

ii. **Plan for the implementation of the Concept of Cooperation of the SCO Member States in the Field of Environmental Protection for 2025-2027:** The main objective is to strengthening cooperation in the field of environment protection and establishing channels for information exchange, improving the technical level environmental agreement, climate change, promoting green development, waste management, water resources management, development of specially protected areas and implementation of scientific and technical cooperation in the field of environment and climate change.

iii. **Agreement between the governments of the SCO Member States on the Cooperation in the field of environmental protection:** In order to create favorable conditions for the conservation of environment & sustainable use of natural resources, cooperation in the field of environmental protection between the Parties may be promoted as it contributes to collaborative environmental protection and strengthening of friendship between the Parties.

iv. **Regulations of the Meeting of Heads of Ministries and Departments of the SCO Member States Responsible for Climate Change Issues (SCO Climate Council):** The Regulation defines the tasks and organizational principles, functions, structure and composition of the Meeting of the Heads of Ministries and Departments of the Shanghai Cooperation Organization (SCO) Member States Engaged in Cooperation on Climate Change (hereinafter referred to as the Climate Council). The Climate Council is a multilateral consultation platform for the interaction of the SCO member states and the identification of promising areas of cooperation in the field of climate change that contribute to the achievement of SDG 13, as well as the goals of the UNFCCC and the Paris Agreement.

2.3.12. Engagement with UN-Habitat

UN-Habitat is the United Nations programme working towards a better urban future. Its mission is to promote socially and environmentally sustainable human settlements and the achievement of adequate shelter for all. Pakistan is founding member of UN-Habitat and contributes US$ 6000 yearly to the Core Budget of UN-Habitat.

The Government of Pakistan is keen on taking measures to formulate the first Pakistan Resilient Urban Policy Framework. The Government of Pakistan is taking a participatory approach where the projects on urbanization are being revitalized to guide government in shaping the guiding principle for proper implementation Urban Policy Framework. Meeting challenges in the 'New Urban Agenda' requires a paradigm shift in the approaches to development not only in Pakistan but in the world at large. The dialogue will also be part an urban campaign which would reinforce efforts to ground the consultations among people and arrive at solutions to new evolving ideas of resilient urban development.

Ministry of Climate Change & Environmental Coordination is the focal of UN-Habitat in Pakistan. With collaboration of this UN agency, a number of activities have been undertaken in the country. Following initiative are under taken with the assistance of the UN-Habitat:

2.3.13. Green Building Guidelines

Ministry of Climate Change & Environmental Coordination has developed Green Building Guidelines with collaboration of UN-Habitat, Switch-Asia and UNEP. These Guidelines are advisory in nature and aim to incorporate the lessons learnt in the process of making Pakistan Green Building Code, green eco-friendly practices of building's design, construction & operation stages; besides, ensuring the sustainable utilization of construction materials to save energy, conserve water, improve indoor environmental quality and lower GHG emissions.

2.3.14. Pakistan Green Building Code 2023

Ministry of Climate Change in collaboration with UN-Habitat, Pakistan Engineering Council and other relevant stakeholders has formulated Pakistan Green Building Code 2023. This policy document addresses and provides a thorough roadmap and guidelines for the design and construction of environment friendly and energy efficient buildings in the country.

2.3.15. Adaptation Fund Project

UN-Habit is implementing another project of adaptation fund project in Nowshera and Rawalpindi titled “Enhance community, local and national-level urban climate change resilience to water scarcity, caused by floods and droughts”.

2.3.16. World Environment Day

World Environment Day (WED) is observed globally on June 5th each year and serves as a platform for raising awareness and promoting action on pressing environmental issues. The day is coordinated by the United Nations Environment Programme (UNEP) and is celebrated by various organizations, communities, and individuals around the world. The overarching objectives of World Environment Day includes environmental awareness, encouraging action, global participation, advocacy and policy influence. WED provides a platform for advocacy and influencing policies related to environmental protection. It encourages dialogue between governments, NGOs, businesses, and citizens to shape policies that promote sustainability.

Ministry of Climate Change & Environmental Coordination celebrated this day along with their other related agencies including Pakistan Environmental Protection Agency and Provincial EPDs.

2.3.17. Earth Hour, 2023

Earth Hour is a global environmental initiative. The event encourages individuals, communities, and businesses around the world to turn off non-essential lights and other electrical appliances for one hour as a symbolic gesture to raise awareness about the need for action on climate change and the importance of sustainable energy consumption. In these challenging times, Earth Hour offers us a moment for solidarity to come together for our planet, the one home we all share. The science is clear. We know that the next few years are crucial in determining whether we can halt irreversible environmental degradation and climate change or business as usual will continue. In such an exceptional circumstance, Earth Hour is needed more than ever, as it offers us an opportunity to pause, reflect, renew our commitments, and inspire millions to take action.

Ministry of Climate Change and environmental coordination celebrated activities of the Earth hour this year in close coordination with Ministry of Information and Technology and World-Wide Fund for Nature (WWF). By “switching off” your lights or switching off from daily habits and distractions and doing something positive for the planet, we can turn a single Earth Hour into thousands and millions of hours of action, making this the Biggest Hour for Earth yet. The choices we make today will have an immediate impact on our country and our planet’s well-being organized by the World-Wide Fund for Nature (WWF).

2.3.18. Projects of Environment/Climate Change Wing

Details of Projects related to the Environment & Climate Change Wing are reported under the Section on Development Wing.

2.4. Forestry Wing

The Status of Forests, Biodiversity, and Wildlife Resources in Pakistan

Based on the latest findings from the National Forest Reference Emissions Level (FREL), the country is maintaining a 4.786-million-hectare area under forest cover, which represents 5.45% of its land area. By forest type, dry temperate forests have the largest proportional coverage (36 %) followed by sub-tropical broadleaved shrub (19 %), moist temperate (15 %), Chir pine (13 %), riverine (4 %), irrigated plantation (4 %), thorn (3 %), mangrove (3 %) and subalpine forests (2 %).

Unfortunately, climatic conditions, rural poverty, dependence on natural resources, meager forest cover, and high rate of deforestation has left the country exceptionally susceptible to the impacts of climate change. Forest, biodiversity, and wildlife resources have also suffered from the adverse effects of climate change. Also, these resources are under tremendous pressure owing to changes in land use and habitat destruction. Further, the rise in population has led to an increased demand for fuel, wood, and timber extraction. Such pressures have significantly impacted forests of poor and medium density, necessitating urgent and extensive restocking efforts. The overall improvement of the sector in the country requires continuous efforts through several initiatives under long-term planning and programs. The existing meager forest resources being crucial to environmental stability demand serious interventions and adequate financial flows to improve and enhance the overall forestry, wildlife and biodiversity sector.

The major activities of Forest Wing during the year 2022-23 are as under:

2.4.1. REDD+ Readiness and Preparation Project

The Ministry of Climate Change successfully implemented REDD+ Readiness grant supported by the Forest carbon Partnership Facility (FCPF) of the World Bank. The readiness grant helped establishing REDD+ institutions, technical assessments and capacity building of relevant stakeholders for accessing forest carbon financing through implementation of REDD+ and under voluntary carbon markets.

The major achievements under the project included formulation of National REDD+ Strategy and Sub-national REDD+ Action Plans, Establishment of National Forest Monitoring Systems, Setting up Forest Reference Emission Levels and Safeguards Information System. The project also led to assessment of deforestation and forest degradation in country and economic contribution of forestry ecosystem products and services to the GDP. The data and products could be accessed from the websites, https://redd-pakistan.org and https://nfmspak.org.

Indus Delta Blue Carbon initiated by the government of Sindh has been registered as one of the first forest carbon trading project in the country focusing on restoration of 350,000 hectares of mangroves over the period of 60 years under public-private partnership with carbon sequestration potential of 127 million tons.

2.4.2. Reversing Deforestation and Forest Degradation in High Chilghoza Pine Forests Baluchistan: Project Progress

The project focusing on conservation of Chilghoza forests in Baluchistan, KP and GB and is being implemented in collaboration with FAO. The project has directly benefited 8,443 households. Four Chilghoza processing units have been provided to communities including 600 sets of Chilghoza cone collection and storage tools. In addition, the project has assisted natural regeneration over 2153 hectares (ha) (4 million seedlings) and plantation of fruit and forest seedlings on 653 hectares. The project has also introduced 2,100 fuel efficient stoves and gasifiers to reduce community pressure on forest resources.

2.4.3. Upscaling of Green Pakistan Programme (UGPP)

MoCC & EC is implementing Green Pakistan- Upscaling Program, Phase-I across the country with the overall objectives to revive forestry and wildlife resources. Total cost is Rs.125.1843 billion. Under the programme, plantation target of sowing, re-growing and distribution of 2.069 billion plants has been accomplished at national level. An independent third-party consortium of IUCN, WWF and FAO conducted monitoring of the achievements with success rate ranging from 75% to 95%.

2.4.4. National Action Plan for Forest Landscape and Restoration (FLR)

National Action Plan for Forest and Landscape Restoration has been prepared through extensive consultations with the relevant provincial and national stakeholders. The action plan identifies strategic priorities and actions for FLR through domestic resources and donor funding.

2.4.5. Bamboo Resource Assessment Training and Inventory in Pakistan

Pakistan is one of the member countries of International Network on Bamboo and Rattan (INBAR). Through the financial support of INBAR, Pakistan has undertaken assessment of bamboo resources in the country and is process of developing a strategy and action plan for promotion of bamboo cultivation and value chain development in the country.

2.4.6. Saudi Green Initiative (SGI) and Middle East Green Initiative (MGI)

Pakistan is one of the founding members of Saudi and Middle-East Green Initiatives led by the Kingdom of Saudi Arabia. The initiatives target planting or regenerating 50 billion trees across the region equivalent to 200 million hectares of land in Central Asia, West Asia, South Asia, North Africa and Sub-Saharan Africa to promote nature-based solutions and ecosystem-based approaches. Pakistan facilitated exchange visits of two delegations from the National Centre for Vegetation Cover (NCVC), KSA in Pakistan to share knowledge and experiences on management, protection and restoration of forests, rangelands, national parks, development of vegetation cover and combating desertification.

2.4.7. Forest & Climate Leaders' Partnership (FCLP)

Pakistan has joined UK-led Forests and Climate Leaders' Partnership (FCLP) as one of the members. The FCLP aims to accelerate global progress to halt and reverse forest loss and land degradation by 2030 while delivering sustainable development and promoting an inclusive rural transformation through a voluntary and focused partnership of countries that are making a strong contribution to this agenda. The initiative maintains high-level attention on the issue of deforestation, and committed governments work together to implement solutions that reduce forest loss and increase restoration.

2.4.8. UNCCD's Report (PRAIS-4)

Pakistan is party to United Nations Convention to Combat Desertification (UNCCD) since 1997. Under article 26 of the UNCCD, countries are obliged to report periodically on the measures taken for the implementation of provisions of the Convention. Pakistan National Report (Prais-4) was submitted on 15th February, 2023 to the UNCCD Secretariat through the online portal.

2.4.9. Land Degradation Neutrality Target Setting Programme (LDN TSP 2.0)

Pakistan has been selected by the UNCCD as one of the eighteen countries that will participate in the second phase of Land Degradation Neutrality Target Setting Programme to strengthening LDN targets and integrated land use planning frameworks. The programme will improve joint implementation efforts among the Rio Conventions and make key contributions to multiple SDGs and the UN Decade on Ecosystem Restoration.

2.4.10. Mountain Area Partnership

Pakistan is one of the six countries partnering with FAO in the implementation of the Mountain Area Partnership project. The project is aimed to improve the livelihoods of rural communities through sustainable management of natural resources with a focus on mountain areas. The main implementing partner is the University of Rome "La Sapienza".

Project activities will identify the areas where environment and livelihoods are particularly vulnerable to climate change and economic stress. The results obtained from the overall project analytical process will be presented at an international workshop to be organized towards the end of the project, where the involved countries will present their findings/ outcomes and possible follow-up actions.

2.4.11. Recharge Pakistan Programme

The Indus River is Pakistan's lifeline, and is now experiencing catastrophic floods and droughts exacerbated by climate change. The MOCC&EC and WWF have collaborated to develop the "Recharge Pakistan" for funding through Green Climate Fund (GCF). The project is focused on Ecosystem based Adaptation for integrated flood risk management and enhancing resilience of vulnerable communities to climate change with a paradigm shift towards Ecosystem based Adaptation in Pakistan. The project duration is 7 years (Dec. 2023-Dec. 2030). It will help to

reduce the climate induced flood risks and droughts through EBA for improved resilience of vulnerable communities at three sites in Baluchistan, Khyber Pakhtunkhwa and Sindh provinces.

2.4.12. Conservation of Snow Leopard in Pakistan

The snow leopard is found in high mountains of Central and South Asia including 12 countries as its range states (Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyz Republic, Mongolia, Nepal, Pakistan, Russian Federation, Tajikistan, and Uzbekistan). Pakistan is a member of the Global Snow Leopard and Ecosystem Protection Program (GSLEP) which aims to address high-mountain environmental issues using the conservation of the charismatic and endangered snow leopard as a flagship. A conservation programme is being implemented for protection of the species, establishment of protected areas, research and monitoring of species, addressing human-wildlife conflict through construction of predator-proof corrals, livestock insurance schemes, ecotourism and awareness raising.

2.4.13. Regulation of import and export of Wildlife

Under the convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) the import and export of wild fauna and flora is being regulated to ensure that they are not exploited unsustainably. Three meetings of apex body, CITES Management Authority were held to decide policy issues and allocation of quotas for community-based trophy hunting programme. During the period an amount of Rs.6, 258,500/-was deposited in Government exchequer collected from wildlife import/ export fees.

2.4.14. Biodiversity Conservation Planning

Pakistan developed its National Biodiversity Strategy and Action Plan (NBSAP) 2017-2030 in line with Aichi Biodiversity Targets (ABTs 2011-2020) and Sustainable Development Goals (SDGs) to support conservation of biodiversity and promote sustainable use of biodiversity resources, and fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

Pakistan endorsed GEF Umbrella initiative: Early Action Support Project to align National Biodiversity Strategy and Action Plan with Kunming Montreal Global Biodiversity Framework targets. The initiative is led by UNDP-Pakistan.

During the period, new Protected Areas were established including two new Biosphere Reserves, Gallies Biosphere Reserve and Chitral Bashkar Garam Chashma Biosphere Reserve which were notified by UNESCO's Man and Biosphere Programme. The dossiers of two other MAB sites are in process of submission to UNESCO. These include, Sheikh Badin Biosphere Reserve and Indus Blind Dolphin Biosphere Reserve.

Under Cartagena Protocol and Biosafety Clearing House Project, second and third workshops of the Biosafety Clearing House (BCH) were conducted. The impact of this exercise will be significant in contribution towards data for BCH.

Through a consultative process with relevant stakeholders, academia and R&D institutions, revision of Pakistan's Biosafety Rules and Guidelines was carried out to streamline the process of

approvals for genetically Modified Organisms for Food Feed and Processing (GMOs FFP). A summary for the Cabinet has been processed for approval by the Federal Cabinet.

2.5. International Cooperation Wing

International Cooperation Wing of the Ministry of Climate Change & Environmental Coordination consists of three sections/units which are mandated and responsible for performing functions as follows:

- Chemical Section is mandated to set ground for implementation of various chemical and waste-related Conventions namely Basel, Stockholm, Minamata and Rotterdam Conventions, etc.
- International Cooperation Section is responsible for coordination with international donor agencies on environmental issues, signing & implementation of MOUs, handling of matters related to GSP+. Moreover, it also represents Pakistan at international forum with respect to the signed Conventions and Protocols.
- National Ozone Unit was established in 1996 after the signing and ratification of Vienna Convention and Montreal Protocol on substances that deplete the Ozone Layer in Pakistan. The main objectives of the NOU are to control consumption of Ozone Depleting Substances (ODS) and assist the local industry for phasing out the use of ODS through financial and technical support of the Multilateral Fund Secretariat (MLFS).

During the Financial Year 2022-23, all the aforementioned sections performed a number of functions, while keeping in view their main agenda items. Details of the activities and achievements of the IC Wing has been enunciated below:

2.5.1. Chemical Section

Federal Cabinet approved Single-Use Plastics (Prohibition) Regulation 2023 on 04-06-2023. The aim of Regulations is to fight littering and prevent carcinogenic and problematic plastic items from entering the market to achieve the following objectives:

i. Reducing adverse impacts on human health and environment
ii. Transitioning to a circular economy
iii. Making solid waste systems more efficient by reducing burden
iv. Shifting responsibility of waste collection on polluters
v. Encourage engagement of private sector and community for plastic pollution.

The salient features to 'Single-Use Plastics (Prohibition) Regulations 2023 are as under:

i. **Recycled Plastic Bottles:** Due to lack of 'alternatives' and need for transition to a circular economy, single-use plastic beverage containers shall contain at least 50o% recycled plastic from 1st July 2028
ii. **Extended Producer Responsibility:** Based on 'polluter pays principle 'plastic waste may be collected by producers, importers and beverage companies
iii. **Data Inventory:** Record keeping and disclosure of data by producers and importers of' single-use plastics

iv. **Awareness Campaign:** Producers, importers, distributors, suppliers and beverage companies may be directed to initiate awareness campaigns
v. **Penalties:** For enforcement of these Regulations, fines may be imposed by the Pakistan Environmental Protection Agency for violations

The prohibition of single-use plastic items under these Regulations with timelines are as under:

i. Single-use polythene bags including but not limited to carrier bags and flat bags upon commencement of these regulation;
ii. Single-use plastic drinking straw within two years of commencement of these regulations;
iii. Single-use plastic crockery including plates, bowls, cups, glasses from 1st August 2023;
iv. Single-use plastic cutlery designed for eating or serving food including forks, knives, spoons, chopsticks from 1st August 2023;
v. Single-use plastic foodservice ware designed or used for serving or transporting food or beverage ready to be consumed including lidded container, box, cup, plate, bowl from 1st August 2023;
vi. Single-use plastic stirrers including any plastic item designed to stir or mix beverages or to prevent a beverage from spilling from the lid of its containers from 1st August 2023.

2.5.2. International Cooperation Section

i. A new Memorandum of Understanding on cooperation on Green and Low-carbon Development between the Ministry of Climate Change & Environmental Coordination was signed between MOCC&EC and the National Development and Reform Commission of the People's Republic of China
ii. Two months Internship offered to 6x interns of NDU, Islamic University, NUST etc. who were interested in environmental and climate change policies. The interns were sensitized with the working and mandate of the International Cooperation Wing and were briefed about Pakistan's ongoing international collaborations
iii. An annual report on the "Observance and Implementation of Principles of Policy" was prepared and submitted under the Article 29(3) of the Constitution of Islamic Republic of Pakistan, 1973
iv. The second Pak-US Joint Working Group on Environment's meeting was held, which resulted in a press release and added new dimensions to the bilateral cooperation between USA and Pakistan
v. As per Rules of Business, 1973, IC Section consistently coordinated with M/o Economic Affairs and M/o Foreign Affairs and provided technical input for Bilateral Political Consultations, Inter-Ministerial Consultations (IMM), Joint Commissions (JCs) etc.
vi. IC Section is also part of the Single-Use Plastic Ban, implementation team, and is working in collaboration with Chemical Section and Pak-EPA
vii. The Ministry of Climate Change & Environmental Coordination held a 1-day workshop in March 2023 with the GCF team visiting from Korea. The main purpose of the workshop was to equip the Government and private organizations in getting

accredited with the Fund and also, to know the working modalities regarding the Fund. The workshop was attended by over 100 participants including a huge representation from the provinces. The Ministry also recently chaired GCF board Pakistan meeting and endorsing projects worth USD 200 Million for the GCF Funding

viii. Pakistan currently has 6 projects approved (03 under implementation), amounting to a total of USD 221 Million, under GCF (Global Climate Fund). This accounts for an increase of approximately USD 90 Million in the last 6 months

ix. Pakistan currently has 6 projects approved (03 under implementation), amounting to a total of USD 17.9 Million and Two concept notes recently approved amounting to USD 10.8 Million under GEF (Global Environment Facility)

2.5.3. National Ozone Unit

I. Implementation of the ODS Phase Out Projects

Progress

a) Implementation of The ODS Phase Out Projects

i. NOU, MoCC&EC completed 01 research project with NUST titled "Role of Refrigeration Services Sector in Eradication Efforts of ODS in Pakistan"

ii. Collected HCFC import data on the monthly basis from FBR and importers to monitor the import of HCFCs in the country and correlating with the allowed quota quantities

iii. NOU improved its presence in field by visiting warehousing facilities of all quota holders which resulted in significant improvements with regards to handling of HCFCs and awareness of dealing with flammable refrigerants

iv. NOU, MoCC&EC completed 01 HCFCs conversion project in XPS Foam Sector. The completion enabled Pakistan to phase out 76.67 MT (4.68 ODP tones) of HCFC-142b/ HCFC-22 (60:40 ratio) from the manufacturing of extruded polystyrene at Symbol Industries, Lahore

v. NOU, MoCC&EC completed 02 HCFC 141-b conversion projects in PU Foam Sector. The completion enabled Pakistan to phase out 82.37 MT (9.06 ODP tones) of HCFC-141b from the manufacturing of PU Foam at M/s Kold Kraft Pvt. Ltd, Lahore and M/s Foster Refrigeration Pvt. Ltd, Lahore

vi. Pakistan got approved in principle stage III of the HCFC phase-out management plan (HPMP) for the period 2022 to 2030 to completely phase-out of HCFC consumption in Pakistan by 2030;

vii. Ratification process for Kigali Amendment is underway and NOU, MoCC&EC has developed the draft Country Assessment Report (CAR) and Legal Instrument for management of Ozone Depleting Substances in Pakistan. The CAR and Legal Instrument have been extensively discussed through consultative sessions. MoCC&EC is now in the process of submitting the ratification instrument for Kigali Amendment to the Ministry of Foreign Affairs

viii. NOU, MoCC& EC facilitated SAMA VERTE in organizing the 1st Working Group Meeting of the Pakistan Cooling Action Plan (PCAP) on October 14, 2022 at Islamabad.

The objectives of the 1st PCAP Working Group meeting was to assimilate the directions of cooling need assessment and to bring synergies among the working group members on overall objectives of the PCAP with the intention to accelerated PCAP development

ix. NOU, MoCC& EC facilitated SAMA VERTE in organizing the 2nd Working Group Meeting of the Pakistan Cooling Action Plan on March 21, 2022 at Islamabad. The objectives of the 2nd PCAP working group meeting was to present the PCAP Zero Draft to working group members and obtain endorsement on the priority actions and get input on the pending sections of the PCAP document

x. Organized thermos ware sector and PU Foam manufacturing industries meetings with UNIDO's International Foam Expert Mr. Risto Ojala from 24 - 30 July, 2023 at Lahore and Karachi. The meetings with thermos ware sector remained focused on discussing the raw material issues and supply of raw material for test and trial run. All the thermos ware sector industries were visited and way forward / schedule for procurement of raw material, test and trial run was agreed. The project cycle, technology option and its working in Pakistan was also discussed in detail for PU Foam sector

xi. For smooth implementation of the HCFC phase out Programme the industrial / commercial importers data for HCFCs import was monitored on monthly basis during the reporting period. National Ozone Unit updates the HCFCs importers regarding latest requirements of the ODSs storage and maintenance.

b) Enforcement of Policy / Regulatory Measures

a. NOU remained vigilant in controlling illegal imports and trading of HCFCs in close coordination of Pakistan Customs

b. The Pakistan Cooling Action Plan (PCAP) working group was notified by the Ministry of Climate Change in the Gazette of Pakistan on September 1, 2022. The Working Group includes the representation from all the relevant stakeholders including Public and Private sector

c. NOU, MoCC&EC in collaboration with FBR is working on developing PCT codes to manage the import of HFCs in Pakistan in line with the adopted HS code 2022 version which came in effect from July 01, 2022

d. Drafts Policy Order/ Legal Document for implementation of Montreal Protocol in Pakistan has been prepared and put into finalization process before formal notification/approval

e. Advertisement for inviting quota requests was published on 03rd January, 2023. Applications received for the quota were minutely examined in a full transparent way. Quota for 2023 was issued on February 06th, 2023. The criteria of the Montreal Protocol were followed as per the commitment and practice

f. In order to phase out the ODSs from the thermos ware, PU sandwich panel, spray foam and air conditioning industries; NOU along with relevant implementing agencies is implementing HPMP Stage-II & III

g. Collected, analyzed and submitted Data for Article 7 Report and Country Programme Reports for 2022 well on time to ensure compliance status of Pakistan. To Check the compliance, data was collected from both available sources i.e. FBR and importers. Data provided by the FBR and importers was examined in detail for the illegal / excess status

clearance and accordingly the details were submitted to the NPD/Additional Secretary, MoCC & EC

h. Organized Project Steering Committee meeting of the Montreal Protocol (MP) project on June 27, 2023. The PSC members reviewed the project performance and approved the Annual Work Plan for 2023

i. Various online meetings were held with UNIDO and UNEP offices on the following issues regarding policy and phasing out of the ODSs:
    - Implementation of HPMP stage-III;
    - Implementation of HPMP-II remaining projects and corresponding challenges;
    - Working of the PMU for HPMP-II projects completion;

ATTACHED DEPARTMENTS AND AUTONOMOUS BODIES

3. PAKISTAN ENVIRONMENTAL PROTECTION AGENCY (PAK-EPA)

Introduction

Pakistan Environmental Protection Agency (Pak-EPA) is a statutory body that was created under the Pakistan Environmental Protection Act of 1997. In order to efficiently carry out its mandated duties, Pak-EPA is organized into the following:

- Directorate of Laboratory/National Environmental Quality Standards (Lab/NEQS)
- Directorate of Administration/Legal/Enforcement (Admn/Legal)
- Directorate of Environmental Impact Assessment/Monitoring (EIA/Monitoring)

During 2022-23, the following major activities were undertaken by the different Directorates of Pak-EPA:

3.1. LAB/NEQS Directorate

i. Introduction

The Lab/NEQS Directorate of Pak-EPA is responsible for the development, review, and compliance-monitoring of National Environmental Quality Standard (NEQS) that have been notified for ambient air, water, noise, and liquid/gaseous emissions. The Lab/NEQS also issues certifications to environmental labs and authorizations to manufacturers/distributors for exempted Polythene bags. Monitoring and field inspections are conducted for the resolution of public complaints. It also provides technical support to Pak-EPA's Legal/Admin and EIA/Monitoring Directorates and manages public complaint resolution. Lastly, it provides technical input in public policies, plans, documents, and legislative frameworks.

ii. Activities/Achievements (July 2022 – June 2023)

3.1.1. Air Quality:

Through its fixed monitoring station located in H-8/2, Pak-EPA monitors ambient air quality of Islamabad, the results of which are shared via official website and social media. Pak-EPA has also established a data surveillance room for 24-hour monitoring of emissions by steel industries to ensure NEQS compliance. Additionally, major industries in Islamabad submit their monthly/quarterly stack emission reports to Pak-EPA, in compliance of NEQS.

Table No:1. Air quality parameters monthly average from June 2022 to June 2023.

