Global Change Impact Studies Centre (GCISC)
(A Body Corporate established under the GCISC Act 2013)

YEAR BOOK (2020-21)
(in pursuance of Rule 25 of Rules of Business 1973)

1. INTRODUCTION

Being cognizant of the fact that Climate change is a stark reality and no more a fiction and Pakistan cannot remain secluded from the adverse impacts of this global concern, Global Change Impact Studies Centre (GCISC) was established as a dedicated research Centre to address climate change issues in 2002 with seed money provided by the Ministry of Science & Technology. From July 2003 to September 2009 GCISC was supported by the Pakistan Planning Commission under its Public Sector Development Programme and thereafter by the Ministry of Environment from its development funds.

The status of Body Corporate was granted to the Centre under the GCISC Act notified through Gazette of Pakistan on March 26, 2013. According to the act, the Centre is a body corporate working under Ministry of Climate Change, Government of Pakistan as its research arm. The Centre is run through a high level 28-member Board of Governors (BoG). Minister-in-Charge of Climate Change serves as the Chairman of BoG whereas Secretary Ministry of Climate Change is the Vice Chairman.

The Centre 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.

2. ROLES & FUNCTIONS

Under the GCISC Act, the Centre is tasked with three functions, namely research, capacity building, and outreach and awareness:

a. **Research**: the research program is driven by national policy goals, namely protecting people against the impacts of climate change, promoting economic growth and sustainable development in a climate-constrained future, and honoring Pakistan's international commitments. To these ends, research is organized in three groups:

- **Climatology and Environment**: using climate system models to predict future climate behavior in Pakistan, including monsoons, temperature, precipitation, and climate extremes.
- ***Water Resources*** **and Glaciology**: using glacio-hydrological and water models to assess future behavior of glaciers, aggregate and seasonal flows in the Indus River System, and changes in the hydrological extremes across the country.
- ***Agriculture, Forestry & Land Use****:* use of crop simulation models to predict the impact of projected changes in temperature, precipitation, and water availability on agriculture and food security of the country and to assess the impacts on Forestry, Land Use.

b. **Capacity building**: imparting technical and communication skills to GCISC staff as well as students and climate scientists at other national research organizations and universities.

c. **Dissemination of research findings**: to the scientific community, planners, policymakers, and to the public at large, in order to raise awareness of climate change among policymakers as well as the citizenry.

3. ACTIVITIES

RESEARCH

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

I. Climatology & Environment Section

- Assessment of past climatic changes;
- Development of future climate projections for Pakistan by employing state-of-the-art high resolution Climate Models;
- Scientific Investigation and Prediction of Climatic Extremes by using modeling as well as statistical techniques;
- Simulation modeling to study monsoon dynamics and its associated impacts;
- Intra seasonal to inter decadal climate predictions;
- Development & Updating of GHG Inventory of Pakistan for Energy & Industrial Processes Sectors;
- Research dissemination (International and national science journals and books, newspaper articles, policy briefs, etc)
- Capacity building and awareness raising

II. Water Resources & Glaciology Section

- Application of Machine Learning and Artificial Intelligence (AI) techniques to model Indus River System flows;
- Climate change analysis for the high elevation Karakoram region;
- Drought prediction in the Indus Basin as a climate adaptation strategy;
- Spatio-temporal assessment of climate change impacts on the UIB-cryosphere and variability of flows;
- Analysis of climate impact on the frequency and intensity of hydrological extreme events;
- Plausible Adaptation strategies in line with national Climate change and Water policies to ensure country's water security.
- Research dissemination (International and national science journals and books, newspaper articles, policy briefs, etc)
- Capacity building and awareness raising

III. 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

4. GOALS & TARGETS

During the year, GCISC made significant contributions to the international scientific literature in the field of climate change and its associated impacts, and provided tangible inputs in a no. of research projects. It also organized a no. of workshops/seminars for information dissemination and awareness.

The following is a summary of the accomplishments in 2020-21:

- National Greenhouse Gas Inventory (2017-18) prepared by GCISC was approved by Prime Minister's committee on Climate Change (PMCCC)
- Publication of key research findings in scientific journals = 19
- Contribution towards technical reports = 10
- Contributions in research projects = 6
- Organization of scientific activities/workshops/seminars for information dissemination and awareness = 11
- 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
- Provision of training to university students across Pakistan in the field of climate change through internship program = 16
- GCISC experts delivered lectures as resource persons and imparted trainings to the researchers of various organizations = 18
- Muhammad Arif Goheer, Principal Scientific Officer/ Head- Agriculture and Coordination served as Chair in UNFCCC's Consultative Group of Experts(CGE) which provides technical support and advice, consistent with its mandate, to developing country Parties that responds to their technical assistance needs to implement, in a timely manner, the existing MRV arrangements under the Convention and the ETF under the Paris Agreement, including putting in place sustainable institutional arrangements and data management systems.
- Contributions to Pakistan's 1st Biennial Update Report to be submitted to UNFCCC by Ministry of Climate Change, Government of Pakistan.
- Two scientists from GCISC contributed as Lead Authors to the IPCC 6th Assessment Report.
- One GCISC scientist contributed as "Reviewer" to the GEO report on Cities.
- One GCISC scientists contributed as "Technical Reviewer" in the UNEP's Global Methane Assessment Report released in January 2021.
- GCISC is serving as the Secretariat of NDC and its scientists have contributed to the deliberations of working groups under Technical Committee on Adaptation and Mitigation.

