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CLIMATE CHANGE: CHALLENGES AND RESPONSES (IC4R-2023)

Editors
Prof. Dr. Khalid Manzoor Butt
Sanwal Hussain Kharl

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MARCH 15-16, 2023

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International Conference on Climate Change: Challenges and Responses (IC4R-2023)

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EDITORIAL

The Faculty of Humanities and Social Sciences, University of Central Punjab, Lahore, has arranged the international conference on Climate Change: Challenges and Responses on March 15-16, 2023. It has provided a platform for experts and scholars to share their insights and discuss the pressing issues which have posed a serious threat to the environment and human life. The conference brought together a diverse group of experts, including academics, researchers, policymakers, and civil society organizations, to explore the challenges posed by climate change and to identify doable solutions.

The conference has brought together about 50 scholars from various fields to present their research papers in 6 academic sessions dedicated to different themes of climate change. After these sessions, the policy dialogue also took place which was Chaired by eminent political scientist Dr. Ishtiaq Ahmed from Sweden.

The conference proceedings contain a wealth of knowledge on a range of topics, including Climate Change and National Security, Climate Change and Global Economy, Global Responses to Climate Change, Climate Change Hazards and Policy Making, Climate Change and Social Transformation, and Global Environmental Politics. One of the standout aspects of the conference was the thought-provoking keynote address by Justice Mr. Jawad Hassan (Judge of Lahore High Court). He highlighted important decisions taken by the judiciary of Pakistan. He further shared the role played by Pakistan in the international community on this very issue, threatening humanity.

The presence of His Excellency Mr. Jakob Linulf (Ambassador of Denmark to Pakistan), Mr. Michael Rossman, (Deputy Mission Director USAID), and Dr. Sajid Mahmood Chauhan (Secretary Environment, Government of Punjab) enhanced the significance of the conference by all means.

The conference proceedings also feature a number of papers and presentations that explore the challenges of climate change from a global perspective. For instance, Mr. Adil Daniel from WWF Pakistan presented research on the Impacts of Climate Change on Global Food Security. His emphasis was the need for sustainable agricultural practices and policies that support smallholder farmers. Similarly, Mr. Ahmed Nazir Warraich, Dean EDI, National School of Public Policy Lahore, Dr. Bilveer Singh from Singapore, Dr. Sabu Thomas from India, Dr. Xiaoqing Xia from China, Mr. Tariq Khan from South Africa presented their papers. Some notable experts like Ms. Aisha Khan, Mr. Ahmed Rafay Alam, Dr. Blveer Singh, Dr. Shazia Hassan, Mr. Ahmed Nazir Warraich, Ambassador (R) Nadeem Riyaz, chaired different sessions. However, Dr. Ishtiaq Ahmed Chaired one of the academic sessions as well as Policy Dialogue of the conference.

Overall, the conference proceedings would have an important contribution to the ongoing global conversation on climate change. The research papers added new insights and perspectives on the problem and provided a valuable source for researchers, policymakers, and practitioners working

on this issue. As we continue to grapple with the impacts of climate change, it is vital that we draw upon the latest research to address this pressing global challenge.

The proceedings of the conference will provide a valuable resource for policymakers, researchers, and practitioners working on climate change issues in Pakistan and around the world. By sharing knowledge, practices, and innovative solutions, we can collectively tackle the challenges of climate change and work towards building a more sustainable future for the next generations.

To conclude, I extend my gratitude to foreign scholars who have come through difficult traveling conditions. I am also grateful to our national scholars and academics for their contribution to the conference. I appreciate and acknowledge the support of all the people, who extended their hands for organizing the conference. A note of thanks to my faculty, organizing team, administration, and students of UCP for making a collaborative effort for the success of the conference.

Thank You.

Prof. Dr. Khalid Manzoor Butt
Conference Chair
Dean, Faculty of Humanities and Social Sciences

WELCOME NOTE

Prof. Dr. Khalid Manzoor Butt
Dean, Faculty of Humanities and Social Sciences
University of Central Punjab, Lahore, Pakistan

Pro-Rector, Dr. Nassar Ikram, Justice Mr. Jawad Hassan, Keynote Speaker, Guests of Honor; Mr. Michael Rossman (Deputy Mission Director USAID), and His Excellency, Mr. Jakob Linulf (Ambassador of Denmark to Pakistan), delegates, Deans, Directors, Guests and dear students Assalamu Alaikum and very warm welcome.

First of all, I am thankful to Justice Mr. Jawad Hassan who is a really great supporter of us. He has not only spared his valuable time for the conference, but also gave very important tips and, he personally called some experts in climate change for this conference. Though he is a jurist yet he has a huge interest in and knowledge about climate change. His various judgments and speeches on climate change have been used as references in judicial and academic circles. We are very proud for having Justice Jawad here as Keynote Speaker.

I am also thankful to Mr. Michael Rossman (Deputy Mission Director USAID) for his presence as Guest of Honor which is an honor and great encouragement for us. It shows Pakistan has support from the international community to deal with the damages of climate change.

Let me express our gratitude to His Excellency Mr. Jakob Linulf (Ambassador of Denmark to Pakistan) and his spouse for gracing the Inaugural Ceremony of the conference. It is very heartening that they have spared time from their busy schedule and come all the way from Islamabad on our request. His Excellency and Madam your presence here mean a lot to us. I am glad that the topic of the conference, we chose about three months back and today, has materialized. When we started deliberating on the topics of the conference, many topics were discussed like Women's Rights, Governance, Justice, and local self-government, however, a consensus emerged on climate change.

The purpose of the conference is, to collect opinions and experiences of different intellectuals, researchers and experts on a challenging issue. Pakistan is known as one of the most vulnerable countries regarding the effects of Climate Change. In recent devastating floods, 1/3 area of Pakistan and 5 million people have been affected, 35% of standing crops were ruined and other damages if counted, in terms of money are about 30 billion dollars. Many people died, were injured and became homeless in this calamity. Just look at the phenomena of smog, high Air Quality Index (AQI), drought, and excessive rains which have been causing so many medical, economic, and social problems. These are just signals if we could visualize catastrophic changes in the climate in our region.
In fact, a country like Pakistan does not have the sources and capacity to coop with such challenges so it would cause multiple efforts. If we would not take preemptive measures then such kind of calamities are just beginning and we would face unimaginative consequences in the future.

Thank you very much.

KEYNOTE ADDRESS

Justice Mr. Jawad Hassan
Judge, Lahore High Court, Punjab, Pakistan

Respected guests, conference organizers, and dear participants *Asalm o Alikum*.

I am honored to address you today as a representative of the judiciary in my state. It is important to highlight that in our state, judiciary is a key pillar of the government, and all three branches - legislative, executive, and judiciary - have played their roles in formulating laws, policies, judgments, authorities, and agencies.

Pakistan has been actively focusing on environmental issues since the Stockholm conference in 1972, where 11 countries including Pakistan participated for the first time. We returned from the conference and drafted environmental laws, which were presented in 1992, after 20 years, when Pakistan sent a delegation to highlight our vulnerability as one of the most affected countries by climate change.

As a representative of the judiciary, I cannot make a speech on what we have done, but I can cite the constitutional provisions and judgments that we have made, and how we are taking action. For instance, in 2012, the Supreme Court of Pakistan, along with judiciary from 40 other countries, committed to establishing green benches and green courts. It took almost 10 years, but we finally achieved this goal in 2022. Recently, during the International Water Conference, which lasted for three days from 9th to 11th, representatives from all over the world gathered to discuss water and climate change issues in Pakistan.

The Constitution of the Islamic Republic of Pakistan, 1973, has specific articles that address climate change. Article 4 guarantees the right to life, stating that no action detrimental to the life, liberty, body, reputation, or property of any person shall be taken except in accordance with the law. Article 14 ensures the inviolability of the dignity of man, subject to the law, and guarantees the privacy of the home. Article 24 protects property rights, stating that no person shall be compulsorily deprived of their property except in accordance with the law.

Pakistan ratified the United Nations Framework Convention on Climate Change in June 1994, which was later supplemented by the Kyoto Protocol in 1997. Several agreements have been reached under the umbrella of the Framework Convention on Climate Change, including the Cancun Agreement and the Paris Agreement in 2015.

The role of the superior judiciary in the development of environmental laws in Pakistan has been commendable. The superior courts have recognized the concept of environmental rights, as demonstrated in the Shehla Zia case, where it was established that the fundamental right to life includes the right to a clean and healthy environment. The preamble of the climate change act in Pakistan acknowledges the country's obligation under international conventions and aims to adopt comprehensive adaptation and mitigation policies, plans, programs, projects, and measures to address the effects of climate change.

The concept of sustainable development is perfect and is emphasized in every religion. For example, the Quran states that one should not cause mischief on Earth and should not harm the environment, as everything on Earth is given in proportion. Similar doctrines are present in common law and the concept of public trust doctrine of Thomas in the USSR.

However, we are ashamed that we have not been able to fully protect the environment, despite the efforts of all three branches of the government. The executive branch could have been more effective in implementing environmental policies. As Tammy Tucker, a US senator, said, "Do not pity me and do not laugh at me. I own this feature. I can run faster because I told you." We need to ensure that environmental rights are protected, and that people have equal access to employment, education, and opportunities for mobility.

Justice is about upholding the rule of law, ensuring access to justice, dispensing justice, and administering justice. This can be achieved without cutting down trees, as demonstrated in a climate change case in the Philippines where the Supreme Court ruled that logging permits cannot be granted without conducting an environmental impact assessment.

Furthermore, we need to prioritize climate justice, recognizing that the impacts of climate change disproportionately affect vulnerable communities, including marginalized groups, indigenous peoples, and low-income populations. It is our responsibility as a society to ensure that these communities have access to justice and are included in decision-making processes related to climate change mitigation and adaptation measures.

As a judiciary, we are committed to upholding the rule of law and protecting the environment. We will continue to interpret and apply existing laws in a manner that promotes environmental sustainability and holds those who harm the environment accountable. We will also strive to ensure that access to justice is available to all, regardless of their socio-economic status or background, to address any environmental violations or injustices.

Additionally, we will continue to work with other branches of the government, civil society organizations, and international partners to develop and implement effective environmental policies and regulations, promote environmental awareness, and encourage sustainable practices in all sectors of society.

In conclusion, the judiciary in our state recognizes the importance of addressing climate change and protecting the environment for present and future generations. We are committed to upholding the rule of law, promoting environmental justice, and ensuring access to justice for all. We urge all stakeholders to work together in a collaborative and coordinated manner to tackle the challenges of climate change and safeguard our planet for a sustainable and prosperous future.

Thank you for your attention. Let us all join hands and take decisive actions to mitigate climate change and protect our environment.

GUEST OF HONOR'S SPEECH

Mr Micheal Rossman
Deputy Mission Director, USAID Pakistan

His Excellency Mr. Jakob Linulf, Respected Pro-Rector, worthy keynote speaker, the conference organizer Prof. Dr. Khalid Manzoor Butt and dear Students, a very good noon.

The past year has been extraordinarily difficult for our friends and colleagues in Pakistan. The devastating floods caused immense loss of life and livelihoods, and continue to have a major impact on food security, health, and access to education. As we've been discussing here today, the 2022 floods have highlighted that climate change is a global problem that cannot be solved by one country alone. It requires the political will and active contribution of a strong coalition of partners and the United States is leading the global effort to address this issue. The United States and Pakistan have a long history of working together to advance economic growth and build a brighter future for Pakistan.

In the 1960s, the United States supported Pakistan through its green revolution, which improved crop yields boosting economic opportunities for Pakistanis increasing food security and life expectancy. The United States also invested in the construction of reliable electricity infrastructure, such as dams, which provide affordable, clean, and renewable energy while also supporting year-round irrigation and flood control for millions of Pakistanis.

In response to the floods, the United States' support to Pakistan included an initial 100-million-dollar commitment to immediate flood relief efforts, disaster resilience, food security, and relief logistics. As the need was seen and understood, this led to an additional 100-million-dollar commitment to strengthen climate-smart agriculture and food security systems and to scale up essential health services, which had impacted flood-affected communities as well as expedited the return to learning among marginalized populations, particularly girls and young women.

Recently, Ambassador Bloom announced 500 new scholarships for Pakistani university students, specifically targeting women who were affected by the floods, to help them complete their degrees. Looking to the present and future, the United States would like to work with Bacchus Grow and learn to mitigate and adapt to these terrible climate crises.

The US-Pakistan green alliance will address shared challenges relating to agriculture, energy, water, and other environmental issues to strengthen climate resilience and foster inclusive economic growth. And as we know these issues are even more critical in the aftermath of the devastating floods. A green alliance between the United States and Pakistan can help us both face the consequences of this climate crisis and prepare our societies and economies together to adapt to a changing future. So, we know that the best way to mitigate the impacts of the climate crisis is by continuing to work together and that is exactly what the United States intends to do with our excellent partners in Pakistan.

As part of our support, we also aim to ensure representation, inclusion, and protection of the human rights of those who are most vulnerable to the effects of climate change. We must recognize that climate solutions must promote equity, assure adequate access to basic resources and ensure that young people can live, learn and play and work in healthy and clean environments.

And as I stand here today, I recognize that Pakistan is indeed a young country, more than 60% of the country's population is under the age of 30 This demographic represents the future of the country and has the potential to be a catalyst for positive change. And who best to harness the potential of Pakistan's youth than educational institutions such as the University where we are gathered today.

At last, I thank the university again for providing this opportunity.

CHIEF GUEST'S SPEECH

His Excellency Mr. Jakob Linulf
Ambassador of Denmark to Pakistan

Ladies and Gentleman, thank you very much for inviting me.

I am seeing many faces today, and I appreciate your engagement in the climate change agenda, which is important not only for me but for the entire world. I have been working on this issue since September 2022, and it is a great honor for me to serve as Denmark's ambassador to this important country. Since arriving here, I have been amazed by the beauty of nature, the kindness of the people, and the rich culture and history of Pakistan that I have witnessed. But the very first thing I saw when I came to Pakistan was the province of Sindh, right in the middle of the devastating floods. And I think that experience will stay with me throughout my tenure here in Pakistan. What I witnessed there was unbelievably tragic, and I am committed to doing whatever I can – to combat climate change so that we do not have to witness such events again.

Denmark, where I come from, might be familiar to you because of our fairy tales, education system, or maybe even our delicious food. But to give you a brief overview of Denmark, I will just mention three things: Denmark is well-known for its expertise in maritime business, agriculture, and trading. Our country has a large facility in Karachi and we've invested heavily in Pakistan through the Danish company Merce, creating thousands of jobs. Denmark is also famous for its dairy products such as cheese, which we hope will feed people around the world. As a small country, we believe in open borders, globalization, and trade. However, our most important export is sustainability. Denmark is a world leader in renewable energy and energy efficiency, and we take pride in preserving our resources for future generations. And we are very good at water management as well.

How did we get there? Well, it's more that Denmark has become a world leader in sustainability and sustainable energy. When I was a child – growing up in Denmark, we faced a similar crisis to what Pakistan is facing now with its energy sector. We were heavily dependent on imported oil and we could not afford it anymore. Our country was in a big economic crisis, and people could not even drive their cars because they couldn't afford the oil. Our politicians at that time realized that this was not sustainable for the world. We couldn't continue polluting so much by using all that oil. So, we made the decision to become self-sufficient in our energy needs. We need to establish a foundation where we can generate our own energy from wind, solar, biomass, biogas, and waste. Denmark did it, and you can follow too.

Your country has abundant wind, solar, and hydropower resources that you can utilize. You just need to create a conducive long-term environment for investors, establish a strong public-private partnership, and work with international partners to achieve this goal. We are committed to working with Pakistan to create a sustainable environment here. Let's work together to create a cleaner and more sustainable world, not just for me but for you and future generations.

At last, I appreciate the organizer for such an important conference.

CONCLUDING REMARKS

Dr. Nassar Ikram
Pro-Rector, University of Central Punjab

Good afternoon everyone,

It is my great pleasure to welcome you all to the inaugural ceremony of this **International Conference on Climate Change: Challenges and Responses**, organized by the Faculty of Humanities and Social Sciences, University of Central Punjab. I would like to begin by expressing my gratitude to our esteemed keynote speaker, Justice Jawad Hassan, and our worthy guests of honour, Mr. Michael Rossman (Deputy Mission Director USAID), and His Excellency Mr. Jakob Linulf (Ambassador of Denmark to Pakistan), for gracing this occasion with their presence.

I would also like to extend my heartfelt appreciation to the organizing team for their untiring efforts in putting together this conference. It is through their dedication and hard work that we have this opportunity to bring together national and foreign experts, policymakers, and other stakeholders to discuss and deliberate on the most pressing issue of our times - climate change.

Climate change is no longer a theoretical concept or a distant problem. It is a reality that we are facing today, with severe and widespread impacts on our environment, economy, and society. In Pakistan, we have seen an increase in extreme weather events such as floods, droughts, and heatwaves, which have devastated communities, displaced people, and caused significant economic losses.

Recent scientific evidence has also shown that Pakistan is among the countries most vulnerable to climate change. The latest report by the Intergovernmental Panel on Climate Change (IPCC) has highlighted the urgent need for ambitious action to limit global warming to 1.5°C above pre-industrial levels, beyond which the impacts of climate change will be catastrophic and irreversible.

It is therefore imperative that we come together to address this global challenge through collective and collaborative action. This conference provides a platform for us to exchange knowledge, share experiences, and explore innovative solutions that can help us mitigate and adapt to the impacts of climate change.

In conclusion, I hope that this conference will serve as a catalyst for change, inspiring us to take bold and decisive action toward a sustainable future. I wish you all fruitful deliberations and a memorable stay in Lahore.

Thank you.

DAY-1

The Climate Change-National Security Nexus in Southeast Asia: An Analysis

Dr. Bilveer Singh*

Abstract

Today, there is no longer a major debate about the nexus between climate change and national security – it is not whether but when, how, and to what extent has it impacted states both nationally, regionally and globally. While a strong consensus has emerged in the world, both the Western and non-Western, that climate change poses a clear existential threat to national security, the precise nature of the threat and its timeframe remains difficult to ascertain and is often contested. Still, there is no question about the linkage between climate change and its consequences on national security. This paper, focusing on the case of Southeast Asia, especially Indonesia, will look at the following twin aspects: the general discussion of climate change and its impact on national security, and more importantly, how climate change has impacted the national, including regional security, of Southeast Asia. The continuous series of punishing droughts, forest fires, floods, tsunamis, earthquakes, and haze, have fueled conflicts over natural resources and their deployment by the state as well as led to the outflow of refugees, both nationally and internationally. This has had a debilitating impact on most states in the region, including in the domain of national security. Today, one does not need an armed force to threaten national security; the dangers posed by climate change on a state's politics, economics and social order can be even more dangerous with long-lasting negative consequences. The havoc wreaked by the 2004 tsunami on Aceh, Indonesia, where more than 220,000 people perished, is a case in point, even though it had the unexpected knock-on effect of ending the more than three-decade bloody insurgency in that part of Indonesia.