Monthly average	Temperature	Humidity	NO2	SO2	PM2.5
NEQS value	**°C**	**%**	**80 µg/m3**	**120 µg/m3**	**35 µg/m3**
Jul-22	29.5	74.03	3.58	12.15	17.70
Aug-22	28.7	73.03	3.7	11.02	19.97
Sep-22	28.44	66	3.84	13.06	22.25

Oct-22	24	54.31	3.7	17.43	25.62
Nov-22	25.6	40	4.2	22.8	39.4
Dec-22	13.38	49.15	11.44	32.01	65.46
Jan-23	10.5	51.4	13.50	37.70	62.88
Feb-23	13.51	47.7	7.57	22.84	36.73
Mar-23	17.9	55.64	4.54	19.6	22.69
Apr-23	20.23	51.82	3.74	17.3	18.097
May-23	25.51	47.03	3.87	14.88	15.88
Jun-23	34.53	68.23	5.43	8.23	14.58
Annual Mean	**23.50**	**55.13**	**5.67**	**18.99**	**29.73**
PM	Particulate Matter				
NEQS	National Environmental Quality Standards				

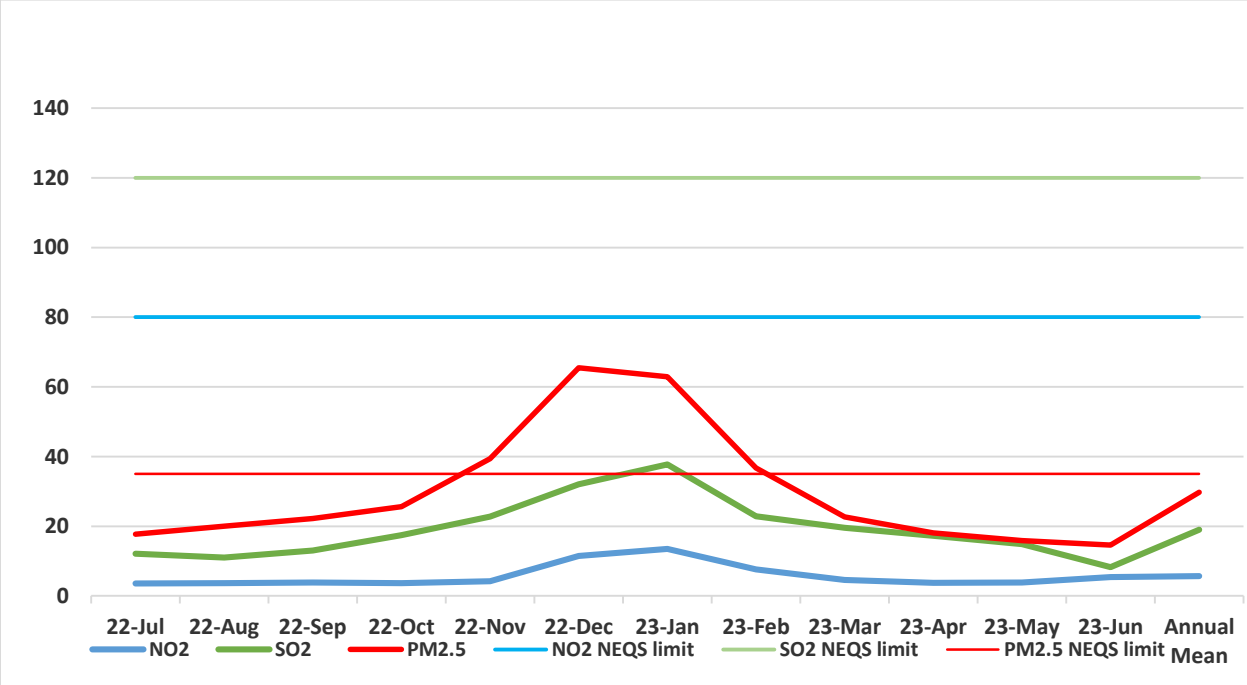


Figure i: *Graphical representation of Concentration of $PM_{2.5}$, NO_2, and SO_2 in Islamabad*

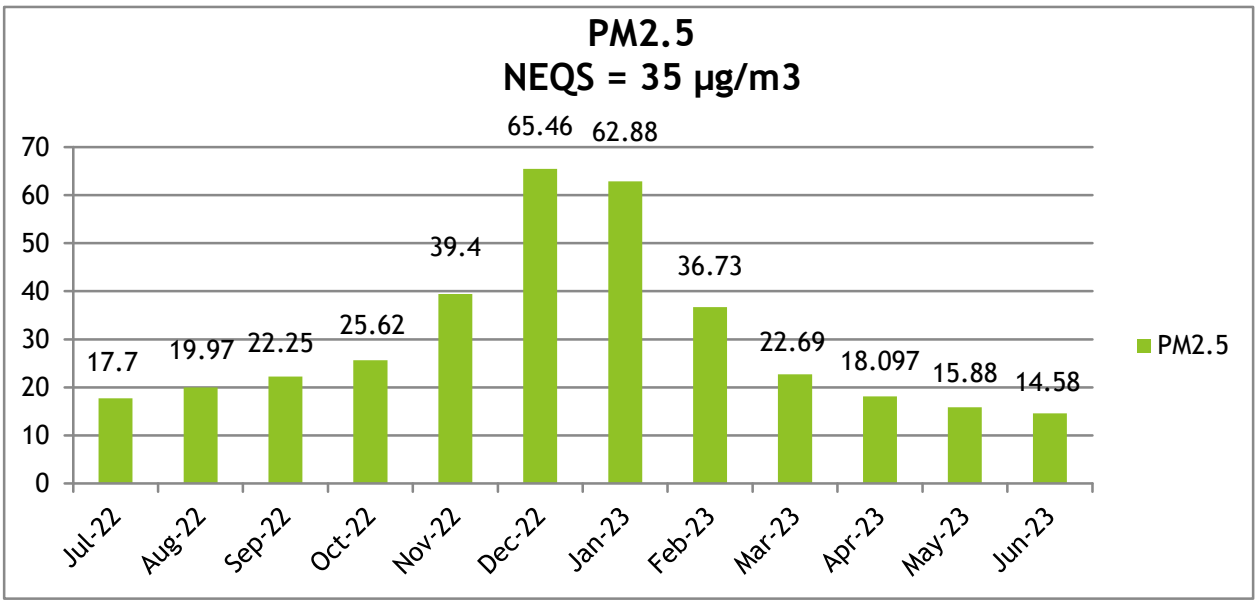


Figure ii: *Graphical representation of Concentration of $PM_{2.5}$ in Islamabad*

3.1.2. Water Quality

Pak EPA Lab/NEQS Directorate analyzed 140 water samples in EPA laboratory during July 2022 to June 2023. These samples were collected from natural water bodies (Rawal Lake, Simly Dam, Korang River etc.), Shahdra natural streams. Forty-eight (48) drinking water samples were collected from filtration plants located in various CDA's sector/societies and Government offices. Further thirteen (13) bore water samples were collected from Satrameel, Naval farms, I-8, Chak Shahzad and Bani Gala etc. which were chemically and microbiologically tested, while a few samples were received from public and other departments. Sixty-five (65) water samples from natural streams (ups and down streams), Waste-water samples from industries, NUST and I-9 nullahs and sewerage system of ICT villages, industrial sites and developmental project site. During inspections fourteen (14) water samples collected from STP's of Pvt. Housing societies and restaurants.

***Figure i**: Collection of filtration plant Surface, Nallah and Natural Streams Water Samples by LAB/NEQS TEAM.*

3.1.3. Noise Quality

Pak-EPA's Lab/NEQS Directorate inspected a number of sites for compliance of NEQS for noise. In total, 18 inspections were carried out from July 2022 to June 2023 in commercial, industrial, and residential areas of Islamabad Capital Territory for noise levels.

3.1.4. Technical Training, Research Facilities, and Internships

Lab/NEQS Directorate has provided technical trainings, research facilities, and summer internships to **125** students of BS, BE, MS and PHD from UET, NUST, AIOU, QAU, IIU, FJWU, UAF and University of Poonch Rrawalkot etc. PMAS –AAUR, UAF, F.G Postgraduate College Wah Cantt and FMC students, and AHKNC trainees visited EPA Air and Water Quality Labs.

***Figure ii:** Students' visit to Pak-EPA under the technical training, research and internship programme*

3.1.5. World Environment Day 2023/Seminar

On June 5, 2023, in celebration of World Environment Day, Pak-EPA, in collaboration with the Pakistan Academy of Environmental Sciences, organized a walk from China Chowk to D-Chowk with the aim of beating plastic pollution and introducing a zero-waste march. Students from IMCG/i-9, Quaid-e-Azam University, COMSATS University, and Arid University enthusiastically joined the walk, making it a resounding success. The Pakistan Boy Scouts Association, Pakistan Girls Guides, Rescue 1122 Management, organizations like PODA, Environmental Journalist Organizations, and several social and environmental activists were also present, contributing to the march's success and showcasing their dedication to a clean and green Islamabad and Pakistan.

In March 2023, Pak EPA organized one-day seminar on "Challenges, Opportunities and Trends in Biotechnology in Pakistan. The speakers at the seminar highlighted the potential of biotechnology to transform various sectors of the economy, including agriculture and environmental management. They also discussed the challenges faced by the biotechnology industry in Pakistan and the need for a supportive regulatory framework.

Figure iii: *Site Inspections conducted upon of violation of environment i.e. brick kilns', noise generators, contamination in surface water and solid plastic waste.*

3.1.6. Environmental Laboratory Certification

As per the Certification of Environmental Laboratories Regulations, 2000, five (05) environmental laboratories in ICT were certified.

Figure iv: *Field visits of Environmental Laboratories and Health Facilities*

3.1.7. Public Complaints and Field Monitoring

Ninety (90) environmental complaints were received from public, and Prime Minister's Pakistan Citizen's Portal. Environmental monitoring team inspected housing societies, brick kilns, tyre burning units, asphalt plant, industries working in residential, industrial areas and MHNP and checked pollution issues and improper waste disposal.

Figure v: *Site Inspections conducted upon of Violation of environment i.e. Brick kilns', Noise Generators, Contamination in surface Water and Solid Plastic Waste.*

3.2. Directorate of Administration/Legal/Enforcement (Admn/Legal)

Introduction

Pakistan Environmental Protection Agency (PAK-EPA) is a statutory body established under Section 5 of the Pakistan Environmental Protection Act, 1997 for enforcement of Environmental Laws, Rules and Regulations made under the Act.

3.2.1. Activities, Role and Functions

According to PEP Act, 1997 the activities/role & functions of Legal/Enforcement Directorate of Pak-EPA are followings;

i. *draft and prepare reports and para-wise comments and defend the cases before Hon'ble Supreme Court of Pakistan;*
ii. *prepare appeals, reports and para-wise comments and represent this Agency before Hon'ble High Courts;*
iii. *prepare cases/complaints for Environmental Tribunal/Environmental Magistrate and appear, act and plead as prosecutor in Environmental cases before Environmental Tribunal and Environmental Magistrate; appear and defend this environmental Agency before Hon'ble Wafaqi Mohtasib;*
iv. *appear and represent this environmental Agency before Human Rights Commission of Pakistan;*
v. *appear and plead the cases of this environmental Agency before lower courts.*

Moreover, the Legal/Enforcement Directorate of Pakistan Environmental Protection Agency are defending, prosecuting and representing the cases of criminal as well civil nature before different courts of law and forums.

3.2.2. Goals and Targets

- Prepared draft Regulation on "Review of Initial Environmental Examination and Environmental Impact Assessment) Regulations, 2023" and forwarded to Ministry of Climate Change and Environmental Coordination for further process

- Initiate draft Rules on "Ban on Handling, Storage, Sale, Purchase, Import, Export of Hazardous Substance Rules, 2023"
- Implementing the Single Use Plastics (Prohibition), Regulations, 2023

3.2.3. Achievements

- Approximately 70 field visits conducted by the Enforcement Team(s) of Pak-EPA for the implementation of the provisions of PEP Act, 1997, Rules & Regulations
- Approximately forty thousand rupees. 40,000/- fine imposed upon accused persons on contravention of Single Use Plastics (Prohibition), Regulations, 2023
- 131 notices of personal hearing/notices of compliance served upon brick kilns, hospitals, food/steel/pipe/marble/pharmaceutical industries, housing societies, asphalt plants, tyre burning units and against the complaints received on Pakistan Citizen Portal under Pakistan Environmental Protection Act, 1997
- 11 Environmental Protection Orders issued including brick kilns, hospitals, food / steel / pipe/marble / pharmaceutical industries, housing societies, asphalt plants and tyre units
- 06 brick kilns were sealed for non-compliance of PEP Act, 1997 NEQS & after giving them an opportunity of hearing
- 20 Cases/Complaints filed in Environmental Protection Tribunal on violation of environmental laws
- One millions (Rs. 1,000,000/-) administrative penalty imposed by Pak-EPA upon violators
- Penalty of approximately fifty-eight million and nine hundreds sixty-five thousand (58,965,000/-) was imposed by Environmental Protection Tribunal upon the complaints of Pak-EPA
- Seventeen (25) Reply, Para-wise Comments and reports filed before Hon'ble High Courts in different Writ Petitions/Appeals relating to environmental issues.

3.3. Directorate of Environmental Impact Assessment (EIA/IEE)

Introduction

Environmental Impact Assessment (EIA) / Initial Environmental Examination (IEE) Directorate plays a major role in implementing the Pakistan Environment Protection Act (PEPA) -1997 specifically Section-12 and Review of IEE/EIA Regulations 2000. This Directorate comprises of two sections namely EIA/Monitoring and Environment Engineering and Technology Transfer.

3.3.1. Role & Function

All developmental projects from public and private sector that fall under any of the Schedules of Regulations have to obtain environmental approval in respect of their projects. In addition to evaluation of reports issuance of environmental approvals or otherwise, the EIA/Monitoring Section also conducts post environmental approval monitoring to ascertain the compliance status of the Environment Management Plan (EMP).

3.3.2. Goals and Target

During year 2022-2023 EIA/IEE directorate evaluated and processed maximum number of IEE/EIA reports. The environmental monitoring team, which carries out the field activities,

submits its report after ascertaining the ground situation and non-compliance by the proponents is liable to invite legal action by the Legal section

3.3.3. Activities

During the period 2022-23, thirteen (13) Initial Environmental Examination (IEE) Reports have been received for review at this Agency, six (06) environmental approvals have been granted, six (06) cases are under process and one (01) case has been rejected. Twelve (12) Environmental Impact Assessment (EIA) Reports have been received for review at this Agency, five (05) environmental approvals have been issued and seven (07) cases are under process.

3.3.4. Achievements

During the year seven (7) public hearings of various project had been conducted, in which relevant stakeholders, public, academia, and students participated.

3.4. National Biosafety Centre (NBC)

Pakistan has been a party to the Cartagena Protocol on Biosafety (CPB) under the Convention on Biological Diversity (CBD) since May 31, 2009. It is obligatory to devise an implementation mechanism for regulating Genetically Modified Organisms (GMOs) and their products. In the exercise of the powers conferred by section 31 of the Pakistan Environmental Protection Act (PEPA) 1997, Pak-EPA drafted and notified Pakistan Biosafety Rules, 2005 vide S.R.O. 336 (1)/2005 on 21st April 2005 to provide legal cover for regulating GMOs. National Biosafety Guidelines were notified in October 2005 for the facilitation of the applicants to follow the procedures for the implementation of the Biosafety Rules in the country.

National Biosafety Centre (NBC) under a development project was established at Pak-EPA in April, 2006. The center provides implementation setup for biosafety rules to regulate the activities related to import, use and propagation of the GMOs and their products. The regulatory activities are necessary to offset the impacts of modern biotechnology on food, health, environment, and socio-economic progress of the country

Under section 6 of Pakistan Biosafety Rules, 2005, Technical Advisory Committee (TAC) comprised of 22 members including Director General Pak-EPA as Chairperson and Director NIBGE, Faisalabad as Vice Chairperson. Similarly, the National Biosafety Committee (NBC) comprised of 17 members including Secretary, Ministry of Climate Change as Chairperson. The TORs of the both committees defined in Pakistan Biosafety Rules, 2005. The approval process for the Genetically Modified Organisms (GMOs) involves three tiers of forum i.e.

i. Institutional Biosafety Committee (IBC), Chaired by Head of concerned Institution.

ii. Technical Advisory Committee (TAC), Chaired by DG Pak-EPA.

iii. National Biosafety Committee (NBC), Chaired by Secretary MoCC & EC

All cases of GMOs either for laboratory manipulation work, field trials, import or commercial release required approval from all three committees. A total of 25 numbers of National Biosafety Committee (NBC) meetings and 32 numbers of Technical Advisory Committee (TAC) meetings have been convened so far to approve or otherwise the GMOs related cases. Since July, 2022, a total of one hundred two (102) cases of Genetically Modified Organisms (GMOs) related activities have been decided by the forum. Among these thirty-nine (39) case was of laboratory genetic manipulation work, fifty-one (51) cases were of field trials and twelve (12) cases of commercialization.

4. ZOOLOGICAL SURVEY OF PAKISTAN

Introduction:

The Zoological Survey of Pakistan (ZSP) is a key Federal Agency involved in policy-making for wildlife conservation in the country. The mandate of ZSP is to monitor the current status and distribution of wildlife in Pakistan. Besides these objectives, ZSP is also mandated to maintain standard zoological collections for reference from different parts of the country, impart education, and raise awareness among the masses for biodiversity conservation.

Role & Functions

The specific objectives of the Zoological Survey of Pakistan are as follows:

- To obtain information on distribution, population dynamics and status of animal life in the country.
- To undertake research on the ecology and biology of wildlife populations of Pakistan.
- To set up and maintain standard zoological collections for reference.
- To advise the Government on all zoological matters, including conservation, management, and trade in wildlife.
- To impart training and create public awareness about wildlife conservation.

4.1. Targets, Activities &Achievements

The detail of targets, activities &achievements during the current FY 2022-23 is given below:

4.1.1. Target: Baseline Ornithological (bird) studies at Takht-e-Suleiman Sherani Protected areas

Some of the important areas of the country having rare and threatened species of wildlife have been declared protected areas as National Park, Wildlife Sanctuaries and Game Reserves. Baseline surveys of the protected areas are essential to assess the biodiversity of the sites.

4.1.2. Status of Avifauna at Takht-e-Suleiman Protected areas of KPK

During the FY 2022-23, baseline study of Takht-e-Suleiman Protected areas of KPK Province carried out along with the team of Khyber Pakhtunkhwa Wildlife Department Pakistan WWF-Pakistan and Pakistan Forest Institute Peshawar (PFI). The Takht-e-Suleiman the highest peak of the Suleiman Range (3487 meters) in elevation is located near Armanda District Dear Ismail Khan. These studies were. The survey aimed to record the status and distribution of avian species in this area along with the identification of threats to the species and their habitat and to prepare avifaunal inventory of Sherani Protected areas.

- **Activities**

The field visits were carried out in the month of October 2022.At least five days were spent in the field area. Line transects method and point count method was applied to study the avifauna of the area. The scientific reports, papers and other literature were also reviewed.

- **Achievements**

During the study of Sherani area, 74 species of birds were observed belonging to 8 orders and 22 families of class Aves. Out of 74 species, 48 birds were resident and 26 were migratory species. Among recorded species, Egyptian vulture (*Neophron percnopterus*) is listed as Endangered (EN), while rests are of the species are least concern (LC) on IUCN Red Data List (2015). The wood cutting and manmade fires were observed as the main threats to fauna of the area. Public awareness and participation was recommended for conservation of biodiversity of the area.

4.2. Target: Annual Mid-winter waterfowl census

Mid-winter waterfowl census is an annual activity of the department since 1982 carried-out in the second week of January. The basic and essential motive of conducting these surveys is to estimate and monitor migratory waterfowl population annually and also study the trends of their population at various wetlands during migratory season i.e., winter (non-breeding). Pakistan is also signatory to the three Rio conventions i.e. CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), CMS (Convention of Migratory Species) and Ramsar Convention. All these conventions require member states to protect the both migratory and resident fauna and their habitat. In addition, these surveys are crucial for promoting waterfowl conservation by raising awareness and interest among local communities about migratory water birds and wetlands. The collected data also provide substantial insights on population declines, causes of decline in time as well as trigger adequate management actions both at site and at flyway level.

- **Activities**

Field surveys of globally protected Ramsar sites and important wetlands of country for the population estimates of water birds, especially migratory waterfowl were carried out. The point count method was applied at each wetland. The community meetings were also held for raising awareness amongst local people regarding the importance of migratory water birds and wetlands.

During the current FY (2022-23), following wetlands of Punjab and Sindh province were visited for waterfowl census:

4.2.1. Punjab Province

Kalar kahar Lake, Namal Lake, Chashma and Jinnah Barrages, Ucchali Wetlands Complex, Head Marrala, Head Qadirabad and Rasool Barrages.

Total of 58 Species of both migratory and resident water birds were recorded with 39823 in number. Among these 58 bird species, 12 belong to Family Anatidae (Ducks).

The highest number of birds were recorded at Ucchali lake 22409 (56%), 2nd highest number were recorded at Chashma Barrage 4732(12%), 3rd highest number were recorded at Head Maralla 3178 (8%) followed by Jhaller Lake 2297 (6%), Kallar Kahar lake 1894 (5%), Rasool Barrage 1801 (4%), Khabeki Lake 1272 (3%), Jinnah barrage701 (2%), Head Qadirabad 571(1%), Namal lake 418(1%), and Ahmadabad Lake409 (1%).

4.2.2. Sindh Province

Ranpur Dam, Nurri Lake, Phoosna Lake, Haleji Lake, Kheenjhar lake, Manchar Lake, Lungh Lake, Drigh Lake, and Hammal Lake. During the current waterfowl census at the wetlands of Sindh province, total of 143218 water birds belonging to 76 species of both migratory and resident birds were recorded. The Nurri Lake was observed most populated with water birds' number (73704) birds followed by Manchar lake (22692) birds and Hammal Lake (16766) birds. The Common Coot (*Fulica atra*) was observed most abundant migratory bird with total number of (45175) individual birds followed by Common Teal (*Anas crecca*) with number of (31871) birds. In contrast, Ruddy Schelduck (2) birds were observed as less abundant migratory duck species at the wetlands of Sindh.

4.3. Target: Studies on threatened species of wildlife:

4.3.1. Survey of Rakshan Wildlife Conservancy, District Washuk, Baluchistan with special reference to Houbara Bustard

During the current financial year 2022-2023, the study of Houbara Bustard (*Chlamydotis undulata macqueenii*) at Rakshan Wildlife Conservancy, District Washuk, Baluchistan was carried out under the "Ten Billion Tree Tsunami" project of Ministry of Climate Change & Environmental Coordination, the TBTT program Wildlife component, Baluchistan.

- **Objectives**

These surveys were aimed to study the population estimates of Houbara Bustard and its habitat area, and also prepare a conservation strategy for the protection, conservation and management of the species and its habitat.

- **Activities**

Population estimation of Houbara Bustard comprised of simple strip with the probability methods. Binoculars (Olympus 8-16x40, DPS-I) were used to spot the birds. Transects of 5 km length and 500m width (250m on either side) were surveyed by driving 4x4 vehicles at a speed of 15 km/h along the transects. Transects were randomly taken indifferent habitats. GPS coordinates were marked at the start and finish point of each transect using Garmin map 64 GPS receiver. Digital camera was used for taking photographic evidence of different species and their habitats (Sony 20X Optical Zoom) for further identification.

- **Achievements**

The surveys were conducted in the month of January 2022. The results of current counts revealed estimated number of 192 individual birds of Houbara Bustard. The Rakshan Conservancy area provides a feeding ground to Houbara Bustard and other migratory birds. The seasonal scientific surveys prevent illegal hunting and wood cutting, and contribute to public awareness, and empowerment of local communities for conservation and protection of Houbara Bustard is recommended.

4.3.2. Survey of Punjab Urial (ovis vignei punjabiensis) in the Salt Range, Punjab

During the current financial year 2022-2023, the Survey of Punjab Urial (*ovis vignei punjabiensis*) along with team of Punjab Wildlife Department, WWF Pak, and Academia, was carried out in the Salt Range, Punjab comprising four Districts, i.e. Jhelum, Chakwal, Khushab and Mianwali.

- **Objectives**

The current surveys were aimed to record the population estimates of Punjab Urial. To suggest measures for protection and conservation Punjab Urial and its habitat. Further, to recommend the government for sustainable harvesting (Trophy hunting) of Punjab Urial.

- **Activities**

Field surveys for the population estimates of Punjab Urial were carried out using the line Transect method. Transects were randomly taken indifferent habitats. Binoculars (Olympus 8-16x40, DPS-I) were used to spot the Urial. GPS coordinates were marked at the start and finish point of each transect using Garmin map 64 GPS receiver. Group composition of Urial was noted on pre-described Performa. Digital camera was used for taking photographs of Urial and its habitat.

- **Achievements**

The surveys were carried out in the month of October 2022, in mentioned four districts of Salt Range Punjab. The current counts revealed the population estimates of 2744 individuals of Punjab Urial in the Salt Range.

The monitoring of species through modern communication tools, public awareness, and empowerment of the local community for the conservation and protection of Punjab Urial are recommended.

4.3.3. Survey of Chinkara (Gazella bennettii) in the Cholistan Desert, Punjab

During the current financial year 2022-2023, the Survey of Chinkara (*Gazella bennettii*) was carried out in Cholistan Desert, Punjab along with team of Punjab Wildlife Department and the University of Okara Punjab.

- **Objectives**

The main objectives of the survey were to determine the population estimates and density of Chinkara in the Cholistan desert and also identify the threats to species and habitat.

- **Activities**

Field surveys for the population estimates of Chinkara (*Gazella bennettii*) were carried out using the line Transect method. Random sampling approach was used to select transect in the core habitat of Chinkara. Each Transect were 10 km in length and 250 m in width. Observations were made during peak activity time using 4x4 Vehicles. GPS coordinates were marked at the start and finish point of each transect using Garmin map 64 GPS receiver. Group composition was noted on pre-described Performa. Digital camera was used for taking photographs.

- **Achievements**

The field surveys were conducted in October 2022 in the Cholistan Desert consisting of Bahawalpur & Rahim Yar Khan Districts, Punjab. The results of current study revealed the population estimates of Chinkara about (82 individuals) with a population density of 0.41 per km^2. The results of current study show a slight increase in the Chinkara population as compared to previous studies conducted in the last decades. Illegal hunting and livestock grazing were observed as the most probable threats to Chinkara population in future. Systemic studies, sustainable livestock grazing and local community awareness are recommended for the protection of Chinkara and its habitat.

- **Publications**

ZSP annually publishes the results of surveys and research in its Journal "RECORDS" Zoological Survey of Pakistan, to create awareness regarding important groups of animals. During the current financial year research articles writing and formatting for the upcoming volume-25 of Records Zoological Survey of Pakistan is in the pipeline.

5. GLOBAL CHANGE IMPACTS STUDIES CENTRE (GCISC)

5.1. Introduction

The Global Climate Change Impact Studies Centre (GCISC) is mandated to undertake scientific investigations of the phenomenon of climate change at regional and sub-regional levels and study its impact on various sectors of socio-economic development in order to prepare the country to meet threats to its water resources, agriculture, ecology, energy, health, bio-diversity etc.

5.2. Roles & Functions

GCISC, under the act, is tasked with the following three functions (A) research, (B) capacity building, and (C) outreach and public awareness.

5.3. Activities

Research

The key research activities of the Research Sections revolve around following themes:

5.3.1. Climatology & Environment Section

The Climatology & Environment Section research areas focus on key aspects of climate variability and change, which can be summarized as follows:

- To assess historical climate trends over Pakistan and its regions;
- Climate profiling of Pakistan based on IPCC future climate scenarios (RCPs, SSPs etc.);
- To generate up-to-date information on changes in near to long term climate extremes and to study associated impacts;
- Study variations in summer monsoon patterns for impact assessments;
- High resolution climate information for future urban climate issues
- Intra seasonal to inter decadal climate predictions;
- Integrated modeling of air pollution and greenhouse gas emissions;
- Development & updating of GHG inventory of Pakistan for energy & industrial processes sectors;

5.3.2. Water Resources & Glaciology Section

- Application of Machine Learning and Artificial Intelligence (AI) techniques to model Indus River System (IRS) flows;
- Climate change analysis for the high-elevation Hindukush-Karakoram- Himalaya (HKH) region;
- Application of different hydrological and cryospheric models to assess the water availability and variability (quantitatively) in space and time in the Indus River System (IRS) under the latest socio-economic and climate projections;
- Analysis of climate impact on the frequency and intensity of hydrological extreme events at seasonal and sub-seasonal scales;
- Drought prediction in the Indus Basin as a climate adaptation strategy;
- Plausible Adaptation strategies in line with national Climate change and Water policies to ensure the country's water security;

- Research dissemination (International and national scientific journals and books, newspaper articles, policy briefs, etc.);
- Capacity building, awareness raising and collaboration among National and International institutions, researchers and academicians
- Identification of location and time-specific climate extremes (dry and warm) for related impacts on water availability and variability from different sources (surface water and groundwater)

5.3.3. Agriculture, Forestry and Land Use Section

- Assess impacts of projected climate change on productivity of key agricultural crops in different climatic zones using crop models;
- Assess impacts on related areas, including productivity of forestry, grasslands, rangelands and fragile ecosystems (i.e., mountains, wetlands, coasts, and arid areas); livestock; and land degradation and deforestation, insect-pest infestation dynamics;
- Assess food security in the face of future climate change and especially under reduced availability of irrigation water;
- Devise adaptation measures, including smart agriculture;
- Studies on water, food, energy nexus;
- Updating GHG emissions from agriculture, forestry and land use and waste sectors.
- Research dissemination (International and national science journals and books, newspaper articles and policy briefs etc.)
- Capacity building and awareness raising

5.4. Goals & Targets:

Throughout the year, GCISC made notable advancements in the international scientific literature concerning climate change and its associated effects, while also offering substantial inputs to various research projects. Additionally, the organization conducted several workshops and seminars aimed at disseminating information and raising awareness on pertinent issues:

The following is a summary of the accomplishments in 2022-23:

- Publication of key research findings in scientific journals = 22
- Contribution towards technical reports = 12
- Organization of scientific activities/workshops/seminars for information dissemination and awareness = 12
- Scientific contributions/ presentations and effort on capacity building of GCISC young scientists through academic and specialized trainings and participation in online conferences, workshops etc. at International level (Nos) = 23
- Effort on capacity building of GCISC young scientists through academic and specialized trainings and participation in conferences, workshops etc., at National Level (Nos) = 80
- Scientific Contribution Presentation in National Conferences and Workshops = 43
- Provision of training to university students across Pakistan in the field of climate change through internship program = 30

- Responses to NA/Senate starred questions and provided inputs (presentations/ briefs) for NA Standing Committee on Climate Change on the aspects of Climate Change = 10
- Muhammad Arif Goheer, Principal Scientific Officer/ Head- Agriculture and Coordination contributed to UNFCCC's Consultative Group of Experts (CGE) activities.
- Contributions to Pakistan's 1st Biennial Update Report submitted to UNFCCC in 2022.
- GCISC provided technical inputs in the preparation of National Adaptation Plan
- GCISC has been awarded contract by Ministry of Climate Change (MoCC) to contribute in various chapters of Third National Communication (TNC).
- Development of MRV platform for GHG Inventories & MRE platform for Adaptation tracking in Agriculture (Pilot basis).
- One Water Section Scientist is working as a Co-PI in "Flash Floods Harnessing for the Prosperity of Arid and Resource-stressed Neglected Agro-based Communities (ProNAC)" approved by Higher Education Commission (HEC) in National Research Program for Universities (NRPU) (Ongoing).
- Global Climate-Change Impact Studies Centre (GCISC) is leading a project on Climate Risk Assessments under GIZ's Strengthening Adaptation and Resilience (SAR) Programme. Water section taking the lead as Expert Working Group Coordinator to perform Climate Risk Assessment (CRA) related to the Water Sector.