5. ACHIEVEMENTS & SALIENT RESEARCH FINDINGS

A) Research

a) Future climatic changes, extreme events, related uncertainties and policy recommendations over Hindu Kush sub-regions of Pakistan

The study explores relative changes and future projections of temperature and precipitation for baseline (1976-2005) and future (2006–2040, 2041–2070 and 2071–2100) periods for Bajaur, Mohmand and Khyber districts of Pakistan situated in the Hindu Kush region based on 14 GCMs (out of which five GCMs were selected based on evaluation and validation) and three RCMs. The future extremes were projected by using standard indices of Expert Team on Climate Change Detection and Indices (ETCCDI).

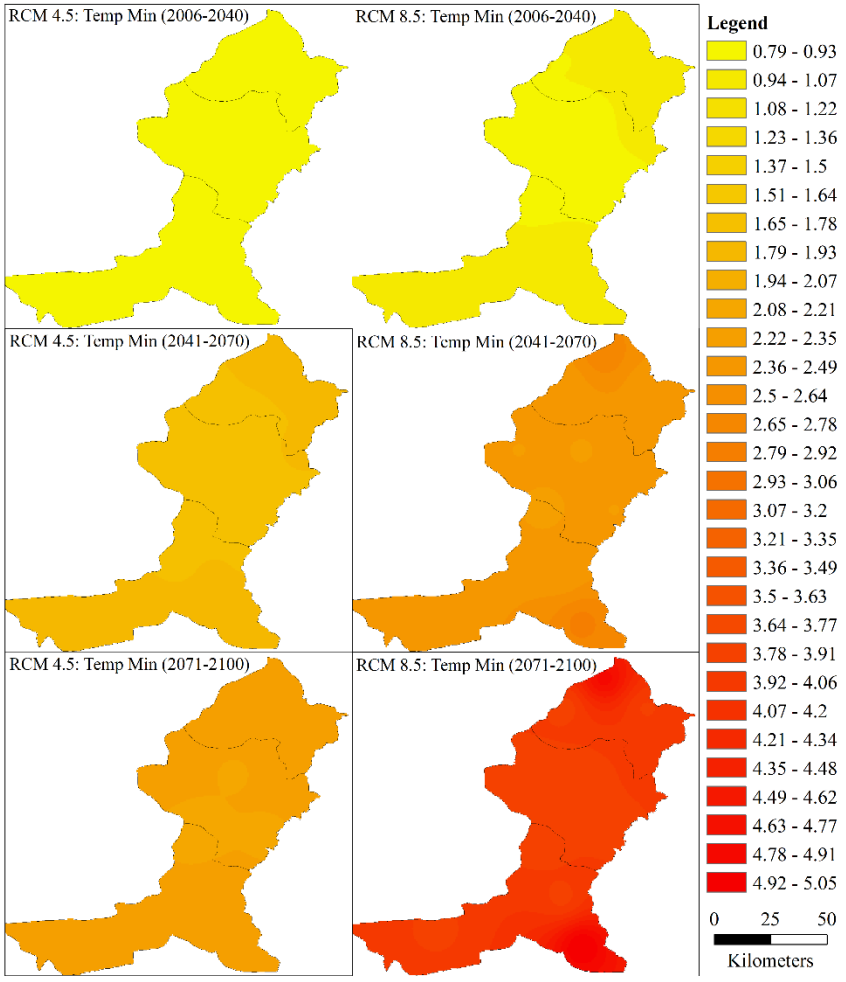

Figure: *03 RCMs ensemble projections for average minimum temperatures for the periods: F1 (2006-2040), F2 (2041-2070) and F3 (2071-2100) under RCP4.5 and RCP8.5*

For RCP4.5, GCMs and RCMs projections show an increase in average maximum temperature to 0.98 °C for 2006-2040, 1.89 °C and 2.04 °C for 2041-2070 and 2.25 °C and 2.56 °C for 2071-2100 while it is almost double for RCP8.5 during last period (2071-2099) over whole study area respectively. The percentage increase in precipitation for RCP4.5 is 10.00%-17.00% and 21.14%-34.47% for GCMs and RCMs while for RCP8.5 it is 11.73%-22.12% and 16.17%-31.50% respectively over the whole study area. In terms of extreme events, warm temperature extremes and extreme precipitation events show an increasing trend accompanied by a decrease in cold extremes over all the regions. Hence, it is concluded that warm and wet condition are projected to prevail in overall regions.