Key Words: Climate Change, Southeast Asia, Indonesia, Security, Securitization

Quotes

> *"Climate change constitutes a serious threat to global security, an immediate risk to our national security, and, make no mistake, it will impact how our military defends our country".*
>
> President Barack Obama

> *"Climate change is and will be a significant threat to our national security and in a larger sense to life on earth as we know it to be".*
>
> Gordon R. Sullivan

> *"With far-reaching consequences like food scarcity, climate change is a major security challenge… It is indeed a threat multiplier, exacerbating existing pressures as well as presenting new challenges to our national security. With Pakistan ranked seventh in the list of countries who are at risk from climate change,*

* Deputy Head, Department of Political Science, National University of Singapore. Adjunct Senior Fellow, Centre of Excellence for National Security, S. Rajaratnam School of International Studies, Nanyang Technological University & President, Political Science Association, Singapore

some lawmakers have called for declaring climate change a 'national security issue' for its devastating effects".[1]

Introduction

Over the last three decades, the policy and scientific community have increasingly reached a consensus that climate change is real and can have a strong paralyzing and crippling impact on all aspects of states, including human and national security. The more regular occurrences of floods, forest fires, droughts, and earthquakes, including tsunamis and monsoons, have impacted all aspects of Mankind, putting immense pressure on states on how to deal with these non-traditional security threats. It has spared no one.

Even the developed West, located geographically mainly in the north, is faced with global warming and the threat of melting land and sea ice, including ushering in new geopolitical conflicts as new shipping lanes are opened in areas that were frozen and impassable in the past centuries such as in the Arctic region. While climate change is not really a direct cause of instability and conflict, its potential as a 'threat multiplier' cannot be ignored, where it can exacerbate existing conflicts, especially for the competition of natural resources and among different ethnic groups, thereby worsening national, regional and international instability.

Against this backdrop, this paper examines two areas that are directly linked to the issue of climate change and its threat to national security. First, it will broadly, as a backdrop, provide an overview of the discussion about climate change and the national security nexus. Second, in view of the general discussion of climate change and national security, the case in Southeast Asia, with a focus on Indonesia, will be elucidated in terms of climate change and national security.

Overview of Climate Change-National Security Nexus

First and foremost, what are some of the consequences of climate change as far as national security is concerned? Among others, this can involve the following:

- Constant extreme weather conditions through higher temperatures, frequent floods, droughts, wildfires, storms, hurricanes, and monsoons, the rise of sea level, soil degradation, and ocean acidification have negatively affected infrastructure, water, and food security
- There has been a rise of internally displaced people and international refugees
- There have been rising tensions and competition among great powers, especially as global warming has opened up new strategic routes that were unpassable in the past, as in the Arctic region
- Major powers are also negatively affected by climate change as regular floods, droughts, wildfires, storms, and desertification have impacted their military capacity and missions with many installations even destroyed or under threat of being made un-operational. In the US alone, more than half of the 79 bases are at risk from drought, while nearly half are vulnerable to wildfire (Angelo and Kaufman, 2021). The US $1 billion radar

[1] Mehtab Ali Bhatti, "Climate Change and National Security: A Looming Threat for Pakistan?", World Jahangir's Times, 6 November 2019.

installation on a Marshall Island atoll "is projected to be underwater within two decades" (Angelo and Kaufman, 2021).

-
- As developing states are increasingly threatened by climate change with knock-on effects on food and water security as well as unleashing of diseases, more states are expected to be suffering from becoming 'dysfunctional and failed states', in turn, becoming breeding groups for extremism and terrorism, and general political and military instability and insecurity.

Based on these developments, even the most powerful nation such as the United States is in agreement, as was stated in the *2010 Quadrennial Defense Review*, that climate change presents two distinct types of security threats: direct threats to government military installations and indirect geopolitical and global economic threats (Melton, 2018). In the same vein, Tom Middendorp, the former defence chief of Netherlands, noted that there was a close nexus between climate change and national security: "They all feel the impact of climate change in their daily work. In Afghanistan, water shortages led to tensions in populations, which were leveraged by the Taliban. In Somalia, we saw how the increasing number of droughts pushed poor farmers and fishers into piracy. In Mali, we saw herders and nomads forced to join extremist organizations" (Melton, 2018).

It is against this backdrop that this paper will briefly share the impact of climate in Southeast Asia, especially in Indonesia, on the security domain.

Climate Change-National Security Nexus in Southeast Asia - focus on Indonesia

Today, Southeast Asia as a whole is highly vulnerable to climate change, creating serious security issues for the various national governments and in turn, having implications for regional security at large. This is best evident by glancing at the natural disasters, mainly linked to climate-related vectors, that caused this all-round havoc, often described as the 'mother of all security issue'. This has made the issue of climate security an urgent one in the region.

Philippines: key natural disasters, 2021-2022

Natural Disasters	**2021**	**2022**
Earthquakes	Davao del Sur earthquake Davao Oriental earthquake	Luzon earthquake
Typhoons/Tropical Storms	Typhoon Chanthu Tropical Storm Choi-wan Tropical Storm Conson	Tropical Storm Ma-on Tropical Storm Megi Tropical Storm Nalgae Tropical Storm Noru

	Tropical Storm Dujuan Typhoon In-fa Typhoon Rai Typhoon Surigae Tropical Storm Kompasu	
Floods		Philippines floods
Volcanic Eruptions	Mount Taal eruptions	

Source: Compiled by Author

Two other Southeast Asian neighbours have also been badly hit by natural disasters. In 2021 and 2022, Thailand was badly hit by floods. Some nine provinces were affected in 2021, affecting more than 100,000 people. Similarly, in 2022, nine provinces in southern Thailand were covered with floods, hurting agriculture and people's livelihood. Thailand was also affected by a number of tropical storms and typhoons in 2021 and 2022. In 2021, typhoon Kompasu, Lionrock, Conson, and Koguma, affected various parts of southern Thailand. In 2022, typhoon Noru, and Ma On ravaged the country.

Thailand's neighbour, Myanmar, was also badly hit by various natural disasters in 2021 and 2022. In October 2022, Deputy Prime Minister, Vice-Senior General Soe Win, who is Chairman of the National Disaster Management Committee and Vice-Chairman of the State Administration Council (SAC), observed that between 2021 and 2022, Myanmar, due to climate change, was hit by "748 outbreaks of fire, 161 flooding, 1,502 storms, and 1,178 times of disasters including earthquakes, totaling 3,589 within 18 months. The government provided more than K3,647 million for over 1.5 million disaster-hit victims" (Infonews, 14 October 2022). Myanmar has been hit by severe floods, earthquakes and cyclones in the past. In May 2008, Cyclone Nargis ravaged the coastal parts of the country, being the country's worst natural disaster in the country that killed more than 120,000 people with damage worth hundreds of millions of US dollars.

The Case of Indonesia

Whether related to climate change or not, in the past, Indonesia has suffered gravely from natural disasters. In August 1883, the eruption of the Krakatoa Island in the Sunda Straits, was one of the deadliest and most destructive in modern history, impacting some 3000 kilometres away. Nearly 36,500 people are believed to have been killed (Simkin, 1983). In December 2004, a major

earthquake hit the western coast of northern Sumatra, killing more than 220,000 people, with more than half a million being displaced (Jayasuriya and McCawley, 2010).

Indonesia, the largest archipelagic state, with more than 17,000 islands, a land area of 1,904,569 square kilometres, a population of more than 275 million and a total coastline of 54,720,000 kilometres, is a highly diversified state all-round. Being located between the Indian and Pacific Oceans, and more dangerously, in the 'Ring of Fire', a region around the Pacific Ocean rim that is highly susceptible to volcanic eruptions and earthquakes, means that she is highly prone to natural disasters on land and sea. In 2020, Indonesia experienced 8260 earthquakes, even though this was less than the 11,500 earthquakes in 2019.

Key Natural Disasters in Indonesia

In 2020, the natural disasters that hit Indonesia included the following:

Year	**Disasters**	
2020	May: floods in Samarinda, East Kalimantan and Kapuas Hulu in West Kalimantan June: flooding in Central Java, Aceh, North Sumatra Flooding and landslides in South Sulawesi Flooding in Aceh July: flooding in Sulawesi and Maluku islands Flooding in West Kalimantan Flooding in Aceh and Bengkulu Provinces August: flooding in Central and South Sulawesi provinces September: flooding in West Sumatra, West and Central Kalimantan provinces September: flooding in West Papua province Flash floods hit West Java November: flooding in West and Central Java, West Nusa Tenggara and Aceh province December: flooding hit central Java, Banten, Sulawesi and Aceh provinces	

Source: Compiled by Author

The number of natural disasters increased from 2925 in 2020 to 3,034 in 2021 (Xinhua, 27 December 2021). The natural disasters in 2021 caused the death of 662 people and affected 8.3 million people. As in 2020, floods were the main sources of natural disasters, accounting for one-third of the total, followed by whirlwinds, landslides, forest and land fires, tidal waves, earthquakes, droughts and volcanic eruptions. Natural disasters in 2021 injured more than 14000 people with 95 still missing. Most of the impact area of the disasters was in Java where more than 60 percent of the Indonesian population live, with 749 natural disasters in West Java, 384 in East Java, 304 in Central Java and 214 in Aceh in the island of Sumatra. Due to natural disasters in 2021, the final losses in Indonesia amounted to about US$1.4 billion (Xinhua, 27 December 2021).

Compared to 2020 and 2021, 2022 saw a marked rise in the number of fatalities due to natural disasters. In 2022, around 900 people were killed or reported missing due to natural disasters, with the November 2022 earthquakes in West Java alone accounting for about 600 deaths (Antara, 29 October 2022). The number of natural disasters also rose to nearly 3500. Up to October 2022, there were 1,238 flood events, 931 extreme weather events, 562 landslides, 248 forest and land fires, 22 tidal waves and abrasion, 22 earthquakes of volcanic eruptions and four drought events (Antara, 29 October 2022).

Nexus of Climate Change and National Security in Indonesia

The list of natural disasters enumerated above is clear evidence that natural calamities have been increasing gradually in Indonesia, a trend also evident elsewhere in Southeast Asia and probably elsewhere. There are a number of related questions: first, are the increasing number of natural disasters due to climate change? Second, have the increasing natural disasters led to issues related to national security. In a way, both questions are difficult to ascertain definitely. Also, related to the second question, there is probably a widening of the concept of security and this may lead many to make a clear link between natural disasters, climate change and national security.

Putting aside these questions, based on existing literature, one can make a case that climate change is having an impact on national security in Indonesia, even though the extent and scale of it may differ from crisis to crisis in different contexts. What is clear is the rising helplessness of states to deal with these climate change-related crises that are affecting people negatively, including rising tensions within and between states. Various reports have highlighted how climate change have affected national security. A 2016 report listed six ways in which climate change can impact national security including posing "threats to the stability of countries, heightened social and political tensions, adverse effects on food prices and availability, increased risks to human health, negative impacts on investments and economic competitiveness, and potential climate discontinuities and second surprises" (White, 2020: 323).

Extrapolating from this, there is some evidence that natural disasters, partly induced by climate change, can have national security implications in Indonesia. This is alluded by the cases below:

2004 Aceh Tsunami: facilitated the ending of a twenty-year Islamist insurgency

Droughts and Starvation in Papua: facilitated the escalation on the 50 years-old low-level conflict in the highlands of Papua

Recurrent Floods: undermine the image and credibility of the regional and national governments

Recurrent Earthquakes: undermine the image and credibility of the regional and national governments

Intermittent volcanic eruptions in Java, including in Central Java: undermined the image and credibility of the regional and central government, including providing extremist groups the opportunity to exploit the crisis by winning adherents to their cause

Forest fires and haze: negatively affected the local and national economies, undermining the regional and central governments' capabilities as well as negatively affecting Indonesia's relations with Malaysia, Singapore, Brunei and to some extent Philippines

The Weaponization-Securitization of Climate Change-related Natural Disasters

Indonesia has long tried to decouple the concept of national security and national defence, with the former placed within the domain of the police and the latter with the military. Yet it is clear that the attempt to dichotomize the two concepts is largely an artificial one due to the continuous osmosis between the two with security no longer simply affecting the military but also politics, economics, social-culture as well as the environment. Yet, almost day in and day out, Indonesian security is under challenge in one way or another from within due to climate-change-related issues.

For instance, Dwikorita Karnawati, the Indonesian Head of the Meteorology, Climatology, and Geophysics Agency, warned that "extreme events and hydrometeorological disasters have made agricultural and fishery activities more vulnerable to disruption and failure, and they have even threatened the productivity of crops and fishing, as well as the safety of farmers and fishers" (Antara, 8 August 2022). At the same time, "sea level rise threatens to drown the small islands, erase baseline territorial islands that establish Indonesia's Exclusive Economic Zone (EEZ), exacerbate catastrophic disasters such as flooding in their large urban cities, and inundate critical coastal zone that is necessary for the domestic crop production" (Antara, 8 August 2022).

In short, climate change is causing existential threat issues that were in the past associated with national security or not even included in the domain of what constitutes national security. While the military can attempt to defend the national borders from attacks by foreign troops, changes in weather patterns, especially causing either too little or too much rainfall and the rise of global temperature, can negatively affect farming and contribute to floods, flash floods, and landslides, in turn, causing massive harm during rainy seasons and severe drought during dry seasons.

In the case of Indonesia, there are four interrelated security issues linked to climate change. First, has been the worsening of the insurgency situation in Papua, partly linked to the worsening human security situation in the largely mineral-rich but poor agricultural territory. With the worsening security situation, partly caused by the poverty of the people located in a rich land that is being exploited by Indonesians and their foreign counterparts and the havoc caused by the weather, many Papuans have migrated to neighboring Papua New Guinea, which has negatively affected Indonesia-Papua New Guinea relations while boosting the strength of the rebel groups operating on Indonesia's borders.

Second, Indonesia's security situation has been partly worsened by climate-change issues elsewhere. A case in point is the worsening floods that have hit Myanmar and Bangladesh, in part, exacerbating the Rohingya situation, which in turn, have led to some 200,000 Rohingya refugees being based in Sumatra. Many of these Rohingyas have fallen prey to extremist and radical groups in Indonesia, such as the pro-Al Qaeda Jemaah Islamiyyah or the pro-Islamic State Jemaah Anshorut Daulah.

Third, due to the new challenges thrown up by climate change, Indonesian radical groups such as the Hizbut Tahrir Indonesia (HTI), which was banned in 2017, have tried to weaponize the issue of climate change as a source to challenge the Indonesian government and its legitimacy. Many of the former activists of the pan-Islamist HTI have devised a climate narrative, legitimizing the global caliphate, to undermine Indonesia and its existing political system. Despite the 2017 ban, the HTI activists have continued their activities under new names and organizations, including a monthly magazine called *Al-Waie*, to reach out to the young urban educated who tend to form the core members of HTI and who tend to resonate with HTI's ideological appeal.

The HTI climate appeal includes the notion that climate change is real; that the climate has been affected by uncontrolled carbon emissions caused by extensive industrialization, deforestation, and use of fossil fuels, partly causing the sea-level rise that is threatening to 'sink' Jakarta, the capital city; that the West's secular capitalist ideology and practices are the key enablers of climate change as the human-centric ideology of trade liberalization animated capitalism that led to profiteering that caused environmental degradation; and that the fight against climate change will not succeed until secular capitalism was destroyed (Alvian, 19 August 2022).

Using these climate-linked narratives, the HTI has been able to exploit various grievances in the country, as part of the effort to delegitimize the present government and the political system and push forth the global caliphate system. While the HTI may not succeed in doing so in the short-term, it is , nevertheless, a powerful source of opposition to the West and as Indonesia prepares for the 2024 general and presidential elections, narratives of this nature, albeit at a time of continuous natural disasters, would be able to resonate with whichever political party or presidential candidate the HTI throws its support behind, thereby weaponizing, politicalizing and even securitizing climate change within the context of Indonesia. This is all the more as the government will be in a difficult position to label the HTI as an unpatriotic or extremist group as the group is championing national causes that are of grave importance to Indonesia, and hence, the rise of new issues linked to climate change and national politics with serious security implications.

Fourth, Indonesia is a key exporter of 'bad air' to Southeast Asia, especially to Malaysia, Singapore, Brunei, and the Philippines. This has been ongoing, especially during the summer months, brought about by the 'slash and burn' practice of deforestation in Sumatra and to some extent, Kalimantan. The consequence of this climate-change-related man-made and sometimes, nature-induced pollution export is that it has blanketed Indonesia's neighbours for weeks, and created tense Indonesia's bilateral ties with the countries on the receiving end of the haze (Desker, 2015).

Conclusion

Clearly, the debate is no longer about the link between climate change and national security, but more, about how much climate change has impacted upon security. The continuous forest fires,

floods, blizzards, etc. in the Western world also signal that this is no longer an issue of the Third World but of what can be seen as the 'security of the one-world'. More importantly, climate change has directly led to severe geographical conditions that have undermined human security. Its impact on the ecosystem, natural resources, human settlements, spread of diseases, etc. has undermined the well-being of human beings on a large scale that it is threatening domestic stability, providing fertile grounds for the radicalization of national politics, threatening national security, which in turn, can undermine regional security. What science and studies have made clear is that climate change has undermined national security through a wide variety of means, viz. environmental degradation, compelling human internal and external migration, loss of arable land and drinking water, rising desertification, and pollution in general. In turn, this has weakened various aspects of the national economy and in turn, harmed political and social stability. While each political unit may confront this pandemic differently, eventually the 'one-world' is in this harms-way together and no one state can address these issues alone, and hence, the all-important mantra of the need to work together. Only an integrated approach at the national and regional levels will be able to develop sustainable modes that can provide climate security and in turn, ensure the sustainability of human security.

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Impact of Climate Change on the Hard Power of Pakistan: Implications for National Security of Pakistan

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Abstract

Pakistan is among the most affected countries by climate-induced disasters, and the recent flood has damaged the Pakistani economy. Climate Change is going to impact the hard power of Pakistan significantly. Hard power consists of two elements: economic power and military power. Climate change impacts economic power significantly because, due to climate change, Pakistan lost 10 percent of its GDP. As military power is a function of economic power, the damage to the Pakistani economy due to climate change can impact its military power due to a lack of resources for buying military equipment. Furthermore, Climate Change impacts the agriculture sector in two ways. First, it damages crops due to extreme weather events. Secondly, in the long turn, agriculture productivity will decline in Pakistan. The agriculture sector plays an essential in the economy of Pakistan, and the decline in Pakistani agriculture production will impact the economy and food security. The world is going through geopolitical competition, and states, especially India, are modernizing their weapons systems, such as the S-400 missile defense system and Rafale aircraft. Pakistan's lack of military spending is going to have severe implications for the national security of Pakistan. This study focused on the climate change effect in the context of hard power elements that will affect the national security of Pakistan.

Keywords: National Security, Climate, Hard Power, Economic Power, Military Power

Introduction

Climate change is expected to have a significant impact on the economic and military aspects of Pakistan's hard power, which will have implications for the country's national security. Changes in the average annual temperature and the frequency of extreme weather events are called "climate change." They have been occurring for decades. Natural causes, such as the sun's cyclical changes, might be at play here. Human activities, in particular the utilization of fossil fuels like charcoal, petroleum, and gas, have been a significant cause of global warming since the 1800s. The combustion of fossil fuels produces greenhouse gas emissions. These stop the gasses, trapping the heat from the sun and making the planet too hot (Nations, 2022). The increasing rate of recurrence and intensity of natural catastrophes such as floods, droughts, storms, and heat waves are among the most severe repercussions of climate change on developing nations. Examples include the 2017 South Asian floods that killed thousands and displaced millions.

One of the most significant economic impacts of climate change on Pakistan's hard power is related to agriculture, the primary source of income in many developing countries, which suffers when harsh weather strikes (UNDP, 2020, p. 2). Pakistan is heavily dependent on its agricultural sector,

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which accounts for a significant share of its GDP and employs a large portion of its population. However, as climate change leads to more frequent and severe droughts, it is likely to have a significant impact on crop yields, which could lead to food shortages, inflation, and economic instability. Drought and food insecurity are two effects of the interconnected problems of climate change and water shortage. Because of increased evaporation and lower soil moisture, agricultural yields and animal output fall as temperatures rise. Other factors reducing agricultural output include the effects of climate change on precipitation patterns, such as the increasing frequency of severe rains and protracted dry periods that cause waterlogging and soil degradation (Ipcc, 2022). Pakistan can also face a significant impact due to climate change.