5.5. Achievements & Salient Research Findings:

5.5.1. Research

- State of Climate, State of the Basins Report- Afghanistan–Pakistan Shared Waters:

Research was carried out to study the changing climate trends in three Afghan–Pakistani transboundary river basins: The Kabul, Kurram and Gomal, and it was found that there is a consistent rise in temperature over the last 30 years. By the end of the 21st century, temperatures may rise by an additional 3–4°C under RCP1 4.5 and 5–6°C under RCP 8.5, relative to 2020 levels. The potential impact of temperature rise is compounded by considerable uncertainty associated with the current and future behavior of precipitation in the three basins.

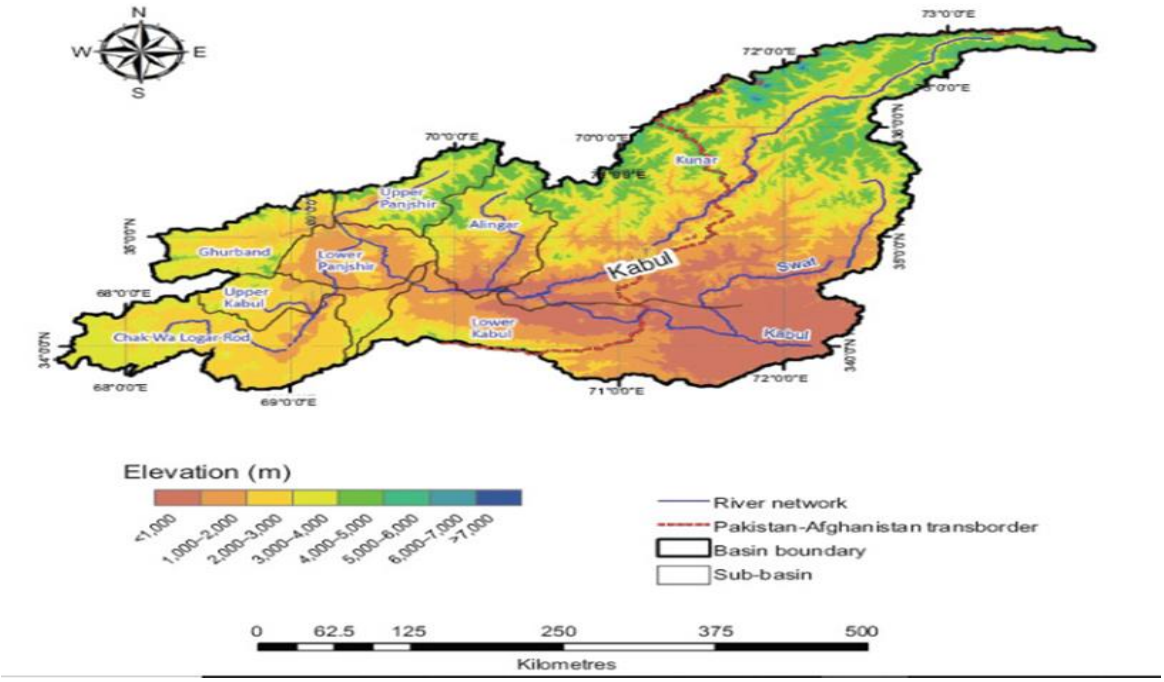


Figure 1: The Kabul river basin, glaciated and non-glaciated sub-basins.

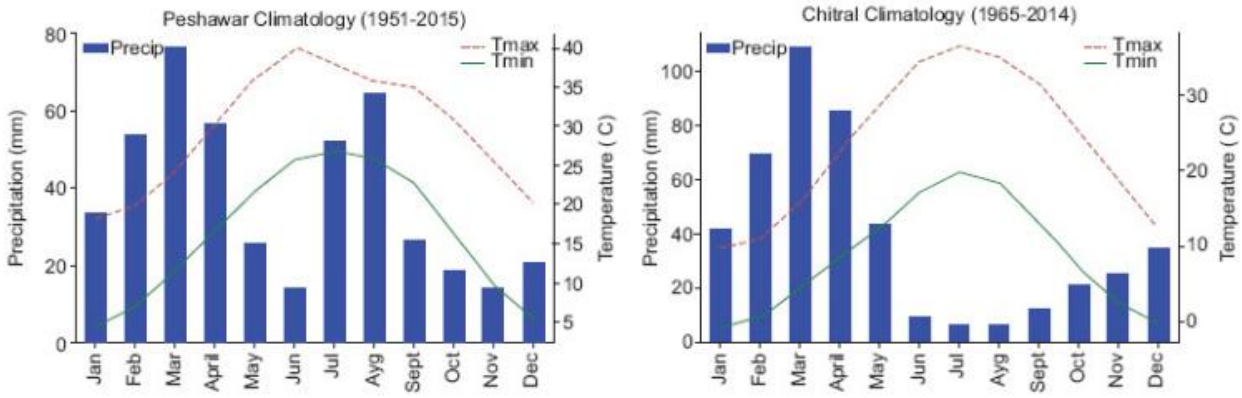


Figure 2: *Monthly variation in temperature and precipitation at Peshawar and Chitral in the Kabul River basin*

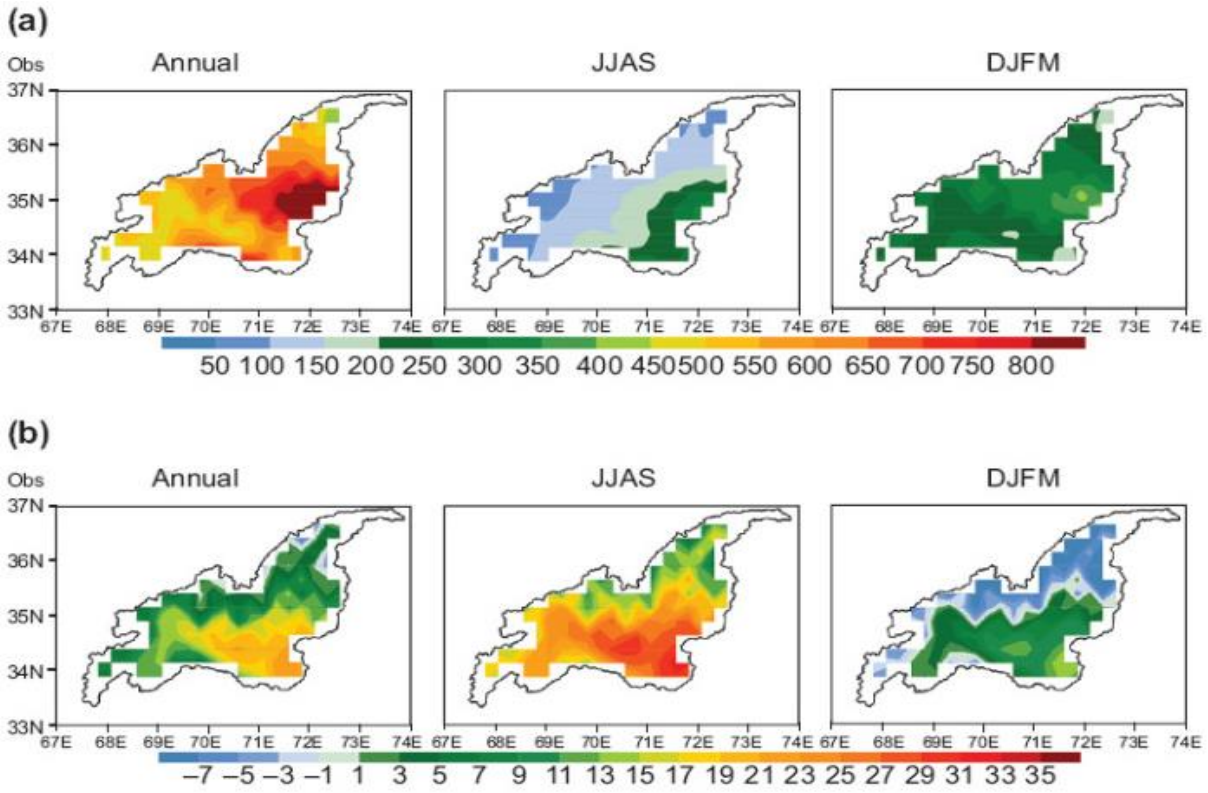


Figure 3: *(a) Mean precipitation (mm) 1975–2005; (b) Mean temperature (°C) 1975–2005. (Adapted from Bokhari et al., 2018)*

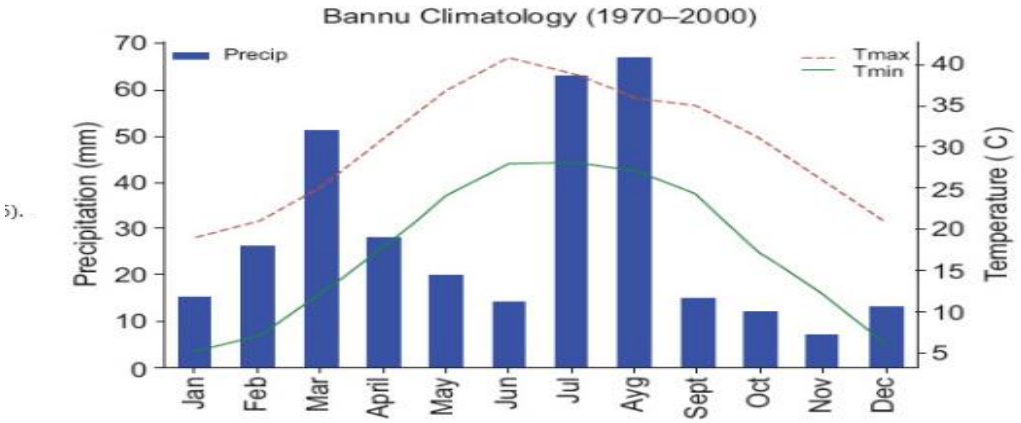
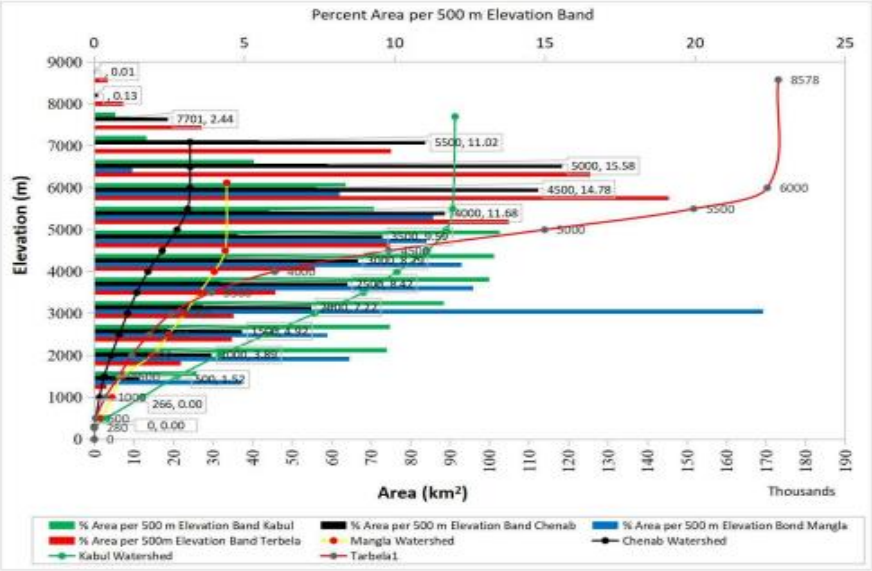


Figure 4: *Monthly variation in temperature and precipitation at Bannu in the Kurram river basin*

i. Hydrologic Interpretation of Machine Learning Models for 10-daily streamflow simulation in Climate Sensitive Upper Indus Catchments

A study was carried out to evaluate the potential of three machine learning models for streamflow simulation while it also focused on the hydrologic interpretation of machine learning models using Shapley Additive explanations(SHAP). XGBOOST, Random Forest and Classification and Regression Trees(CART) were evaluated. All of these models performed well and range of R 2 and Nash Efficiency for all three models lies between 0.65 to 0.90. Our study's most crucial contribution is Shapley Additive explanations (SHAP) method which gives extensive insights into the influence of each variable on simulated streamflow. SHAP analysis highlighted the significance of minimum temperature in high elevation zones for both Indus and Chenab catchment where stream flows are dominated by snow and glacier melt. We strongly believe that the findings of this study will promote the use of SHAP analysis for streamflow forecasting in data scarce and high elevation catchments in Pakistan.

Figure 5: *Overview of study area for meteorological and hydrological analysis, that includes the*



four western river catchments of the Upper Indus Basin Chenab and Upper Jhelum, and the studied streamflow stations at respective catchment outlets, i.e. Nowshera, Tarbela, Mangla and Marala (Akhtar et al. 2020)

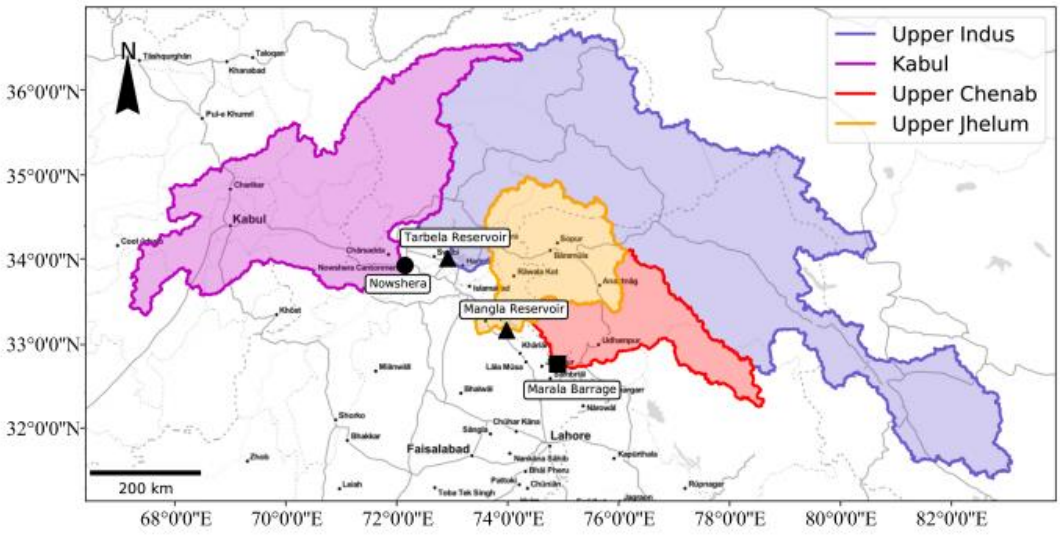


Figure 6: *Hypsometric curve of the study watershed at four catchments namely: Indus at Tarbela, Jhelum at Mangla, Chenab at Marala and Kabul at Nowshera*

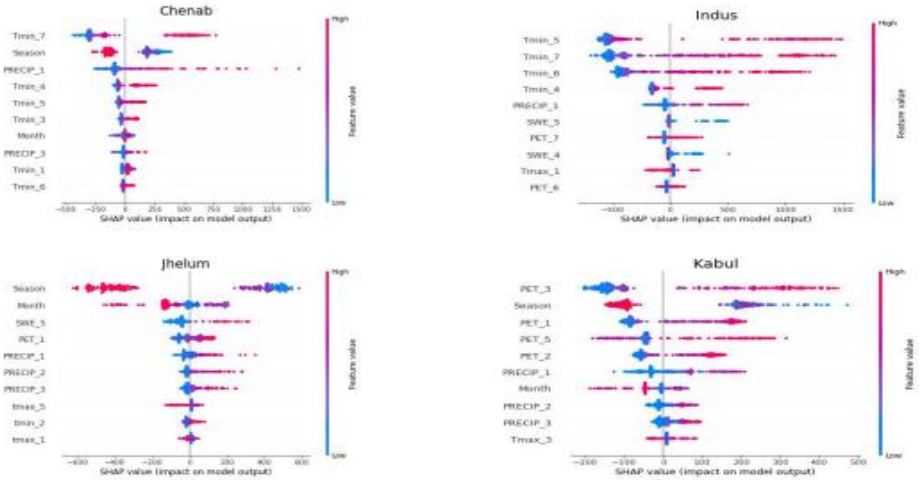


Figure 7: *SHAP summary plot. Each dot corresponds to a sample, and its x position shows the impact a predictor variable has on the simulated streamflow for Random Forest Model testing period 2005-2014*

ii. Climate-induced shifts in irrigation water demand and supply during sensitive crop growth phases in South Asia

This study investigated the shifts in irrigation water demand and supply of the major staple and water-intensive crops (wheat and rice) in the Indus, Ganges and Brahmaputra (IGB) river basins of South Asia under the combined impacts of climate change and socio-economic development during the period 1981–2100. It explores irrigation water usage during climate-sensitive crop growth phases, which is supposed to be crucial for long-term integrated crop water management. The study finds that irrigation supply by surface water and groundwater is likely to change in future due to warmer and drier growing periods, causing a significant increase in groundwater irrigation, mainly for rice. Our major research findings show the importance of crop water assessments during the sensitive crop growth phases of wheat and rice which vary in space and time. Including crop phase-specific, climate impact assessments of regional and global projection will help improve the region's existing crop-water management strategies and adaptation practices.

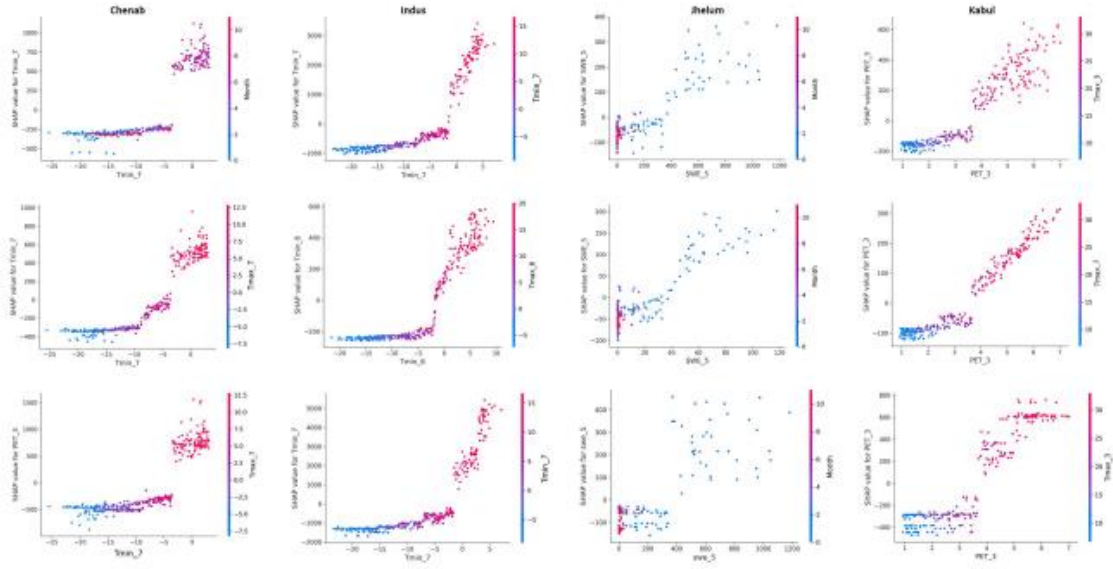


Figure 8: *SHAP dependence plots for XGBBoost (First Row), Random Forest (Second Row) and CART (Third Row). The variables are plotted against the SHAP values. Each dot corresponds to a sample*

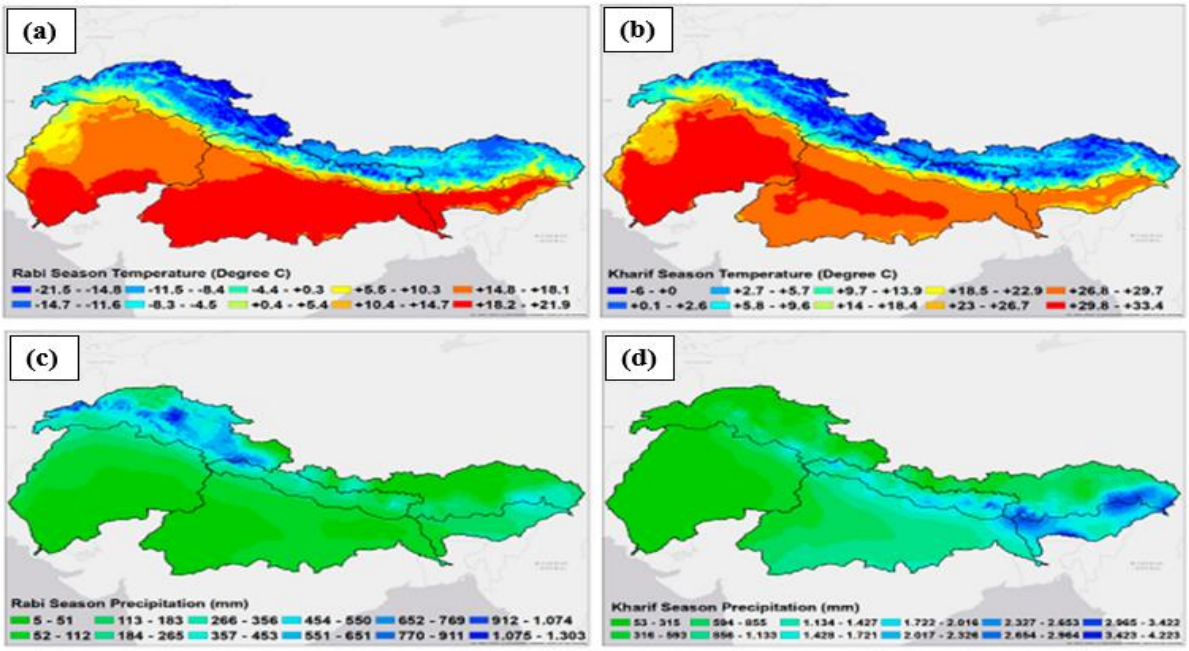


Figure 9: *S1 30 years mean temperature (◦C) of wheat in rabi season (a), rice in kharif season (b), 30 years mean of season total precipitation (mm) of wheat in rabi season (c), and 30 years mean of season total precipitation (mm) of rice in kharif season (d) during 1981–2010 over whole IGB river basins. Climate data (i.e., temperature and precipitations) at 5 arc-min spatial resolutions has been acquired from HI-AWARE data archive, particularly developed for the IGB river basins (Lutz & Immerzeel, 2016).*

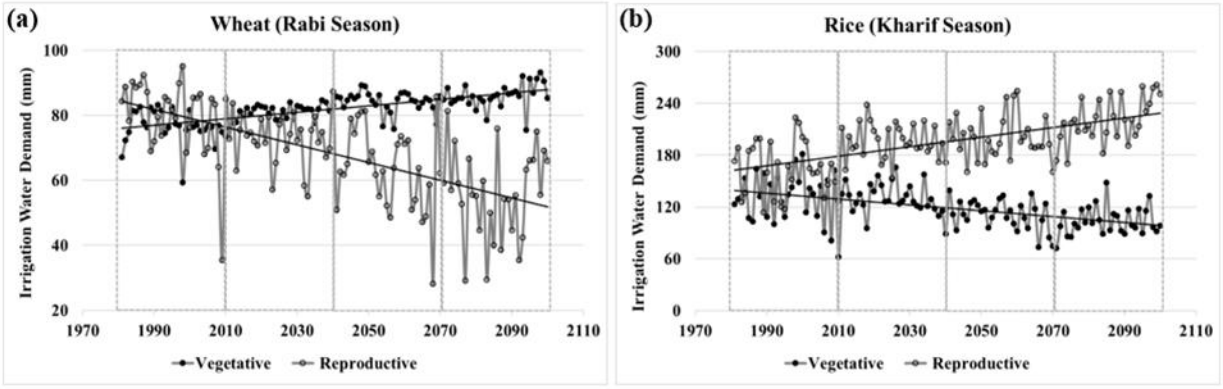


Figure 10: *Inter-annual variations and trends of irrigation water demand (mm) of wheat (a) and rice (b) during the vegetative and reproductive crop growth phases for the period 1981-2100 for Punjab Pakistan.*

iii. Mid-century change analysis of temperature and precipitation maxima in the Swat River Basin, Pakistan

This study analyzes trends in historical (1989–2018) and projected (2041–2060) temperature and precipitation maxima in the Swat River Basin, Pakistan. Observed temperatures showed a decreasing trend at all stations except Saidu Sharif, but the differences were not significant. Precipitation showed an increasing trend at two stations, Kalam and Malam Jabba, and a decreasing trend at two other stations, Dir and Saidu Sharif. A >2°C rise was noted for the annual projected maximum temperature (2041–2060) at areal and Dir, while Kalam, Malam Jabba, and Saidu Sharif showed a 1°C rise. For precipitation, an approximately 12% increase in annual maximum (areal) and seasonal precipitation (summer and autumn) was seen under all scenarios except RCP 4.5 in which there was a 20% and 32% increase in summer and autumn, respectively. The performance of SDSM in simulating maximum temperature and precipitation was satisfactory.

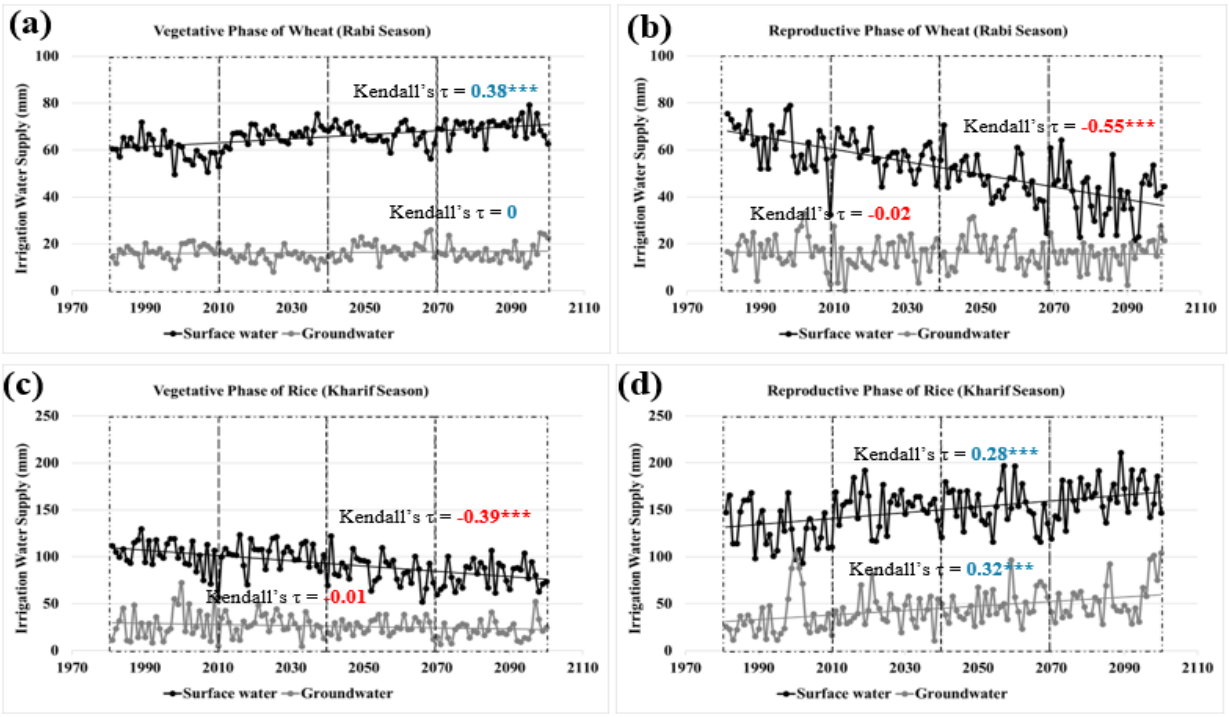


Figure 11: S3 Inter-annual variations and trends (presented as Tau value where blue color shows increasing trend and red as decreasing) of irrigation supply (mm) by sources (surface water and groundwater) during the vegetative (a, c) and reproductive (b, d) phases of wheat (a-b) and rice (c-d) for the period 1981-2100 for Punjab Pakistan simulated by LPJmL using the ensemble mean of four GCM's of RCP4.5-SSP1 emission scenario

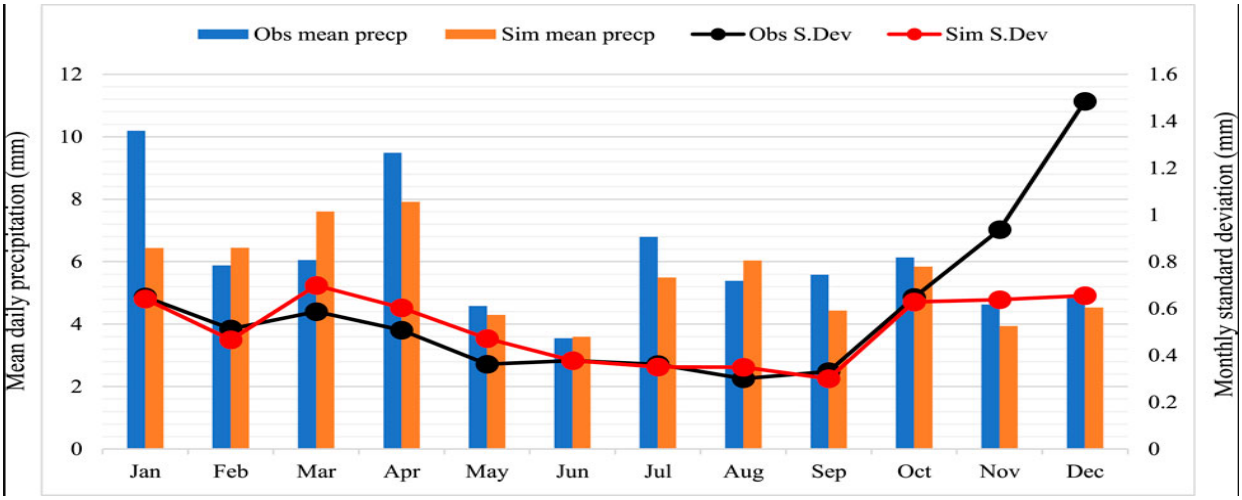


Figure 12: *SDSM calibration of observed and simulated areal precipitation characteristics*

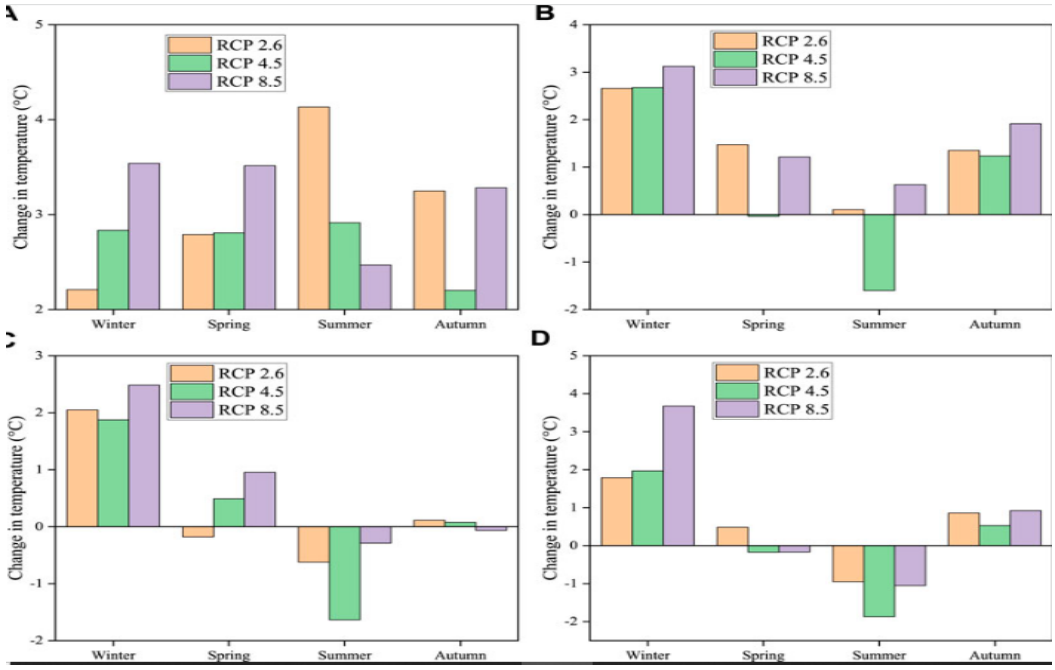


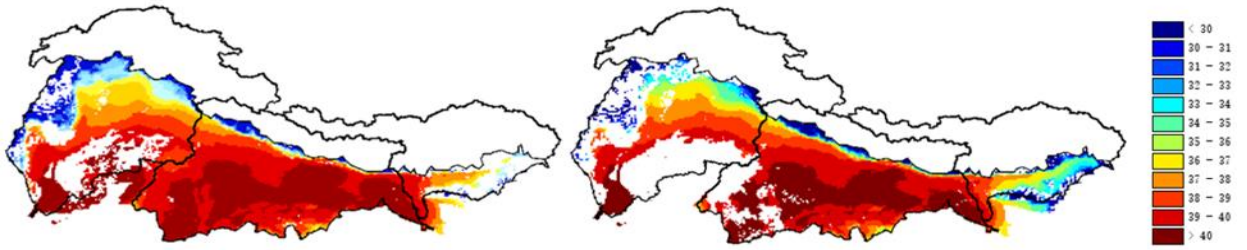
Figure 13: *Changes in maximum seasonal temperatures of Dir* ***(A)****, Kalam* ***(B)****, Malam Jabba* ***(C),*** *and Saidu Sharif* ***(D)****.*

iv. The Coincidence of Climate Extremes with Sensitive Crop Growth Phases: Projected Impact on Sustainable Crop Water Use and Crop Yield in the IGB River Basins

We investigated the coincidence of climate extremes with sensitive crop growth phases of wheat and rice in the Indus, Ganges and Brahmaputra (IGB) river basins of South Asia. We also quantified the related impacts on irrigation water demand (IWD), gross primary production (GPP) and crop yields (CY) simulated by a hydrological-vegetation model (LPJmL) during 1981-2100 using RCP4.5-SSP1 and RCP8.5-SSP3 framework. The climate extremes revealed a higher frequency and intensity during crop growth phases with significant increasing trends in future.