b) Spatio-Temporal Variability of Summer Monsoon Onset over Pakistan

This study focuses on prediction of moon onset and associated rainfall. Mean monsoon onset has observed a shift over 40 years to an earlier time from first week of July to last week of June at most of the stations in Pakistan. Total amount of precipitation has decreased during the onset period has decreased after 1970's in almost all regions. North eastern region of Pakistan received highest amount of precipitation among all others. This study is useful for policy making and associated planning purposes, as the variability in monsoon rainfall has huge impact on the socio-economic sectors and enhanced predictability of rainfall can help in better planning of water resource management for agricultural sector.

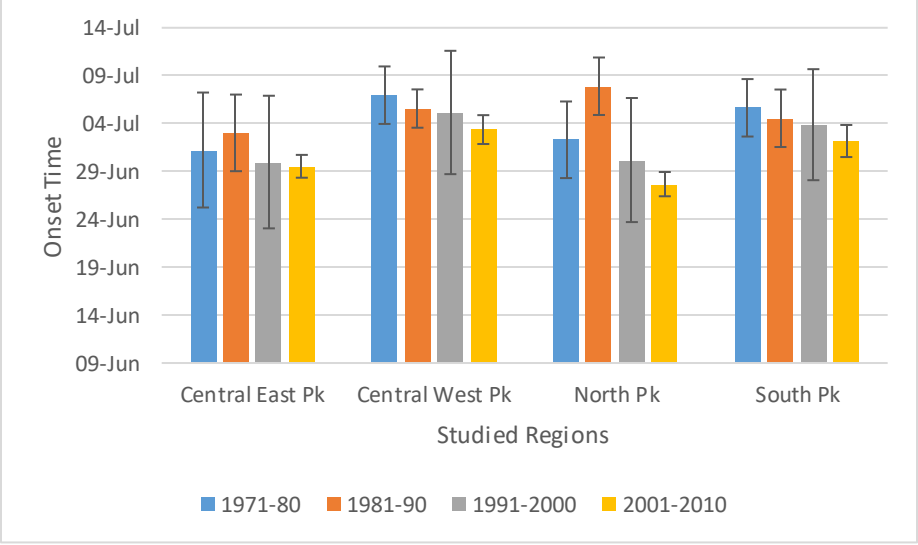

Figure: *Trend of monsoon onset over four regions of Pakistan from 1971-2010*

c) Future Extremes and Variability of Rainfall over Monsoon Region of Pakistan

The results generally reveal that the temporal variability of rainfall in the selected region is projected to decrease till the end of this century under both RCPs. Owing this decrease in variability, alteration in river flows may have an impact on yield of many crops. As heavy rainfall over consecutive days can create the flood conditions, therefore, RX5day is usually defined as a potential flood risk index. Increase of this index is projected to be 117.50mm (109mm in base period) by the end of this century under RCP 8.5 which indicates the risk of flooding in future over monsoon region of the country.

d) Data-Driven Machine learning semi distributed model for ten daily streamflow modelling in the Upper Indus Basin Catchment

Machine learning methods for hydrological modeling have seen extensive development over the last few decades and been proposed as a useful complement to physical hydrologic models, particularly in basins where data to support process-based models are limited. Despite the encouraging results, most applications of machine learning for streamflow forecast have been limited to watersheds where rainfall is the major source of runoff. In this study, we have developed XGBoost (*eXtreme Gradient Boosting*) model in Python, to make streamflow forecast at 10-day lead time at Indus Catchment. The catchment has varied contributions of rainfall and snowmelt to its streamflow. The model produced exceptional results on test data with NSE value as high as 0.90. Thus, it suggests that XGBoost is better suited in watersheds where streamflow contributions come from a mix of snowmelt and rainfall. Moreover, SHapley Additive exPlanations (SHAP) method is used in this study for the analysis of feature importance, that provides detailed insights into the impact of individual feature (parameter/predictor) on the prediction of streamflow.

e) The Impacts of Climate Variability on Crop Yields and Irrigation Water Demand in South Asia

The objective of this study was to improve understanding of the impact of inter-annual climate variability on crop yields and crop water demand from irrigation in selected study sites of the IGB river basins in South Asia during the historical period 1981–2010.Results of this study confirm the importance of climate-related assessments in crop yields and irrigation water demand at higher spatial (grid cell aggregated over study sites area) and temporal (crop phenological phases) scales. The results confirm that climate variables (i.e., temperature and precipitation) play a major role in crop development and growth. However, the degree of crop yield relationship strength with climate variables varies largely between seasons and among locations. Crop yields (i.e., wheat and rice)

show very low sensitivity to climate variables (i.e., up to 4% to temperatures and up to 21% to precipitation) when assessed at the province and state level using observed yield and climatic data. However, crop yield showed a little higher sensitivity to temperature (up to 32%) and precipitation (up to 20%) variations at higher spatial scale i.e., districts level in Punjab Pakistan.