Although Pakistan produces less greenhouse gas, Pakistan is among the countries highly impacted by climate Change. Pakistan's share of global greenhouse emissions is 0.6; however, it is among the 8th most vulnerable countries globally. (Ahmed, 2022) It is going to impact the hard power of Pakistan. States care about relative power, and then the increase and decrease in the power of other countries will also impact other countries.

This study attempts to understand the impact of climate change from the perspective of Pakistan and its impact on the hard power of Pakistan. This study also tries to decipher the impact of climate change on the economy. Hard power is a term used to describe the use of military and economic tools to achieve a country's foreign policy objectives. It includes using force or coercion to influence the behavior of other countries. There is a close relationship between military power and economic power. A country's economic strength is often a key determinant of its military capabilities, as it provides the resources necessary to support military research and development, procurement, and personnel training.

In turn, military power can help protect a country's economic interests by ensuring access to critical resources and trade routes. One study by the Stockholm International Peace Research Institute (SIPRI) found a strong correlation between a country's economic power and military spending. The study found that the world's top 15 military spenders in 2020 accounted for over 80% of global military spending and were among the world's largest economies (SIPRI, 2021). Sates are also concerned about the relative gains in International relations (Powell, 1991). Therefore, an increase or decrease in the power of one state impacts other states as well.

Different authors have discussed the impact of climate change in different ways. Some authors have discussed the impact of climate change on agriculture(Syed et al., 2022). Authors have also discussed the impact of climate change on food security(Raj et al., 2022). Authors have also discussed the impact of climate change on the chances of increasing hunger and food supply problems due to climate change (Parry et al., 2005). This

The first section discusses the conceptual study framework and its application in Pakistan. This study will further discuss the impact of climate change on the economy, and then it will discuss the impact of climate on military power. In conclusion, this study discusses climate change's impact on Pakistan's national security, especially in the traditional and non-traditional domains.

Conceptual Framework

The United States military and security establishment promoted the idea of climate change as a "threat multiplier" around the turn of the 21st century. The Center for Naval Analyses commissioned and funded the 2007 paper "National Security and the Danger of Climate Change," written by a group of retired military officials and national security specialists, which first

suggested the concept(Corporation, 2007). The paper said that in many regions of the globe, climate change would serve as a "threat multiplier," adding to existing political, economic, and social tensions and perhaps leading to conflicts over resources like water and food. Since then, the term "climate threat" has been frequently used in the military and security communities to describe the possible effects of climate change on international stability(Corporation, 2007).

The concept of "Climate Change as a Threat Multiplier" is based on several key assumptions about the relationship between climate change and security. These assumptions include that climate change can exacerbate existing security challenges and interact with other social, economic, and political factors to increase the likelihood or severity of conflicts, resource competition, and humanitarian crises (Hagmann & Merten, 2013). Environmental challenges can lead to social and political instability: Environmental challenges such as water scarcity, food insecurity, and natural disasters can increase social and political tensions, leading to conflicts over resources or migration (Salehyan & Hendrix, 2014).

Climate change can impact economic stability because it can increase the frequency and severity of natural disasters, which can disrupt supply chains, damage infrastructure, and cause economic losses (IPCC, 2014, p. 110). Climate change can affect military readiness and effectiveness: Climate change can limit access to resources, such as water and energy, and increase the risk of operational disruptions due to extreme weather events, impacting the ability of armed forces to respond to security threats (US Department of Defense, 2014, p. 3). These assumptions are based on a growing body of research on climate change's complex and interconnected nature and security. They suggest that addressing the security implications of climate change will require integrated and adaptive responses considering the full range of social, economic, and environmental factors contributing to security risks.

The climate multiplier concept emphasizes the interconnectedness of different systems and the importance of understanding and addressing the feedback loops that can exacerbate the impacts of climate change. By addressing these feedback loops, it may be possible to mitigate the worst effects of climate change and build more resilient and sustainable systems that can adapt to a changing climate.

Climate Change as a threat multiplier in the Context of Pakistan

The "climate multiplier effect" refers to the exacerbation of existing challenges and vulnerabilities, including those related to hard power, due to the impacts of climate change. In the case of Pakistan, which faces a range of security challenges related to its hard power, the climate multiplier effect could have significant implications. Pakistan faced multiple natural disasters and heat waves due to climate change, including floods in 2010 and a recent flood in 2022, and these floods will increase due to climate change. Climate change is multiplying the risk of these threats multiple times. Climate change is expected to increase the risk of extreme weather events 30 times more than expected (McGrath, 2022).

Pakistan's economy faced many challenges, and the inflation rate was high. In March 2022, the inflation rate in Pakistan was around 15 per cent (Maryam, 2022). In September 2022, the inflation rate was around 25 percent; however, climate-induced floods multiplied this inflation, and the cost of some items increased by 500 per cent (Tewari, 2022). Pakistani economy, which was facing challenges, further bore a loss of USD 30 billion, and according to one estimate, floods removed 10 per cent of countries GDP (Xinhua, 2022). Military power is the function of economic power;

therefore, the decline in economic power will also impact Pakistan's military preparedness and relative military capabilities, which will have significant implications for Pakistan's national security.

Climate Change Impact on the Economy

Climate change has significant implications for the Pakistani economy in every aspect (Dawn.com, 2022). The impact of Climate change on the Pakistan economy could be short-term and long-term. Pakistan, a warm region, is especially vulnerable to atmospheric changes since its temperatures are higher than the global average. Most of the country is dry and semiarid (around 60% of the area receives less than 250 millimeters of rain annually, with the remaining 24% receiving between 250 and 500 mm), while Hindu Kush-Karakoram Himalayan glaciers provide the majority of the nation's rivers. Due to global warming, they are fast disappearing, making the economy extremely susceptible. (Syed et al., 2022) Pakistan is especially vulnerable to climate change because it affects agriculture and people's ways of living. It is the 12th country most severely affected by climate change.(Awan & Yaseen, 2017) The agriculture sector is significant in Pakistan because it plays a huge role in Pakistan's economy and employs the people.

Pakistan's arable land is currently under cultivation as the nation works to provide its rapidly expanding population with food security that can be sustained. Temperatures have risen due to climate change, causing rapid changes in rainfall patterns directly related to agricultural output, water availability, and forest resources. As shown by the severe drought and catastrophic floods that destroy infrastructure and agricultural plains alike, the distribution and intensity of rainfall have altered significantly. Like most nations, it depends on producing arable crops in semiarid regions.[1]

According to the Pakistan Bureau of Statistics (PBS), agriculture contributes 24% of the GDP and provides employment to half of the country's labor force. Furthermore, it is a vital source of the country's foreign exchange. [2] In 2021, over 22.67 per cent of Pakistan's GDP was derived from agriculture, 18.8 percent from industry, and more than half came from the services sector (O'Neill, 2023).

According to the study, damages of over USD 14.9 billion and overall economic losses of about USD 15.2 billion are projected. To aid in the country's adaptation to climate change and overall durability in the face of future climatic shocks, Pakistan is estimated to require at least USD 16.3 billion for rehabilitation and rebuilding in a resilient manner. (Bank, 2022) The housing market lost $5.6 billion, the agriculture and livestock market lost $3.7 billion, and the transportation and communications market lost $3.3 billion. With nearly 70% of overall damages and losses, Sindh is the most impacted province, followed by the other three provinces. (Bank, 2022).

Pakistan has long felt the consequences of climate change. Many devastating floods occurred between 2010 and 2014. The 2010 floods were the worst natural disaster in Pakistan's history, causing $10 billion in damages and a 10% rise in food insecurity. While being felt throughout many industries, the consequences of climate change are more severe in the agricultural sector. Agricultural output in Pakistan is predicted to fall sharply in the following decades. The research

[1] (Syed et al., 2022), p. 7.
[2] PBS, "Agriculture Statistics | Pakistan Bureau of Statistics," Official Website, Pakistan Bureau of Statistics, 06-05-2022, https://www.pbs.gov.pk/content/agriculture-statistics.

predicted that by 2040, Pakistan's agricultural output would drop by 8-10% due to climate change, with wheat being one of the most hit crops(Ramay, 2022).

Furthermore, industrialization is crucial for countries with weaker economies like Pakistan. To create final products, industries need raw materials. Manufacturing in Pakistan relies on agricultural exports for its supply of raw materials. Pakistan's leading agricultural export is cotton, an important agricultural crop. It is a crucial component in producing clothing and other textiles(Falcon, 2022). These textile industries generate foreign cash by exporting their wares to other nations. Farming also includes raising livestock. Supplying raw materials to sectors like the sports goods and leather industries also plays a vital role in the export of commodities. Hence, agriculture contributes to Pakistan's economic growth and development (Falcon, 2022).

Impact on the Military Power

Heat waves, record-breaking temperatures, and a general trend towards higher mean and rising daily maximum temperatures pose severe risks to military personnel and equipment during training exercises and other military operations(Wang et al., 2021). This has been brought up in the research on climate change and geographical concerns for the Indian military. Thus, it may be applied with some degree of generality to the Pakistani army. Reduced functioning and increased maintenance costs of mechanized weapon systems may affect operations. Hence, military security is jeopardized because of diminished crisis response capacities, operational preparedness, and border patrolling capabilities, among other sectors(Gülenç, 2022).

When it comes to operational preparedness, climate change's indirect challenges to Pakistan's military security are expected to have a negative influence on force capacity. These dangers are made possible by the risk of flooding and its consequences, and the increasing frequency and intensity of catastrophes result from overlapping manifestations of climate change(Raza & Kandhro, 2015). A nation's armed forces are often enlisted to aid with Humanitarian Aid and Disaster Relief (HADR) operations after any catastrophe(Raza & Kandhro, 2015).

The frequent and robust military involvement in disaster management in Pakistan makes this aspect of society vulnerable. The military was instrumental during the 2005 earthquake and the 2010 floods. Also, the effects of climate change are exacerbated by the deterioration of civilian infrastructure, such as water supply and electrical networks. As future operational conditions may be impacted by climate change, evaluating the robustness of military estates' infrastructure and army equipment is essential. (Shaheen, 2021)

Pakistan's military has been in increased danger due to the country's warming tendencies and rising mean and daily average temperatures. Heat-related severe events are expected to become 5.6 times more likely every decade worldwide, even in the most conservative warming scenarios. (Haider & Sultan, 2022)

Moreover, Pakistan and India are located opposite one other in the most militarized zone. Therefore, Pakistan's military confronts the same risks as India's military. The first danger is the melting of glaciers, which poses a greater risk to soldiers' lives and deploys forces. Ten Indian soldiers were killed in 2018 by an ice avalanche. Undoubtedly, global warming had a role in this Siachen Glacier incident. In Pakistan, a similar thing occurred, although it was far worse. In 2012, 140 individuals, including 120 members of the military forces, were killed when an ice avalanche struck a Pakistani installation in the Gayari sector of the northern glacial area (Haider & Sultan, 2022). Furthermore, a bad economic situation can create multiple challenges for Pakistan in

maintaining a conventional balance with India, as its economy is bigger than Pakistan(Hussain, 2023). On the military side, climate change could impact Pakistan's national security in several ways. For example, changes in weather patterns could impact the country's ability to conduct military operations, particularly in remote areas. Additionally, climate change could impact Pakistan's maritime security, particularly as sea levels rise and the risk of flooding increases. This could impact the country's naval bases and ports, which could limit its ability to project military power in the region.

Discussion: Impact on National Security

This study found that the impact of all these changes will create implications for Pakistan's National Security in two domains. Pakistan released a National Security Policy 2021, which talked about providing comprehensive National Security to Pakistan. This National Security Policy states the importance of economic strength for providing security against traditional and non-traditional threats.

Around the world, military spending is increasing. In 2021, the world's military budget hit a new record high of $2.1 trillion. The growth in expenditure continued for the sixth year in a row (SIPRI, 2022). However, in Pakistan, in yet another effort to adjust financial policies and secure the essential IMF agreement, Pakistan has planned to reduce the defense budget by 35%. The military has agreed to cut one-third of its budget to meet the government's austerity requirements (Usman, 2023).

Furthermore, the US and India are conducting technological deals. US and Indian officials agreed to increase their collaboration in areas such as sophisticated weapons, supercomputing, semiconductors, and other high-tech industries to counter China's supremacy in these areas. The agreements were reached after two days of high-level meetings in Washington between government officials and executives from dozens of companies, the first under a new dialogue about critical and emerging technologies announced by President Biden and India's prime minister, Narendra Modi (Swanson, 2023). Besides the deal with the US, India is also increasing its defence budget.

The budget for the next fiscal year, which began on February 1, 2023, anticipates a total expenditure of 45.03 trillion rupees. Almost 13% of the overall budget, or 5.93 trillion rupees, has been set aside for the military (Raghuvanshi, 2023). The second impact of climate change on the economy will make defence spending difficult and unpopular. India is a bigger country than Pakistan regarding national power(Dwivedi, 2008). Therefore, the decline in the economic growth of Pakistan can exacerbate threats for Pakistan. Furthermore, technological development will more quickly.

Technical progress related to military innovation may occur quickly and have a more significant impact than in the past. Importantly, given the current rate of computer invention, the next two decades may be much more revolutionary than the previous two. Future robots and cyber security developments may be much more dynamic than anticipated. More use might be made of them by 21st-century military establishments. They will also have significant implications for artificial intelligence (AI). Looking back over the last 20 years hints at the possibility of such a quickening (O'Hanlon, 2018, pp. 2020–2040). Artificial intelligence algorithms use in the military, particularly in object identification, cybersecurity, robotics, and logistics (Bistron & Piotrowski, 2021). In the long run, Pakistan's conventional military balance will be hurt by its economy, while India's options will grow (A. Qureshi & Jalil Shah, 2019). The importance of R&D in producing new technologies

and having a competitive edge in new technologies(Sarpong et al., 2022). Pakistan's research and development spending has consistently remained low. Pakistan spends a smaller percentage of its GDP on research and development. During 2005-2017, the average annual growth rate was a paltry 0.38%(Jawaid, 2020). Due to climate change, this might further decline.

In addition, natural disaster relief efforts also engage the Pakistan military. Pakistan's military is already facing a bigger enemy on the Indian border. Furthermore, it is also conducted anti-terrorism operations across the country. Prolonged engagement in natural disaster efforts can burden it (Tribune, 2022).

In the non-traditional domain, climate can exacerbate threats. According to the Human Development Index, Pakistan is ranked 144 out of 187 countries (Ahmar, 2022). It shows that human security in Pakistan is already going turbulent (Niazi, 2022). The Global Hunger Index (GHI) put the country at 92 out of 116 in 2015, with a significant hunger level. Despite having enough food, Pakistan still needs to be in a food security position (Niazi, 2022).

A 2019 study by the State Bank of Pakistan (SBP) found that approximately 37% of families in Pakistan are food insecure, despite the country ranking 8th in wheat output, 10th in rice production, 5th in sugarcane production, and 4th in milk production. The situation has remained the same in the three years following the SBP's report (Niazi, 2022).

Climate Change is going to multiply the threat to food security in Pakistan. More than 1,100 people have died, and over 33 million have been impacted by the floods, which have inundated a third of the nation. According to the Ministry of planning, the estimated recovery cost is more than $10 billion (AFP, 2022). In addition, Pakistan requires around 30.8 million tonnes of wheat annually since it is the country's most significant source of fiber and a major factor in its food security. Mid-March heat waves and rising fertilizer prices accounted for over two million tonnes of lost production, compared to the season's goal of 28.9 million tonnes (Malik, 2022). As 40% of the population already struggles with persistent hunger, this is a significant national issue (Malik, 2022).

Furthermore, since marine and freshwater fisheries are major economic drivers for many communities in Sindh and Punjab and, in some cases, the region's sole access to animal protein, the expected loss in fisheries due to climate change has significant societal repercussions. The fishing communities of Sindh and Balochistan are facing a reduction in future fishery harvest since their income has fallen, and they cannot buy as much food (Hasnain, 2010). Pakistan has one of the youngest populations. Due to dire economic conditions, the unemployment rate was also high. Climate Change further exacerbates unemployment because it damages the agriculture sector in Pakistan(ANI, 2022). In addition, it can also impact the secondary industry because agriculture provides raw materials.

Food insecurity can increase the national security challenges for Pakistan. The ability to provide food is one of the basic physiological. Food insecurity raises legitimate complaints and the need for government intervention. Those dissatisfied with their government might find an outlet for their frustrations in terrorist organizations, which helps them take collective action and rally others (Bellinger & Kattelman, 2021). Pakistan is facing the challenge of terrorism, and terrorist organizations can easily find recruits in youth. Therefore, it can increase the national security challenges for Pakistan. Therefore, climate change could also exacerbate existing security challenges in Pakistan, particularly terrorism and political instability. As climate change leads to

resource scarcity and displacement, it could create new opportunities for extremist groups to exploit vulnerable populations and expand their influence. This could lead to increased instability and conflict, which could impact the country's national security.

Conclusion

This study discusses that climate change is a threat multiplier for Pakistan because it can exacerbate existing threats and create new ones. In the case of Pakistan, climate change is increasing the threats to the country's national security in both the traditional and non-traditional domains due to the impact of climate change on the hard power of Pakistan. In the traditional domain, it can impact military training and preparedness due to the heatwave. Secondly, it can increase the military's role in disaster relief of the Pakistan army, which is already fighting the war on many fronts. Furthermore, it can also impact the capability of Pakistan's army because it will not be able to increase its defence budget and include a new weapons system. It will have implications for Pakistan's national security.

The conceptual framework for the climate multiplier effect on Pakistan's hard power highlights the complex interplay between climate change impacts, vulnerabilities, adaptive capacity, policy responses, and regional dynamics. Addressing these challenges will require a coordinated and comprehensive approach that addresses the root causes of vulnerability and promotes resilience across multiple sectors.

In the non-traditional domain, Pakistan will face many issues due to the impact of climate change on agriculture. Agriculture plays an essential role in the economy of Pakistan. Agriculture is also an important source of food security in Pakistan. Pakistan was already a food-insecure country; however, climate change further increased food insecurity. Food and other challenges can pose significant challenges to Pakistan's national security. Climate change is likely to lead to increased migration and displacement, as people are forced to move due to environmental disasters and resource scarcity. This can create new challenges for Pakistan's security institutions, as they must deal with the influx of refugees and ensure that they do not pose a threat to national security.

Hence, the impact of climate change on the economic and military aspects of Pakistan's hard power will have significant implications for the country's national security. It will require a coordinated effort by the government and other stakeholders to address these challenges and ensure that Pakistan is able to maintain its security and stability in a rapidly changing world.

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Climate Change Impact on Top Ten African Economies with Focus on Agriculture: Challenges and Response

Tariq Khan*

Abstract

Climate change is a serious issue that affects every aspect of society, including agriculture and the economy. The study's goal was to examine how climate change will affect the top 10 African economies, with an emphasis on the agriculture sector. The study has used a comparative approach to examine the experiences of these Top Ten African States and assessed the responses of their governments to the challenges posed by climate change from 2018 to 2022. The results revealed that all countries faced challenges such as decreased agricultural productivity, water scarcity, and increased pests and diseases. To combat these challenges, governments implemented various policies, including investing in renewable energy, promoting climate-smart agriculture, improving irrigation, and sustainable land management. Additionally, policies were aimed at increasing access to climate finance, developing climate-resilient infrastructure, and promoting public awareness of climate change. However, there is still a need for further policy development and investment in research and development. Overall, the findings suggest that effective policies and investments are necessary for mitigating the impact of climate change on the economy and agriculture.