Diverse changes in IWD, GPP and CY are projected in future under the influence of crop phase-specific extremes. More than 50% of the change in future wheat irrigation is caused by warm and dry extremes during the ripening phase. Whereas, increase in IWD for rice is mainly associated with warm extremes only. The crop phase-specific GPP shows a decreasing trend in future for both wheat and rice in the Western part of IGB with the largest decrease during the reproductive phase of wheat (up to 36 %) and vegetative phase of rice (> 20%). This decrease is clearly reflected in seasonal yields i.e., both wheat (20%) and rice (12%) showed a decrease in future linked with warm and dry extremes. However, in the Eastern part of IGB, the GPP will mostly increase in future during the three crop phases of wheat and rice. These results can be used to help develop efficient adaptation strategies considering seasonal changes and sensitive crop phases for sustained food and water security in South Asia.

Figure 14: *Spatial distribution of P99 (0C) over the irrigated areas of wheat (a) and rice (b) during base line period (1981-2010) in the IGB river basins.*



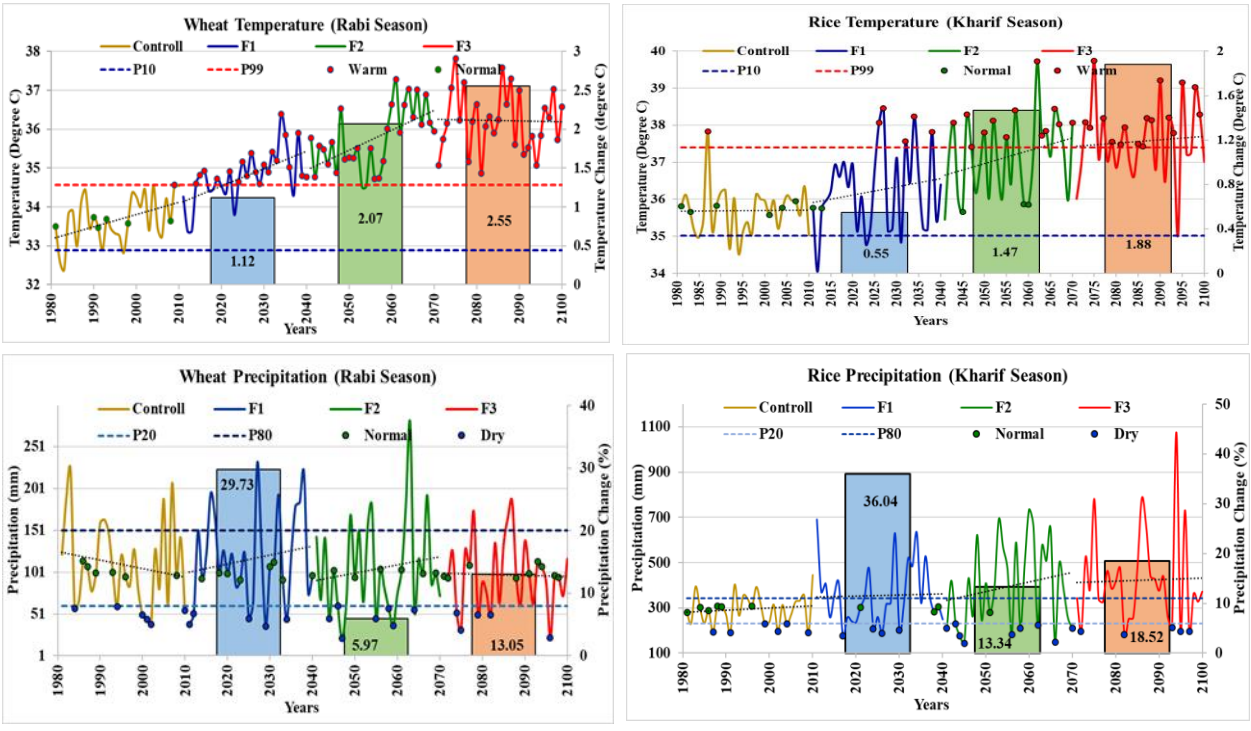


Figure 15: *3a-b: Warm and dry extremes estimated using temperatures data (^{0}C) at seasonal (sowing to harvest) scales of wheat (rabi season) and rice (kharif season) for the Punjab Pakistan*

during the period 1981-2100 using the ensemble mean of four GCM's of RCP4.5-SSP1 emission scenarios. Dotted lines show the upper and lower bounds of temperature extremes estimated at 99th (red) and 10th (blue) percentiles. Future changes in temperature (^{0}C) (colored bars in each panel) are estimated for three scenario periods i.e., F1 (2011-2040), F2 (2041-2070) and F3 (2071-2100) w.r.t base line period (1980-2010).

v. Climate Projections over Pakistan using Bias Corrected CMIP6 model Data at a higher Spatio-temporal scale for planned adaptations and informed policy decisions

The assessment and quantification of future climate projections at higher Spatio-temporal scales in Pakistan is vital for food security-related adaptation. In this study, daily bias-corrected climate data of 13 individual General Circulation Models (GCM's) from CMIP6 (Climate Model Inter-comparison Project Phase 6) project was chosen for future changes in seasonal climate data in the two major wheat and rice-producing provinces of Pakistan. We have estimated the climate projections uncertainty range of 13 CMIP6 models and Multimodel Ensemble Mean (MMEM) under two emission scenarios i.e., SSP245 and SSP585 scenarios for the historical period 1951-2100. These results provide a basis for developing a better understanding of crop and region specific adaptation measures for an agriculture dependent country like Pakistan.

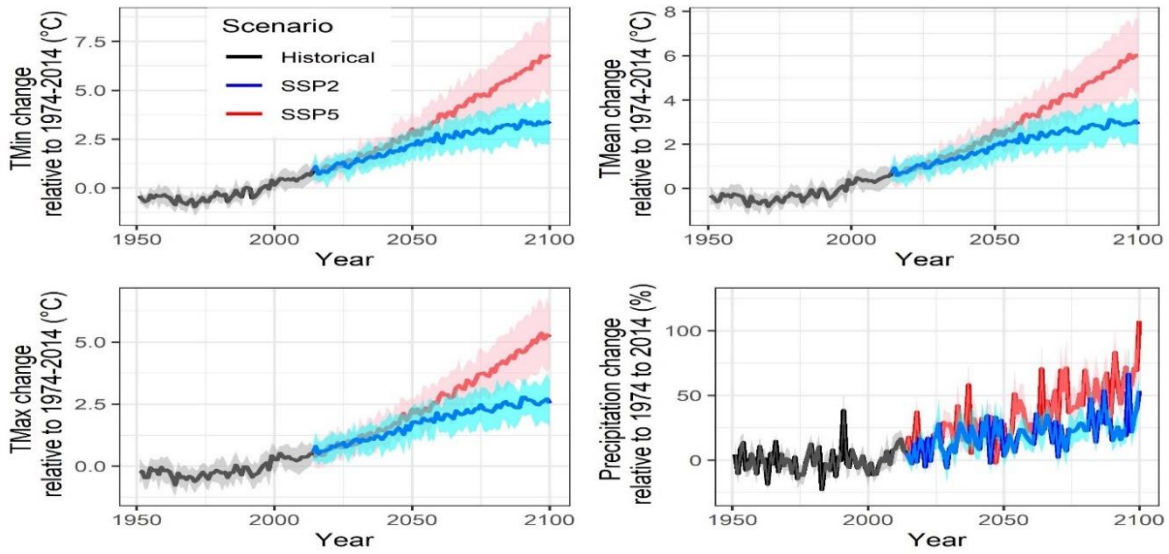


Figure 16: *shows the long term trends, inter-annual variations and uncertainty range of the 13 GCM's CMIP6 models data along with multi-model ensemble mean (MMEM). The climate data of temperature and precipitation has been plotted at annual scale over whole Pakistan using two selected emission scenarios for period (1951 -2100). The MMEM data is plotted with the dark lines (i.e., black during control period (1974 -2014) and blue (SSP245) and red (SSP585) line for future period (2020 – 2100).*

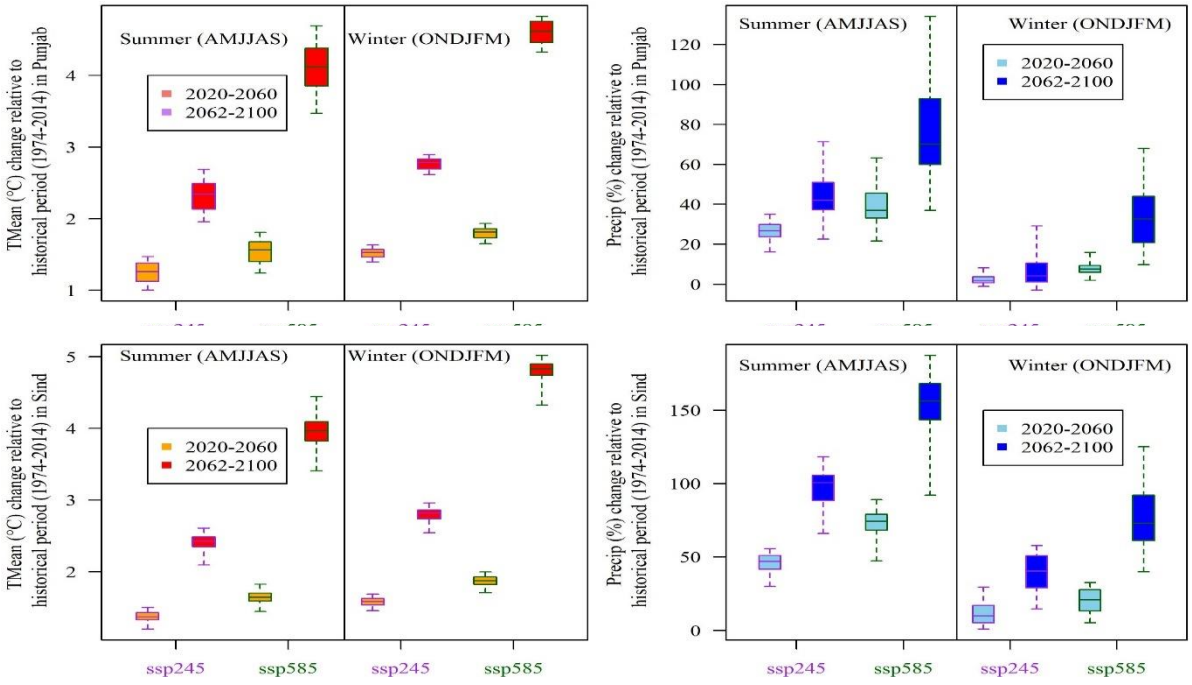


Figure 17: *Box and whisker plots for projected changes in seasonal temperature and precipitation over Punjab and Sindh provinces of Pakistan under two emission scenarios i.e., SSP245 and SSP585. The boxes show the interquartile range, horizontal lines represent the median and the whiskers show the maximum/minimum value of the lower/upper quartile.*

vi. Optimized irrigation scheduling as an adaptation option to support Wheat production in the Indo-Gangetic Plain (IGP) of South Asia

A study was carried out to investigate supplemental irrigation as an adaptation strategy by determining the effects of optimal irrigation scheduling, including quantity and time, during critical crop growth stages of wheat using the Crop Kites concept. Crop kites investigate the relationship between water use and yield, showing that this can change substantially between locations and years. This study explores the potential of increasing water productivity in irrigated fields with supplemental irrigation. Specifically, we investigate the potential of maximally reducing irrigation while minimally reducing yield. Our modelling results show that the same total irrigation amount distributed differently can produce significantly different outcomes. For example, in our study, the Crop kite for a specific location but for a different year showed 60% of the previous maximum, with a slight increase in water use. Our results of crop water productivity under the prioritizing irrigation water productivity scenario show that by using 4% of the total irrigation water, we maintain 56% of the full irrigation harvest. Furthermore, our other statistical analysis results under maximizing irrigation water productivity show that by using 23% of the irrigation water, 84% of the full irrigation harvest is maintained. Our study outcomes suggest that an optimal distribution of supplemental irrigation is a promising adaptation measure to help increase water productivity and yields and buffer climatic variability with limited water availability.

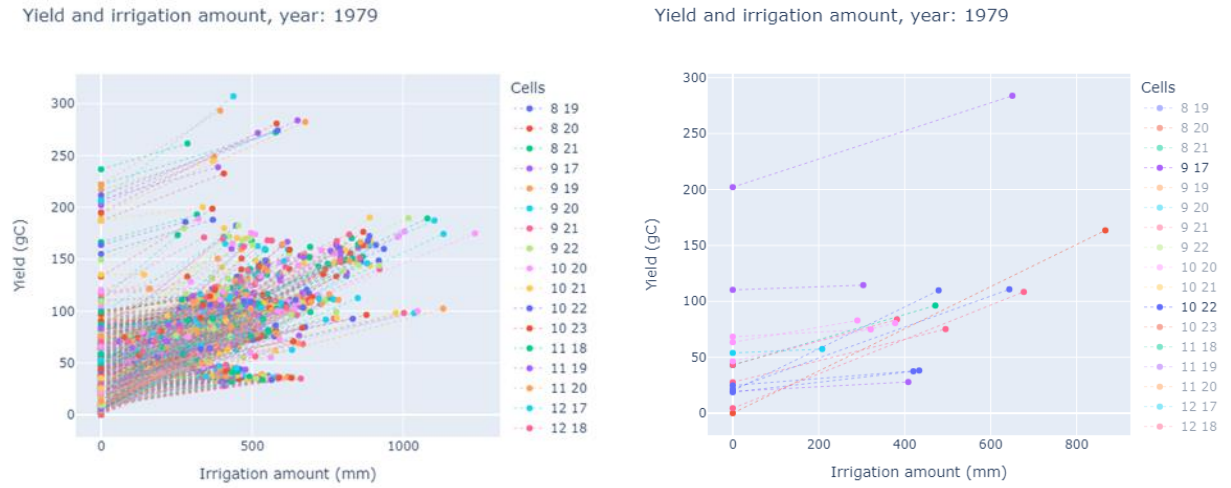


Figure 18: *Total Yield and irrigation for wheat for each 30-arcminute cell across India in 1979*

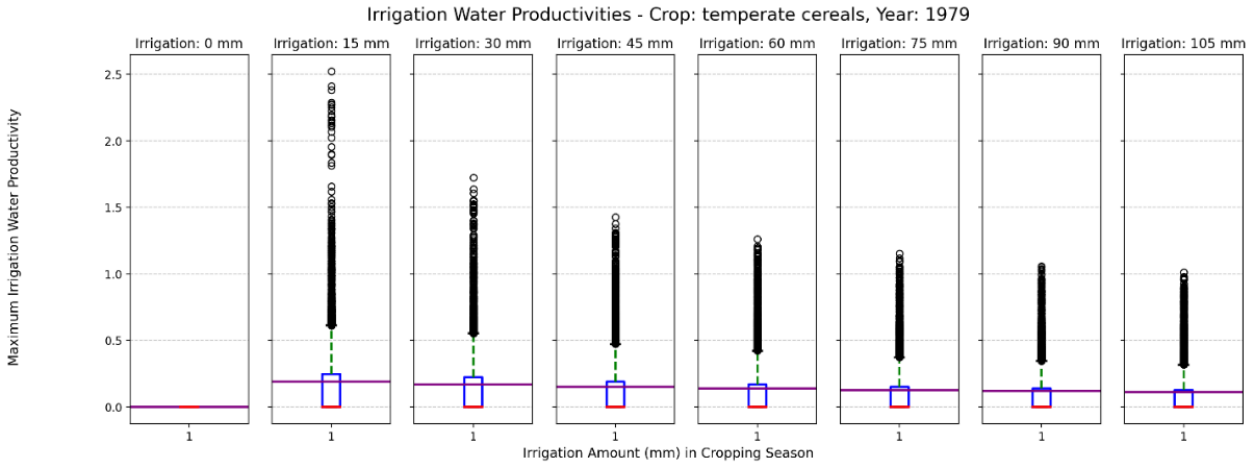


Figure 19: *Box Whisker plots of Maximum irrigation water productivity of wheat over whole study area for 1979*

vii. Sediment Load Forecasting of Gobindsagar Reservoir using Machine Learning Techniques

With ever advancing computer technology in machine learning, sediment load prediction inside the reservoirs has been computed using various artificially intelligent techniques. The sediment load in the catchment region of Gobindsagar reservoir of India is forecasted in this study utilizing the data collected for years 1971–2003 using several models of intelligent algorithms. Firstly, multi-layered perceptron artificial neural network (MLP-ANN), basic recurrent neural network (RNN), and other RNN based models including long-short term memory (LSTM), and gated recurrent unit (GRU) are implemented to validate and predict the sediment load inside the reservoir. The proposed machine learning models are validated for Gobindsagar reservoir using three influencing factors on yearly basis [rainfall (R_a), water inflow (I_w), and the storage capacity (C_r)]. The results demonstrate that the suggested MLP-ANN, RNN, LSTM, and GRU models

produce better results with maximum errors reduced from 24.6% to 8.05%, 7.52%, 1.77%, and 0.05% respectively. For future prediction of the sediment load for next 22 years, the influencing factors were first predicted for next 22 years using ETS forecasting model with the help of data collected for 33 years. Additionally, it was noted that each prediction's error was lower than that of the reference model. Furthermore, it was concluded that the GRU model predicts better results than the reference model and its alternatives. Secondly, by comparing the prediction precision of all the machine learning models established in this study, it can be evidently shown that the LSTM and GRU models were superior to the MLP-ANN and RNN models. It is also observed that among all, the GRU took the best precision due to the highest R of 0.9654 and VAF of 91.7689%, and the lowest MAE of 0.7777, RMSE of 1.1522 and MAPE of 0.3786%. The superiority of GRU can also be ensured from Taylor's diagram. Lastly, Garson's algorithm and Olden's algorithm for MLP-ANN, as well as the perturbation method for RNN, LSTM, and GRU models, are used to test the sensitivity analysis of each influencing factor in sediment load forecasting. The sediment load was discovered to be most sensitive to the annual rainfall.

Figure 20A depicts the comparison of actual volume of sediments deposited inside the Gobindsagar reservoir with reference neural network model and proposed machine learning models using tested data from year 1971 to year 1999 while in Figure 20B it can be seen that the relative errors estimated using GRU model are lying between -0.5% and 0.5% inside the grey rectangle and showing the better results as compared to the other models. Figure 21A, B, and C depict the three yearly forecasted influencing factors for the Gobindsagar reservoir: rainfall, inflow of water, and storage capacity.

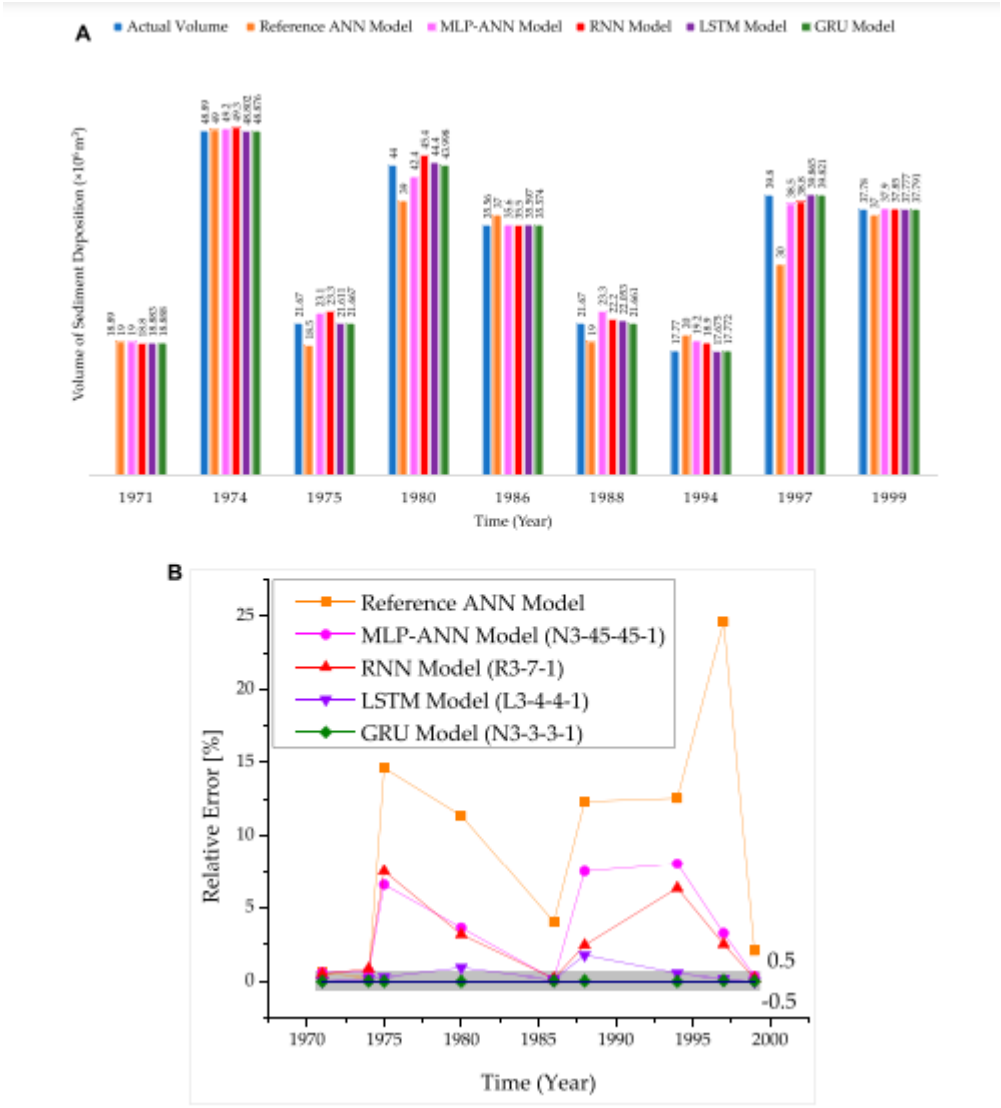


Figure 20: *(A). Comparison of actual volume of sediments retained inside the Gobindsagar reservoir with reference ANN model and proposed machine learning models using tested data from year 1971 to year 1999, (B). Reduction in relative error of proposed machine learning models in comparison with the reference model.*

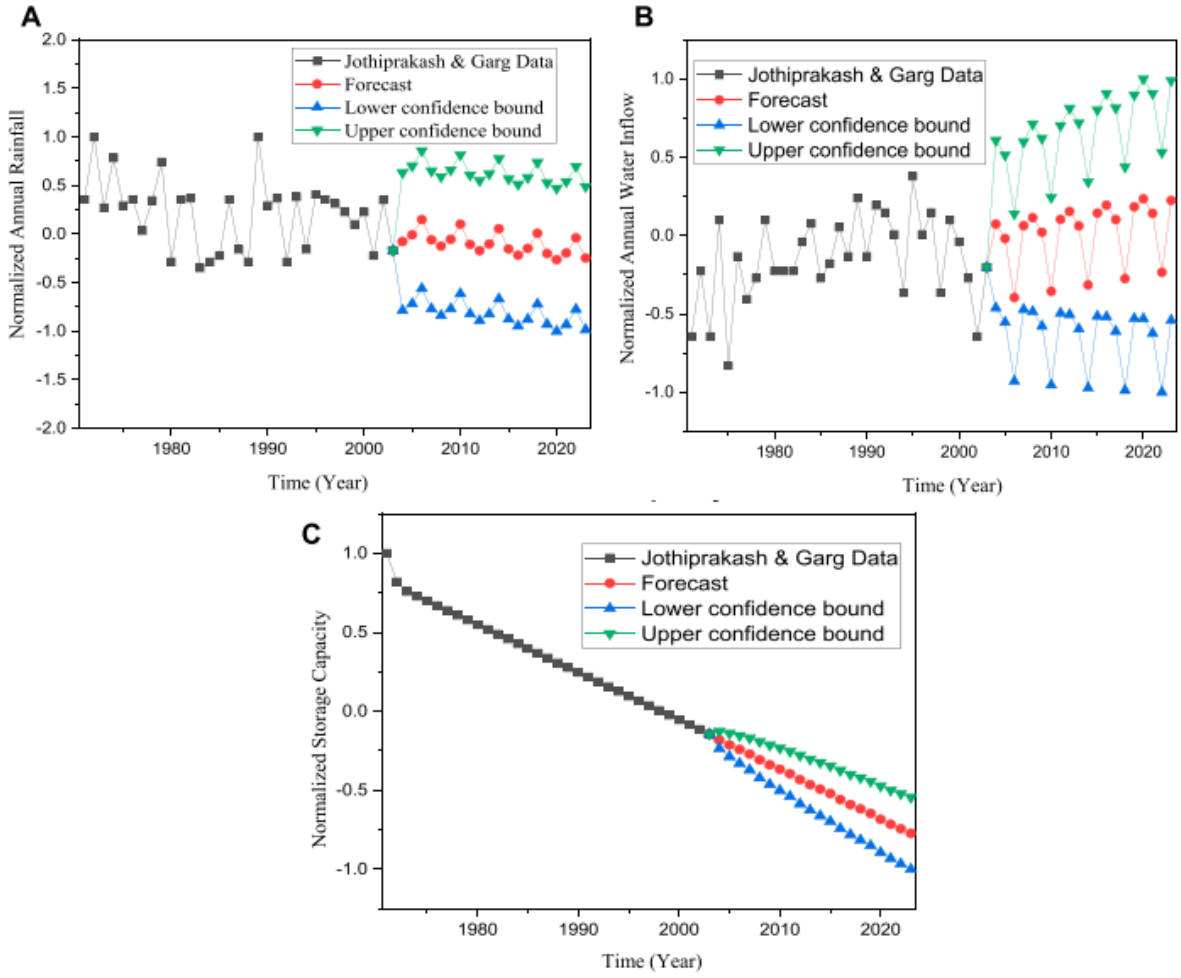


Figure 21: *Forecasted input parameters for the Gobindsagar reservoir including (A) normalized rainfall; (B) normalized inflow of water and (C) normalized storage capacity.*

viii. Spatiotemporal Characterization of Meteorological Drought in Saudi Arabia

The drought phenomenon is a natural disaster that occurs due to a lack of water supply and harms the growth and production of crops and other agriculture and socio-economic activities along with the ecosystem. Lack of precipitation for a longer period is the main cause of the drought. The Kingdom of Saudi Arabia (KSA) lies in a water-stressed region with high rainfall inter-annual variability and is highly vulnerable to recurring droughts. There are several indices/methods to measure droughts but the Standardized Precipitation Index (SPI) is the widely used index because of its simplicity. The analysis showed negative (decreasing) SPI trends in all the drought years starting at the end of the 20th century and continuing till 2012. There are no or very rare extreme wets in the country within the data while there are many severe and extreme droughts (highest SPI =3.87, and lowest SPI =-5.38). Percentiles mapping 90th (10th) and 95th (5th) for upper (lower) bounds of SPI help policymakers manage the adaptive measures to overcome the consequences of drought based on different levels of uncertainty represented by these percentiles.