Simulated wheat and rice yields at 5 arc-min spatial resolution aggregated over selected study sites show that 27–72% variations in wheat and 17–55% variations in rice yields are linked with temperature variations in the Rabi and Kharif cropping seasons, respectively. In the absence of irrigation application, precipitation variations also play a major role, i.e., up to 39% variations in wheat yield and up to 75% variations in rice yield are directly linked with precipitation changes in the IGB river basins. Statistically significant and strong negative correlations between temperature and wheat yield indicate that wheat crop is quite vulnerable to heat stress. Kharif precipitation shows a statistically strong and positive relationship with rice yield production, indicating that a change in monsoon onset and uncertain climate extremes can impact the rice yield productivity.

The study concluded that wheat yields are most vulnerable to increasing winter temperatures in the reproductive phase. In the absence of irrigation application, both wheat and rice crop yields show mainly a significant positive relationship with crop phase-specific precipitation for all study sites with the strongest correlation, however with a large range, during the reproductive phase −0.12 to 0.75 for wheat and −0.18 to 0.77 for rice. Our analysis confirms that the crop yield sensitivity to climate variables depends on time and space specific climatic conditions.

Timing and quantity of irrigation water demand are also strongly associated with the variations in temperature and precipitation. We observed that irrigation water demand by both wheat and rice are generally positively correlated with temperature in both climate-sensitive crop phases with an exception during the reproductive phase of wheat where it shows a mixture (both positive and negative) of correlations for different locations. Whereas, crop phase-specific irrigation water demand by both crops show a negative relationship with precipitation i.e., under increased precipitation scenarios, decreased irrigation projections are expected. This study shows that crop phase specific climate variables play a major role in crop yield fluctuations within and between the years and also drive irrigation water demand in quantity and time. Therefore, improved knowledge on the shifts in irrigation water availability and demand based on local soil and climate conditions during sensitive crop growth phases and possible impacts on crop yields of rice and wheat in the IGB river basin will support adaptation strategies to cope with projected climate change and socio-economic scenarios.

f) Future changes in growing degree days of wheat crop in Pakistan as simulated in CORDEX South Asia experiments

This study was designed to assess the increasing daily maximum as well as minimum temperatures and to determine the impacts of rising daily mean temperature on heat requirements of wheat crop in wheat-growing zones all over Pakistan. The study applies RCP 4.5 and RCP 8.5 over two future time-slices, i.e. near-century and mid-century using the CORDEX datasets.

Daily mean temperature significantly affects phenology and grain yield of spring wheat. An increase in temperature is expected to shorten the crop lifecycle and lowering grain yields as a result of faster accumulation of GDDs in wheat crop. Studies indicate that temperatures in the southern part of Pakistan have shown to exceed the thresholds at the times of flowering and ripening. An overall increase of 1000 Growing Degree Days (GDDs) between past and mid-century extreme scenarios (RCP8.5) has been observed in case of wheat, implying that southeastern side of Pakistan is likely to become unsuitable for wheat production due to temperature extremes in future.