Keywords*:* Africa, Agriculture, Climate Change, Challenges, Economy, Impact, Response.

Introduction

Climate change is affecting agriculture and the economy, particularly in Africa, where the agricultural sector has been severely impacted. Crop patterns have changed, crop yields have decreased, and pest and disease outbreaks have increased, leading to reduced productivity, economic growth, and increased poverty.

This study aims to examine the impact of climate change on the Economy with a focus on the agricultural sector of the top ten African economies using a comparative approach. It will assess their experiences over the last five years; evaluate their responses to the challenges posed by climate change, and identify countermeasures of its negative effects on agriculture and the African economy. The top ten African economies including Egypt, Nigeria, South Africa, Algeria, Morocco, Ethiopia, Kenya, Ghana, Tanzania, and Angola as well as the consequences of climate change on agriculture will all be examined in this study. Important indicators and sub-indicators will be used to provide a comprehensive understanding of the effects on the economy focusing on the agricultural sector.

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The top ten economies in Africa will be used in this study to assess the effects of climate change on the agriculture sector and economy using both qualitative and quantitative research methodologies. Together with a review of the available databases and publications, in-depth interviews with experts, decision-makers, and business owners will be undertaken. The study intends to give a thorough understanding of the effects of climate change and to pinpoint strategies to lessen adverse effects. The results will help us comprehend the effects of climate change and guide policy decisions.

So, the study has taken into consideration the following research questions that might explore the relationship between climate change and its influence on the African economy, particularly the impact of climate change on the African economy due to the agriculture sector:

1. How has climate change impacted the Top Ten African economies, particularly agriculture, in the last five years?
2. How have these countries' governments responded over the past five years to the problems that climate change has caused for agriculture and the economy?
3. What steps can be implemented to lessen the damaging effects of climate change on these African economies' agriculture and economies?

Research Methodology

This study used a mixed-methods approach, gathering qualitative data through in-depth interviews and quantitative data through secondary data analysis.

Data sources: This can include primary sources including interviews and secondary sources such as government data, published articles, and tertiary sources such as books, and websites.

Sample size and selection: This study has chosen the top ten African economies focusing on indicators of the impact of climate change on the agriculture and economy of each state from 2018 to 2022, the last five years. I have taken two interviews with scholars from each state.

Data collection procedures: The procedures used to collect data, including the instruments or tools were interview questions and the mode of data collection was online.

Theoretical Framework and Analytical Model: In order to assess and analyze the effects of climate change on the economies of the top ten African economies—Nigeria, South Africa, Egypt, Algeria, Morocco, Ethiopia, Kenya, Ghana, Angola, and Tanzania—the research implemented a comparative method with a focus on the agricultural sector. The study will explore the similarities and differences in the challenges faced and response strategies implemented by these countries, and identify country-specific factors that may be contributing to the different experiences and outcomes. The comparative method will enable a study of the connections between environmental and economic elements and how these connections differ between geographical locations.

Limitation: Conducting a comprehensive study on the impact of climate change on the African economy is a complex and time-consuming task, and the time frame for this study may not be sufficient to fully explore all the relevant factors. Limited funding may limit the scope of the study, including the number of regions that can be analyzed, the number of respondents interviewed, and the level of detail that can be included in the analysis.

Literature Review

The literature review shows that Africa's growing market is expected to experience rapid economic growth, infrastructure expansion, and global connection, but its economies are vulnerable to the effects of climate change. Even if global warming is limited to 1.5C, African countries could see a significant reduction in GDP growth rate. The continent is most impacted by disastrous climate changes such as sea level rise, glacier melt, droughts, wildfires, floods, and heat waves. (World Bank, 2022)

Nigeria is highly exposed to climate change with recurring environmental disasters that are impacting food production and causing human suffering. (World Bank, 2022) The country is collaborating with domestic and international organizations to create decarburization pathways. However, coordination between Nigerian ministries and agencies is poor, with climate change not regularly integrated into governmental strategies. (Baxter et al, 2022)

South Africa is mainstreaming sustainable and climate-resilient development into its policy environment, driven by expanding industries like clean energy, low-carbon transportation, water management, circular economy, and intelligent agriculture. (Cassim et al., 2020) To meet its NDCs, South Africa will need to invest R8.9 trillion over 15 years, with an annual investment of R596 billion required to reach the 2030 target. (Ray, 2021)

Egypt's agriculture is highly vulnerable to climate change due to extreme temperature variations, heat waves, desertification, and droughts. By 2050, crop yields are expected to decline further, posing a threat to food security and causing severe economic disruptions. Climate change is estimated to cost the Egyptian economy $55.3 billion between 2020 and 2050. (Fatma Barakat et al., 2022)

Algeria is becoming more vulnerable to climate change due to harsh weather events and prolonged droughts, resulting in desertification affecting over 50 million hectares and forcing rural populations to move to cities. On the other hand, Morocco can benefit significantly from investing in climate action by generating new jobs, reviving rural areas, and positioning itself as a center for the green industry, while achieving its larger development goals. (World Bank, UN, 2022; Bensmaine, 2022)

Kenya is open to climate-related hazards such as heat waves, droughts, floods, and landslides. These hazards are becoming more frequent and severe as a result of climate change. The National Climate Change Action Plan lists a number of these hazards and paves the way for the National Adaptation Plan (NAP) 2015-2030 and Kenya's Nationally Determined Contribution (NDC) in compliance with the Paris Agreement of the United Nations Framework Convention on Climate Change. (NCCAP Report, 2021)

Ethiopia is particularly susceptible to drought, which can lead to food shortages, malnutrition, and instability. Ethiopia has created climate change strategies that emphasize both adaptation and mitigation, with a focus on increasing the use of climate-smart agriculture (CSA) in agricultural production. (Bizikova et al., 2022, Country Diagnostic Report: Ethiopia)

Ghana's economy heavily relies on natural resources, such as gold, cocoa, and oil, which make it vulnerable to the negative impacts of climate change. Environmental deterioration costs Ghana USD 6.3 billion, which is almost 11% of the country's 2017 GDP. Agriculture, which is the

backbone of Ghana's economy, is highly dependent on rainfall and lacks irrigation facilities, making it susceptible to climate change. (AfDB, 2022)

Angola is highly vulnerable to climate change impacts, with almost half of the population at risk from rising sea levels, and 85% of adults working in agriculture face the threat of flooding and drought (USAID, 2018; World Bank Group, 2022). The country ranks 154th out of 182 nations in the Notre Dame Global Adaptation Initiative's Country Index, making it one of the world's most susceptible and least prepared countries. (Amakoh, 2022) However, the government has established a National Committee on Climate Change and Biodiversity and a Climate Change Office to integrate climate adaptation into national development goals (World Bank Group, 2022). Tanzania is also experiencing climate change impacts, such as droughts and floods, which have adverse economic and social effects and hinder the country's progress toward sustainable development and poverty reduction (World Bank, UN 2022). Tanzania's nationally determined contribution (NDC) outlines adaptation and mitigation measures to improve resilience to climate impacts and reduce greenhouse gas emissions (Nationally Determined Contribution Report, 2021).

Analyzing the Data

Data demonstrates the overall GDP and agricultural GDP of the top ten African economies for the years 2018 to 2022. It shows that the agricultural GDP of most of these countries has been impacted by climate change, which in turn affects their overall GDP.

For instance, Nigeria's agricultural GDP has fluctuated over the years, with a significant drop in 2020, which may be attributed to the impact of climate change on the country's agricultural sector. Similarly, South Africa's agricultural GDP has remained relatively stable, but its overall GDP has fluctuated, indicating that other sectors of the economy may have been affected by climate change.

Egypt has experienced a steady increase in both its overall GDP and agricultural GDP over the years, with a significant increase in agricultural GDP in 2022. This may imply that the nation's agriculture industry has been successful in adjusting to the shifting environmental conditions. Algeria and Morocco have experienced fluctuations in their agricultural GDP, which may also be attributed to the consequence of climate change. However, Algeria's overall GDP has shown steady growth, while Morocco's overall GDP has been impacted by climate change, with a significant drop in 2020.

Kenya and Ethiopia have shown fluctuations in both their overall GDP and agricultural GDP, indicating that climate change has affected various sectors of their economies. However, in 2022, Ethiopia's agricultural GDP increased significantly, which would mean that the nation's agricultural sector has been able to adjust to the shifting climate circumstances.

Table.1: Comparison of Overall GDP and Agricultural GDP (2018-2022)
(**Data Sources:** World Bank, the United Nations, and the Country government's official website for up-to-date)

Country	2018		2019		2020		2021		2022	
	Overall GDP	Agriculture GDP	Overall GDP	Agriculture GDP	Overall GDP	Agriculture GDP	Overall GDP	Agriculture GDP	Overall GDP	Agriculture GDP
Nigeria	$397.47	$87.12	$448.12	$118.39	$432.20	$140.7	$440.83	$114.06	$504.203	$110.754
South Africa	$404.16	$11.40	$388.53	$10.71	$337.62	$10.05	$419.02	$10.58	$435.550	$12.189
Egypt	$249.4	$28.2	$303.2	$29.5	$303.0	$31.1	$404.1	$31.9	$469.094	$54.93
Algeria	$169.987	$13.034	$172.781	$12.861	$143.714	$12.734	$163.71	$20.12	$193.601	$42.516
Morocco	$118.48	$14.84	$118.61	$13.9	$102.11	$13.3	$142.9	$17.209	$145.76	$14.20
Kenya	$87.91	$25.47	$99.24	$28.62	$95.50	$27.66	$110.3	$22.8	$116.641	$33.85
Ethiopia	$84.35	$36.1	$96.12	$41.2	$96.12	$42.3	$111.3	$41.828	$291.09	$54.74
Ghana	$65.56	$16.21	$67.077	$16.637	$67.077	$16.677	$77.59	$14.1833	$183.01	$40.46
Angola	$105.24	$9.26	$91.28	$8.14	$63.15	$5.78	$67.4	$5.354	$208.01	$16.54
Tanzania	56.99	13.13	61.03	14.09	62.71	14.51	67.84	14.3	71.44	$17.86

Ghana, Angola, and Tanzania have shown fluctuations in both their overall GDP and agricultural GDP, suggesting that climate change has affected various sectors of their economies. Tanzania's agricultural GDP, on the other hand, has increased steadily through time, demonstrating that the nation's agricultural industry has been able to adjust to the changing climate circumstances.

Ethiopia appears to perform relatively well in terms of its agricultural GDP. Ethiopia's agricultural GDP has shown a steady increase over the years, with a significant increase in 2022. This would mean that the nation's agriculture industry has been successful in implementing efficient agricultural processes and regulations while also being able to adjust to the shifting environmental conditions. In terms of potential, Tanzania and Ghana have shown some promising signs of growth in their agricultural GDP, with a steady increase over the years despite

Table.2: Indicators of Climate Change Impact on Agriculture and Economy (2018-2022)
(**Data Sources:** World Bank, the United Nations, and the Country government's official website for up-to-date information on the indicators)

Country	Indicators of Climate Change Impact on Agriculture	Indicators of Climate Change Impact on Economy
Nigeria	Temperature, precipitation, loss of grazing lands, reduced crop yields, rainfall, pests and diseases, food production, drought, reduction in forestry produce and low income	Losses in agricultural productivity, reduced income for farmers, Increased cost of food, infrastructure and energy production, reduced revenue, decreased economic growth
South Africa	Decrease in crop yields, increase in pests and diseases, increase in water scarcity	Decreased agricultural productivity, Increased cost of energy production and transportation, Impacts on mining, Increased healthcare and infrastructure costs
Egypt	Water scarcity, Increased pest and disease outbreaks, heat waves and droughts	Agricultural productivity, Energy production, Infrastructure damage costs, financial losses, Employment, Foreign trade
Algeria	Changes in rainfall patterns ,Droughts, Increased temperatures, heat waves, Soil erosion and degradation, Pests and diseases, crop yields , Loss of biodiversity	Increase in energy consumption, Disruption in transportation and infrastructure, higher costs for food imports, Increase in healthcare costs
Morocco	Decreased crop yields, Changes in cropping patterns, Increase in pests and diseases, soil degradation	Decreased agricultural productivity, Loss of biodiversity and degradation of natural resources
Kenya	Decreased crop yields, Decreased availability of water, Reduced soil fertility	Reduction in tourism, Reduction in agricultural productivity, Loss of biodiversity, Increased healthcare costs
Ethiopia	Erratic rainfall patterns, Increased temperature, Soil erosion, Pests and diseases	Agricultural productivity decline, Energy generation challenges, Infrastructure damage, Increased health risks
Ghana	Erratic rainfall patterns, Increased temperature, Soil erosion, Pests and diseases	Agricultural productivity decline, Energy generation challenges, Infrastructure damage, Increased health risks
Angola	Erratic rainfall patterns, Increased temperature, Soil erosion, Pests and diseases	Reduced agricultural production, Water scarcity, Energy challenges, Infrastructure damage
Tanzania	Erratic rainfall patterns, Increased temperature, Soil erosion, Pests and diseases	Agricultural productivity decline, Energy issues, Infrastructure damage, Increased health risks

fluctuations. However, these countries still have room for improvement and could benefit from increased investment in the agricultural sector and the implementation of effective policies and practices.

The top ten African economies' indications of how climate change is influencing agriculture and the economy demonstrate the many ways that each country's economy and agriculture are being impacted.

Nigeria is susceptible to the effects of climate change on agriculture due to factors such as temperature, precipitation, loss of grazing lands, reduced crop yields, rainfall variability, pests and diseases, food production, drought, reduction in forestry products, and low income. These impacts have led to losses in agricultural productivity, reduced income for farmers, increased cost of food, infrastructure, and energy production, reduced revenue, and decreased economic growth in Nigeria.

South Africa's agriculture sector is impacted by decreased crop yields, pests and diseases, and water scarcity, leading to decreased productivity, increased energy, and transportation costs, and impacts on mining and infrastructure. Egypt's agriculture sector faces water scarcity, pest and disease outbreaks, heat waves, and droughts, leading to decreased productivity, infrastructure damage costs, financial losses, and impacts on employment and foreign trade.

Algeria is facing impacts on agriculture due to changes in rainfall patterns, droughts, increased temperatures, soil degradation, and loss of biodiversity. This is resulting in higher energy consumption, disrupted transportation and infrastructure, and increased healthcare costs. In Morocco, decreased crop yields, changes in cropping patterns, an increase in pests and diseases, and soil degradation are impacting agriculture, leading to decreased productivity, loss of biodiversity, and degradation of natural resources.

Kenya's agriculture is impacted by decreased crop yields, reduced water availability, and soil fertility, with impacts on tourism and healthcare costs. Ethiopia, Angola, and Ghana face impact on agriculture from erratic rainfall patterns, increased temperature, soil erosion, and pests and diseases, with negative economic impacts on agriculture, energy generation, infrastructure, and health risks.

Challenges and Response of Top Ten African Economies on Climate Change: 2018-2022

Nigeria launched several programs to combat challenges related to climate change, including the Nigerian Climate Innovation Center (NCIC) for supporting climate-focused startups, the Green Bonds Program to fund green infrastructure projects, and the National Action Plan for the Implementation of the Climate Change Paris Agreement (NDC) to reduce greenhouse gas emissions and adapt to climate change impacts. (BNRCC Report, 2022) The Climate Change Knowledge Management Center (CCKMC) was established to enhance climate knowledge management and promote research, while the Green Stimulus Program aims to promote green growth and sustainable development through investments in renewable energy, afforestation, and climate-smart agriculture. Additionally, the Energy for All initiative seeks to increase access to clean and affordable energy for all Nigerians through investments in renewable energy, energy efficiency, and off-grid solutions. (Nigeria’s Federal Ministry of Environment Report, 2022)

South Africa is heavily reliant on fossil fuels for its energy needs, which contributes significantly to greenhouse gas emissions. The country is particularly vulnerable to the impacts of climate change, including water scarcity, droughts, floods, and food insecurity. This has a lack of adequate financing and capacity for climate change adjustment and mitigation measures. South Africa has launched the Climate Change Bill, the National Climate Change Adaptation Strategy, and other initiatives to provide a legal framework and institutional mechanisms for effective climate change mitigation and adaptation. (Republic of South Africa Report (2019). The country is working to increase the share of renewable energy in its energy mix through the Renewable Energy Independent Power Producer Procurement Program. The Green Fund provides financing for green economy projects and supports the transition to a low-carbon and resource-efficient economy. The Working for Water program employs people to remove invasive plant species that threaten water resources and biodiversity while also creating employment opportunities. South Africa has established several initiatives and programs to implement the National Climate Change Adaptation Strategy and promote capacity building, technology transfer, climate finance, and public awareness and education on climate change. (National Climate Change Report, World Bank, 2022)

Egypt launched several climate change programs, between 2018 and 2022, including its sustainable development strategy "Egypt's Vision 2030," the Renewable Energy Feed-in Tariff Program, the Green Energy Investment Initiative, the National Adaptation Plan, the Climate Risk Profile, and the Integrated Sustainable Cities Program. These programs aim to increase the share of renewable energy in the electricity mix, attract investment for renewable energy projects, build resilience to climate change impacts, and encourage sustainable urban growth. (UNDP Report 2022)

In accordance with Algeria's Nationally Determined Contributions (NDCs), it is planned to reduce greenhouse gas emissions from transportation and increase the proportion of renewable energy to 27% by 2030. Adaptation measures include improving coastal and wetland resilience, water management, and land management. Algeria has launched several initiatives to support its commitments, including the National Plan for Energy Efficiency and Renewable Energy (PNEER), the National Adaptation Plan for Climate Change (PAN), and the National Program for the Development of New and Renewable Energies (PNDER). (UNFCCC Report 2022)

Morocco has launched several climate change programs, including the Moroccan Climate Plan 2020-2030, National Adaptation Plan, Climate Investment Plan, Green Morocco Plan, and National Sustainable Development Strategy. (Dove, 2021) These programs aim to reduce greenhouse gas emissions, increase the share of renewable energy, enhance adaptation to climate change impacts, promote sustainable agriculture and rural development, and integrate climate change considerations into all sectors of the economy. (Climate Risk Profile: Morocco (2021): The World Bank Group)

Kenya has implemented several climate change programs and initiatives between 2018 and 2022. These include the National Climate Change Action Plan (NCCAP), Scaling up Adaptation in Africa (SUAA) (African Development Bank, 2019) Climate Smart Agriculture (CSA), Kenya Climate Innovation Center (KCIC), and the National Drought Management Authority (NDMA). These programs aim to guide Kenya's climate change response and adaptation efforts, increase resilience to climate change, promote sustainable agriculture, support innovative climate change solutions, and manage drought-related interventions. (Government of Kenya Report, 2018)

Ethiopia's climate change programs include the CRGE Strategy to achieve middle-income status while keeping emissions low, the National Electrification Program for renewable energy and universal access to electricity, the SLMP for sustainable land management practices (World Bank, 2020) the CRGE Academy for capacity-building, and the ECIC for supporting entrepreneurs and SMEs with innovative climate change solutions. (International Renewable Energy Agency (IRENA), 2019)

Ghana has implemented several climate change programs between 2018 and 2022, including the NDC Partnership Plan, the Ghana Climate Innovation Center, the Scaling-up Renewable Energy Program, the Forest Investment Program, and the Green Climate Fund Readiness Program. (Agyei, 2018) These programs spotlight on climate change mitigation and adaptation efforts, increasing entrée to renewable energy, promoting sustainable forest management, and building institutional and technical capacity to develop and implement climate change projects. (UNDP, World Bank, 2019)

Angola's climate change programs between 2018 and 2022 include a National Adaptation Plan, Climate Resilient Agriculture Program, Renewable Energy Program, and Forest Landscape Restoration Program. These programs aim to address the impacts of climate change on the economy, environment, and vulnerable populations by promoting climate-smart agriculture practices, increasing renewable energy, and restoring degraded forest landscapes. (National Adaptation Plan (NAP) Report for Angola, 2022)

Tanzania has implemented several climate change programs between 2018 and 2022, including the National Climate Change Strategy, Tanzania Climate Smart Agriculture Program, National REDD+ Strategy, Tanzania Renewable Energy Policy, National Adaptation Program of Action II, and the Green Climate Fund Readiness Program. These programs aim to promote low-carbon development, enhance adaptive capacity and resilience to climate change, increase agricultural productivity, reduce emissions from deforestation and forest degradation, increase access to renewable energy, identify and address priority areas for adaptation to climate change, and enhance Tanzania's capacity to access and utilize climate finance. (Source: Tanzania Ministry of Environment and Union for the Conservation of Nature, UN, 2022)

Discussion: Results and Findings

Based on the analysis, the following results and findings can be identified:

The analysis shows that the agricultural GDP of most of the top ten African economies has been impacted by climate change, which in turn affects their overall GDP. (ECA, 2018) Nigeria, South Africa, and Morocco have experienced significant drops in their overall GDP because of how climate change is affecting on other sectors of the economy. (World Bank, 2021) Egypt has been successful in adjusting to the shifting climate, as indicated by the significant increase in its agricultural GDP in 2022. Ethiopia's agricultural GDP has shown a steady increase over the years, with a significant increase in 2022, indicating that the nation's agriculture industry has been able to establish efficient agricultural policies and procedures while also responding to the shifting environmental conditions. Tanzania and Ghana have also shown some promising signs of growth in their agricultural GDP, with a steady increase over the years despite fluctuations. (African Development Bank (AfDB), 2022) Nonetheless, the effects of climate change on agriculture and the economy pose difficulties for all ten of the largest African economies,

including decreasing agricultural production, water scarcity, pests and illnesses, infrastructure damage, and monetary losses.