Figure 22 (the last-row left image) represents the 32nd percentile which exhibits that most of the country is observing mild droughts while some parts are also observing mild wets such as the southern part Riyadh region (Wadi ad Dawasir), Asir, Madina, and Hail regions. Figure 22 (the last-row right image) represents the 68th percentile which exhibits that the whole country is exhibiting mild wets. It means more intense drought events happened in different years throughout the KSA which can also happen in the near and far future as well based on the trends of SPI values.

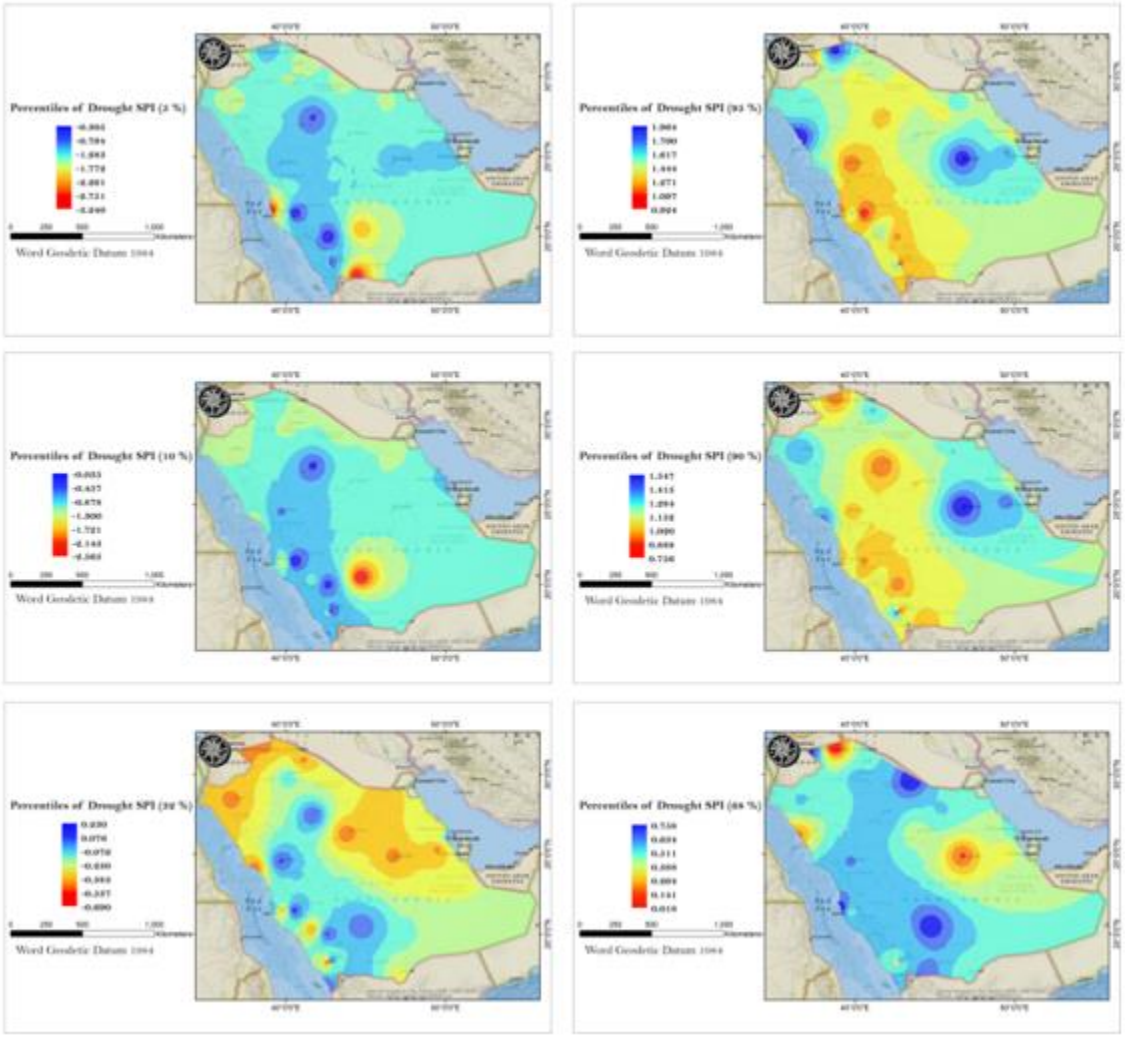


Figure 22: *Percentile mapping: First row 5th Percentile values (left), and 95th Percentile values (right), middle row: 10th Percentile values (left) and 90th Percentile values (right), last row: 32th Percentile values (left) and 68th Percentile values (right).*

ix. Simulation of the meltwater under different climate change scenarios in a poorly gauged snow and glacier-fed Chitral River catchment (Hindukush region)

Seasonal and annual water supplies of the rivers originating in the Hindukush-Karakoram-Himalaya (HKH) region of Pakistan are important to manage the Indus basin irrigation system for

better agricultural production and its dependent agrarian economy. In this study, we simulated the current and future snowmelt runoff in a poorly gauged river basin of the Hindukush region under Representative Concentration Pathways (RCP) climate change scenarios. Snowmelt Runoff Model (SRM) furnished with satellite snow cover maps and hydro-meteorological data were used to simulate the daily river discharge for the period 2000–2005. The results indicated that SRM has effectually simulated the runoff in Chitral River with Nash-Sutcliffe model efficiency coefficient of 0.85 (0.84) and 0.88 (0.83) in the basin-wide (zone-wise) application during the calibration and validation periods, respectively. The results obtained under future climate change scenario showed ~14–19% increase in mean summer discharge under three mid-21st century RCP (2.6, 4.5 and 8.5) scenarios. While an increase of ~13–37% is expected under late-21st century RCP scenarios. This study can help water resource managers to plan and manage peak discharges from the Chitral River Basin in the future and can thus prevent major losses due to floods in the area.

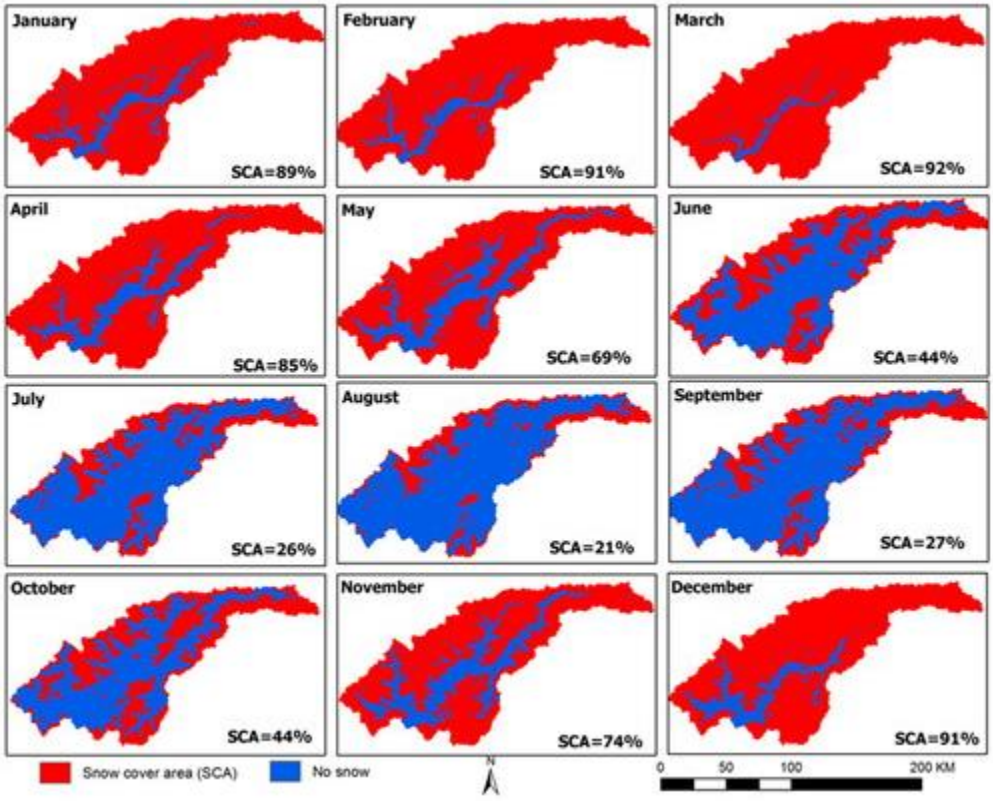


Figure 23: *Spatial extent of mean monthly snow cover area (SCA) estimated from the MODIS data period of 2000–2005 for the Chitral basin.*

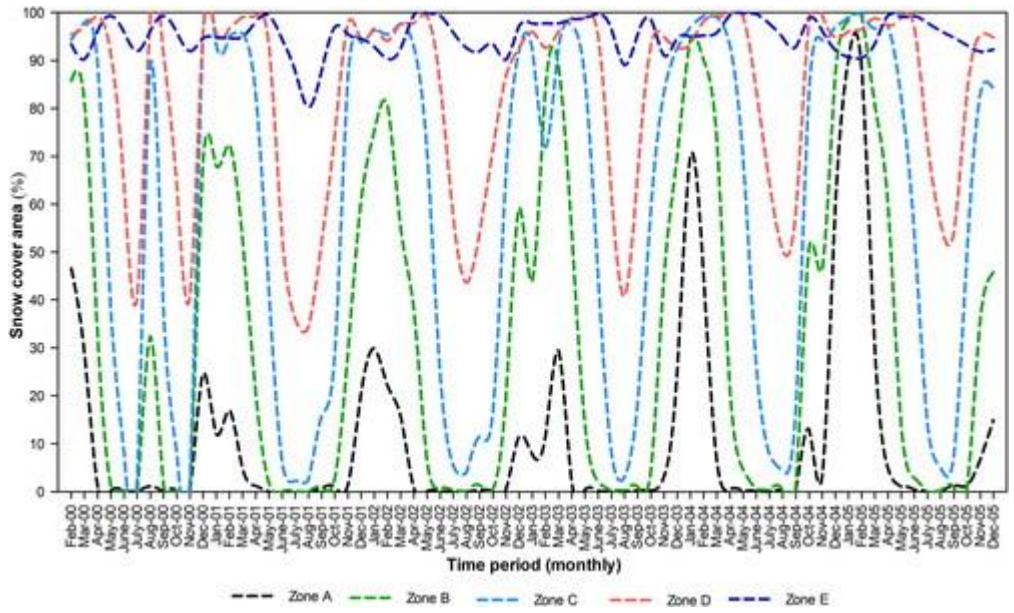


***Figure 24**: Mean monthly snow cover distribution (zone-wise) in the Chitral River basin over a period of 2000–2005.*

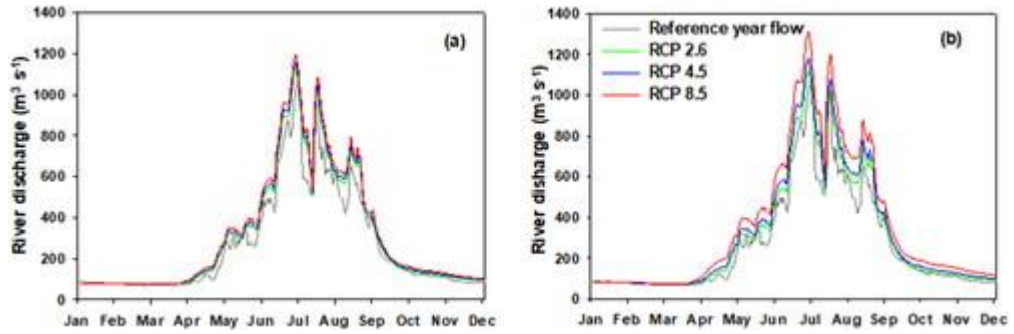


***Figure 25:** (a) Simulation of the Chitral River discharge under RCP 2.6, 4.5 and 8.5 climate change scenarios for the (a) mid-21st century, and the (b) late-21st century.*

x. Assessing drought and its impacts on wheat yield using remotely sensed observations in rain fed Potohar region of Pakistan

Drought is a serious threat to agriculture particularly of rain fed regions like Potohar region of Pakistan. Wheat, staple food crop of this region is mostly affected by drought, thereby impacting food security of the region. Effective drought monitoring and its impacts on wheat production have therefore been the key concerns of the farmers and policy makers in order to plan for any upcoming food crises in the region. A proactive drought management approach is needed in this regard. This study aims to assist the decision-making process for drought monitoring and yield predictions, as it informs drought assessment and its impacts on crop yield using drought and vegetation indices along with climate and crop yield data. This research quantifies recurrent drought events for Rubi (wheat crop) season (November-April) from 2000 to 2018 in the Potohar region using indices such as; Standardized Precipitation Index (SPI), Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI) and Soil Adjusted Vegetation Index (SAVI) along with climatic

parameters i.e., mean temperature, rainfall and soil moisture. Results show a strong positive correlation of wheat yield with rainfall (r = 0.97) and soil moisture (r = 0.88), while a strong negative correlation with temperature (r = -0.98). Three moderate (2000-01, 2001-02, 2009-10) and two weak (2011-12, 2017-18) drought events are identified using SPI, whereas two more drought events (2007-08 and 2016-17) are noticed when vegetation indices are used. Looking at Oceanic Niño Index (ONI), no definite pattern relating to ongoing La Nina or El-Nino conditions during the specific drought years is observed for the Potohar region. Artificial Neural Network (ANN), a multilayer perception (MLP) model is applied afterwards to see the individual impact of each study parameter on wheat yield. Soil moisture is found to impact yield by 100 %, temperature as 74 %, rainfall as 61 % and then rest of the indices. The findings of this study not only provide a scientific base for future studies on drought indicators, but assert that a cumulative approach is needed for effective drought management at national level.

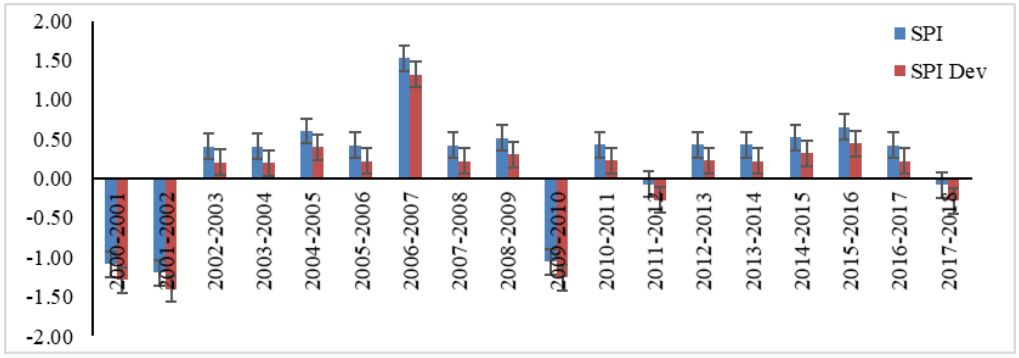


Figure 26: *6-month SPI and SPI Deviation in the Potohar region during Rubi season from 2000-2018*

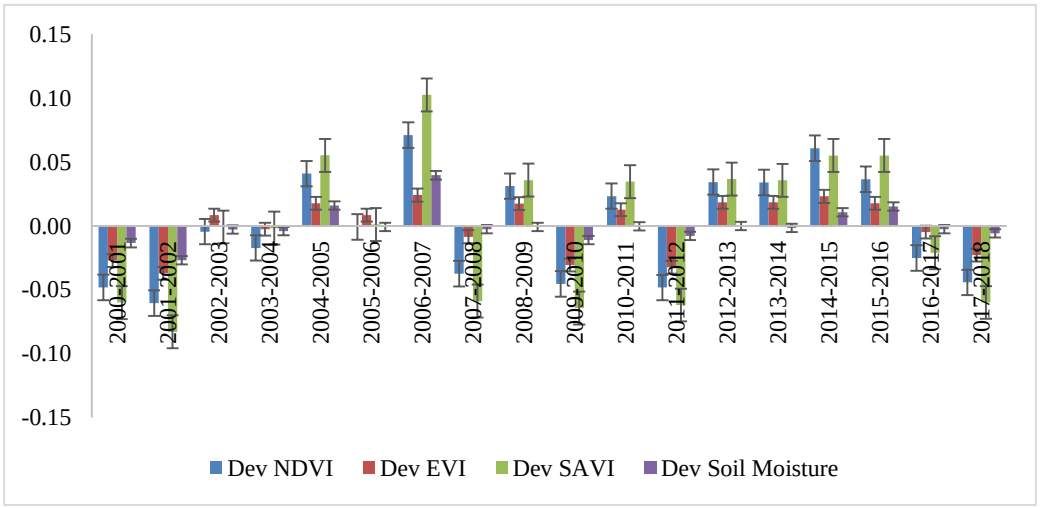


Figure 27: *Deviation of NDVI, EVI, SAVI and soil moisture in the Potohar region during Rubi season from 2000-2018*

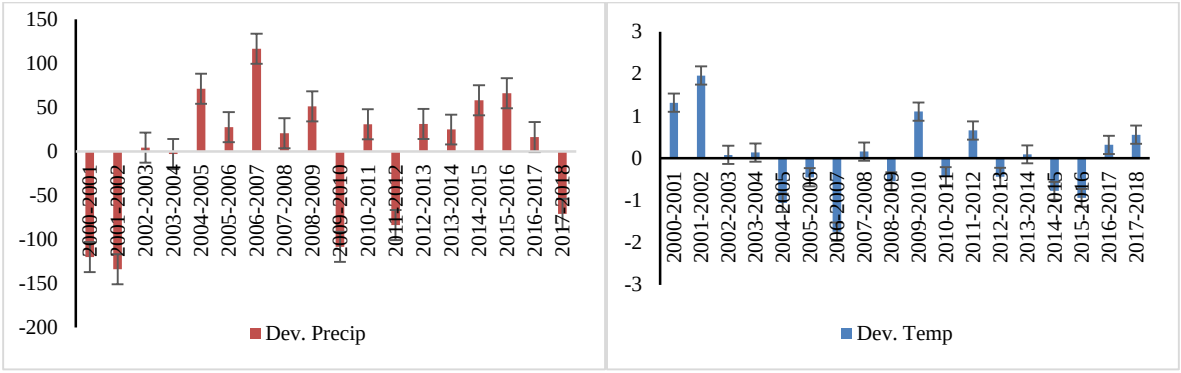


Figure 28: *Deviations of (a) Rainfall (in mm) and (b) Mean surface temperature (°C) in the Potohar region during Rubi season from 2000-2018*

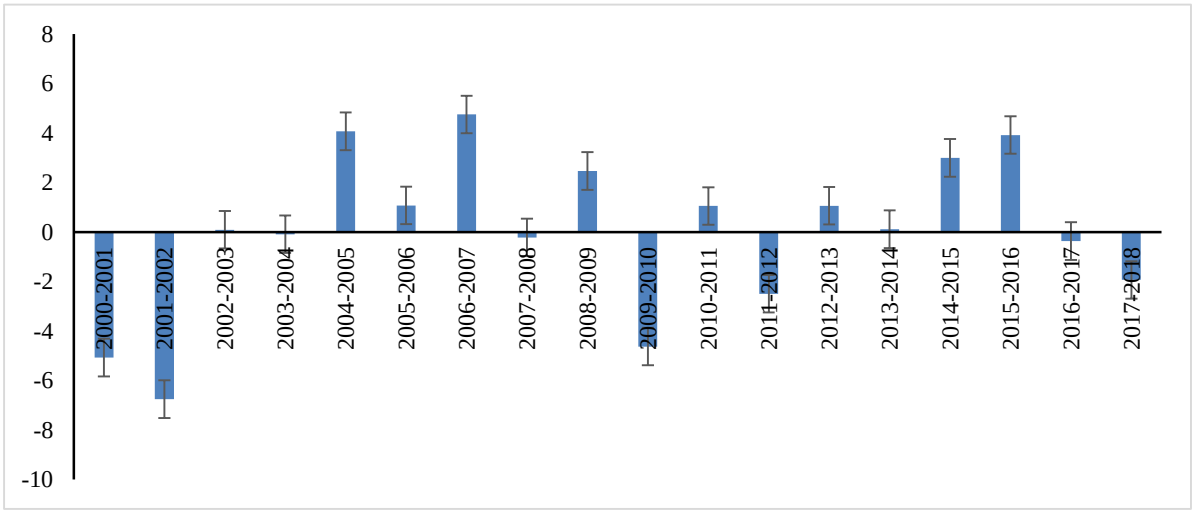


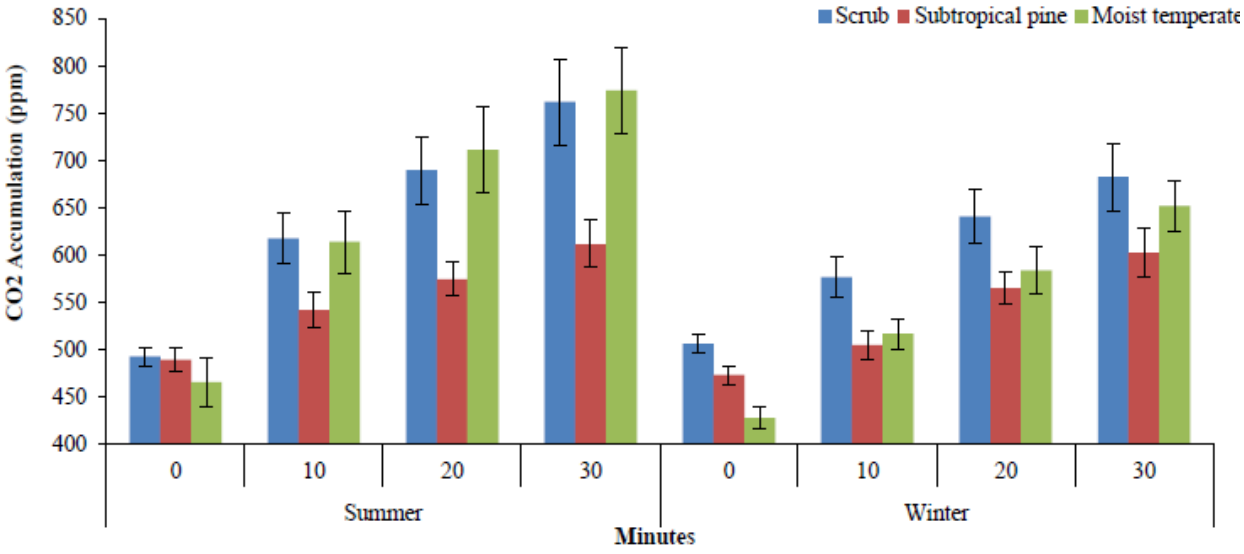
Figure 29: *Yield deviation (Maund/ha) in the Potohar region during Rubi season from 2000-2018*

xi. Spatio-temporal dynamics of greenhouse gas emissions from soils in forest ecosystems of Pakistan

Intergovernmental Panel on Climate Change (IPCC) in its sixth assessment report (AR-6) has documented that the atmosphere, ocean, and land have been warmed at an unprecedented rate as per history of last 2000 years. Greenhouse gas (GHG) emissions from agriculture and forest soils account for 24% of the total global emissions. Soil processes directly contribute to climate change through the production and consumption of carbon dioxide (CO2), methane (CH4) and nitrous Oxide (N2O). Because of huge spatial and temporal variability in the soil-atmosphere exchange of GHGs, the measurement of prevailing concentrations and prediction are still difficult. Under different forest types, soil responds in a dissimilar fashion under varying climatic conditions.

This research endeavor was pursued to estimate GHG accumulations from soil under scrub, subtropical pine and moist temperate forests. This study is of unique scientific efforts and features in which empirical data of the soil GHG emissions was gathered based on field observations. The present study apprehended forest diversity and temporal variations using a static chamber and

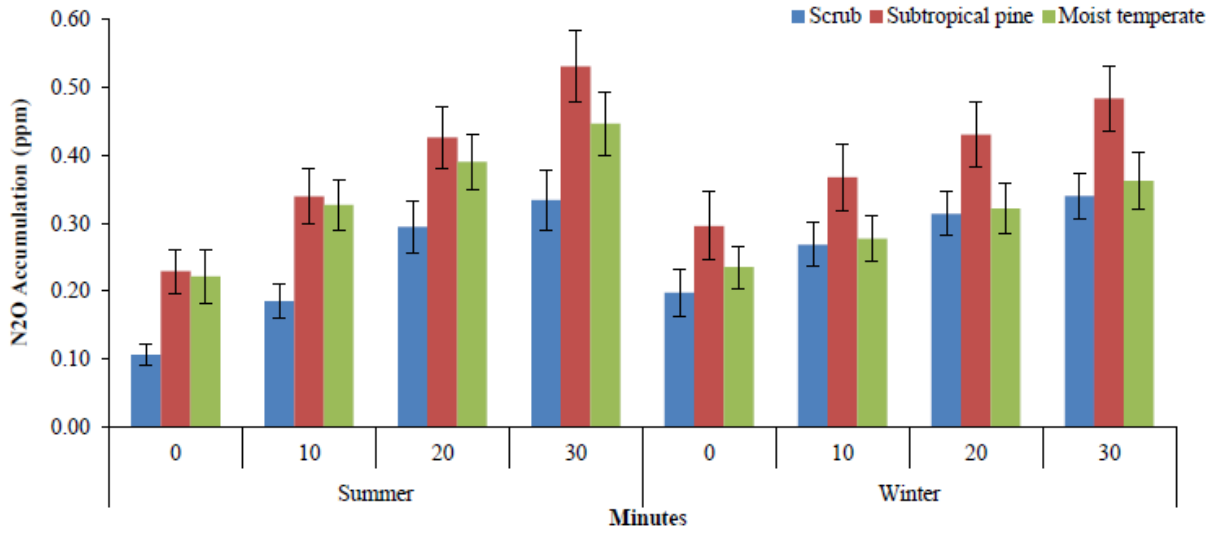
photoacoustic spectroscopy to estimate GHG accumulations from soil. Seasonal variations strongly influenced CO2 emissions in three forest types (Fig. 30), while N2O accumulation was not influenced by seasonal variations.



- Error bars are indicating Standard Error

Figure 30: *Carbon dioxide accumulation by season from soils of three forest types*

In the winter season, the GHG accumulation decreased due to reduced microbial and root respiration. Methane was not detected in any of the forest types investigated in this study. Our results showed that soil under moist temperate forests produced more CO2 in summer as compared to that in the other forest types. The subtropical chir pine forest has the highest N2O accumulation in both summer and winter seasons. The outcomes of the research will be useful for developing national GHG inventory as well as Forest Reference Emission Levels (FREL) for REDD+ implementation under the Paris Agreement. Further, the data produced in this study may be helpful in carbon trading under Kyoto Protocol. The present approximations of GHGs will aid in predicting the future climate trends.



- Error bars are indicating Standard Error

Figure 31: *Nitrous Oxide accumulation by season from soils of three forest types*

xii. GIS-based spatio-temporal assessment of forest cover change and carbon sequestrations of District Abbottabad, Pakistan

Forest plays an important role in the climate of a country and ecosystem's balance. During the last decade, District Abbottabad of Pakistan has gone through extensive land-use changes due to accelerated development, urbanization, and agriculture. This study examines the change in forest cover due to environmental factors with the help of satellite images (Landsat, Sentinel) and their classification through supervised classification, as well as the application of change detection technique after classification using geographical information system (GIS) over the last three decades (1986–2019). The land-use transition matrix was calculated from the year 1986 to 2019. The result shows an overall increase of 3.17%, 17.24%, and 7.24% in the forest, vegetation, and build-up areas, respectively; whereas water-bodies and others (barren land) has decreased significantly by 0.69% and 26.96% respectively (Figure 32). Figure 33 presents the temporal pattern of various LULC for the period of 1986 – 2019. Results revealed that carbon sequestration increase as the year passes due to afforestation in the study area. From 1986 to 2004 carbon sequestration decreased by 12.93%, while in 2002 – 2014 carbon sequestration increased by 19.54% between 2014 – 2019. Figure 34 shows the trend of total wood volume, Dry matter biomass, total carbon, carbon dioxide during 1986 – 2019 for Abbottabad District.