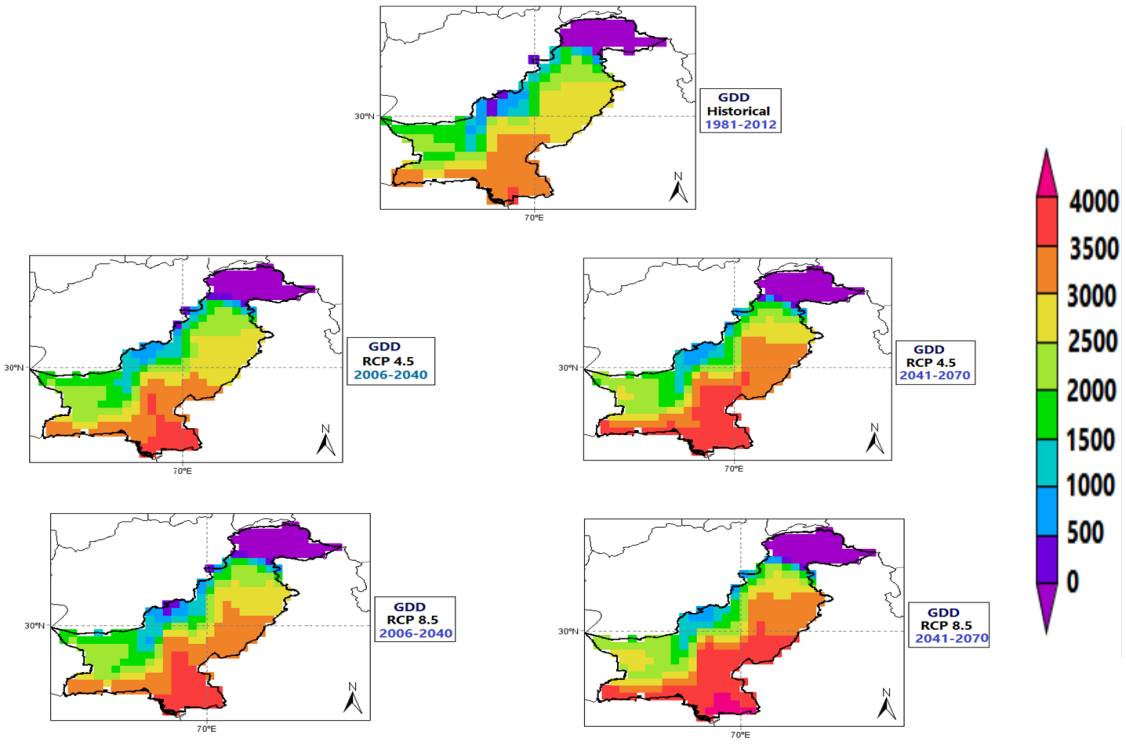

Figure: *Spatial mapping of seasonal GDDs over Pakistan for control, F1 (near century) and F2 (mid-century) for RCP 4.5 and RCP 8.5 contribution during the season.*

An urgent response is required to help combat heat stress in cereal crops in order to ensure sustainability in food security. It requires high-quality research and policy planning for adopting to local scale, nationally oriented and forward-looking climate-smart practices and well-suited adaptation strategies, for resilient agriculture. Based on our study results, it is suggested that strategies like bringing more area under cultivation in North-Western and Mid-Western sides of Pakistan, considering multi-cropping and terracing options, early planting to avoid heat stress, and developing drought tolerant and heat resistant varieties can be wise options to minimize climate change impacts on wheat crop in Pakistan.

g) Analysis of future warming extremes impacting crop growth stages in wheat

An analysis of future warming extremes (Consecutive Summer Day Index (CSU), impacting critical crop growth stages of wheat crop in Pakistan was also done. The study reports that Consecutive summer day index CSU. CSU 32 is consecutive 5 or > days of daily maximum temperature occurrences. 32 degrees is the threshold/upper limit in wheat during flowering, while threshold of 36 degrees was taken for ripening, beyond theses temperatures yield losses occur. It is evident from Observed data that South Eastern side of Pakistan is most vulnerable for flowering and ripening stages of Wheat Crop due to consecutive heat days.