In general, the agricultural sector in these countries is vulnerable to climate change, as changes in temperature, precipitation, and extreme weather events can reduce crop yields, degrade soils, and increase the incidence of pests and diseases. These impacts can result in decreased agricultural productivity, which can have a ripple effect on the economy as a whole. These African states are significantly impacted by climate change, especially in the fields of agriculture and the economy. Several parts of these countries are feeling the effects of climate change in diverse ways, with some being more sensitive than others. For example, countries such as Nigeria, Egypt, and Ethiopia are facing significant challenges related to water scarcity and agricultural productivity decline, while countries such as South Africa and Ghana are facing issues related to pests and diseases and erratic rainfall patterns.

Some similarities and differences between the challenges and responses of these top ten African economies are the following:

Similarities: Aside from the increased frequency and intensity of extreme weather events, water scarcity, food insecurity, and health effects are all significant issues that all of the countries mentioned are dealing with as a result of climate change. Every nation understands how crucial it is to take action to lessen and prepare for the effects of climate change. Every nation has started projects and programs with the goal of lowering greenhouse gas emissions and expanding the usage of renewable energy sources.

Differences: The specific challenges faced by each country may differ, depending on factors such as geography, economy, and population size. The responses to these challenges also vary, with each country pursuing a unique set of policies and programs to address climate change. The level of funding and resources allocated to climate change initiatives varies by country, which can impact the scope and effectiveness of these programs. Also, the rate of development on mitigating and adapting to climate change differs by nation, with some moving more quickly than others. Overall, while there are similarities in the challenges faced by different countries and the responses they are pursuing, there are also significant differences based on a variety of factors.

Overall, the outcomes and findings of the study suggest that climate change is already having a significant impact on the economies and agricultural sectors of these African countries. However, governments are taking steps to address these challenges, such as implementing climate-smart agriculture policies, promoting renewable energy, improving infrastructure, and increasing access to climate finance for farmers. These efforts will be critical in helping African countries adapt to the changing climate and build more resilient economies and agricultural sectors for the future.

Recommendations

Here are some suggestions for future policy development, overcoming obstacles, and dealing with climate change and its special effects on the economy and agriculture based on the findings and analysis of the data:

- Increase funding for research and development in agriculture, climate-smart agriculture, and sustainable land management practices.

- Develop and implement policies to promote renewable energy and climate-resilient business models for small-scale farmers.
- Promote conservation agriculture practices and increase investment in renewable energy to address the challenges faced by the agriculture sector.
- Increase public awareness on climate change, promote sustainable water management practices, and develop adaptation measures for vulnerable groups.
- Promote the adoption of crops that can withstand drought, soil conservation, reforestation, better water management, and sustainable land management techniques.
- To lessen the damaging effects of climate change on the economy, create initiatives for disaster risk reduction, climate-resilient infrastructure, and green employment creation.
- Improve planning and decision-making in the agriculture sector by expanding farmers' access to climate finance, encouraging organic farming, and offering weather forecasting services.

Conclusion

Climate change has a significant impact on these top ten economies of Africa with respect to agriculture being particularly vulnerable. Climate change is affecting their agricultural productivity, food security, and water availability, leading to a reduction in crop yields and an increase in pests and diseases. This is a noteworthy challenge, particularly for developing countries that rely on agriculture as a resource of income and food. the financial implications of climate change on these economies, such as increased healthcare costs, infrastructure damage, and decreased tourism revenue can have severe consequences to responding adequately to these challenges. However, the governments of these states are responding to the challenges of climate change by implementing policies that promote climate-smart agriculture, renewable energy, sustainable land management, and climate-resilient infrastructure. However, more needs to be done to increase access to climate finance for farmers, promote sustainable water management practices, and develop adaptation measures for vulnerable groups. Governments, public society, and the private sector must work together to adopt strategies that support sustainable development and counteract the negative impacts of climate change on these top ten economies and agriculture.

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Impact of Climate Change on the Economy of Pakistan

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Abstract

Although Pakistan does not contribute to global warming and climate change, because its CO2 emissions are way below 0.5% levels, but still Pakistan is a front-line state against Climate Change, one of the 10 countries that are most affected by Climate Change. Its glaciers have melted causing water deficiency, artificial lakes, land erosion, and floods downstream. The country has faced drought and in 2022 deviating floods causing human and economic losses as well as loss in agricultural productivity and decrease in biodiversity. The objective of the study is to analyse through secondary sources the impact of climate change on the economy, biodiversity, agriculture and population of Pakistan in 2022. Researches show that the impact of Climate Change on Pakistan would be that temperatures will rise significantly by 4 to 6 degrees Celsius, average rainfall would rise by 60 centimetres and the sea level would rise by 1.1 mm every year due to the melting of glaciers that would lose 40% of their ice cover. There would be extreme weather, floods and droughts in the country and Pakistan is among the 10 most affected countries due to Climate Change. Devastating floods of 2010 and 2022 have affected millions of people and destroyed infrastructure worth US $ 30 million. There is a threat to biodiversity loss due to extreme climatic conditions as well as an increase in diseases and parasites. GDP of the country would be reduced by 18 to 20 percent if proper measures are not taken to mitigate the effects of climate change and environmental pollution. The World Bank recommended that Pakistan "(a) Transform agriculture, water preservation, and the food systems, (b) Develop Resilient and Liveable Cities, (c) Accelerate the Transition to Sustainable Energy and Low-carbon Transportation, (d) Build upon Human Capital to Achieve Sustained and Equitable Development and Climate Resilience, and (e) Align Financing Policies, Incentives, and Institutions to Support Scale-up of Climate Actions."

Keywords: Climate Change, Pakistan, Floods, Droughts, Economic Losses, Agriculture

Introduction

Al Gore in his book *The Inconvenient Truth* (Gore, 2006) had through real-time data predicted Global Warming and Climate Change and their impact on the natural and human environment. Since then the world has moved in two opposite directions: On one hand, committing to reduce carbon emissions around the world to less than 2%, (UNEP Intergovernment Pannel on Climate Change, 2005) and on the other hand, failing to streamline the use of fossil fuels and other industrial activity in such a way to meet these commitments.

Problem Statement

Although Pakistan does not contribute to global warming and climate change, because its CO2 emissions are way below 0.5% (Worldometer, 2022) levels, but still Pakistan is a front-line state against Climate Change, one of the 10 countries that are most affected by Climate Change

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(Concern World Wide, 2023). Its glaciers have melted causing water deficiency, artificial lakes, land erosion, and floods downstream. The country has faced drought and in 2022 deviating floods causing human and economic losses as well as loss in agricultural productivity and a decrease in biodiversity.

The problem is managing the adverse impact of climate change on its economy, food security and infrastructure.

Objective of the study

An Analysis of economic losses to Pakistan's economy due to Climate Change in 2022

$$y = f(x, a, b, c, \dots, n)$$

Where y is Pakistan's Economic losses, X is Climate Change and a, b., C, ..., n are other factors remaining constant in this study.

Sources of Study

Secondary Sources and data would be used from national and international documents and reports as well as from input from other researchers on the topic.

Literature Survey

Asian Development Report 2017 states, "By the end of this century, the annual mean temperature in Pakistan is expected to rise by 3°C to 5°C for a central global emissions scenario, while higher global emissions may yield a rise of 4°C to 6°C. Average annual rainfall is not expected to have a significant long-term trend but is expected to exhibit large inter-annual variability. Sea level is expected to rise by a further 60 centimetres by the end of the century and will most likely affect the low-lying coastal areas south of Karachi toward Keti Bander and the Indus River delta" (Asian Development Bank, 2017).

Economic Survey of Pakistan 2020-2021 states, Pakistan is vulnerable to the effects of climate change which has occurred due to rapid industrialization with substantial geopolitical consequences. As things stand, the country is at a crossroads for a much warmer world. According to German Watch, Pakistan has been ranked in the top ten of the countries most affected by climate change in the past 20 years. The reasons behind this include the impact of back-to-back floods since 2010, the worst drought episode (1998-2002) as well as more recent droughts in Tharparkar and Cholistan, the intense heat wave in Karachi (in Southern Pakistan generally) in July 2015, severe windstorms in Islamabad in June 2016, increased cyclonic activity and increased incidences of landslides and Glacial Lake Outburst Floods (GLOFs) in the northern parts of the country. Pakistan's climate change concerns include increased variability of monsoons, the likely impact of receding Hindu Kush-Karakoram-Himalayan (HKH) glaciers due to global warming and carbon soot deposits from transboundary pollution sources, threatening water inflows into Indus River System (IRS), severe water-stressed conditions, particularly in arid and semi-arid regions impacting agriculture and livestock production negatively, decreasing forest cover and increased level of saline water in the Indus delta also adversely affecting coastal agriculture, mangroves and breeding grounds of fish". (Ministry of Finace, Govenment of Pakistan, 2021)

Analysis

National Geographic in its article on Effects of Global Warming wrote, "The planet is warming, from North Pole to South Pole. Since 1906, the global average surface temperature has increased by more than 1.6 degrees Fahrenheit (0.9 degrees Celsius)—even more in sensitive polar regions. And the impacts of rising temperatures aren't waiting for some far-flung future–the effects of global warming are appearing right now. The heat is melting glaciers and sea ice, shifting precipitation patterns, and setting animals on the move" And further underlines that, "Climate change encompasses not only rising average temperatures but also extreme weather events, shifting wildlife populations and habitats, rising seas, and a range of other impacts. All of these changes are emerging as humans continue to add heat-trapping greenhouse gases to the atmosphere" (National Geographic, 2023). The effect of global warming and climate change are that ice is melting everywhere, that contributes to sea-level rising, habitats of animals are vanishing, therefore the animals are on the move. Although rain and snowfall has increased substantially causing extreme weather and floods, there are still areas that are experiencing extended droughts that consequently are increasing the risk of wildfires, lost crops, and drinking water shortages. At the same time, pests and parasites population has increased across the globe due to warmer and wetter weather conditions. Less fresh water is available due to melting of glaciers and shifting of rain patterns.

United Nations WMO Said, "the outgoing La Nina phenomenon, a cooling of surface temperatures that can have a widespread impact on global weather conditions, started in September 2020. However, despite La Nina's cooling effect both 2021 and 2022 were warmer than any year prior to 2015. Now El Nino, its warming opposite in the cycle could be on the way this year" (DAWN, 2023).

According to Asian Development Bank Report, "By the end of this century, the annual mean temperature in Pakistan is expected to rise by 3°C to 5°C for a central global emissions scenario, while higher global emissions may yield a rise of 4°C to 6°C. Average annual rainfall is not expected to have a significant long-term trend, but is expected to exhibit large inter-annual variability. Sea level is expected to rise by a further 60 centimetres by the end of the century and will most likely affect the low-lying coastal areas south of Karachi toward Keti Bander and the Indus River delta" (Asia Development Bank, 2017).

In Pakistan data shows that due to climate change and global warming the following impacts can be seen:

1. **Melting of Glaciers**: According to Benji S. Jones "Pakistan is home to over 7,200 glaciers, more than anywhere outside the poles. Rising temperatures, linked to climate change, are likely making many of them melt faster and earlier, adding water to rivers and streams that are already swollen by rainfall" (Jones, 2022). According to a study by Ethan Lee and others, show that the Himalayan glaciers have lost more than 40% of its ice mass due to climate change and carbon emissions (Lee, 2021) to which Pakistan is not a contributor as its carbon emissions are insignificant to world standards.
2. **Rising Sea Levels**: According to Golam Rabbani and others, "The mean sea level (MSL) along the coast at Pasni is about 1.4 m from the chart datum. The MSL is slowly but gradually rising at a rate of about 1.1 mm/year. Although a small sea level rise may be compensated by tectonic uplift rate of the Makran coastline estimated at 1-2 mm/year at Ormara (Golom Rabbani, 2008)".

3. **Extreme Weather** condition: due to climate change, Amnesty International wrote "From March-May 2022, Pakistan recorded some of the highest temperatures in the country in the last 60 years. The heat waves from March to mid-June are now followed by the onset of the monsoon in parts of the country with flash flood warnings and torrential rains causing loss of life and damage to property. Pakistan is one of the most affected countries in the world by climate change, putting marginalized groups at high risk, exacerbating public health concerns, increasing demands for energy, reducing access to food, all affecting the right to an adequate standard of living". "65 persons are estimated to have died in Pakistan including at least three children reportedly linked to the effects of the heat wave- but the actual numbers may be higher. Extreme heat can be deadly, especially for children, older people, people with disabilities and chronic diseases. The heat waves from March to mid-June are now followed by the onset of the monsoon in parts of the country with flash flood warnings and torrential rains causing loss of life and damage to property. A glacial lake also burst due to the combined effect of high temperatures and rain in Laspur Valley of Khyber Pakhtunkhwa Province, blocking roads. In May 2022, climate change triggered a melting glacier and flash floods damaged a bridge and homes and businesses in Gilgit" (AMNESTY INTERNATIONAL, 2022)
4. **Draughts**: Relief Web reported, "During March, light to moderate rainfall reported from most of the places in Pakistan including Azad Jammu and Kashmir. Precipitation during the month of March was below normal and not enough for most of the drought prone areas of Sindh while in Baluchistan some areas are still under moisture stress. Mild to moderate drought conditions are prevailing over southwest areas of Baluchistan". Further reported that, "In April 2022, Light to Moderate rainfall was reported from most of most of the Upper parts of Pakistan including Khyber Pakhtunkhwa, Azad Jammu and Kashmir. Precipitation during April 2022 was below normal especially over most of the drought-prone areas of Sindh and Baluchistan due to which some areas are still under moisture stress. Mild to Moderate Drought Conditions are prevailing over SW areas of Baluchistan and Sindh". "The country overall received below normal (-21.6%) rainfall from January to April 2022". "Keeping in view the impact of heatwave, the drought-like situation has emerged over most of the high-temperature regions of the country" (Reliefweb, 2022). For 2023, Relief Web reported that, "During the month of January 2023, below normal to normal rainfall recorded across the country" and "Drought Conditions has been minimized or terminated over Baluchistan and Sindh except Nukundi and Dalbandin areas in Baluchistan" (Reliefweb, 2023). "Exposure to drought poses the potential health risks in the form of food insecurity and malnutrition; anaemia; night blindness; and scurvy".
5. **Floods**: In June 2022 there were Climate Change Induced floods in Pakistan. Dr. Qais Aslam wrote, "The velocity of recent monsoon rain has created an unpresented flood situation in Pakistan. A large part of the country was seriously affected by these floods that left mass destructions in its path. Whole villages (80% houses in Pakistan) were washed away leaving no trace of the settlement behind. More than 3,500 people lost their lives, and 33 million were left homeless. 8,00,000 officially registered internal refugees living in make shift tents. 1,460 health facilities have been affected. (Aslam, 2022) According to UNICEF "Months after unprecedented floods ravaged Pakistan, vast swathes of cropland and villages remain under water, while nearly 10 million girls and boys remain in need of immediate, lifesaving support. By mid-January 2023, as many as 4 million children are still

living near contaminated and stagnant flood waters, risking their survival and wellbeing". Saroop Ijaz wrote, "Considering the devastation caused by the recent flooding, the government should use the influx of funds to expand support for affected people and the IMF should ensure it has the time and flexibility to achieve a sustainable, inclusive, and rights-based recovery" (Ijaz, 2022).

6. **Threat to Biodiversity**: Asad Zia wrote "Only 5.7% of the total land area of Pakistan is covered with forests, but the rate of depletion of the forest cover that's left continues to be high. Commercial logging and overexploitation of forests by a growing population for fuel, fodder, building materials, resin and charcoal has resulted in crippling forest ecosystems. The disappearance of trees and shrub means that the associated flora and fauna, dependent on the forest, are also lost. Species that thrive in the ecological niches created by thick tree-cover – animals such as squirrels, woodpeckers and snails, and plants including numerous fern and mushroom varieties – are also likely to become extinct once those protective and nutrient rich surroundings are degraded. The impacts of deforestation can already be seen in Baluchistan's juniper forests, and in the Indus River Basin mangrove forests." (Zia, 2022).
7. **Parasites and Disease**: being an underdeveloped South Asian nation, malaria and TB are chronic diseases in Pakistan, but global warming and Climate Change has brought in Dengue mosquito that has affected thousands of people in the country over the past few years. According to WHO, "Between 1 January and 27 September 2022, a total of 26 thousand confirmed dengue cases and 62 deaths (CFR 0.25%) were reported in Pakistan, with 74% of these cases reported in the month of September alone. The current surge in cases follows unprecedented flooding that began in mid-June 2022" (World Health Organization, 2023). Since 2020, the pandemic of COVID-19 also plagued the nation and effected 1.58 million people with more than 30.6 thousand COVID related deaths in the country (Google, 2023).. Sadia Malik and others wrote, "Increases in temperature pose health risks of heat stroke; malaria; dengue; respiratory diseases; and cardiovascular diseases" (Sadia Mariam Malik, 2012).
8. **Threat to Agriculture**: According to Shakeel Ahmad Ramay, "A study points out that in Pakistan climate change will decrease agricultural productivity by 8-10% till 2040 and wheat will be one of the major losers. Another study predicts that the worst impact of climate change will be felt by wheat and rice (especially Basmati rice) crops in the coming years. It anticipates that wheat yield will decrease by 6% and the Basmati rice yield will fall by 15-18% across Pakistan". He further writes that, "millions of people draw their livelihood from the agriculture sector while on the other, it provides cheap raw material for the leading industries" … "Pakistan is already facing the challenge of food insecurity as almost 58% of the population is food insecure" (Ramay, 2022).
9. **Threat to Pakistan's Economic Activity**: World Bank Climate Related Report on Pakistan states that "heatwave and devastating floods (in 2022) are a reminder that climate change-induced disasters can significantly set back Pakistan's development ambitions and its ability to reduce poverty. These disasters have caused more than 1,700 deaths and displaced more than 8 million people. The damage to infrastructure, assets, crops, and livestock has also been massive, with more than $30 billion in damages and economic losses". The Report notes that, "the combined risks of extreme climate-related events,

environmental degradation, and air pollution are projected to reduce Pakistan's GDP by at least 18 to 20% by 2050. This will stall progress on economic development and poverty reduction" (The World Bank, 2022).