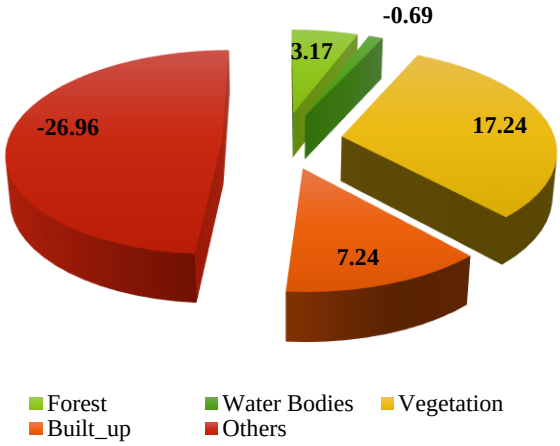


Figure 32: *Net percentage Change in Land Use Land Cover (1986 – 2019)*

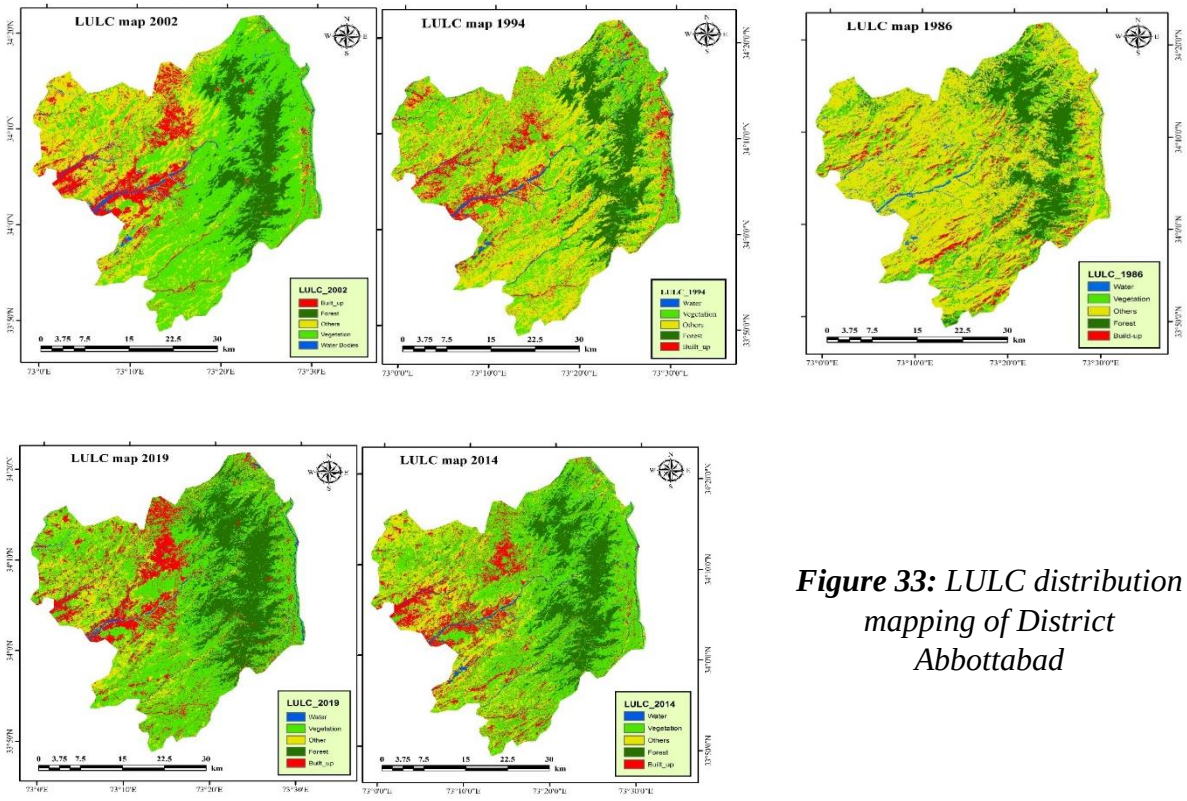


Figure 33: *LULC distribution mapping of District Abbottabad*

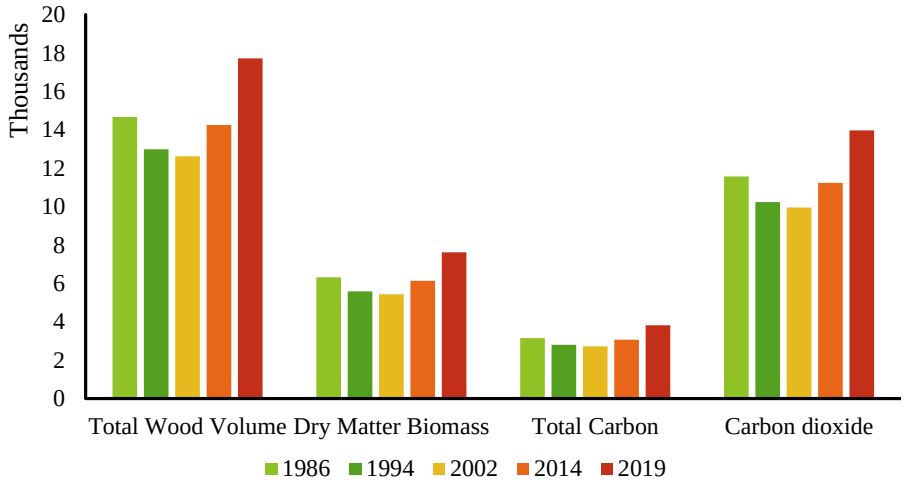


Figure 34: *Trend of total wood volume, Dry matter biomass, total carbon, carbon dioxide during 1986 – 2019 for Abbottabad District*

xiii. Assessment of change in forests land, carbon stock and carbon emissions of KPK, Pakistan for past three decades using geospatial techniques

Reducing emissions from deforestation and forest degradation is a mechanism to cut down GHG emissions and protect the threatened forest ecosystems. Pakistan is suffering from high forest degradation and deforestation rates, but recent plantations under BTTAP have created a significant impact. This study was designed to identify the LULC changes, forest sequestration and emissions from forest degradation in the forest hub districts (Malakand, Mardan, Lower Dir and Upper Dir) of KPK, Pakistan using Landsat imageries. LULC changes were analyzed from 1990 to 2020. In addition, the amount of carbon sequestration and emissions from forest degradation were also calculated. Results of the analysis showed forest area reduction from 1990 to 2009, followed by a sharp increase in the next decade (2010–2020) by 56% (Table 1). Around 836 km^2 of land was found to be covered with forests during BTTAP. The net change was a 32% increase in forest land over three decades. Figure 35 below summarized total carbon sequestration (tons) potential and emissions due to deforestation over the time period in the study area. The study offers important information which environment managers and decision-makers can utilize to encourage the plantation of trees and save existing forests in the country to combat climate change.

Table 1: Net change in classes over the years (1990 - 2020)

Category	**Change (km^2)**	**% Change**
Forest land	565.55	32.17
Agricultural land	-937.75	-44.45

Water Bodies	-28.83	-63.89
Settlement	1493.77	86.95
Others	-1092.48	-47.33
Note: -ive sign shows decreasing trend		

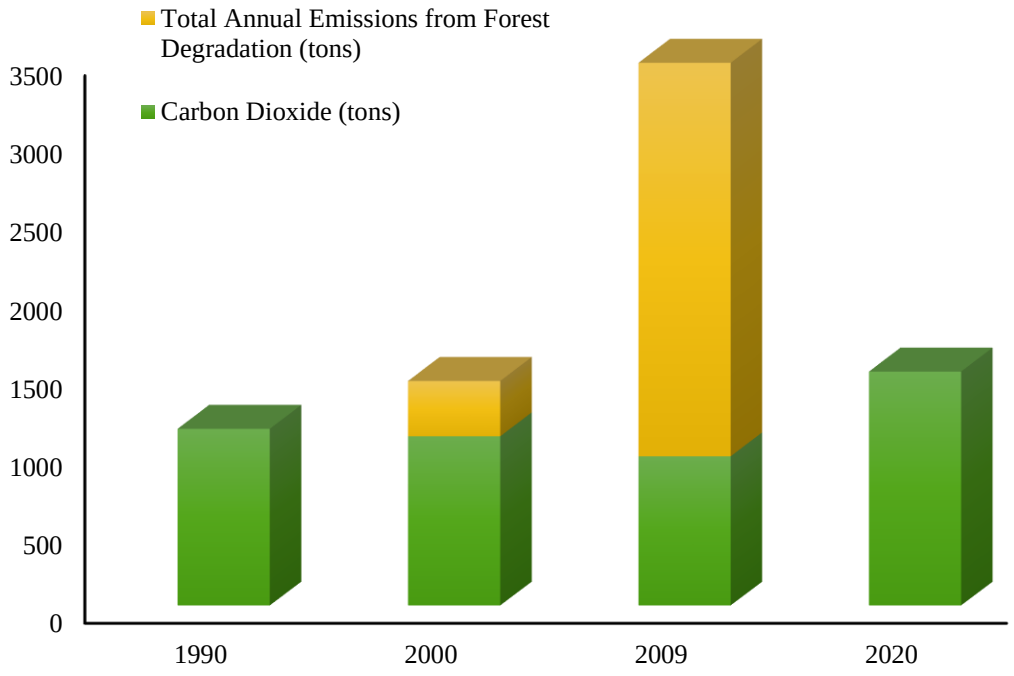
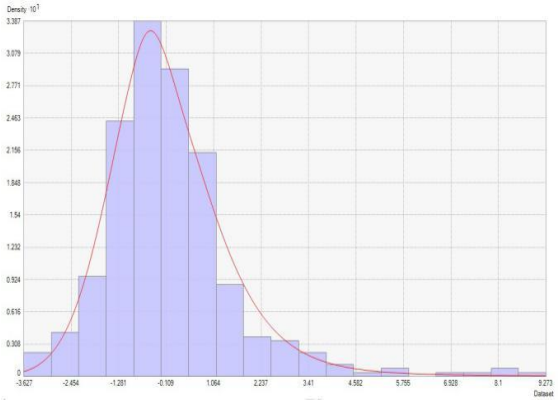


Figure 35: *Carbon Stock Assessment and total annual emissions from forest degradation*

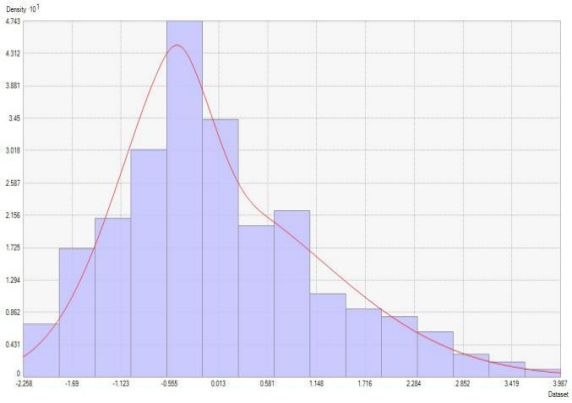
xiv. Geo-statistical investigation of groundwater quality zones for its applications in irrigated agriculture areas of Punjab (Pakistan)

The farmer's income and crop yield are greatly affected in Punjab, Pakistan due to poor quality groundwater. To observe, monitor and categorized groundwater quality, this research study was carried out in Faisalabad (FSD) and Toba-Tek Singh (TTS) districts of Punjab, Pakistan to check its suitability for irrigation with three major parameters (i.e. EC, SAR, and RSC). Geo-statistical water quality analysis was carried out using the GS+ and ArcGIS includes three basic components normalized histograms, semivariograph, and Kriging. The cross-validation techniques were used to determine the accuracy. A hydro-economic model was applied to observe the impact of groundwater quality on crop yield and farmers' income. It was found that the percent area under a good groundwater quality zone in FSD was about 25% fewer than TTS. In FSD, the majority area of the aquifer was under marginal (50-55%) to poor (39-44%) quality groundwater zones and salinity and sodicity are major threats depicted by EC and RSC, respectively. In TTS district, salinity was the only major risk to groundwater quality as about

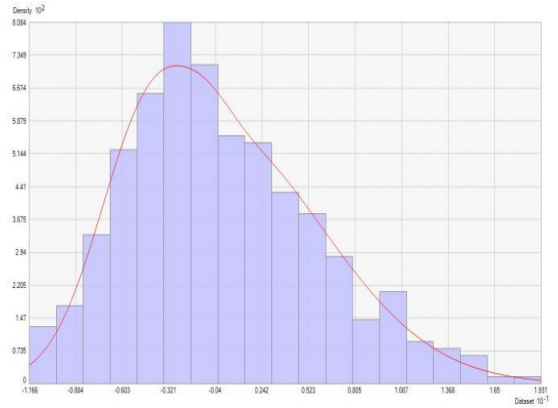
45% area was under poor quality zone. The overall aquifer's area under about good (~33%), marginal (~29%) and poor (~38%) quality groundwater zone. It was found that the impact of the monsoon season was found not considerable on the groundwater quality of both districts. Comparing the economic models in two districts using the different quality water it was found that the BCR (Benefit Cost Ratio) was recorded 2.31, 2.13 and 1.73 in FSD district while in TTS district the BCR was 2.35, 2.09 and 1.58 for good, marginal and poor quality zone, respectively. The results of the research recommend that monitoring and mapping of groundwater s are necessary for proper management of groundwater resources leads to reduce economic losses and increased crop yield.



(a) Electrical Conductivity (EC) Pre-Monsoon

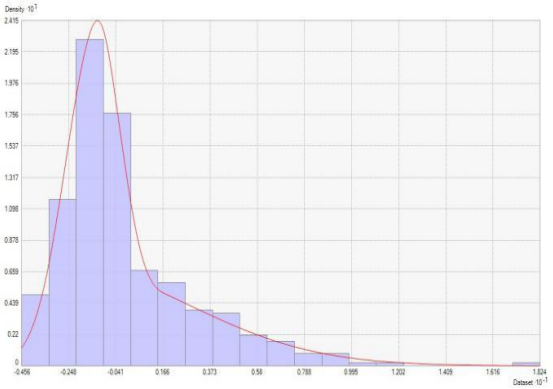


(b) Electrical Conductivity (EC) Post-Monsoon

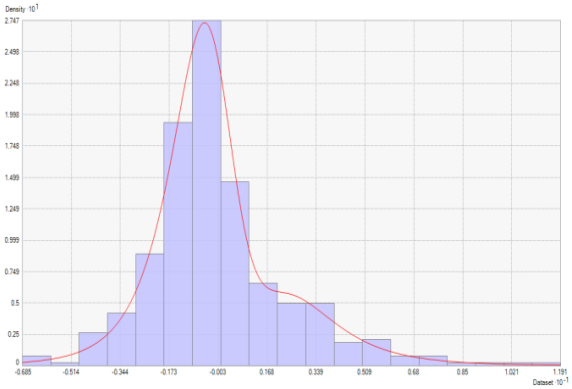


(c) Sodium Adsorption Ratio (SAR) Pre-Monsoon

(d) Sodium Adsorption Ratio (SAR) Post-Monsoon

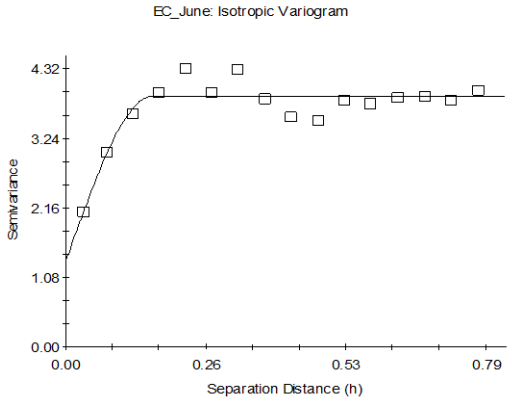


(e) Residual Sodium Carbonate (RSC) Pre-Monsoon

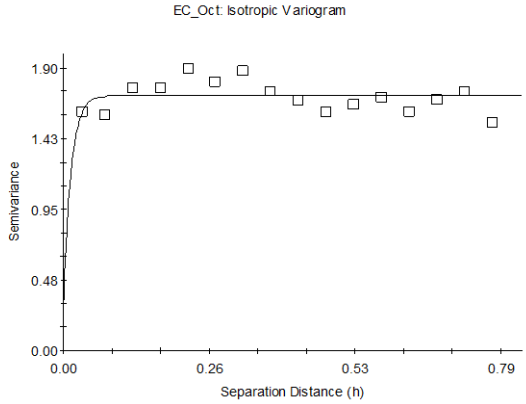


(f) Residual Sodium Carbonate (RSC) Post-Monsoon

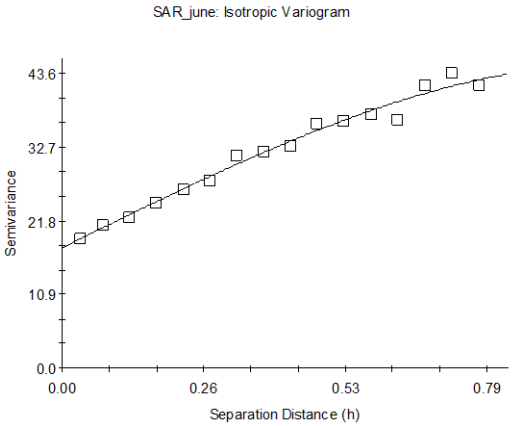
Figure 36: *Normalized histograms of water quality parameters for irrigation*



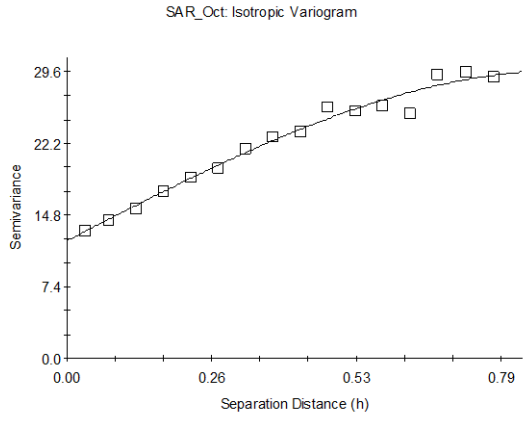
(a) Electrical Conductivity (EC) Pre-Monsoon



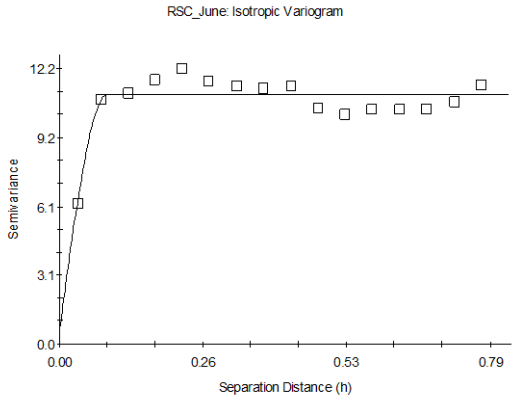
(b) Electrical Conductivity (EC) Post-Monsoon

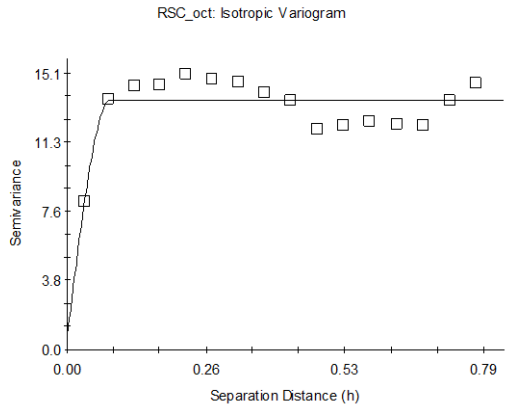


(c) Sodium Adsorption Ratio (SAR) Pre-Monsoon



(d) Sodium Adsorption Ratio (SAR) Post-Monsoon

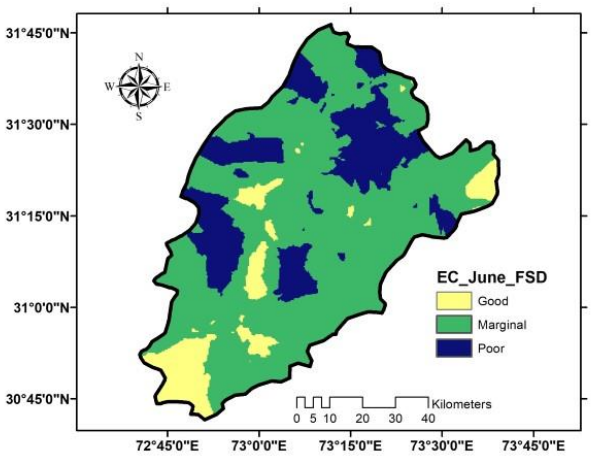


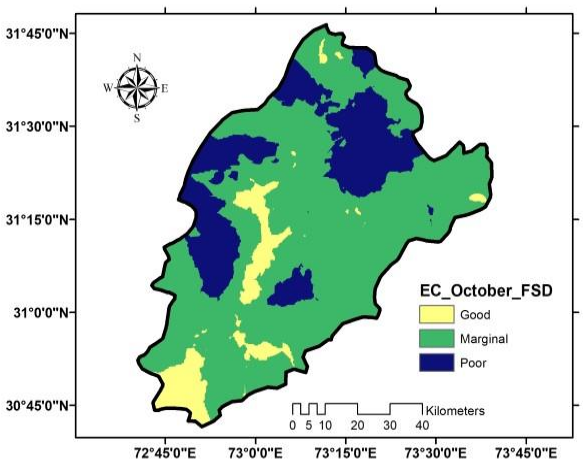


(e) Residual Sodium Carbonate (RSC) Pre-Monsoon

(f) Residual Sodium Carbonate (RSC) Post-Monsoon

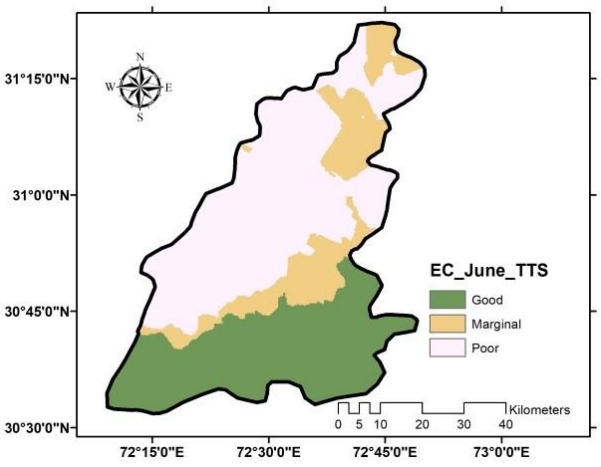
Figure 37: *Best fit experimental semivariogram model of water quality parameters for irrigation*



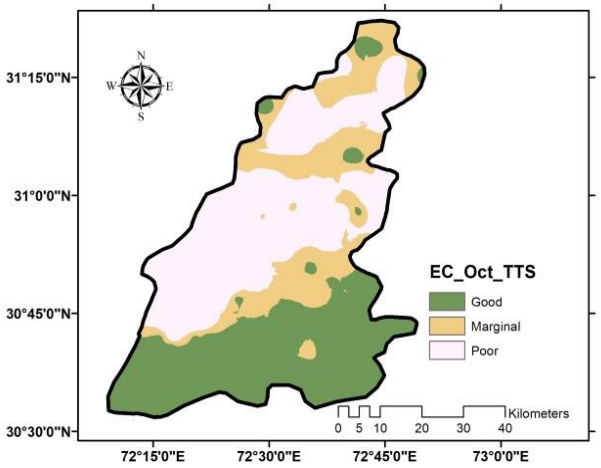


(a) Faisalabad district (Pre-monsoon)

(b) Faisalabad district (Post-monsoon)

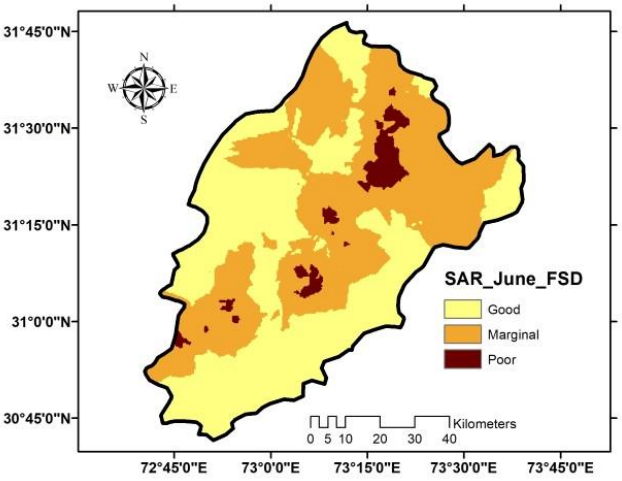


(c) Toba-Tek Singh district (Pre-monsoon)

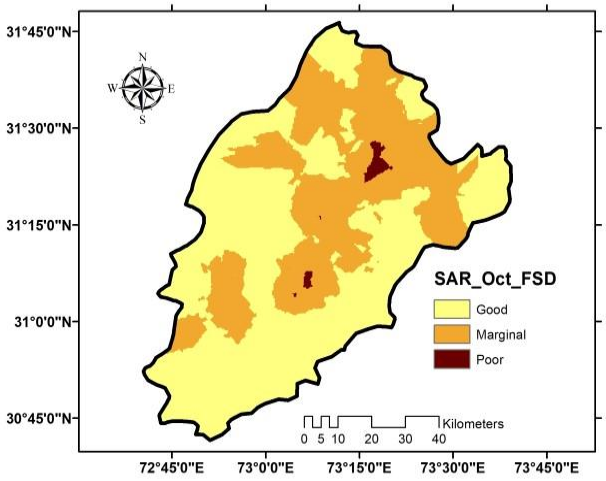


(d) Toba-Tek Singh district (Post-monsoon)

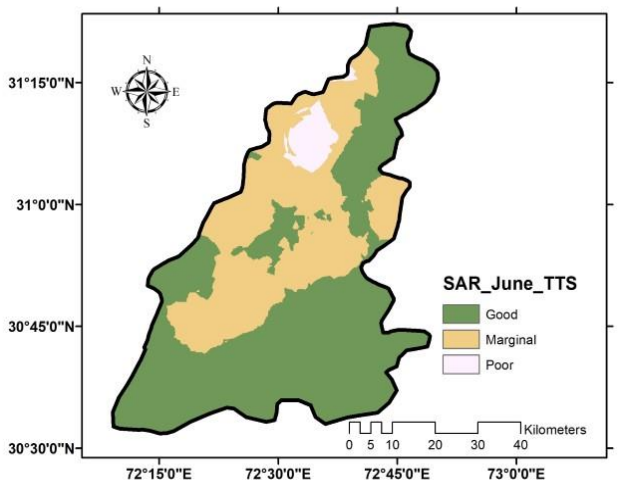
Figure 38: *Spatial variation of electrical conductivity*



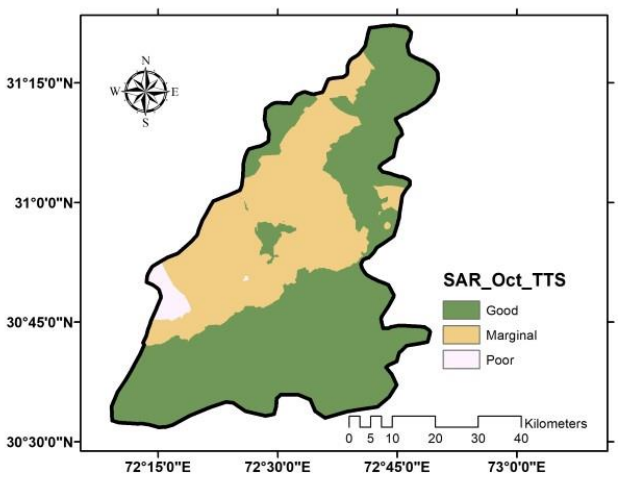
(a) Faisalabad district (Pre-monsoon)



(b) Faisalabad district (Post-monsoon)

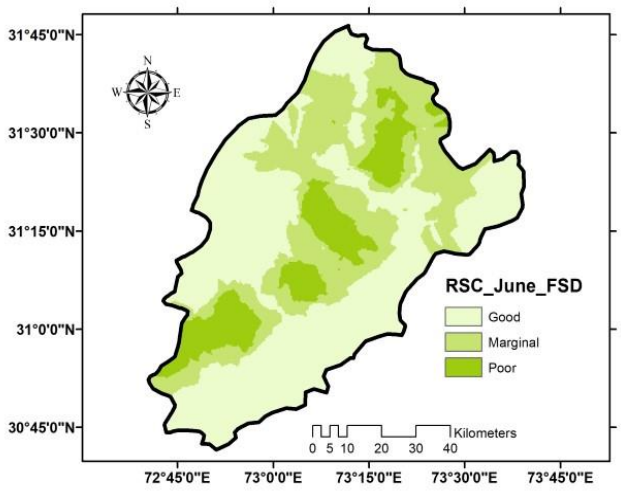


(c) Toba-Tek Singh district (Pre-monsoon)

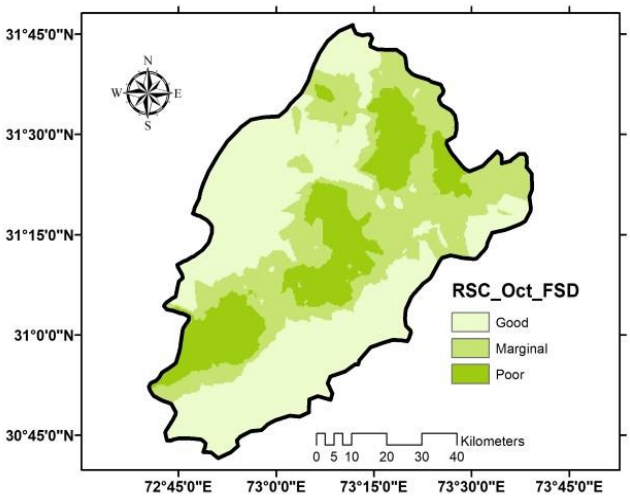


(d) Toba-Tek Singh district (Post-monsoon)