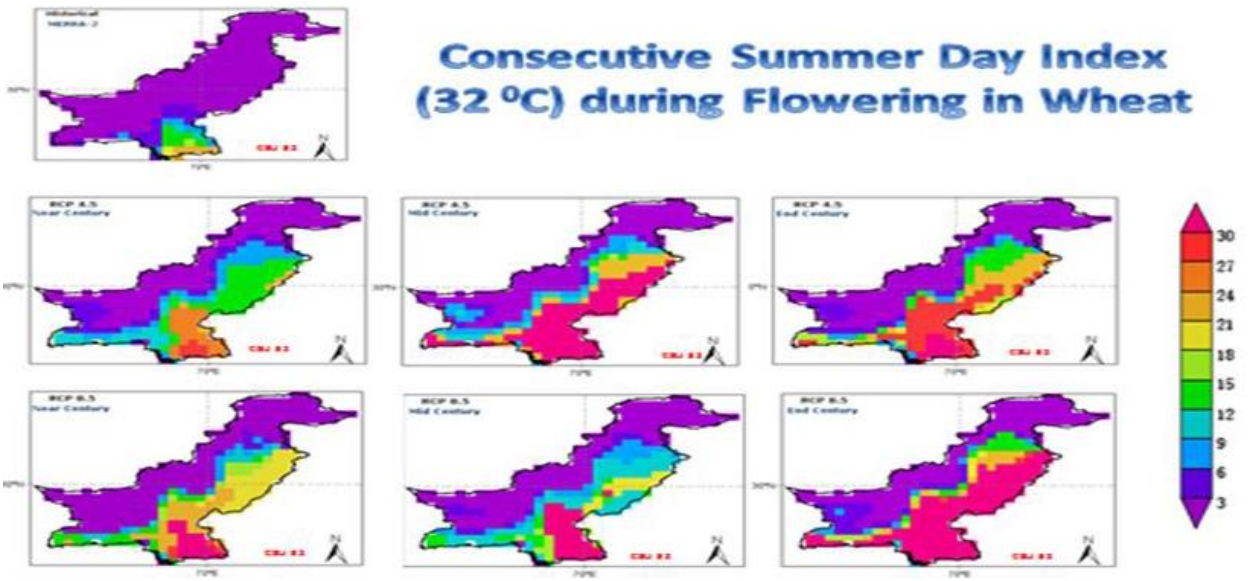

Figure: *Consecutive Summer Day Index at Flowering at flowering stage of wheat*

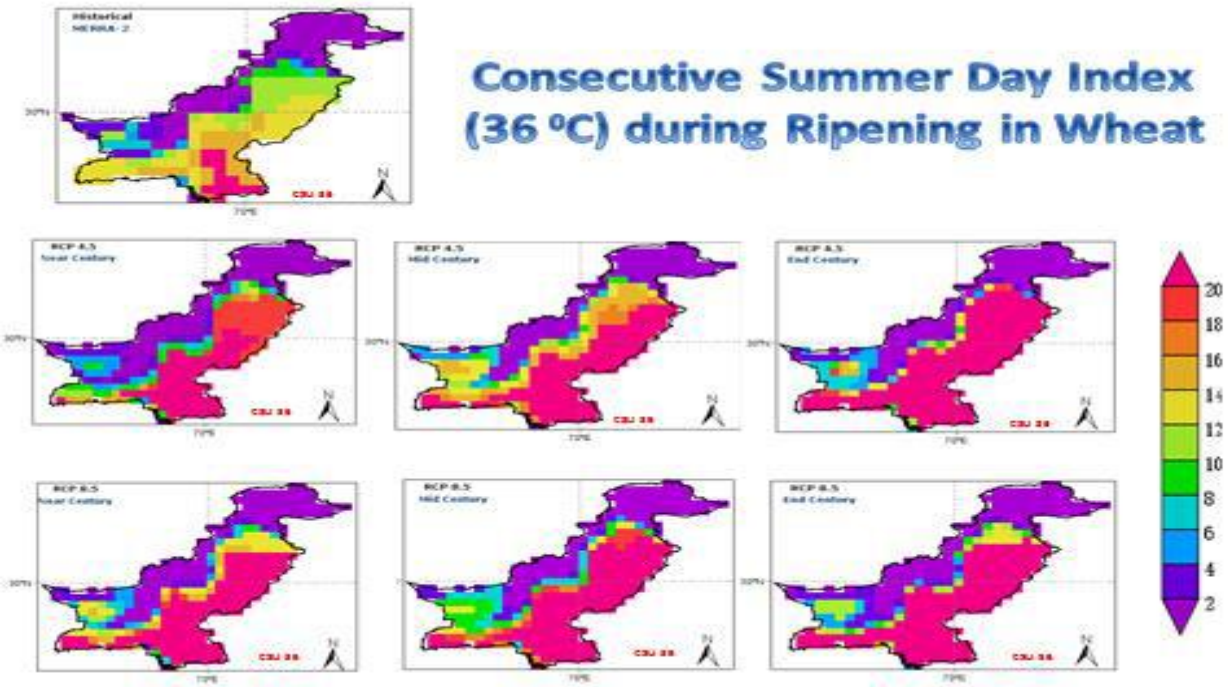

Figure: *Consecutive Summer Day Index at Ripening stage of wheat*

h) Modeling and Monitoring Wheat Crop Yield Using Geospatial Techniques: A Case Study of Potohar Region, Pakistan

The objective of the study was to evaluate the possibility of MODIS-derived vegetation indices using GIS and RS to estimate pre-harvest wheat yield in the Potohar region, Pakistan. Two MODIS product MOD15A2H and MOD13A1 for the period 2009–2018 were used for the derivation of LAI and indices. Wheat yield data of each district for the study period were obtained from the agriculture statistics of Pakistan.

Results shows that overall, the percentage average difference between the actual and predicted yield was within -1.986%. Average RMSE and MAE values ranged from 34.28 to 76.50 kg/ha and 108.09 to 129.99 kg/ha, respectively. The MBE value ranged from 7.20 to 62.80 kg/ha. The results concluded that accurate wheat yield predication can be made almost 2 months before harvesting using geospatial techniques along with the statistical modeling approach.

i) Implications of Remote Sensing Data under GIS Environment for Appraisal of Irrigation System Performance

Remote sensing and GIS tools were used to assess the performance of irrigation system performance. Potential water requirements of the area were found to be 401.66 million cubic meters (MCM) and available canal water supply was found as 247.14 MCM, thus

indicating shortage of 38%. Water consumption of wheat was estimated by remote sensing to be 243.41 MCM which was comparable to the available canal water supply confirming accuracy of the proposed method. Adequacy of the system was found to be 74 % while its reliability varied from 35-73% throughout the wheat season. Strong correlation was found between crop yields and water supplies i.e. crop yield was strongly dependent on water supplied (R2=0.80).