Conclusion

The above analysis shows that there is direct relationship between Global Warming, Climate Change with recent drought and floods in Pakistan as well as change in crop patterns and subsequent economic losses to the country that have affected Agriculture production, infrastructure erosion, settlement erosion, industrial losses, loss of education and health facilities and a need of more than US$ 30 billion to rebuilt the areas affected by floods in 2022 when this danger also lies in the near future, if Climate Change and Global Warming is not tackled in a scientific manner through implementation of SDG goals and sub-goals and recommendations.

Although Pakistan does not contribute in global warming and climate change, because its CO2 emissions are way below 0.5% levels, but still Pakistan is a front-line state against Climate Change, one of 10 countries that are most effected by Climate Change. Its glaciers have melted causing water deficiency, artificial lakes, land erosion, and floods downstream. The country has faced drought and in 2022 deviating floods causing human and economic losses as well as loss in agricultural productivity and decrease in biodiversity.

Researches show that the impact of Climate Change on Pakistan would be that temperatures will rise significantly with 4 to 6 degrees Celsius, average rainfall would rise by 60 centimetres and sea level would rise by 1.1 mm every year due to melting of glaciers that would lose 40% of their ice cover. There would be extreme weather, floods and droughts in the country and Pakistan is among the 10 most effected countries due to Climate Change. Devastating floods of 2010 and 2022 have affected millions of people and destroyed infrastructure worth US $ 30 million. There is threat to biodiversity loss due to extreme climatic conditions as well as an increase of diseases and parasites. GDP of the country would be reduced by 18 to 20 percent if proper measures are not taken to mitigate the effects from climate change and environmental pollution.

Recommendations

The policy makers in the government and ministry of climate change should take serious measures like building of dams and informing the farmers and local communities of how to mitigate the adverse impacts of this global phenomenon. New resilient crops should be introduced in areas effected by. Climate change and floods. Canals and hill sides should be lined with trees that can absorb CO2s and help save the glaciers from melting that bring devastation to the mountainous regions of Pakistan, Dams and water reservoirs should be built to mitigate against both floods as well as against droughts on the plains of Pakistan, and against rising sea levels that bring devastation to the coast line of Pakistan. Climate Change Policy and Sustainable Development Goals should become priority No. 1 to every government action, plan and operation as well as of every Private Sector entity whether in Agriculture, Industry or in the Services sector.

The World Bank Country Climate and Development Report 2022 recommended that in order to mitigate the impact of Climate Change the government, industry and the people of Pakistan should:

1) Transform the agriculture, water preservation and food system and stated that "Pakistan needs to repurpose environmentally damaging subsidies, promote climate-smart and regenerative agriculture and livestock systems, and prioritize ecosystem restoration".

2) Built Resilient and Liveable cities and stated that, "reforms are needed for more integrated land use planning and increased investments in municipal services and in energy efficiency and clean transportation".

3) Accelerate a Just Transition to Sustainable Energy and Low-carbon Transport and stated that, "Pakistan must prioritize reducing the cost of generation including through energy efficiency, ensuring cost-reflective tariffs and improved targeting of subsidies, while addressing technical and collection losses in transmission and distribution. Scaled-up investment in mass transit can avoid locking in highly polluting modes of transport".

4) Strengthening Human Capital to Achieve Sustained and Equitable Development and Climate Resilience, and stated that, "Pakistan needs to improve the management of water, sanitation, and hygiene, which is the main driver of child stunting, and reduce high fertility rates. Pakistan should also ensure universal access to quality education and expand its social-protection system by improving benefits, particularly for those at the highest risk".

5) Aligning Financing Policies, Incentives, and Institutions to Support Scale-up of Climate Actions, and stated that, "A comprehensive financing strategy, involving greater private sector involvement and significant international support (to initiate climate action and policy initiatives mentioned above) will be essential to complement Pakistan's own commitment towards resilient and inclusive development" (The World Bank, 2022).

It is therefore suggested that Pakatan's public and private sectors along with its international partners and neighbouring countries should collectively and individually initiate and implement the above-mentioned recommendations of the World Bank, The UNO and others immediately on an emergency footing in order to mitigate the adverse impacts of climate change on natural and man-made engouement of the country and its poor people before these impacts become irreversible and cost-ineffective.

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Regional Cooperation for Climate Change: Institutional Potency of SAARC

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Abstract

Climate change poses a fundamental threat to humanity. South Asia remains more exposed and vulnerable to the menace of climate change. Various non-traditional security challenges have surfaced in South Asia such as the melting of glaciers, floods, food shortages, water scarcity and health crises due to the phenomenon of climate change. Employing the theoretical framework of liberal inter-governmental and qualitative research methodology, with content analysis as the research method, the article examines inter-governmental regional cooperative measures in the wake of human security challenges faced by SAARC. The research paper has focused on the national policies of SAARC member states to analyze how they tend to cope with the menace of climate change. Moreover, it has focused on SAARC climate-related intergovernmental cooperative policies facing hurdles in implementation. Offering an in-depth analysis of the vulnerability of the South Asian states to climate change, the article has analyzed SAARC's efforts to mitigate the effects of climate change. The research argues that within the regional framework of SAARC, a preliminary level of intergovernmental cooperation exists. However, its capacity/potency to deliver remains low due to ineffective and in-substantive institutional cooperative mechanisms. The research has argued further that SAARC can play an instrumental role in developing a synchronized and effective policy for dealing with climate change. However, the cooperative ability of SAARC in developing a unified approach has remained limited due to inter-state conflicts. Inter-state rivalries have rendered SAARC toothless in devising regional cooperative measures to deal with the menace of climate change. Intergovernmental cooperation at the SAARC level can overcome the menace of climate change in South Asia.

Keywords: Climate Change, Framework, Inter-governmental, Institutional Mechanism, Menace.

Introduction

This research focuses on the urgency of security challenges in South Asia caused by climate change. In examining the steps taken by SAARC member states to deal with the crisis, the research explores climate change cooperation at the SAARC level employing a liberal intergovernmental framework. Within this context, the paper reviews SAARC member states respective national perceptions and public policy strategies related to the phenomenon of climate change. The study discusses ways in which cooperation can lead to countering the consequences of climate change. The research design involves a case study of climate change cooperation at the level of SAARC. Employing qualitative methodology, the research employs content analyses of primary and secondary data. Primary reports include the UN, World Bank, and other institutions' reports on climate change. SAARC website along with those of official national

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governments has been consulted to analyze climate change policies at the national and regional levels. Moreover, SAARC conferences, declarations and events have been analyzed to find out the level of cooperation on climate change.

Environmental issues are borderless; the problems transcend every political and territorial boundary. Rather, these engulf every state and region across the globe. Therefore, the trans-border-nature of environmental problems warrants collective effort by national, regional and international organizations (Zafarullah and Huque, 2018). The subcontinent has a shared history and cultural affinity with clearly defined and densely interconnected ecological space (Saran, 2014). Natural disasters are increasing in frequency and intensity, making the South Asian region vulnerable to environmental degradation and climate change. South Asia is a region rampant with territorial disputes and conflicts. Since South Asia is marred with high politics of territorial disputes, the research has argued that climate change measures have remained highly inefficient to tackle with the menace of climate change. What is important to note that no matter from where the catastrophic event originates, the national boundaries cannot contain the effects of climate change. Existing literature on climate change has not filled up the academic lacuna on how intergovernmental cooperation at the SAARC level can overcome the deadly consequences of climate change. While examining climate change consciousness and policy responses by SAARC member states, the paper argues that public awareness related to climate change has induced governmental-level policy measures among the member states. The cumulative consequences of both climate change and environmental degradation has required South Asian states to find a solution to common challenges at the level of SAARC. Created in 1985 with a membership comprising seven states-- while Afghanistan added in 2006, SAARC was to become a body for political and regional cooperation (SAARC, 2020). However, in the wake of climatic challenges and environmental degradation, SAARC's scope has expanded to incorporate the protection, preservation, and management of the fragile eco-system in South Asia (Zafarullah and Huque, 2018).

The study seeks to draw attention to changes in national threat perceptions and policy measures needed to mitigate climate change. The paper has recommended measures and recommendations for policymakers and academicians on how inter-governmental cooperation at the SAARC level can overcome security challenges posed by climate change.

In its 5th Assessment Report, the United Nation Intergovernmental Panel on Climate Change highlighted the considerable increase in global temperatures (IPCC, 2015). Among the other regions, temperature rise over the past century is the highest in the continental interiors of Asia. Many other regions of the globe have experienced higher temperatures for a decade (2006-2015), with certain regions showing increases up to 1.5 degree centigrade (IPCC, 2018). The change is abrupt and human-induced. Deadly consequences have ensued, making the planet vulnerable to abrupt climate changes. Average increase in temperature has implied a substantial increase in natural consequences. Being a major chunk of global population, Asia's low-lying coastal areas are at extreme risk of an increase in sea-levels (IPCC, 2018). Narrowing down further to the South Asian region, the World Bank report, "South Asia's Hotspot" confirms that almost half of South Asian population, almost 800 million people, will reside in severe or moderate hotspots by 2050 (Mani et al., 2018). South Asian states of Sri-Lanka, Nepal and Bhutan lie among the top

10 states in Climate Risk Index. The data shows a bleak picture for the SAARC region in this context.

The research focuses on human security challenges such as food, water and health insecurities in the wake of climate change in South Asia. Climatic catastrophes and international organization's dismaying figures on effects of climate change have highlighted the need for tangible cooperation among SAARC member states. South Asia is the most densely populated region, since one fifth of the human population of the world resides in South Asia (Relief Web, 2018). The region of South Asia is highly vulnerable to the stresses and strains of global warming and melting of the glaciers.

According to the German Watch Report, 'Climate Risk Index, 2019' South Asian states are among the top ten states most affected by climate change (Eckstein et al., 2019). The UN Food and Agriculture Organization's report 'The State of Food Security and Nutrition in the World 2018' holds that the key drivers behind global hunger and acute food insecurity are climatic vulnerabilities and extremities (UNICEF, 2018). As much as 124 million people face acute food insecurity in 51 states, out of which 37 most affected states fall in Asia (UNICEF, 2018). Climate changes have direct implications for agriculture and food production in South Asia. Insecurities related to food, water or health is acute in South Asia as evident from Climate Risk Index 2019. Climate change calamities have posed grave threats to food security in South Asia—the region is already at the crossroads.

Global Food Policy Report 2018 has highlighted that 3-4 degree Celsius increase in temperature will lead to severe loss in farm income, leaving millions in hunger (IFPRI, 2018). Floods and droughts hit South Asia frequently with Pakistan being the worst affected lately. This has resulted in a sizable drop in food grain production. Moreover, reduction in serial food production occurred due to low rains in 2016 in Pakistan (IFPRI, 2018). Similarly, reports reiterate that abrupt changes in the pattern of rainfall are draining water resources at a much greater pace, risking millions of lives. It is expected that climate change will bring severe shortage of water. Intergovernmental Panel on Climate Change state that melting of snow and ice are altering hydrological systems, affecting water resources in turn (IPCC, 2015). This shows that water shortage will be worst in the developing countries in the future. World Commission on Water has estimated that the demand for water will increase by 50 percent in the next thirty years, leaving four billion people under severe water stress (Tandon, 2011). Similarly another report by IPCC in 2007 stated that by 2020, almost 250 million people will face water shortage (Tandon, 2011).

South Asia is mostly dependent on Himalayas and the Hindu-Kush glaciers; which feed water to the Indus, the Ganges and the Brahmaputra. Owing to the anthropogenic climate change, the report, 'Climate Change Impacts on Glacier Hydrology and River Discharge in the Hindu Kush – Himalayas: A Synthesis of the Scientific Basis' has indicated glaciers have started to retreat, affecting water availability for downstream population (Miller et al., 2012). The heavily populated downstream region of Himalayas is highly vulnerable to glacial retreat. Excessive drainage of water towers like Himalaya will leave a big chunk of population under severe water scarcity posing extreme threat for survival.

Similarly, climate change has severe implications for health security. A majority of South Asian states lay in top 20 most vulnerable states to climatic change, making health insecurity imminent in the region. The WHO report, 'COP24 Special Report on Health and Climate Change'

substantiates that destabilized climate has direct contribution to ill-health globally (WHO, 2018). Moreover, the report suggests that over 90 percent of the world population takes breath in polluted air outdoors. Air pollution is the second most leading cause of death, other than non-communicable diseases such as strokes, heart diseases, and chronic obstructive pulmonary diseases.

Floods and drought are the direct consequences of climate extremes, causing severe health problems. World Health Organization (WHO) presents a bleak picture of health-related issues in the wake of frequent floods in Pakistan. Apart from the direct fatalities caused by the floods, diseases like Cholera, Malaria and Dengue spread among affectees of flood-hit population (Relief Web, 2011). Given imminence of the threat of climate change, the public perception has started to build up in South Asia regarding the risks and dangers of global warming and climate change. Moreover, climate change risk awareness among European and American states is high as compared to Africa, Middle East and Asia (Pugliese et al., 2009). South/East Asian countries have developed greater awareness regarding climate change since some states are highly sensitive to climate change vulnerabilities (Kim, 2011).

Risk associated with climate change has pushed SAARC to concoct national climate change policies. Almost all of the South Asian countries have taken initiatives to make national policies/programs on climate change. South Asian States' national policies have highlighted prominent steps to advance national development and climate change-related goals of mitigation and adaptation (Das et al., 2015). For instance, India has taken the initiative to adopt National Action Plan for Climate Change. While Pakistan adopted National Climate Change Policy in 2013 (Das et al., 2015). Bangladesh, Bhutan, Maldives, Afghanistan, Sri-Lanka and Nepal made their national climate change policies to overcome the menace of climate change.

India's climate change policy the NAPCC (National Action Plan for Climate Change 2008) asks for directional shift in developmental pathways and enhancement of the current and planned programs (Government of India, 2008). The plan highlights steps for adaptation and mitigation to advance India's climate change related developmental objectives. The policy identifies eight national missions- the core of the NAPCC, which form integrated strategies to cope with menace of climate change and achieve the major defined goals. Besides that, according to (Das et al., 2015), Bhutan took an exemplary step by introducing Gross National Happiness (GNH). The crux of the policy is that the purpose of development must be happiness, equating development with conservation of environment.

Bangladesh under the policy of "National Adaptation Programme of Action" and "the Bangladesh Climate Change Strategy and Action Plan" has now adopted 134 action plans to deal with the rising climate change extremities (Das et al., 2015). Many plans are on the plate for Bangladesh, like dredging of rivers, raising the river-banks and excavation of silt to contain water and avoid floods in future. Similarly, Afghanistan gave the climate change policy named as "National Adaptation Programme of Action for Climate Change" in 2009. However, owing to war in Afghanistan, the governance of climate change is still nascent.

Given the catastrophic changes due to climate change, Pakistan launched it National Climate Change Policy in 2012. The policy provides a comprehensive framework for adaptation to cope up with the current issues on climate change (Ministry of Climate Change, 2012). The adaptation-oriented policy has highlighted different sectors' vulnerabilities and spelled-out

adaptation methods for it. Climate change policy's main focus is water, agriculture, forestry, coastal areas, biodiversity and other vulnerable ecosystems.

Taking a glint of the past climate change vulnerabilities, Sri Lanka adopted "National Climate Change Adaptation Strategy for Sri Lanka 2011 to 2016." The National Climate Change Strategy of Sri Lanka has stated 'Living and coping with uncertain impacts of climate change is no longer a choice; it is an imperative.' The policy document outlines a comprehensive adaptation plan to ensure un-interrupted economic development without any set-back by climate change.

Geography has made Maldives the most vulnerable country to climate change consequences. According to a report by World Bank, "Climate change in Maldives", with the rise of sea-level within the range of 10cm to 100 cm, the entire island can sub-merge by 2100 in the worst-case scenario (World Bank, 2010). In order to cope with Climate change, Maldives has introduced a policy named as National Action Programme for Action in 2006 to present a framework of adaptation to enhance the resilience and sustainability of human, natural and social system (ADB, 2006).

In line with the above-mentioned security challenges, several policy initiatives have been adopted within the SAARC forum such as accords, declarations and action plans. Together all such measures provide for a good background marking intergovernmental cooperation. SAARC initiative in Katmandu in 1987 focused on environmental degradation and human security problems caused by droughts, floods, tidal waves, land sliding and rise in sea-levels, leading to SAARC leaders' joint action for disaster management (SAARC, 1987). The declaration provided for initiation of a regional study to find causes and consequences of climate change for preservation and protection of the environment. At the fourth SAARC summit held at Islamabad in 1992, Pakistan initiated a similar study named as "Greenhouse Effect and its Impact on the Region" (SAARC, 1988).

SAARC member states adopted "SAARC Action Plan on Climate Change." The object was to accentuate "south-south support in terms of technology and knowledge transfer" and ''to support global negotiation process under UNFCCC"…"provide impetus for regional level action plan on climate change through national action" (Reuters, 2008). The plan devised a framework under which SAARC states could cooperate with each other to adopt new technologies and ways for mitigating the effects of climate change. In Colombo Declaration (1991),' SAARC member states reaffirmed commitment for implementation of international and regional agreements for environment protection and sustainable use of natural resources (SAARC, 1998). The Dhaka Declaration of SAARC (1993) the next year, sought to protect and preserve environment, seeking enhanced cooperation in disaster management capabilities. The Delhi Declaration of SAARC (1995) urged development of scientific capabilities to deal with environmental problems.

SAARC Environmental Action Plan (EAP) was adopted in 1997 at Male (SAARC, 1997). The EAP called for assessment of environment, regional cooperation and capacity building. The Male Declaration urged adoption of a regional treaty on environment under the framework of international conventions. The Male Declaration was instrumental in fostering regional cooperation through exchange of technologies, strategies, and information sharing on combating air and water pollution (SAARC, 1997). A Coastal Zone Management Center was proposed in the Colombo Declaration (1998) on Maldives initiative on a Common Environment Program. SAARC ministers reaffirmed the will to implement regional and international agreements to

preserve and protect environment through a concerted action to address the issue of trans-boundary environmental degradation and to restrict flow of hazardous wastes via information exchange and harmonization of policies and procedures (SAARC, 1998).