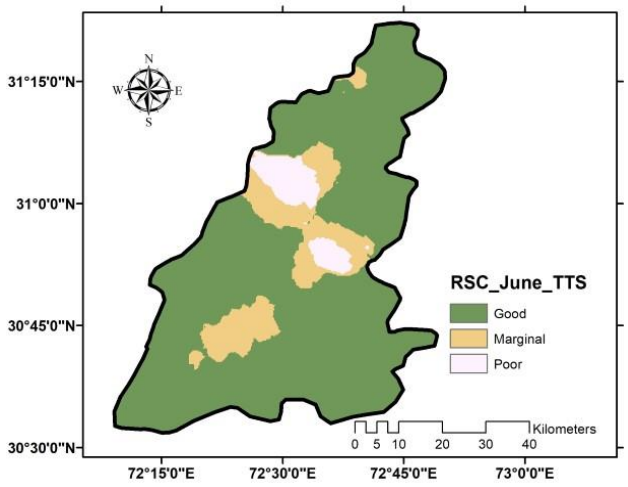
Figure 39: *Spatial variation of sodium adsorption ratio (SAR)*



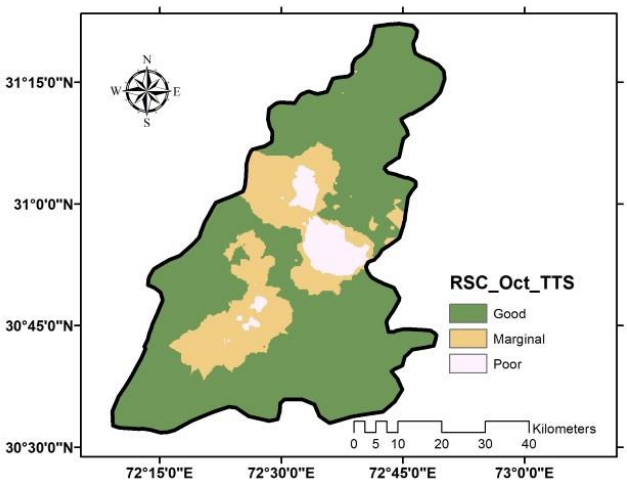
(a) Faisalabad district (Pre-monsoon)



(b) Faisalabad district (Post-monsoon)

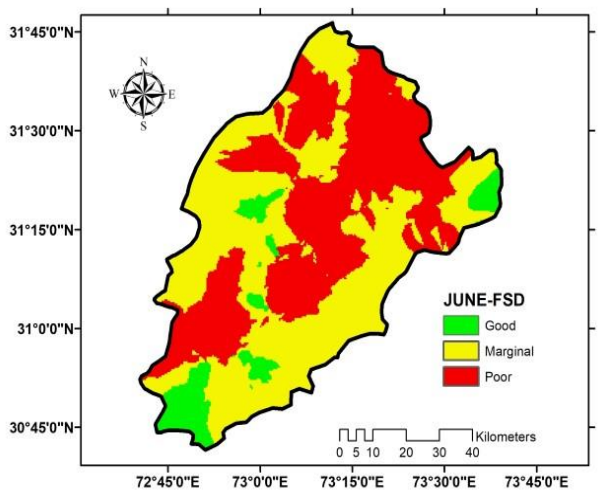


(c) Toba-Tek Singh district (Pre-monsoon)

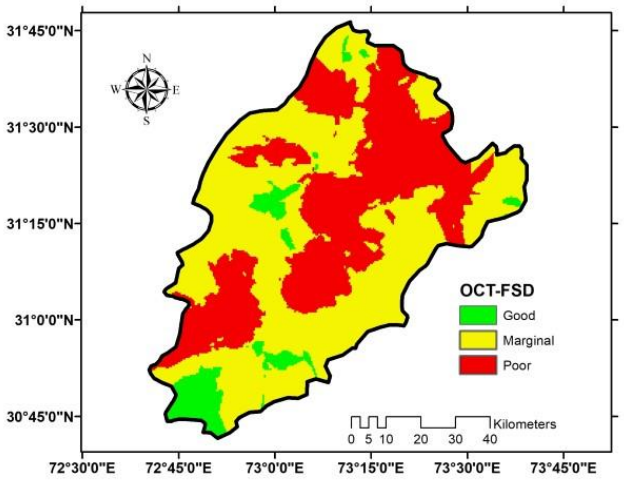


(d) Toba-Tek Singh district (Post-monsoon)

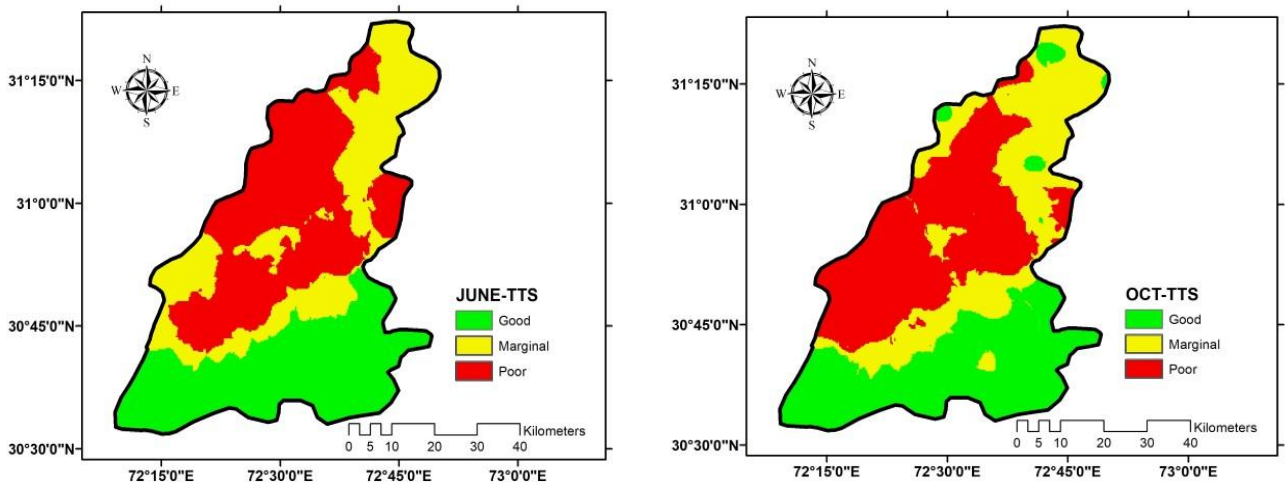
Figure 40: *Spatial variation of residual sodium carbonate (RSC)*



(a) Faisalabad district (Pre-monsoon)



(b) Faisalabad district (Post-monsoon)



(c) Toba-Tek Singh district (Pre-monsoon)

(d) Toba-Tek Singh district (Post-monsoon)

Figure 41: *Spatial variation of overall water quality for irrigation*

xv. Improving decision support system in identifying vulnerability rating and prioritizing the best interventions for sustainable watersheds in Pakistan, Nepal, and Sri Lanka

Quantification of watershed vulnerability rating and prioritization of the best watershed management intervention is always a challenge for multidisciplinary experts in developing consensus. Consequently, the lack of a decision support system (DSS) negatively affects the adoption of promising interventions leading to reduced watershed communities' resilience to climate change. Therefore, a DSS has been developed to integrate local multi-disciplinary knowledge in identifying the watershed vulnerability ratings and prioritizing the best site-specific watershed management interventions. The DSS developed was applied to selected watersheds using 25 local experts in Pakistan, Nepal, and Sri Lanka. Results showed that DSS is conveniently applicable and effective in developing consensus among multidisciplinary experts. The DSS recommended that the best interventions for the selected watersheds should primarily reduce the existing accelerated land and water degradation through engineering and biological actions. These actions may include controlling the rainwater run-off losses through appropriate harvesting systems and their subsequent efficient utilization for improving food security, climate change resilience and livelihood of vulnerable watershed communities. The DSS developed can be helpful in developing local adaptation plans and strengthening the policy support for promoting sustainable watersheds in Pakistan, Nepal, and Sri Lanka. However, the system needs further refinement through the incorporation of the design, specifications and costing of the interventions and making the data acquisition and analysis automatic using an online electronic system for quicker results and appropriate resource allocation for stimulated adoption.

xvi. Climate change and spatio-temporal trend analysis of climate extremes in the homogeneous climatic zones of Pakistan during 1962-2019

Climate extremes, such as heat waves, droughts, extreme rainfall can lead to harvest failures, flooding and consequently threaten the food security worldwide. Improving our understanding about climate extremes can mitigate the worst impacts of climate change and extremes. The objective of this study is to investigate the changes in climate and climate extremes by considering two time slices (i.e., 1962–1990 and 1991–2019) in all climate zones of Pakistan by utilizing observed data from 54 meteorological stations. Different statistical methods and techniques were applied on observed station data to assess changes in temperature, precipitation and spatio-temporal trends of climatic extremes over Pakistan from 1962 to 2019. The results showed increasing precipitation (DJF) and decreasing maximum and minimum temperatures (JJA) at the meteorological stations located in the Karakoram region during 1962–1990. The decadal analysis, on the other hand, showed a decrease in precipitation during 1991–2019 and an increase in temperature (maximum and minimum) during 2010–2019, which is consistent with the recently observed slight mass loss of glaciers related to the Karakoram Anomaly. These changes are highly significant at 5% level of significance at most of the stations. In case of temperature extremes, summer days (SU25) increased except in zone 4, TX10p (cold days) decreased across the country during 1962–1990, except for zones 1 and 2. TX90p (warm days) increased between 1991–2019, with the exception of zone 5, and decreased during 1962–1990, with the exception of zones 2 and 5. The spatio-temporal trend of consecutive dry days (CDD) indicated a rising tendency from 1991 to 2019, with the exception of zone 4, which showed a decreasing trend. PRCPTOT (annual total wet-day precipitation), R10 (number of heavy precipitation days), R20 (number of very heavy precipitation days), and R25mm (very heavy precipitation days) increased (decreased) considerably in the North Pakistan during 1962–1990 (1991–2019).

xvii. Co-benefits of air pollution control and climate change mitigation strategies in Pakistan

In this recent investigation, an insightful examination of prevailing policies in Pakistan has unearthed inadequacies in addressing the nation's escalating air quality crisis. Under the projections of a business-as-usual scenario, the costs associated with air pollution control are expected to soar to a staggering €12 billion or 1.4% of GDP by the year 2050. Despite this substantial financial investment, only modest reductions in SO2, NOx, and PM2.5 emissions are anticipated. In stark contrast, the study introduces the Sustainable Development Scenario, incorporating forward-thinking strategies that promise a paradigm shift. This innovative approach is projected to yield a remarkable 76-88% reduction in emissions, concurrently diminishing control costs by 23%. Additionally, it is anticipated to prevent 24% of total PM 2.5 attributable deaths, making substantial strides towards achieving multiple Sustainable Development Goals. Furthermore, this visionary scenario is poised to curtail greenhouse gas (GHG) emissions by 53% compared to the business-as-usual scenario by the year 2050.

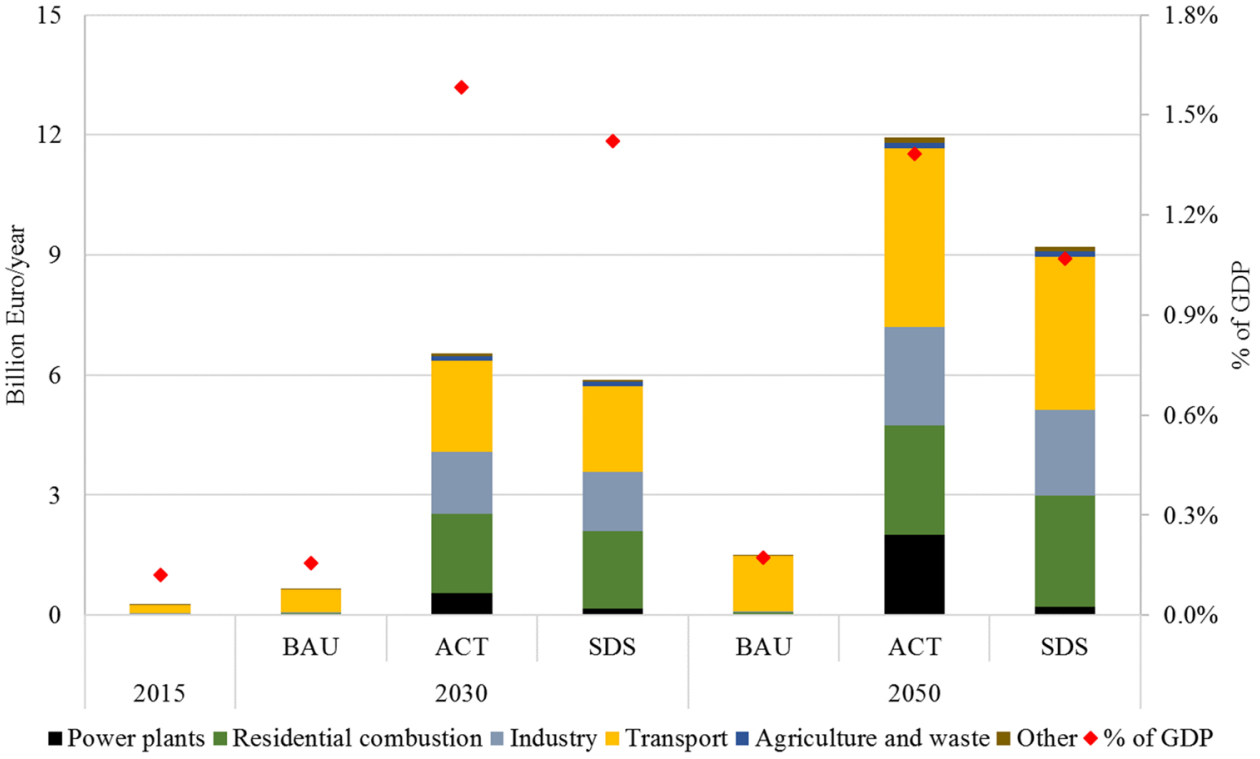


Figure 42: *Air pollutant emission control costs for the various scenarios.*

Foreseeing an annual population growth rate of 2.02% until 2030, followed by a slightly slower rate of 1.22%, Pakistan is poised for a substantial 72% surge in population by 2050, relative to 2015 figures. This demographic surge underscores the urgent need for sustainable development strategies to accommodate and uplift an expanding populace. Simultaneously, the per capita Gross Domestic Product (GDP) is expected to witness an annual increase of approximately 2%, culminating in a nearly fourfold rise in total GDP by 2050—a testament to Pakistan's economic resilience and potential. To facilitate and sustain this robust growth, the study envisions a profound shift in energy consumption patterns. This envisages an augmentation in coal utilization for power generation, aligning with the overarching objective of ensuring affordable and accessible electricity. This shift is anticipated to propel a threefold surge in primary energy demand from 2015 to 2050. In this dynamic energy landscape, biomass usage is expected to remain relatively stable, serving as a cost-effective energy source for rural households. Conversely, coal consumption is slated to undergo a remarkable 18-fold surge, while renewable energies such as wind, solar, and hydropower are anticipated to witness a six-fold increase. Nuclear energy, with its potential for sustainable power generation, is projected to experience a fivefold rise. Additionally, the utilization of oil and gas is expected to surge by factors of 1.9 and 2.6, respectively.

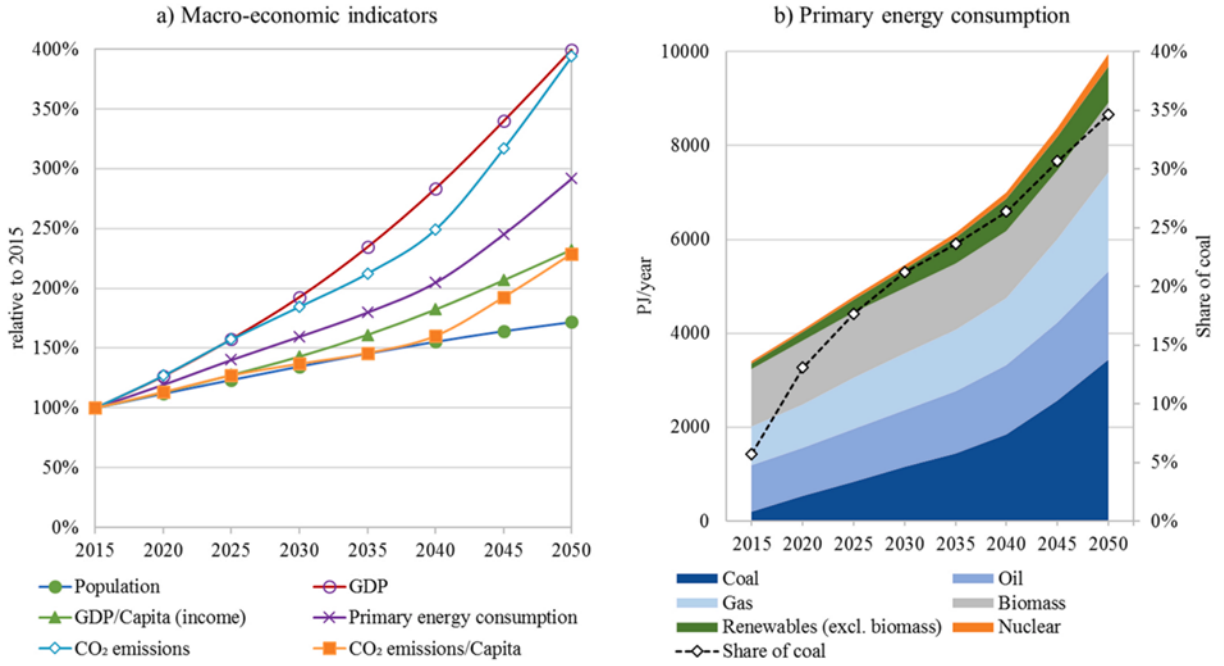


Figure 43: *Assumed baseline trends, of a) macroeconomic indicators relative to the year 2015 and b) primary energy consumption in PJ per year.*

xviii. Ocean–atmosphere circulation coherences associated with temperature increase in Pakistan

In recent decades, temperature variations have significantly affected the ecosystem and human livelihood in Pakistan. This study focuses on identification of the associations between regional temperature change and global teleconnections, i.e. North Atlantic Oscillation (NAO), El Niño–Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO) etc. This paper computes the temperature changes in Pakistan and its homogenous climatic regions during 1960–2020. It is found that the temperature in Pakistan has increased significantly at 0.23 ◦C dec−1 in the last 62 years, which is also higher than the global average increase. This increase is more evident in region in spring at 0.63 and 0.43 ◦C dec−1 followed by summer and autumn. Temperature changes in Pakistan and its sub-regions are mainly associated with higher mean significant coherences. Overall, temperature changes are significantly influenced by multiple interactions of global teleconnections, and these combinations indicate that the integrated influence of teleconnections can better explain the regional temperature changes. The modulation effect of teleconnection patterns has been observed on the temperature changes over Pakistan.

5.5.2. Capacity Building

Capacity building constitutes a crucial element of GCISC's endeavors, given the continuous evolution of climate science. Given the frequent emergence of novel concepts, tools, and methodologies for impact assessment, it is essential to equip the Center's researchers and other institutions with the latest technologies and skills to ensure high-quality research and effective action.

Throughout 2022-23, scientists at the Center actively participated in numerous national and international training workshops, acquiring expertise in a broad spectrum of areas, including climate science, climate modeling, seasonal forecasting, early warning systems, drought monitoring and assessment, hydrological modeling, crop simulation, water management, water surface runoff analysis, water-food-energy nexus, earth observation systems, space technology, and remote sensing/geographic information systems (RS/GIS) tools. These newly acquired skills are being effectively utilized in both ongoing and planned research endeavors at the Center. Additionally, GCISC's scientists contributed as resource persons in workshops and seminars organized by various entities.

Furthermore, thirty students from prominent institutions such as the National University of Science and Technology (NUST), Islamabad, Bahria University, Islamabad, PMAS-Arid Agriculture University Rawalpindi, University of Agriculture, Faisalabad, and University of Engineering & Technology (UET) Peshawar participated in internships at GCISC for periods ranging from 2 to 3 months. During their tenure, the Center's researchers provided them with orientation lectures on climate science, modeling, and other analytical skills. These interns were supervised by GCISC researchers and assigned various studies by their university teachers and GCISC mentors, enabling them to gain practical experience and contribute to ongoing research initiatives.

5.5.3. Mass Awareness / Media Appearance

The scientists at the Center disseminated numerous articles across prominent national newspapers, covering diverse facets of climate science and its implications for water resources, agriculture, and forestry. Additionally, these experts engaged in interviews and offered insights into pressing matters such as heatwaves, glacier retreat, monsoon disruptions, food insecurity, challenges in wheat production, efficient irrigation practices, and other related concerns linked to climate change.

5.5.4. Inputs for parliamentary Business

The GCISC, serving as the research division under the Ministry of Climate Change & Environmental Coordination, regularly offers expert insights on climate change, its effects, and potential mitigation measures to support parliamentary activities. This includes furnishing answers to inquiries from the National Assembly and Senate and actively participating in the discussions of standing committees addressing climate change issues.

5.5.5. Administrative Matters

GCISC Act (Amendments) 2023 after completion of procedure by the Federal Government, finally, GCISC Act amendments passed by the Parliament and President of Pakistan. The Act amendments after publishing in the Gazette of Pakistan, received in GCISC vide MoCC&EC Council & Coord Section's U. O. No. 2-12-2015-N. A dated 22. May.2023. As a result, GCISC name has been changed and other major amendments have been made.

a) **Change in the Name of Centre:** for the words "Global Change" wherever occurring, the words "Global Climate-Change" shall be substituted. However, the acronym of 'GCISC' will remain the same. *Global Climate-Change Impact Studies Centre (GCISC)*

b) Additions of Members in Board of Governors**:**
   i. Chairman HEC
   ii. Secretary, Ministry of Foreign Affairs
   iii. Chairman NDMA
   iv. Two eminent representatives from Civil Society

c) Expansion of Term Technical Experts**:** The term technical expert nominated by respective provincial Governments as members of Board of Governors, shall be expanded to read, "Technical Expert or Scientist".

d) Bifurcation of the Ministries / Divisions Secretaries of the Divisions to which business of the ministries stands allocated.

e) Replacement of the words 'Federal Government' with appropriate authorities in the light of Cabinet Division's instructions the word 'Federal Government' replaced with appropriate authorities.

6. ISLAMABAD WILDLIFE MANAGEMENT BOARD (IWMB)

6.1. Introduction

The Islamabad Wildlife Management Board (IWMB) was established under the Islamabad Wildlife (Protection, Preservation, Conservation, and Management) Ordinance, 1979. Its primary objective is to enforce the Islamabad Wildlife (PPC&M) Ordinance 1979 and its Rules 1983, ensuring the well-being of wildlife and the environment in the Islamabad Capital Territory (ICT). In 1980, Margallah Hills National Park (MHNP) was officially designated as a National Park of Pakistan, covering an area of 67 square miles, and Rawal Lake and Shakarparian areas were also declared National Parks of Islamabad.

In 1981, the Federal Government notified a Wildlife Management Board chaired by the Chairman of the Capital Development Authority (CDA) and including officials from CDA and the Federal Government. However, this Board remained dysfunctional, and the MHNP was managed through the Environment Directorate of CDA without involving the designated Board.

On September 30, 2014, Prof. Z. B. Mirza, a prominent Zoologist, filed a petition in the Islamabad High Court (IHC) highlighting the severe degradation of MHNP due to neglect from CDA. Following a meeting with the petitioner, committee members, and the CDA, the Cabinet Division forwarded its recommendations to the Federal Government. The Board was re-notified on July 7, 2015, and Dr. Anis-ur-Rahman was appointed Chairman, later succeeded by Rina Saeed Khan in November 2020.

In 2015, the IWMB was established under the Islamabad Wildlife (Protection, Preservation, Conservation, and Management) Ordinance 1979. The IWMB is responsible for managing Margalla Hills National Park, aiming to minimize anthropogenic impacts through a park protection program. This includes addressing threats such as illegal wood extraction, wildlife exploitation, forest fires, illegal construction, and encroachment. Additionally, the IWMB collaborates with local communities to enhance environmental awareness, education, and improve living conditions.

As of now, the IWMB is actively building its capacity to fulfill its mandate for wildlife management in the Islamabad Capital Territory.

6.1.1. Objectives

The IWMB has the following objectives:

- To safeguard and manage the unique and exceptional natural beauty of Islamabad for future generations, adhering to international standards and actively involving local communities.
- To conserve, protect, and enhance the indigenous flora and fauna (biodiversity) in Islamabad, creating open spaces that enrich the quality of life for both present and future generations within a safe and secure environment.
- To manage and control the illegal trade of wildlife species in the Islamabad Capital Territory (ICT), Islamabad.
- To develop and maintain physical infrastructure within the Margalla Hills National Park (MHNP), including roads and buildings. In accordance with legislation, all plans related to roads and buildings must be shared with and approved by the Islamabad Wildlife Management Board (IWMB) before implementation.

- To undertake the rescue and rehabilitation of injured and orphaned wildlife species in the Islamabad Capital Territory (ICT), Islamabad.

6.1.2. Margallah Hills National Park

Margallah Hills National Park is situated adjacent to the capital city of Islamabad, with the emerging industrial center of Taxila to the northwest. Encroachments from these urban areas pose serious threats to the park's wilderness. However, the most significant and immediate threat comes from the growing populations of communities residing inside the park. Over the years, these local communities have allowed their livestock to graze freely, causing destruction to the vegetation cover and trampling young seedlings. Additionally, residents cut trees for fuel, collect fodder for their animals, and divert natural water streams to cultivated plots near their homes. Some individuals even engage in hunting native wildlife for both sustenance and sport. Improper disposal of solid and liquid waste further exacerbates negative impacts on environmental and ecological resources.

Within the park, several rock mining quarries severely degrade the habitat. These quarries operate under lease arrangements made by the Planning Directorate of the Capital Development Authority (CDA). While some leases were granted after the park's establishment, public pressure, mainly from a citizens' group called "*The Margallah Hills Society*," led to the termination of such leases. The CDA ordered the closure of all mines on July 31, 1991, with most discontinuing operations and others expected to close in the near future. Notably, the Fecto Cement Company's 30-year lease for mining limestone, granted in 1983, is exempt from this closure order.

Fires are a common occurrence in the Margallah Hills, requiring substantial expenditure and manpower for extinguishment. About 85% of these fires occur during the dry May-June period before the monsoon rains. The annual average number of fires ranged from 49 from 1986 to 2023, with many being manmade and concentrated on upper slope or ridge-top sites, particularly on southern aspects.

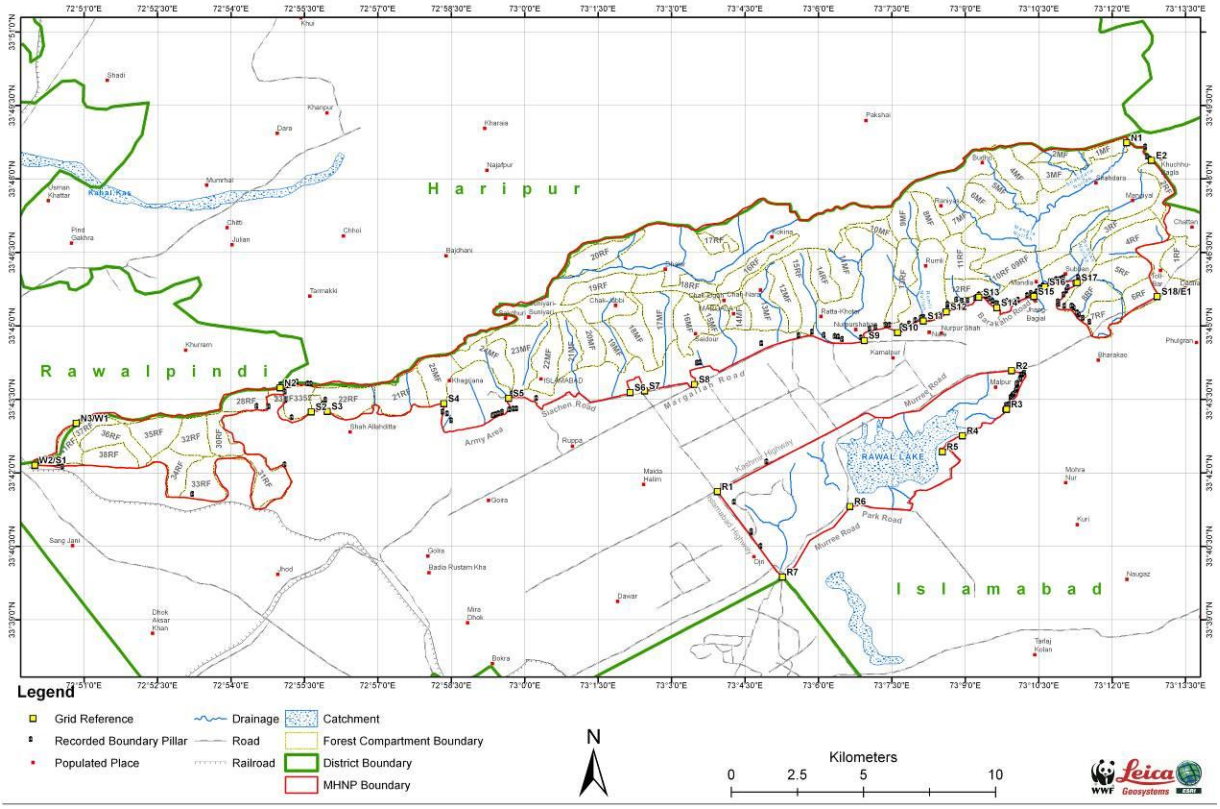
The park also faces the challenge of alien invasive vegetation species that are growing rapidly, competing with native species and disrupting the delicate balance of the ecosystem. The invasion of exotic vegetation, such as Paper Mulberry, *Parthenium Spp*., and *Lantana Spp*., not only impacts the vegetation balance but also contributes to an increase in the incidence of allergies.