j) Implications of Remotely Sensed vs Climate data in assessing Crop Water Ingestion using Machine Learning

The study has been conducted to estimate the seasonal Evapotranspiration of wheat using CROPWAT and SEBAL modelling approaches. The result showed that there has been strong relation of 93% between two approaches in finding seasonal Wheat ET for Peshawar region. Results favors the using of SEBAL model over the other regions of Pakistan where agro climatic data is limiting.

k) National Greenhouse Gas Inventory 2018

In the light of Katowice decision, National GHG Inventory of Pakistan based on the latest data sets available as part of the Pakistan BUR1 Project executed by the Ministry of Climate Change (MoCC) through GCISC has been prepared using IPCC 2006 Guidelines. This report presents the inventory of Pakistan for the year 2017-18 (herein called as 2018). This is third such effort by the Centre.

IPCC 2006 Guidelines have been used. The inventory includes four sectors viz. Energy including Transport; Industrial Processes & Product Use (IPPU), Agriculture, Forestry & other Land Use (AFOLU) and Waste. The activity data have been taken from Pakistan Energy Year Book (2017-18), Economic Survey of Pakistan (2019), Agriculture Statistics of Pakistan (2017-18), State of Industries Report (2018), FAO Stat 2018, FAO 2020 Pakistan Forestry Sector Review, FAO-Smog Report (2019) Country Report of Pakistan, Food and Agriculture Organization (FAO) of United Nations, National Forest and Rangeland Resource Assessment Study (NFRRAS 2004). Peshawar: Pakistan Forest Institute, Government of Pakistan and Supply & Demand of Fuel Wood & Timber for Household & Industrial Sectors & Consumption Pattern of Wood & Wood Products in Pakistan (2003-2004) called as Maanics Report (2004), OIGF, Ministry of Environment, Islamabad.

The total estimated emissions in terms of million tons of CO_2 equivalent for the year 2018 shows an increase in total GHG emissions when compared with the previous (1994, 2008, 2012 and 2015) inventories. The total estimated GHG emissions for the year 2018 are 489.87 million tons of CO_2 equivalents with i) Energy sector contributing (218.95), ii)

Industrial processes (25.76), iii) Agriculture, Forestry and Landuse (223.45) and v) Waste (21.72) $MtCO_2$ equivalent, respectively.

Table: *Summary of Greenhouse Gas Emissions (2017-18)*

Sectors	**Sub-Sectors**	**Emissions (Mt CO_2 Eq)**	**Total Emissions (Mt CO_2 Eq)**
Energy	Energy Industries	43.40	218.94
	Manufacturing Industries and Construction	66.20	
	Transport	51.34	
	Others (commercial, residential & agricultural)	44.06	
	Fugitive Fuel emissions	3.94	
Industrial Processes and Product Use (IPPU)	Mineral industry	22.75	25.76
	Chemical Industry	2.71	
	Non Energy Fuel and Solvent use product	0.10	
	Others (paper & pulp, Food 7 beverages)	0.20	
Agriculture, Forestry and Other Land use (AFOLU)	Livestock	109.12	223.45
	Land	31.52	
	Managed Soils	74.98	
	Rice Cultivation	7.83	
Waste	Solid Waste Disposal	10.23	21.72
	Waste incineration and open burning	0.9	
	Wastewater treatment and discharge	11.90	
Total Emissions			**489.87**

l) Establishment of MRV System for GHG Inventories

Through its Article 13, the Paris Agreement established a framework of enhanced transparency (ETF) to regularly measure the progress made by countries to strengthen the global response to the threat of climate change. The purpose of the framework for transparency of action is to provide a clear understanding of climate change action in the light of the objective of the Convention as set out in its Article 2, including clarity and tracking of progress towards achieving Parties' individual nationally determined contributions under Article 4, and Parties' adaptation actions under Article 7, including good practices, priorities, needs & gaps, to inform the global stock take under Article 14.

The objective of the new international adopted framework is to enable the implementation of mitigation, adaptation and support actions as well as their monitoring over time. This monitoring will be reported on a regular basis as part of the BTR (Biennial Transparency Report) which will replace the BUR (Biennial Updated report) by 2025. In

this context, the inventory of GHG emissions as well as the action monitoring indicators are essential for the monitoring and confidence of the international community.