The next session of SAARC at Dhaka Declaration (2005) called for cooperative modalities to allow for a regional environmental treaty. Delhi Declaration (2007) urged the member states to enhance regional cooperation on environmental conservation and protection, cooperation in early forecasting, warning and monitoring and sharing knowledge on consequences of climate change (SAARC, 2007). Taking a view of disastrous impacts of climate change, members urged climate justice to include the principle of "common but differentiated responsibilities. The declaration included recommendations for sharing of equitable burden on developed and developing countries, binding reduction in anthropogenic emission of GHGs, and transfer of resources/ funds for transfer of technology and adaptation to climate change (SAARC, 2007). SAARC Action Plan on Climate Change, 2008 formulated an extended regional environmental protection framework to cope with the menace of climate change, Climate Disaster Management projects, capacity building, and creation of a climate narrative for mass awareness (SAARC, 2008). It urged establishment of Natural Disaster Rapid Response Mechanism to provide for a coordinated approach in humanitarian emergency under the auspices of SAARC Disaster Management Center (SAARC, 2008). Delhi Statement (2009) emphasized that sustainable development and adaptation are the appropriate ways to counter the effects of climate change (SAARC, 2009). The Thimpu Declaration of SAARC (2010) aimed at developing clear policy directions on cooperation under established intergovernmental expert group in accord with the SAARC Action Plan. SAARC leaders showed their determination to work on renewable energy and low-carbon emission technologies. In the 16th SAARC Summit at Thimphu in Nepal, leaders welcomed climate change as the theme for the summit. Thimpu declaration aimed at ensuring implementation of the SAARC Action Plan, and showed great concern for degradation of regional environment leading to increase in natural calamities. It called for 'effective regional programs in early warning, preparedness and management including response and rehabilitation while remaining within respective national laws and procedures.'

SAARC Regional Institutions such as SAARC Meteorological Research Center, SAARC Coastal Zone Management Center, SAARC Disaster Management Center (SDMC), SAARC Forestry Center and Early Warning and Disaster Management Center are a few examples of SAARC initiatives at the regional level (SAARC, 2005). SAARC Environment Action Plan, 1997 binds member states to share oceanographic and meteorological data and share experience, information, and resources on disaster preparedness, mitigation and management control (SAARC, 1997). Disaster Management Center aims at regional disaster management to decrease risk and improve response. SAARC member states have adopted a multi-sectoral stake-holder approach to integrate disaster risk reduction and provide for sustainable development policy (SAARC, 1997). SAARC Meteorological Research Center (SMRC) provides a web of information to the member states to support data collection and forecast (SAARC, 2007b). SAARC Forestry Centre (SFC) provides assistance on mountain ecology and forest and SAARC Coastal Zone Management Center (SCZMC) for regional cooperation in management, planning and sustainable development of coastal areas (SAARC, 2007b).

SAARC member states have taken a joint position on the UN Framework Convention on Climate Change, (UNFCCC), calling for climate justice, technology transfer and allocation of additional finances to cope with the menace of climate change. The Colombo Declaration (1991) had already put the onus of corrective measures on the developed world as they are big contributors to anthropogenic emission of GHGs (SAARC, 1991). SAARC has demanded technology transfers and loans on preferential and concessional basis to mitigate adverse ramifications for environment (SAARC, 1993). SAARC summit at Dhaka endorsed UNCED at Rio, highlighting continuous flow of resources to the developing world with emphasis on climate justice and 'common but differential responsibilities' (SAARC, 1993). Moreover, SAARC members urged industrial states to ratify Kyoto protocol, and undertake actions to ensure reduction of GHGs emission (SAARC, 1998).

However, despite SAARC joint cooperative approach, certain problems continue to persist. For example, climate change has been formalized through Summit's declarations, action plans and ministerial level meetings; there is still no treaty or convention on climate change that can be enforceable at regional level. Mere declarations, discussions and future action plans do not amount to treaties or conventions.

Secondly, the action plans and declarations pertaining to climate change put the onus of implementation on the member states. For instance, the SAARC Action Plan on Climate Change rests the responsibility of implementation on national governments and asks the governments to agree upon a mechanism by giving clear direction and guidance for regional cooperation under existing setup. The transnational nature of climate change entails concentrated actions, involving national, regional and transnational organizations.

Third, Article 10 of the SAARC constitution provides that contentious issues will not be discussed. South Asian states bilateral problems are the "most common reason" for the postponement of the SAARC summits. In addition, most bilateral problems are pertinent to environment and climate change. All parties except Bhutan are mired by water conflicts in the SAARC region. More surprisingly, India is party to every dispute since it's upper riparian to Pakistan and Bangladesh, and lower riparian to China and Nepal. Therefore, without discussion on the bilateral issues related to sharing of rivers, SAARC cannot overcome the menace of climate change.

Fourth, high political issues are the biggest hurdle to climate change cooperation in South Asia, such as terrorism, territory and border related disputes. These issues have pushed climate change and environment to the back-burner. Even SAARC summits have been postponed time and again. Unless, these problems are not addressed, the chance of overcoming the menace of climate change is very low.

Fifth, the 49th session of the programming committee decided to merge the four SAARC regional centers- SDMC, SFC, SCZMC and SMRC in 2014. The intention behind the merging was to reduce cost burden and overlapping of tasks. However, scholars say that the merging has resulted into reduction of policy capacity. The greater the number of subsidiary institution the more tasks is being carried out. These institutions provided professional and technical support for regional environmental policy formulation and implementation (Sarker et al., 2018).

Sixth, SAARC member states have diverse priorities, given the variation in their territorial sizes, economies and socio-economic relations. For instance, countries like Nepal, Bhutan, Afghanistan, Sri-Lanka and Maldives opt for "adaptation funds". While India and Pakistan want access to the "Clean Development Mechanism funds". Given the differences, the international common position is greatly affected and the credibility of SAARC is put under question. For instance, in conformation with Bali action plan, all the SAARC countries, except India, committed to keep the temperature below 1.5 degree centigrade by 2015. However, India pushed for 2 degree centigrade and did not discuss the 2015 timeline with the pretext that unless developed countries didn't give binding commitment, India would not go for any timeline. Besides that, there are many other areas such as funding, definition of vulnerabilities and resource allocations which stops the association to present a common position at international negotiation under UNFCCC.

Seventh, there is a dearth of joint narrative and public awareness. One reason that can be attributed to lack of awareness is the overriding nature of fractious relations which dominated the low political issues in the region. Additionally, the goals of action plans and declaration remained unmet because the policy rhetoric has not been translated into reality. For that the adequacy of information and the well of politician is sin quo non. The leaders in the region discuss issues that have direct bearing on the state survival. The public awareness regarding the climate change is not up to the mark that is required to compel the governments to go for cooperative measures on regional level.

Lastly, SAARC being a region which mainly comprises developing countries faced with the problem of financial funding. SAARC doesn't provide climate related funding, hence most of the countries draw climate funding for the national level activities from the various funds under the UNFCCC framework. Among many problems with the Green climate Fund, one is the hollow commitment of the developed countries to contribute Green Climate Fund. The ambitious target of $100 billion per year set by the Paris climate summit remained unmet when the US under the leadership of Trumph withdrew from it. The action has affected the developed countries. Australia stopping their contribution to fund is the latest disappointment. Since, funding is central to climate policies implementation, problems with funding on regional and global level can be a big hurdle towards implementation of climate related plans.

Conclusion

SAARC has formalized the environmental and climate change issues through summit declarations, Action Plans, Environmental Convention and establishing subsidiary bodies. Still SAARC faces a colossal task of overcoming the menace of climate change. SAARC has to go a long way to overcome the menace of climate change in the region. Additionally, the phenomenon of climate change is real and causing severe consequences for the region which will define the future of the region. As Barack Obama said, "there is one issue that will define the contours of this century more dramatically than any other and that is the urgent threat of the climate change". Therefore, it is required that SAARC go for meaningful and serious cooperative measures in order to deal with the phenomenon of climate change.

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DAY-2

Phenomena of Climate Change: A Comparative Analysis of Indo-Pak Food Security

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Abstract

Climate change is a global issue that is affecting the environment, food production, and the livelihood of people. This study examines the phenomenon of climate change and its effects on food security in India and Pakistan. This research will focus on the comparison of climate change and food security in both countries. Data will be collected through a comprehensive analysis of existing literature, research studies, and scientific reports. The findings of this research will provide an in-depth understanding of the impact of climate change on food security in India and Pakistan. The results of this study will provide insights into the challenges and opportunities for both countries to mitigate the impacts of climate change and improve food security. Additionally, this study will also highlight policies and strategies to promote food security in both countries in the face of climate change. This study will contribute to the existing body of knowledge by providing an in-depth analysis of climate change and its effects on food security in India and Pakistan. The findings of this research will be beneficial for policymakers, researchers, and the general public.

Keywords*:* Climate change, Food security, Pakistan, India, Sustainable agriculture

Introduction

One of the most pressing issues that humanity is now facing is climate change. While the occurrence is a worldwide issue, it is especially detrimental to less-developed nations. In nations like India or Pakistan, where a sizable percentage of the population makes their living on farmland, climate change poses serious threats to food security. Due to variables like population increase, water scarcity, inadequate infrastructure, and climate change, both nations are struggling to feed their people. This research aims to examine the impact of climate change on agricultural stabilization in Pakistan & India, and to provide recommendations for addressing these issues. (Bhargava, V. K. , 2006). Climate change is a developing worldwide concern that threatens many facets of human existence, including food security. Food insecurity is a major concern in developing nations like India & Pakistan, where a big proportion of the population relies on agriculture for their livelihood. The goal of this research is to compare and contrast the ways in which climate change has affected food availability in Pakistan and India. (Bandara, J. S., & Cai, Y. , 2014).

Several secondary sources were used to compile this paper: scholarly publications, reports from the World Bank as well as the United Nations, as well as official records from the governments of India and Pakistan. Many factors, including agricultural output, water accessibility, food costs, and eating habits, are taken into account in the study (Reutlinger, S. , 1986). Taking into consideration variables like location, population development, and poor infrastructure, but rather climate

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variability, this study aims to compare and contrast the impact of climate change on food availability in the two countries. This article aims to promote healthy farming practices and explain methods for combating climate change. The study's ultimate objective is to shine attention on the critical need of taking action to lessen the impact of climatic shifts on nutrition and food security in developing nations, and to contribute to a deeper understanding of the impact climate change is having on this issue. (Thornton, P. K., Ericksen, P. J., Herrero, M., & Challinor, A. J. , 2014).

Climate change, one of the most important issues of the twenty-first century, is complex and widespread. A long-term shift in Earth's climatic system due to human actions, especially the production of greenhouse gases like carbon dioxide and methane, is what is meant by the word "climate change" in this article. The availability of healthy food is only one aspect of human life that is being threatened by global environmental changes. (Bord, R. J., O'connor, R. E., & Fisher, A. , 2000). The term "food security" refers to a situation in which everyone always has access to the resources necessary to purchase, prepare, and consume a variety of foods that provide the nutrients necessary to maintain a busy and healthful lifestyle. Food insecurity is a serious issue in countries like India and Pakistan, where a sizable portion of the population relies on agriculture for subsistence. (Mittal, S., & Sethi, D., 2009).

There are few nations in South Asia that really can relate to India and Pakistan's struggles with food insecurity more than they can. Large populations, scarce farmland, and widespread destitution are characteristics shared by both nations. Their ability to provide food security is hampered by a number of factors, including rising populations, water scarcity, poor infrastructure, and fluctuating weather patterns. Particularly in low-income countries, agricultural security is threatened by climate change. Due to changes in rainfall & temperature patterns, as well as an increase in extreme weather events like drought and floods, agricultural harvests and productivity may be significantly impacted by climate change, potentially leading to food shortages and higher prices. (Ringler, C., & Anwar, A., 2013).

This study intends to examine the impact that climate change is having on agricultural stability in both Pakistan and India and draw comparisons between the two countries. Several secondary sources were used to compile this paper: scholarly publications, reports from the World Bank as well as the United Nations, but also official records from the governments of India and Pakistan. Many factors, including agricultural output, water accessibility, food costs, and eating habits, are taken into account in the study. This study aims to examine how climate change has affected the food supply in both nations, and how those effects are similar and different. The research's overarching goal is to suggest ways forward in the fight against climate change and for healthy farming methods. The ultimate goal of the research is to shed light on the urgent need to act to reduce the detrimental impact of climatic conditions on food security through emerging economies and to add to a wider knowledge of the impact that climate change is having on this issue. This document is organized as follows. After this, you'll find a summary of the research done on how global warming threatens the availability of food in poor nations. What follows is a look at how climate change is affecting agricultural stability in India and Pakistan, side by side. Key results and suggestions for future study and policy action are discussed in the final section of the report.

Methodology

A broad range of secondary sources, such as academic journals, studies from global bodies like the World Bank and the United Nations, as well as policy documents from the administrations of

India and Pakistan, were consulted for this study. To examine how climate change is affecting food safety on a global scale, this research employs a comparative analysis technique. Several variables are considered in the analysis, such as farming production, water availability, food prices, and dietary habits.

We will use qualitative study techniques to conduct in-depth analyses of food safety and climate change in Pakistan and India. Qualitative research is ideal for this study because it allows the researcher to fully understand the topic at hand and the perspectives of all stakeholders. As a result of the study's use of a qualitative approach, the events of climate change as well as a comparison examination of food security in India and Pakistan will be better understood. To make sure the findings are valid and trustworthy, we will do everything in our power to overcome the study's constraints.

Literature Review

Food security is just one element of human existence that is threatened by the worldwide phenomenon of climate change. Climate change is a major danger to food security, especially in nations with low incomes per capita, such as Pakistan and India. Changes in temperature and precipitation patterns, as well as more frequent and severe weather events, have been attributed to climate change, leading to decreased agricultural productivity and food scarcity. The goal of this review of the relevant literature is to synthesize and compare the results of previous research on the impact of climate change on food availability in India and Pakistan.

Over half of India's labor population is involved in agriculture, which contributes heavily to India's Economy. It has been shown via scientific research that rising temperatures, changing rainfall patterns, and uncommon weather events are already affecting agricultural harvests and productivity in India. A World Bank study warns that by 2050, climate change could reduce agricultural productivity by as much as 30 percent, causing severe financial hardship for producers and endangering global food supplies (Ahmad, J., Alam, D., & Haseen, M. S., 2011). There is a severe threat to global food security from climate change for countries like theirs, where farming is a primary source of wealth and food. Large populations, growing urbanization, and inadequate infrastructure all make countries like Pakistan and India especially susceptible to the effects of climate change on food security. (Nawaz, A., Farooq, M., Ul-Allah, S., Gogoi, N., Lal, R., & Siddique, K. H., 2021).

Over half of India's population is involved in agriculture, which contributes significantly to India's Economy. Studies show that increasing temperatures, shifting rainfall patterns, as well as severe thunderstorms are already influencing agricultural yields and output in India, suggesting that the influence of climatic change on agriculture there will be significant. The World Bank has issued a warning that climate change might reduce agricultural output by as much as 30 percent by 2050, which would have devastating financial effects for farmers and threaten world food supply. Pakistan's food supply is at jeopardy as a result of climate change. The agriculture sector is directly or indirectly responsible for over 25% of Pakistan's GDP and employs about 40% of the country's total workforce. Natural disasters such as floods, floods, & heatwaves are more likely to occur in Pakistan due of its location in a quasi-region that is particularly vulnerable to the impacts of climate change. (Bandara, J. S., & Cai, Y., 2014).

Numerous reports have pointed out how climate change is affecting harvests in both countries. For instance, Lobell et al. (2008) showed that wheat harvests in both countries could be significantly

impacted negatively by climate change, with a predicted decline from around 6% even by the 2030s. Similar to the potentially serious impact that climate change might have on rice harvests in India and Pakistan, research by Fischer et al. (2005) showed that this could happen by the 2020s, with a drop of around 15% predicted.

Climate change's effect on water supply is another major cause for alarm when it comes to India and Pakistan's ability to provide for their populations' nutritional needs. Due to climate change, water shortage is predicted to increase in both countries, particularly in dry regions. The World Bank has issued a warning that due to climate change's impact on water supplies, agricultural yields & output might decrease in the northwest and central regions of India as well as the Indus valley of Pakistan. (Qureshi, R., & Ashraf, M., 2019). The impact changing climate will have on food prices is a further danger to food security both in nations. Climate change has been shown to have a negative impact on agricultural yields & productivity, which in turn leads to higher food prices, especially for key commodities like rice and wheat. Because of the price hikes, some people may not be able to afford food. (Alvi, S., Roson, R., Sartori, M., & Jamil, F. , 2021).

Food insecurity is a major issue in both Pakistan and India because of the effect climate change will have on people's eating habits. Changes in crop output due to shifts in weather and precipitation trends have been shown to have an effect on food intake habits, according to studies. The detrimental effects of climatic change on wheat production in Pakistan and India, for instance, could reduce calorie consumption per capita, especially among the impoverished, according to research by Parry et al. (2004).

India and Pakistan have each taken separate legislative steps to deal with the threats presented by climate change to their food supplies. The "National Action Plan on Climate Change (NAPCC)" in India contains goals like increasing water efficiency, creating drought- and flood-resistant crops, and promoting healthy agricultural practices. In a similar vein, Pakistan's National Climate Change Strategy contains initiatives to expand access to water and support environmentally sound agricultural methods. Unfortunately, there are still significant obstacles to enacting these policies, especially in areas where inadequate infrastructure and scarce resources make it difficult to counteract the effects of climatic change on food security.

Impact of Global Warming on India and Pakistan's Food Security

India is a major supplier of food goods and a major player in the global food industry. Food supply and transportation have been hampered by climate change. Climate change is reducing wheat yields in India, and that decrease could reach 6 million tons per year by 2030, according to a report through the "Indian Council of Agricultural Research (ICAR)". More than a million metric tons of annual rice output could be lost due to climate change in the nation by the year 2020 (Aggarwal, P. K. , 2008). The prevalence of pests and diseases is increasing as a result of climate change, which is having a detrimental effect on crop yields. Droughts and floods, two extreme weather phenomena, also reduce farming output, contributing to food insecurity and rising food costs. As much as 25% of agricultural production could be lost by 2050 if current trends continue, according to a report by the "Centre for Science and Environment (CSE)," significantly reducing food security (Gitz, V., Meybeck, A., Lipper, L., Young, C. D., & Braatz, S. , 2016).

The country's economy and food supply rely heavily on the agriculture sector. Nonetheless, the country is very vulnerable to the consequences of climate change, which include rising temperatures and varying rainfall patterns, both of which have severe effects on agricultural

productivity. A study by the "Pakistan Meteorological Department (PMD)" found that a 0.6°C rise in temperature over the previous century has led to an increase in water use and a decrease in crop yields across the country. (Sargani, G. R., Jiang, Y., Chandio, A. A., Shen, Y., Ding, Z., & Ali, A. , 2022). Even worse, climatic change is causing extreme weather to occur, such as storms and droughts, which are destroying crops and causing economic losses. Multiple severe weather events have hit the nation, including the devastating 2010 floods that impacted over 20 million people and reduced farming output dramatically. Climate change might reduce wheat and rice production by as much as 6 percent, according to a research by the "International Food Policy Research Institute (IFPRI)," leading to food shortages and soaring prices. (Ye, L., Xiong, W., Li, Z., Yang, P., Wu, W., Yang, G., & Tang, H., 2013).