6.1.3. Area

The Margallah Hills range between 456 m and 1,580 m in altitude. The topography is rugged, with numerous valleys and steep slopes. Rocks have been observed to date back to the Jurassic and Triassic ages, limestone being characteristic of the region (though shale, clay, and sandstone are also present). Soils are dark, with a high mineral content, and are capable of supporting good tree growth despite being shallow. The hills are an extension of the Himalayan range and form the northern boundary of the Potohar plateau. The area is drained by the River Kurang and its tributaries, which flow into the Soan River.

The climate is subtropical semi-arid. The region lies in the monsoon belt and experiences two rainy seasons. Winter rains last from January until March, and summer rains from July to September. Temperatures range from 1-15 °C in winter and 20-40 °C during the summer. Annual average rainfall is 1,000 mm. There have been occasional incidents of light snowfall in severe winters.

There are at least 38 species of mammals, 350 species of birds reported from the Margallah Hills within the MHNP. There are 32 species of reptiles and 9 species of amphibians reported.



Proposed Notification Map of Margallah Hills National Park

Map of Margallah Hills National Park

6.1.4. Governing Body

In pursuance of approval of the Prime Minister, conveyed vide Prime Minister's Office F. No.6(9)/020-Admn-UU-IWMB dated 23.11.2020, Rina Saeed Khan, was appointed as the Chairperson of the Islamabad Wildlife Management Board and in exercise of the powers conferred by section 4 of the Islamabad Wildlife (Protection, Preservation, Conservation and Management) Ordinance, 1979 (LXX of1979) read with sub rule (a) of rule 2A of Islamabad Wildlife (Protection, Conservation and Management) Rules, 1983, Federal Government reconstituted a Board of Wildlife Management on October 23rd, 2020 consisting of the following members, namely;

i. Ex. Official Members

01.	Sr. Joint Secreatry or Joint Secretary, Ministry of Climate Change	Member
02.	Inspector General of Forests, Ministry of Climate Change	Member
03.	Deputy Commissioner, ICT or nominee	Member
04.	Director (Environment) Metropolitan Corporation, Islamabad	Member
05.	Director (Regional Planning), Capital Development Authority	Member

ii. Non-Official Members

01.	Mr. Zahid Baig Mirza, Biodiversity Expert	Member
02.	Ms.Imrana Tiwana, Environmental and Natural Resource Expert	Member
03.	Ms. Rina Saeed Khan, Outreach and Visibility Expert	Member
04.	Mr. Vaqar Zakria, Member Civil Society	Member

6.1.5. Organizational Strength

The IWMB has a team of 45 members that are working for the conservation and protection of wildlife species and National Park in Islamabad.

6.1.6. Committees in IWMB

The IWMB has 5 Committees, Protection Committee, Scientific committee, Legal Committee, HR Committee, Accounts and Finance Committee. Each committee has a chairman and three members who look after their respective tasks.

i. Protection Committee

Chaired by Dr. Anis-Ur-Rehman on a pro bono basis, the Protection Committee of IWMB is actively engaged in formulating policies and plans for the protection of wildlife and Margalla Hills National Park in Islamabad. The Protection Committee of IWMB has successfully curtailed illegal activities in the park. The field staff of IWMB is dedicated to routine patrolling from Margallah Road to the top of Monal, actively searching for encroachments, illegal hunting, trading, poaching, wildlife rescue, wildlife monitoring, and unauthorized wood cutting, among other activities.

ii. Scientific Committee

Scientific Committee chaired by Professor Zahid Baig Mirza (Biodiversity Specialist) is involved in drawing plans and policies for carrying out the researches and scientific studies in the MHNP.

iii. Legal Committee

Legal committee chaired by Mr. Vaqar Zakaria (Member Civil Society) looks after the legal issues of the board.

iv. HR Committee

HR committee of IWMB chaired by Mr. Vaqar Zakaria (Member Civil Society) looks after the recruitment, service of current employees and legal issue of the board.

v. Accounts and Finance Committee

Chaired by Mr. Vaqar Zakaria (Member Civil Society) makes the budgets & accounts related tasks of the IWMB and look after the legal issue of the Board.

6.2. Role and Function

The role of function of Islamabad Wildlife Management Board is given below;

i. The Islamabad Wildlife Management Board (IWMB) has been constituted by the Federal Government in terms of section 4 of The Islamabad Wildlife (Protection, Preservation, Conservation and Management) Ordinance, 1979 ("the Ordinance").
ii. Exercising powers under section 21 of the Ordinance, the Federal Government has issued S.R.O 433(I)/80 dated 28th April, 1980 wherein certain areas have been declared to form the Margalla Hills National Park (MHNP).
iii. The Ordinance envisages IWMB to be the custodian of MHNP since no other body has been tasked to look after or manage the affairs of MHNP in the Ordinance, nor has the Federal Government declared any other body as the custodian of MHNP.
iv. The Federal Government, exercising powers under 41 of the Ordinance, has framed The Islamabad Wildlife (Protection, Preservation, Conservation and Management) Rules, 1983 ("the Rules"), which lay down the functions and powers of IWMB in rules 3 and 4 respectively.
v. One of the functions of IWMB as per rule 3 of the Rules is to "*take all policy decisions, draw plans, programmes and execute them with regard to protection, preservation, conservation and management of wildlife, including the zoos in the Islamabad Capital Territory*," which means that all matters pertaining to management and preservation of MHNP is the domain of IWMB.
vi. The landmark judgment of the Honorable Islamabad High Court in the case titled, Islamabad Wildlife Management Board vs. MCI and others, reported as 2021 PLD Islamabad 6 ("the judgment") lays down in detail the mandate of IWMB with regards to protection of wildlife in Islamabad as well as management of MHNP. Relevant portions of the judgment are reproduced below:

    a. *"The Wildlife Ordinance of 1979 is a special law which was explicitly promulgated with the object to provide for the protection, preservation, conservation and management of wildlife and setting up of a National Park in the Islamabad Capital Territory."*
    b. *"It is declared, therefore, that the Zoo, its management and all other matters relating thereto fall within the jurisdiction and competence of the Board of management constituted under the Wildlife Ordinance of 1979."*

vii. The judgment further directs that "the Board will be assisted by the Chief Commissioner, Islamabad Capital Territory and the Inspector General Police in order to enforce the provisions of the Wildlife Ordinance 1979." Therefore, any hindrance caused to carrying out of the Board's mandate and functions may amount to contempt of court.

6.3. Goals and Target:

Islamabad Wildlife Management Board is working for the conservation of wildlife in Margallah Hills National Park and ICT with following goals and targets;

- To protect and manage Islamabad's unique and outstanding natural beauty for generations to come, through international standards while engaging local communities.
- To preserve, protect, and enhance the indigenous flora and fauna (biodiversity) in Islamabad and create open space to enrich the quality of life for present and future generations in a safe and secure environment.
- Management and Control of illegal trade of wildlife species in Islamabad Capital Territory (ICT), Islamabad.

- Development and maintenance of physical infrastructure inside the MHNP such as roads and buildings. Consistent with legislation, all plans related to roads and buildings need to be shared and approved by the IWMB before implementation.
- Rescue the wild animals in Islamabad Capital Territory that need treatment and further rehabilitation.
- Control the Illegal collection of natural resources from Margallah Hills National Park.
- Create awareness and education among citizens to protect wildlife and their habitat for future generations.
- Community engagement programs developed to empower custodian communities to protect Margallah Hills National Park resources in a sustainable way.
- Scientific research on the Margallah Hills National Park resources to protect these assets scientifically.
- Promotion of Eco-Tourism and responsible tourism, following the principle of "My Waste My Responsibility."
- Establish and enforce sustainable waste management practices within Margallah Hills National Park.
- Implement measures to minimize the impact of climate change on the park's ecosystem.
- Collaborate with educational institutions for environmental education programs targeting schools and colleges in the region.
- Regularly update and implement a comprehensive fire prevention and management strategy.
- Introduce and enforce guidelines for responsible pet ownership within the park.
- Implement measures to control invasive species and restore affected ecosystems.
- Promote sustainable agricultural practices in the vicinity of Margallah Hills National Park.
- Establish a comprehensive monitoring system for wildlife population trends and habitat health.
- Facilitate and support research partnerships with local and international institutions to enhance knowledge about the Margallah Hills National Park ecology.
- Develop and implement a comprehensive eco-friendly waste disposal system for visitors within the Margallah Hills National Park.

6.4. Activities

Islamabad Wildlife Management Board activities related to following;

- Protection of Wildlife
- Community Relations
- Information and Outreach
- Research and Planning

6.4.1. Protection of Wildlife

- Enforcing measures to prevent illegal hunting, poaching, and trade of wildlife species in Islamabad.
- Implementing wildlife rescue and rehabilitation programs.
- Conducting regular patrolling and surveillance to prevent encroachments and protect the natural habitat.
- Collaborating with law enforcement agencies to ensure the safety and well-being of wildlife within the jurisdiction.

6.4.2. Community Relations

- Developing and implementing community engagement programs to raise awareness about wildlife conservation.
- Empowering local communities to become custodians of the natural resources in a sustainable manner.
- Facilitating educational programs and workshops to promote understanding and appreciation of wildlife.
- Encouraging responsible and sustainable practices among local communities living in and around protected areas.

6.4.3. Information and Outreach

- Disseminating information about wildlife conservation through various channels, including social media, websites, and community events.
- Conducting awareness campaigns to educate the public about the importance of preserving biodiversity.
- Collaborating with media outlets to promote wildlife conservation messages.
- Providing accessible and accurate information about Islamabad's wildlife and conservation efforts to the public.

6.4.4. Research and Planning

- Conducting scientific research on wildlife species, ecosystems, and their interactions within the Islamabad Capital Territory and Margallah Hills National Park.
- Developing comprehensive conservation plans and strategies based on scientific findings in Margallah Hills National Park.
- Collaborating with research institutions and universities to enhance knowledge about the ecology of Margallah Hills National Park.
- Participating in regional and international forums to stay updated on the latest research and conservation trends.

6.5. Achievements

6.5.1. Protection of Wildlife

Protection of MHNP and wildlife is core responsibility of IWMB. The staff deputed on different valleys of Margallah Hills National Park to protect the natural resources and wildlife. There are 38 species of mammals, 350 species of birds, 32 reptiles, 09 species of amphibians and 650 species of plants in Margallah Hills National Park. The protection staff control following

i. Control on Wood Cutting in MHNP

The importance of plants to humans and just about all other life on Earth is staggering. Life as we know it would not be possible without plants. They are the main source of food for all animals, they are source of oxygen, medicine, fuel, furniture etc for humans but the current percentage of plants on earth is decreasing due to deforestation and illegal wood cutting. It creates severe loss on young trees and also habitat of wildlife.

ii. Operation against Illegal Wood Cutters

Operation has been started on 2023 with following objectives;

- Prevent unauthorized deforestation
- Safeguard the natural habitat
- Enforce stringent measures to combat illegal activities

iii. Protection of Wildlife from Forest Fire

The fire season starts every year from April to July in Margallah Hills National Park. The fires in the Margallah can erupt due to several reasons such as rising temperatures, burning of garbage or dried leaves or even due to the discarding of burnt cigarettes in the forest area.

iv. Islamabad Wildlife Management Board Fire Protection Plan

Islamabad Wildlife Management Board (IWMB) was formulated a 'Fire Protection Plan', to protect the most valuable and visible forested part of the MHNP. Shortage of supervisory staff does not permit more area to be protected by IWMB staff. IWMB protect the wildlife species in its natural habitat through existing IWMB staff. However, forest fires from April to June 30th in the MHNP every year during dry season cause immense loss of forest, undergrowth cover, damage to wildlife habitat, impact on wildlife and greatly disturb the citizens of Islamabad. The major impact of forest fires is on ground nesting birds, reptiles, amphibians, soil biodiversity and seeds of flora in National Park.

IWMB protects the habitat of wildlife in MHNP; especially ground nesting birds, reptiles and amphibians by developing SOPs which define expectations and responsibilities of all team members. Additional fire staff was hired each fire season from local communities (end April to June 30th).

Equipment provided to staff control the forest fire are;

- Fire Beaters
- Leave scrappers
- Fire extinguishers (Fire ball)
- Fire incident reports/damage reports are also prepared

v. Control on illegal Trade & Hunting of Wildlife

IWMB has moved against monkey "dancing" and the selling of birds in ICT by confiscating the wild animals found on streets and then releasing them back in the wild. Zero tolerance is being shown for those indulging in animal cruelty and wildlife trafficking in ICT.

vi. Control on encroachments in MHNP

IWMB has made SOPs to report encroachments in MHNP. Encroachment is reported on regular basis by the field staff to the field supervisor. After confirmation supervisor report to protection in charge and then it is reported to the Assistant Director, a report is compiled and sent to Deputy Commissioner Islamabad and Environment Directorate CDA with the sign of Director IWMB.

vii. Habitat Improvement and Soil Establishment

For conservation of natural habitat and preservation of national park it is of ultimate importance to remove alien invasive species and replace them with indigenous plants of MHNP. In MHNP the numbers of indigenous species of plants are under competition with the invasive plant species. These invasive plant species release hormones under soil that deteriorate the hyphae present in the roots of these indigenous plant species. These hormones also effect on the regeneration of new saplings that naturally grow in the MHNP.

viii. Need to Improve Removal Techniques

- Scientific study required to control the invasive plants in MHNP.
- Latest technology required to remove the alien invasive plant species

ix. Mass Awareness and Community Trainings

Environmental Education (EE) refers to organized efforts to teach how natural environments function, and particularly, how human beings can manage behavior and ecosystems to live sustainably. IWMB conduct awareness sessions at trail-5, in these sessions following mainly participate.

1. Local Schools Located in MHNP
2. Universities
3. Departments; NGOs
4. General Public/ Visitors of MHNP.

viii. Visitor Management and Cleanliness of MHNP

Visitor management on trails of Margallah Hills National Park is most important component of wildlife conservation. The tourist pressure on trail increases day by day which was managed by the IWMB team work in this wing. The responsible tourism promoted in Margallah Hills National Park to conserve and preserve the natural beauty. The staff deputed on the trails cleans the trail time to time and control plastic pollution from national park. Visitors and tourist were engaged to protect the park from plastic pollution. Littering in MHNP was increasing day by day. IWMB Visitors' Management Team worked on the awareness & education. The IWMB team worked hard to raise awareness amongst visitors and tourists of Margallah Hills National Park to control plastic pollution. Nobody is allowed to take plastic bags and edibles in plastic packing inside the trails.

ix. Day and Night Time Operation

- Bikes: 18 (2 taken by police)
- Donkey-loaded Confiscation: 2
- Persons carrying wood: 7
- Vehicles: 2

x. Wood Distribution Control

- Daig houses directed to obtain wood from authorized toll.
- 7 times increase in sale at Tall (150/mann per day)

6.5.2. Community Relations

i. Socio Economic Baseline of Villages in MHNP

July 2022 the Socio-economic baseline of the 19 villages in Margallah Hills National Park was conducted in implying blended approach (qualitative and quantitative) research methodology by the team community relations. A qualitative consultation log and summary tables were developed in which threats to MNHP, issues of communities, suggestions and recommendations of local villagers and key informants were duly considered was developed so that it could help to protect and conserve MHNP more effectively and included essential data regarding the villages' demography such as population, livestock, agriculture, education, subsistence patterns.

ii. List of Villages

Malach	Subban	Mandla	Shahdara
Pir Sohawa	Ratta Hottar	Nurpur Shahan	Saidpur
Gokina	Talhar	Gandhain	Kalinjer
Sinyari	Kot Jandan	Kainthala	Lubana
Rumli	Dhok Jouri	Mangial	

iii. Education, Information and Awareness Program among Local Communities of MHNP

- **Education and Awareness about Wildlife of MHNP**

In order to mitigate Human-wildlife conflict different session were conducted and information was disseminated for leopard sighting SOPs in communities' mosques, shops, markets and public places in incidents as reported.

- **Community Dialogue and Awareness for Protection, Preservation and Conservation**

21 Community awareness sessions were conducted in villages namely Gokina, Talhar, Rumli, Kainthla, Kot Jandan, Shahdara, Nurpur Shahan, Rumli, Mandla, Jouri Rajgan, HIT Taxila, Saidpur, Pir Sohawa, Lubana for the protection, preservation and conservation of the Margallah Hills National Park (MHNP). In community dialogue different problems were discussed and way forward was decided for the involving community members in decision-making, leading to continuous improvements.

iv. Community Based Conservation Program

Community Relations section, (IWMB) has completed the kitchen gardening programme in communities of MHNP in winter 2023. The female members of local communities participated actively with Ms. Gulshan Mirza (Late), an expert on community engagement and development, accompanied by Ms. Naghmana Irum, Lady Ranger (IWMB). This programme is carried out in 10

villages of MHNP Gokina, Talhar, Shahdrah, Rumli, Nurpur Shahan, Gandhian, Sinyari, Mandla, Sara and Ratta Hottar.

v. Identification of Focal Persons

Identified the community focal persons in each village of MHNP for coordination and smooth running of the activities in communities.

vi. Volunteer Activities

Coordination, facilitation and support to volunteer for smooth conducting of activities in protection of Biodiversity of MHNP.

vii. Liaison with Government/Private Departments

i. Obtained NOC from FDE (Federal Directorate of Education) to initiate the awareness program and kitchen gardening in public school of communities in MHNP.
ii. Developed a connection between the Nurpur Shahan community and stray dog Centre named as "*Stray Dog Population Control Centre*" established by Chief Commissioner was contacted and complaint was forwarded for the further necessary action.
iii. Signed MoU with NUML University and volunteers of GYM where to start registering the new volunteer for IWMB and initiate the awareness raising program on 28th Sep 2022.
iv. Signed MoU with IQRA University to engage students for protection of MHNP being volunteers

viii. Outdoor education and information to public/community on campus

08 schools were given awareness session on campus as mentioned below;

- Federal Govt. Boys Secondary School, Talhar
- Federal Govt. Junior Model School, Gokina
- Federal Govt. Boys Model School Saidpur
- Federal Govt. Girls Model School Saidpur
- GSIS school Islamabad
- Beacon House School F-8/2, Islamabad.
- Fatima Standard School Nurpur Shahan
- AIMS school system (annual sports Gala at Islamabad sports complex)

ix. Trails of MHNP

- The Pak-Turk school children and Hashoo Foundation project team had an exposure visit to Trail 5 on 1st June 2022, where the students were educated about the biodiversity and importance of the communities residing along MHNP
- The students of Learn-a-Licious schools visited Trail 05 of Margallah Hills National Park along with the teachers on 23rd June, 2022 were briefed at the Outdoor education Centre of about the biodiversity of MHNP by IMWB staff
- On 13th Aug, 2022 the Federal Minister for Climate Change Senator Sherry Rehman along visited the Trail 5 office for awareness raising campaign for the protection and preservation of MHNP with school children general community

members and visitors. 02 community schools of Nurpur Shahan and Vision Model school of Bani Gala were engaged for participation on the Day.

- Government college university staff and 20 students of BS (zoology) visited the Trail-5were briefed about biodiversity of MHNP and performed cleanup activity at trail then walk on Trail-5 up to 2 kilometers
- Awareness raisin activity at Trail 05 with LSWO (Life Saver Welfare Organization) and IWMB volunteers dated
- Event at trail 5 with Pakistan movement Festival and Roots Millennium school dated 03-12-2022

x. Facilitation and Coordination

- Visit of Federal Minister for Climate Change Senator Sherry Rehman along with Mr. Asif Hyder Shah (Secretary) and Mr. Jodat Ayaz (Additional Secretary) at IWMB Rescue Centre for fire control room and certificate distribution to Wildlife Rangers of IWMB & CDA dated 8th June, 2022
- Facilitated and coordinated the visit of US ambassador at IWMB rescue center and Trail 6
- Supported the Raid team for rescuing of the two Pangolins Dated12th Dec 2022
- Supported the Raid team in capturing of the vehicle carrying Dhaman Trees dated 27th Dec 2022
- Facilitated for the visit of Assistant Secretary Medina (U.S Department of State) TO IWMB rescue centre.

xi. Field Work

Following field surveys and visits done during the subject mentioned period;

- Conducted field work and research on "*Comparative Study on Soil Biodiversity of Undisturbed Habitat and Communities of MHNP*"

xii. Celebration of International Days

- On June 5th, Sunday, arranged and celebrated World Environment Day at Trail 5; an awareness campaign was initiated with school children with the help of volunteers. 02 community schools of Nurpur Shahan and Bani Gala were engaged for participation on World Environment Day. Volunteer's teams and IWMB staff initiated the cleanup drive of Broti water stream in MHNP Students and the tourists were briefed about the flora & fauna of MHNP, and also rules of the national park.
- Earth Day was observed (trash collection at Talhar More & Trail 1) with the Volunteer group on 22 April 2022.
- Independence Day Awareness Campaign was led by Federal Minister for Climate Change at Trail 5, MHNP on 13th Aug, 2022 and engagement of community schools and general community members was ensured.
- On 2nd Feb 2023, World Wetlands Day was celebrated at Kinara Park with support of IWMB staff, volunteers and local community school sum of 65 participants.
- World Life Day was celebrated on 3rd March 2023, at Trail 5. The Senate Standing Committee On Climate Change and officials from Ministry of Climate Change & Environmental Coordination, participated to celebrate the day with IWMB staff,

IWMB volunteers, general community members and students of school (GSIS, Islamabad), International Islamic University, Islamabad.

6.5.3. Information and Outreach

i. Education and Awareness Sessions

Information and Outreach section conducted informative sessions aimed at raising awareness about wildlife management in MHNP. Additionally, IWMB showcased documentaries and organized guided tours along Trail 5, Trail 6, and Ridge Trail. These efforts contribute to educating the community about the importance of wildlife conservation and the delicate balance required for effective wildlife management. By providing firsthand experiences through guided tours and informative sessions, IWMB aim to foster a greater understanding and appreciation for the diverse ecosystems present in the MHNP.

ii. NOC and Regulatory Compliance

The IWMB has successfully issued No Objection Certificates (NOCs) for all activities conducted in Margallah Hills National Park.

iii. Media Liaison

Following media liaison activities carried out during 2022-23.

- Established regular liaison with media personnel to promote IWMB activities.
- Ensured media coverage of significant events, including visits by ministers and diplomats.
- Highlighted the opening ceremonies of the Ridge Trail and IWMB's official website in electronic and print media.

iv. Social Media Engagement

- Consistently shared all activities on social media platforms for wider reach.

v. Website Development

- Successfully designed IWMB's official website, including domain and hosting.
- Engaged all departments for comprehensive data collection and integration.
- Generated official emails for all officers to streamline communication.

vi. Corporate Social Responsibility (CSR)

The Information and Outreach section of IWMB actively maintained liaison with the corporate sector throughout the year, fostering partnerships and collaborations for Corporate Social Responsibility (CSR) programs. By establishing effective communication channels and building relationships with corporate entities, IWMB sought to harness support for its programs, fostering a sense of shared responsibility and commitment to environmental stewardship within the corporate sector. This collaborative approach reflects IWMB's dedication to engaging diverse stakeholders in the noble cause of wildlife preservation.

6.5.4. Research and Planning

The major activities and achievements of the Research and Planning Section of the Islamabad Wildlife Management Board include the following:

i. Research work and Field Surveys

- Floristic Composition of Margallah Hills National Park: A Study of Slope Variations
- Camera Trapping in the Leopard Preserve Zone: Monitoring Mammalian Fauna Movements in MHNP
- Occurrence and Abundance of Leopards in Margallah Hills National Park
- Exploring Ecological Variation: Biodiversity across Dhoke Jeevan Valley, Margallah Hills National Park, Focusing on Flora and Fauna
- Migratory Avian Diversity in Margallah Hills National Park
- Current Status of Mammalian Diversity in Margallah Hills National Park
- Investigation of Soil Biodiversity in Margallah Hills National Park, Islamabad
- Population Assessment and Spatio-Temporal Distribution of Indian Pangolin in Margallah Hills National Park
- Seasonal Survey of Migratory Birds in Rawal Lake, a Part of Margallah Hills National Park
- Population Assessment and Spatio-Temporal Distribution of Kalij Pheasant in Margallah Hills National Park

ii. Technical Research Reports

- Floristic Composition of Various Mountain Aspects in Margallah Hills National Park
- Soil Biodiversity of Margallah Hills National Park
- Annotated Checklist of Mammals, Birds, Reptiles, and Amphibians in Margallah Hills National Park
- Radio-Tagging of Indian Pangolins in Margallah Hills National Park
- Status of Migratory Birds at Rawal Lake, a Part of Margallah Hills National Park
- Report on the Death of a Common Leopard in Margallah Hills National Park
- Population and Status of Kalij Pheasants in Margallah Hills National Park
- Current Status of Leopards in Margallah Hills National Park, Pakistan

iii. Research Publication

- Rais, M., Ali, M. N., Gray, R. J., Qadir, W., Ali, M., **Muhammad Saeed**, Leston, L. (2023). Niche suitability and spatial distribution patterns of anurans in a unique Ecoregion mosaic of Northern Pakistan. PLoS ONE, 1–16.
- Batool A, Rais M, **Saeed Muhammad**, Akram A, Ahmed J, Ahmed W, Batool A, Kyle KJ (2023) New survey data on abundance and movements for two poorly known Asian Spiny Frogs. Herpetozoa 36: 113-121.
- Khattak, R. H., Ahmad, S., Mehmood, T., **Ali, Sakhawat** and Hua, Y. 2023. Factors affecting habitat selection of the endangered Indian pangolin (*Manis crassicaudata*) in ravine habitats at the Himalayan foothills, Pakistan. Applied Ecology and Environmental Research 21(6):5889-5899.
- Ali A., B. A. Rakha, M. S. Ansari, S. Akhter and **Sakhawat Ali.** 2023. Slope

Direction, Elevation and Clutch Size Influences Breeding Success of White-Crested Kalij Pheasant (*Lophura leucomelanos*) in Margalla Hills National Park, Pakistan. *Pakistan J. Zool.*, pp 1-8, 2023.

- N. Khaliquea, A. M. Khan, A. Ahmed, N. A. Abbasi, M. A. Shafiquee, **Sakhawat Ali,** R. Badar. 2022. Evaluation of Heavy Metals Contents by ICP-MS in Wet Digested Fresh Water Fish. *Ann. For. Res.* 65(1): 5767-5787.

iv. Project Proposals

- Human-leopard coexistence: Mitigating human-leopard conflict through awareness and capacity building in Margallah Hills National Park, Islamabad.
- Preparation and submission of project proposal in ignite entitled "Environmental DNA as an effective monitoring tool for freshwater turtles in Rawal Lake
- Management of the rhesus monkey (*Macaca mulatta*) dispersal to urban areas of Islamabad
- Impact of Climate Change on the Migratory birds at Rawal Lake a Part of Margallah Hills National Park

v. PC-I; PC-II and Management Plan

- Prepared and submitted PC-II for Margallah Wildlife Centre 499.80791 Million PKR.
- PC-I for the Ecosystem restoration and strengthening management of Margallah Hills National Park
- Prepared a Management Plan of Margallah Hills National Park, Islamabad.

vi. Collaboration with Academia

The Research and Planning Section collaborates with the following academic institutions to conduct research activities in Margalla Hills National Park.

- Department of Zoology, Wildlife and Fisheries Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi
- Department of Environmental sciences, Fatima Jinnah Women University, Rawalpindi
- Department of Animal Sciences, Quaid-e-Azam University, Islamabad.
- Department of Anthropology, South Asia Institute, Heidelberg University, Germany.
- Department of Social Sciences, University of Pennsylvania, United States.
- Animal section, Pakistan Museum of Natural History, Islamabad.

vii. Research Scholars

Currently, three PhD scholars are working with the Research and Planning Section of IWMB;

- Mr. Shahzad Aslam. Ecology of barking deer (*Muntiacus muntjak*) in Margallah Hills National Park
- Mr. Muhammad Shakil. Impact of new developments on the Mammalian fauna of Margallah Hills National Park.
- Mr. Sakhawat Ali. Impact of urban environmental factors on the avian diversity of Rawalpindi and Islamabad.
- Ms. Hadia Ramzan. Diet composition of Indian Pangolin (*Manis crassicaudata*) in Margallah Hills National Park, Islamabad.

viii. Training and Capacity Buildings

The following training and capacity-building programs have been organized to enhance the skills of the existing IWMB officers and officials;

- Training session on practical use of GIS application in the field area of wildlife survey and monitoring at IWMB office, Islamabad, January, 2023.
- Training on Style Sheet in MS Word" at IWMB office, Islamabad September-October, 2022.
- Understand the Ecosystem and Eco-linkages of Biodiversity in Margallah Hills National Park", Islamabad August-December, 2022.
- "Snake Handling Techniques" organized at IWMB visitor information Centre Trail-5, Islamabad in January, 2023.

ix. Internship program for Young Scientist

The Internship Program for university students, held from August 22nd to September 20th, 2022, focused on students with a keen interest in wildlife-related studies. The program aimed to provide practical exposure and hands-on experience to the participating students, fostering a deeper understanding of wildlife management and conservation efforts. Throughout the internship, students engaged in various activities and projects under the guidance of different sections of IWMB. The program not only enriched the students' academic knowledge but also allowed them to contribute actively to the ongoing initiatives of the organization. The successful completion of the internship program signifies a valuable investment in nurturing the next generation of professionals dedicated to wildlife conservations.

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