Within this framework, Pakistan is a signatory Party to the Paris Agreement, and Ministry of Climate Change (MoCC) is the official governing representative of Pakistan for the implementation and compliance of the reporting to the UNFCCC. In this context, the Global Change Impact Studies Centre (GCISC) is developing a web based platform for the MRV of GHGs.

m) Pakistan's First Biennial Update Report (BUR1)

BURs are reports to be submitted by non-Annex I Parties, containing updates of national Greenhouse Gas (GHG) inventories, including a national inventory report and information on mitigation actions, needs and support received. Such reports provide updates on actions undertaken by a Party to implement the Convention, including the status of its GHG emissions and removals by sinks, as well as on the actions to reduce emissions or enhance sinks. Ministry of Climate Change is implementing Project on 'Preparation of Pakistan First Biennial Update Report (BUR1) under United Nations Framework Convention on Climate Change (UNFCCC), with financial support from Global Environment Facility (GEF) through United Nations Environment. GCISC has been assigned to contribute to the chapters on Greenhouse Gas Inventory, National Circumstances, Information on domestic Measurement, Reporting & Verification and Information of Technical support needs and provided. The report is in the final stages of its submission to the UNFCCC.

n) Revision of Nationally Determined Contributions (NDC)

The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions. Nationally determined contributions (NDCs) are at the heart of the Paris Agreement and the achievement of these long-term goals. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change.

In fulfillment of the aforementioned obligation, a study regarding Pakistan's Intended Nationally Determined Contribution (INDC), to be submitted to UNFCCC before the start of COP-22, was initiated by Ministry of Climate Change in June 2016. GCISC was declared its secretariat. GCISC contributed to this NDC study by preparing the GHG inventory for the year 2014-15 and providing other technical inputs and collaborative support for the study. Pakistan's 1st NDC document was submitted to UNFCCC in Nov. 2016 which

commits to reduce up to 20% of its 2030 projected GHG emissions, subject to the availability of international support. The document is available at UNFCCC website.

Under the PA, countries revise their NDCs every five years to cut GHG emissions to limit Earth's temperature rise and implement solutions to adapt to the effects of climate change. The updating of NDCs presents countries with significant opportunities to align their climate and development agendas to promote sustainable growth, but also presents challenges in reinventing policies and operations and mobilizing enough investment. Ministry of Climate Change initiated the NDC revision process in 2020. GCISC is contributing to the revision process and has been declared as the Secretariat.

B. Capacity Building:

Capacity building is an important component of GCISC's activities. During 2020-21, the Centre's scientists participated in a number of national/ international training workshops and acquired new skills ranging from climate science, climate modeling, seasonal forecasting, early warning systems, climate data analysis. drought monitoring and assessments, hydrological, crop simulation and water management modeling, water surface runoff analysis, water-food-energy nexus, to earth observation systems, space technology and RS/GIS tools. The acquired skills are being used for the ongoing and planned research activities at the Centre. GCISC's scientists also contributed as resources persons in various seminars and training workshops.

The Centre with the support of GIZ-Pakistan and CITEPA-France organized as series of training workshops on the preparation of Greenhouse Gas Inventories using IPCC 2006 guidelines. Fifteen professionals from GCISC, MoCC, National Ozone Unit, National Energy Efficiency and Conservation Authority, REDD+ Pakistan, Pakistan Forest Institute, Ministry of Industries and Production, University of Arid Agriculture and Fatima Jinnah Women University were trained in the sectors of Energy, Transport, Industrial Processes and Product use (IPPU), Agriculture, Forestry & Other Land Use (AFOLU) and Waste Sectors. The trained professionals will not only effectively contribute in GHG inventory preparation but also will serve as future trainers.

Eight students from different universities attended GCISC as Interns for a period of 2-3 months. The Centre's researchers provided them orientation lectures on climate science, modeling and other analytical skills and supervised them for various studies pertaining to assessment of climate change impacts on crops, soil surface salinity and data analysis for climate studies.

C. Mass Awareness / Media Appearance:

The Centre's scientists gave interviews on various media channels and published several news articles in the leading national newspapers on the various aspects of climate science and its associated impacts on water, agriculture, and forestry. Interviews were with the Voice of America, Reuters and other leading national media groups on the specific aspects of wheat crisis, locust havoc, introduction and production of high value crops like olives and grapes in the Potohar area in the context of changing climate.

D. Inputs for parliamentary Business

GCISC, being the research arm of the Ministry of Climate Change is oftenly asked for providing technical inputs on climate change, impacts and response strategies for parliamentary business. In this regard GCISC provide answers to National Assembly and Senate questions and also contributes to the proceedings of the standing committees on the concerns of climate change. During 2020-21 GCISC provided responses to three (3) NA/Senate starred questions and provided inputs (presentations/ briefs) for NA Standing Committee on Climate Change on the aspects of Climate Change, Agriculture and food security. GCISC also provided technical inputs to various reports and submitted responses to various queries reading Joint and Inter Ministerial coordination meetings, Bilateral Consultations and memorandums etc.