Climate change threatens agricultural security in both India and Pakistan, but these two nations are different in important ways. "Climate change could cause a 4.2% drop in wheat output in India and a 7.8% drop in Pakistan, according to research conducted by "The Indian Institute of Technology in Delhi. According to the research, Pakistan is especially susceptible to climate change because of its topography, infrastructure, and level of understanding (Khan, M. A., Khan, J. A., Ali, Z., Ahmad, I., & Ahmad, M. N. , 2016). Climate change impacts, such as storms and droughts, pose a unique threat to Pakistan because of the country's geography. As it lacks the means and the know-how to adapt to climate change, the country is particularly at risk. Nonetheless, both countries stand to gain by shifting to more sustainable farming practices and adapting to the effects of climate change. Results from the study suggest that working together between the two nations is a reasonable strategy for mitigating the impact of climate change on food production. Climate change is a huge global problem that threatens the availability of safe and nutritious food across the planet. Climate change is a major danger to food security, especially in nations with low incomes per capita, such as Pakistan and India. Both countries, the studies show, are very vulnerable to the adverse consequences of climate change, especially in the form of reduced farming productivity and food shortages. (Singh, R. K., Joshi, P. K., Sinha, V. S. P., & Kumar, M. , 2020).

Comparative Analysis

A decrease in crops, rising food prices, and dwindling water supplies are all issues both countries must contend with. In addition, there is a greater potential for cyclones in India but instead droughts in Pakistan. Both nations have boosted their agricultural output, diversified their food supply, and poured resources into R&D for climate-smart farming in order to mitigate the effects of climate change on food security. Climate change has been felt in both countries, but the writers find that India has come up with better methods to guarantee food security. Though climate change has had a comparable and yet distinct effect on agricultural security in both India and Pakistan, there are also important distinctions between the two countries. Declining crop yields, water scarcity, and increasing food costs are all problems that both nations have to deal with, but the extent to which they suffer from these problems differs greatly.

The position of both Pakistan and India is one of the main distinctions between the two countries. Pakistan is in a semi-arid area prone to extreme weather, whereas India is a big and diverse nation with a wide range of climates. Because of this, Pakistan is extremely vulnerable to climate change and will certainly face significant challenges in providing food security. The effects of climate change on agricultural security are posing challenges for both India and Pakistan. Both countries' economy are highly dependent on agricultural output, water availability, and food prices, all of

which are threatened by climate change. While there are similarities in approach, there are also some key contrasts between the two countries. India and Pakistan rely heavily on wheat and rice for their diets, and both are extremely vulnerable to the consequences of global warming. India's agricultural sector is more varied than Pakistan's, with a greater emphasis on horticulture, livestock, and fisheries. Having less reliance on a small number of primary products could make India more resistant to the effects of climatic change on its food supply.

Seeing the danger that climate change poses to their farming sector & food sources, both Pakistan and India have passed laws to address the problem. Sustainable farming methods, an improved water economy, and the creation of products with increased resistance to drought and flooding are all part of India's "National Action Plan to Combat Climate Change (NAPCC)". Measures to expand access to water and support environmentally responsible farming are also part of Pakistan's Nationwide Climate Change Strategy. However, these rules are not always applied in the same way. Sustainable agricultural methods, like encouraging organic farming and diversifying crops, have been more widely adopted in India. Poor facilities and restricted access to resources, especially in remote areas where cultivation is the main source of revenue, have been obstacles to adoption in Pakistan.

India and Pakistan both face major challenges due to climate change's impact on their water supplies. Changes in rainfall trends could cause water shortages and a decrease in agricultural yields in both nations, which rely significantly on monsoon season water. It's important to note that water supplies aren't equally distributed everywhere. India's irrigation system is more advanced than Pakistan's, and the country also has a larger share of territory that is watered. This may help India better withstand the threats posed to its water supply & agricultural stability by climate change. If climate change has a detrimental impact on agricultural output and efficiency, food prices in both countries might rise. Yet, availability of food is not uniform. A larger percentage of India's agricultural output is made available for human consumption since the country's food distribution system is better developed than Pakistan's. If India follows this policy, the effects of climate change on food prices & food security may be less severe.

Climate change is reducing agricultural output in both Pakistan and India, making it difficult for both countries to satisfy their food needs. In turn, changes in the weather may affect the quantity and when we eat. Nonetheless, dietary habits in the two countries are different. India may be more resistant to the impacts of a changing environment on food consumption patterns due to its less reliance on a select few basic foods due to its more diversified and vegetarian diet. There is a long way to go before either country, including Pakistan, can guarantee its people will have enough to eat as a result of climate change. Yet, the two countries' approaches to these issues are not identical. India has a more varied agricultural business and a better established food delivery system than Pakistan has, which has delayed Pakistan's ability to put its plans into action. Both countries have taken measures to adapt to a warming planet and its resulting impacts on agriculture, but they confront significant challenges in adequately implementing these measures.

Projections put India's population at over 1.4 billion by 2050, making it one of the world's most numerous nations. Thus, ensuring India has access to sufficient sustenance is crucial. India's food stability is already being threatened by climate change because of fluctuating temps and wet/dry periods. The northern regions of India have been hit the hardest by climate change because the rainy season has been postponed and rainfall has decreased. As a result, farmers were not able to

properly prepare their fields and water their harvests, leading to lower returns. In addition, natural disasters like storms and droughts have wreaked havoc on crop output.

Pakistan, like India, is a large South Asian nation that must prioritize food safety. Due to the effects of climate change on farming output, temperature shifts, precipitation patterns, and severe weather events, food insecurity has become an issue in Pakistan. As a result of shifts in the monsoon pattern, agricultural harvests in northern Pakistan have been hit particularly hard by climate change. Natural disasters like storms and wildfires have also hampered efforts to cultivate food.

As a result of climate change, both Pakistan and India are experiencing serious threats to their agricultural security. Northerly areas in both nations have seen the greatest decreases in agricultural yields due to climate change. In addition, natural disasters like storms and droughts have wreaked havoc on crop output. The level to which changing climate has affected agricultural security in each country is the primary distinction between them. Climate change has had serious consequences in India, including substantial decreases in agricultural output and disruptions in farming production. Climate change has had less of an impact in Pakistan, but it has been felt there nonetheless.

Conclusion

Climate change is a danger to the agricultural stability of both Pakistan and India. Northern regions of both countries have seen precipitous drops in crop yields as a direct effect of climate change. Furthermore, weather-related calamities, such as floods and droughts, have wreaked havoc on crop production. The consequences of climate change on agricultural security have been felt more keenly in India than in Pakistan. Thus, it is clear that both countries need to take action to address the difficulties brought on by climate change in order to guarantee the safety of their citizens' food supply.

The consequences of climate change are being felt in a wide range of ways by humans and other kinds of life. Among the most pressing issues is how global warming threatens to affect food supply. This research looks at how rising temperatures are affecting food production in India and Pakistan. Indicators of the influence of climate changes in both countries include rising temperatures and precipitation and the incidence of increasingly extreme weather occurrences. The implications of climate change on food production, distribution, and consumption, as well as the subsequent threats to food security, have been examined.

Scientists in India have found that the consequences of global warming are being seen in agriculture productivity, water availability, and agricultural infrastructure. Reduced agricultural production as a result of these factors has reduced the quantity of easily available foods. The result is a rise in hunger throughout the country. Pakistan's agricultural, water supply, and animal population have all taken hits from the effects of climate change, which include rising temperatures, decreasing precipitation, and extreme weather events. Hence, there is greater anxiety over the country's capacity to satisfy its nutritional demands as food availability and accessibility have diminished.

This research shows that climate change is seriously threatening agricultural stability in both Pakistan and India. Reduced food security in both countries is a direct result of the effects of climate change on food production, distribution, and consumption. It is imperative that we find viable solutions to adapt to and mitigate the consequences of climate change if we are to end world

hunger. Plans to improve agricultural productivity and water supply, as well as robust social security systems, are essential to protecting society's most vulnerable people. Climate change is a major threat to food security in both Pakistan and India, and additional research is needed to better understand this relationship.

Climate change poses a severe threat to the food resources of India and Pakistan since both countries rely heavily on agriculture. A changing climate poses a threat to human food supplies and, by extension, human well-being, in a number of ways. These include water scarcity, decreased agricultural yields, and rising food prices. Thus, both countries need to take measures to lessen the dangers that a warming globe poses to their food sources and to adapt to the new norm.

Looking at food security in the context of climate change in India and Pakistan reveals some remarkable similarities and differences. The two share a vulnerability to swings in the yield of their primary crops and a common difficulty satisfying human demand for water. When comparing India and Pakistan, the former has a more robust agricultural sector and a better-developed food delivery network. On the other side, Pakistan has struggled to implement its goals due to a lack of resources and infrastructure.

Attempts have been made in both Pakistan and India to mitigate the negative nutritional consequences of climate change by promoting sustainable agriculture, developing goods that are resistant to drought and flooding, and increasing the economy's reliance on water. This is especially challenging in rural areas where farming is the main economic driver. Both countries need to priorities increasing expenditure on infrastructure, such as irrigation facilities and food storage facilities, because of the impact climate change is having on water supplies and food prices.

Reducing the impact of climate change on our capacity to feed depends on promoting sustainable agricultural techniques that increase the resilience of farming systems to climatic change. Some of these strategies include increasing crop diversification, introducing drought- and flood-resistant cultivars, and encouraging the use of organic farming practices. In addition, India and Pakistan should improve their capacity to monitor and manage the impact of rising temperatures on food supply by establishing early notification systems and adapting farming techniques to the new conditions.

Finally, within the context of climate change, the similarities and differences between India and Pakistan are underlined in terms of their food security. Agricultural security in both countries would suffer as a result of climate change, but each country also possesses resources that might mitigate those losses. Both countries need to adopt preventative measures to deal with these problems and adapt to changing climatic circumstances if they want to ensure food and nutritional security for their people. Possible responses to the threat of climate change to the world's food supply include increased spending on infrastructure, promotion of environmentally friendly farming methods, and the development of early warning systems.

Recommendations and Suggestions

1. Learn how the environment in the area affects food supplies in Pakistan and India.
2. Second, farmers and politicians tasked with mitigating climate change face a variety of challenges that need to be examined in order to be overcome.
3. Create plans for overseeing farm output in view of shifting weather patterns.

4. Consider the part that local, state, and federal agencies play in efforts to improve agricultural practices that will ensure a steady supply of food for the future.
5. Find alternative products and types with the potential to increase food security in Pakistan and India and evaluate their viability.
6. Get a deeper understanding of how the effects of climate change on food production and supply in both countries.
7. Look into how agroecological methods can help both nations adapt to climate change.
8. Determine how well communities can adjust to new weather patterns.
9. Inquire into how the weather is influencing the quantity and purity of water in both countries.
10. Please provide strategies and policies to enhance food security in light of climate change.

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Modeling Rainfed Cereal-Based Cropping Systems to Climatic Extremes

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Abstract

Rainfed agriculture, which constitutes 80% of global agriculture, is under severe threat due to the frequency and severity of extreme weather events. Increased temperature and water scarcity are major challenge for CEREAL-based cropping systems (CBCS) productivity and ultimately region food security. The objective of this work was to quantify the impact created by climate extremes in relation to crop production, income generation, and poverty reduction at regional level. Since the socio-economic conditions of rainfed farmers have been significantly influenced by CBCS. Therefore, reducing vulnerability to climate extremes is essential for adapting to climate change. In present study two year of work experiment was conducted at three variable sites of rainfed Pothwar using seven different cropping systesm (CS). Collected data of soil, environment and crop was used to calibrate the DSSAT (Decision support system for agro-technology transfer) models which was further used to study impact of rise in temperature studied cropping systems. Model outputs showed that Wheat-Mungbean system showed higher stability to rise in temperature as compared to other cropping systems. Furthermore wheat source-sink trait adaptation traits (Radiation use efficiency (RUE) g (above-ground DM) MJ^{-1} (PAR), light extinction coefficient at GS31 (K) (m^2 (ground) m^{-2} (leaf)), fruiting efficiency (FEspike) (grain g^{-1} (spike DM)), potential grain filling duration (GFD) (°Cdays), potential grain filling rate (GFR) (mg (DM) $grain^{-1}$ $°Cd^{-1}$) potential grain size (GWpot) (mg (DM) $grain^{-1}$)) related to potential grain yield were modified in the model to have future heat resistant wheat ideotypes.

Keywords: CEREAL-based cropping systems (CBCS), Climate extremes**,** APSIM, CropSyst, DSSAT, General Circulation Models (GCM).

Introduction

The mean variability in temperature and precipitation over longer period of time is called climate change. Climate variability is the most probably considered due to global warming (Kanojia & Dijkwel, 2018). The rising temperature due to unsafe levels of greenhouse gases in atmosphere like Methane (CH_4), Nitrous oxide (N_2O), Carbon dioxide (CO_2) and chlorofluorocarbons (CFCs) is the most impending climate change (Mall et al., 2017).The emission of Carbon dioxide (CO_2) out of all these greenhouse gases is the main reason behind the greenhouse effect and global warming (Vaughan et al., 2018). There is a prediction that CO_2 concentration could increase up to 800 μmol^{-1} at the end of 21st century, as its level already has been elevated from 280 μmol^{-} to 400 μmol^{-} contributing to a continuous rise in atmospheric temperature (Acutis et al., 2012). During last 50 years warming trend has been projected 0.18 ˚C per decade due to rising average surface temperature globally (Bin Wang et al., 2015).

The special report of Intergovernmental Panel on Climate Change (IPCC) projected that

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approximately 1.0 ◦C global warming above pre- industrial levels has been caused due to human activities exerting a threat if it increases continuously with current rate, global warming may reach up to 1.5 ◦C within the era between 2030 and 2052 (IPCC, 2018). Moreover, with the rising temperature, the onset, intensity and frequency of rainfall is also changing with passage of time. The change in precipitation pattern in response to warming over the 21st century will not be uniform, some regions will experience higher rainfall leading towards floods whereas other will face drought in response to reduced precipitation (IPCC, 2013). It is considered that global warming will influence more evaporation resulting to the intensification in the frequency and intensity of extreme rainfall events (Meehl et al., 2007). The average intensity of precipitation is generally increasing, whereas, wet days frequency is decreasing in many parts of the world leading towards drought (Khan et al., 2016). A severe drought in 1920s was faced by northern China due to reduced rainfall (Liang et al., 2006).

The overwhelming climate changes have affected agricultural production, human health and natural ecosystems adversely (Arunanondchai et al., 2018). Agriculture production has been turned down due to current global warming and climate variability leading to food security threat (Kurukulasuriya et al., 2008). Furthermore, unpredictable and diverse rainfall pattern is resulting to soil infertility, droughts and floods (Zoellick, 2009). Many countries of the world are at the risk in future, for the drop of major crop productivity due to abrupt climatic changes and global warming (Bonan & Doney, 2018; Tebaldi & Lobell, 2018). Developing countries being the key determinant of agricultural productivity due to their geographical position at the globe are more susceptible to changing climate adverse effects (Zinyengere et al., 2014). The warmer climate shrinks the crop life cycle exerting early maturity compiled with heat stress at reproductive stage causes the reduction in the crop average yield (Craufurd & Wheeler, 2009; Thornton et al., 2014). Cereal yield is highly susceptible to high temperature and drought stress (Barnabás et al., 2008), each degree (◦C) rise in temperature may reduce the wheat and maize yield by 6 % and 8.3% respectively (Asseng et al., 2015; Lobell & Field, 2007). Zhao et al. (2017) analyzed the impacts of climate changes on major crops and concluded 7.4%, 6%, 3.2 and 3.1 % reduction in maize, wheat, rice and soybean respectively. Besides major agricultural crops, minor crops are also affecting adversely threatening to food security due to less area under cultivation as compared to major crops but equally important in food provision. Rising average minimum temperature by 1 ◦C may cause yield reduction of 8.73, 9.79, 24.15 and 30.33 thousand tons in mustard, barley, sorghum and millet respectively (Khatian et al., 2017).

Climate change in the form of increased temperature could lead to declined crop production (Zhang *et al.*, 2015; Hillel and Rosenzweig, 2005, 2013). Therefore, it is imperative to quantify climate change impact on rainfed agriculture to have most favorable crops, cultivars and cropping systems (Tubiello *et al.*, 2000; Asseng and Pannell, 2013). Cropping system in the rainfed agriculture of Pakistan is dominated by wheat crop. Farmers are not willing to grow other crops as returns from these crops are very low. The traditional practice in rainfed farming is summer fallowing and cereal-cereal cropping pattern which resulted to depletion of nutrients in the soil. Therefore, economically viable and environment friendly crop rotation is need of time to achieve sustainability development goals. The incorporation of legumes in the cropping patterns could result to increased organic matter, soil biological activity, enhancement of N supplying power of soil as well as improvement in the nutrients and soil water dynamics. Similarly, it will also help to get higher crop yield (López-Bellido *et al.*, 1998; Galantini *et al.*, 2000; Miglierina *et al.*, 2000).

To address all the problems related to the declined crop productivity of rainfed cropping system climate smart agriculture should be considered using process-based crop model's approach. These models have an important role on informing farmer practice, breeding strategies and government policy in order to address challenges like food security, climate mitigation and adaptation. The management strategies like optimize N fertilization (Rinaldi, 2004), selection of a spring- or summer-planted crop (Saseendran *et al.*, 2013), simulation of both wheat grain yield and soil water content (Mkhabela and Bullock, 2012), climatic variability and the modelling of crop yields (Semenov and Porter, 1995), effects of high temperature stress on productivity (Tao and Zhang, 2013), climate change impacts on soil erosion (O'Neal *et al.*, 2005) and agricultural risk management (Fraisse *et al.*, 2006) were studied using different modeling framework. Agricultural systems model worldwide are increasingly being used to explore options and solutions for the food security, climate change adaptation and mitigation and carbon trading problem domains (Asseng *et al.*, 2013). APSIM (Agricultural Production Systems sIMulator) is one such model that continues to be applied and adapted to this challenging research agenda (Archontoulis *et al.*, 2014; Holzworth *et al.*, 2014). The other models extensively used in the designing of management, adaptation and mitigation strategies in the context of climate variability are CropSyst (Stöckle *et al.*, 2003), DSSAT (Ngwira *et al.*, 2014), AquaCrop (Abi Saab *et al.*, 2015), EPIC (Della Peruta *et al.*, 2014) and STICS (Bergez *et al.*, 2014). Proposed crop modeling technology will help to develop local solutions to climate change challenges. Collected data will be used to provide the spatial distribution of biophysical variables over regions of Pakistan that support primarily rainfed agriculture. Climatic extremes are driving small-scale farmers, most of which are women, off the farm. The tools and technologies we will develop will provide these farmers with the decision support to stay on the farm and improve family economic status. The biophysical variables could be used to calibrate cropping system models to better simulate heat- and drought-stress effects on crop yield with special emphasis on food security. The modeling could facilitate design of cereal-based cropping systems that will be resilient in light of climate change. The technology in future could be made available to farmers as ICT-based agro-advisory tools. Resilient cropping systems require crops adapted to new weather patterns in a changed climate. Modeling with rise in temperature to provide heat shocks to wheat crop helped to predict haet stress impact on crop biomass and yield. Model was further used to have heat- and drought-tolerant prototype genotypes for wheat to enhance the resiliency practicality of the new cropping systems.

Methodology

Experimental design and cropping patterns

A study was conducted for evaluating different cropping systems (CS) at three sites of rainfed Pothwar during 2017-19. Seven CS (i) Wheat-Fallow (WF) (ii) Wheat-Groundnut (WG) (iii) Wheat-Mungbean (WM) (iv) Wheat-Mashbean (WMas) (v) Wheat-Maize (WMa) (vi) Wheat+Lentil-Maize (WLM) and (vii) Wheat+Sorghum (WS) were arranged in a randomized complete block design (RCBD) using three replications at each site of rainfed Pothwar. Sources of fertilizers applied were Urea, DAP and SOP. Other details of crops, inputs and cultural practices are given in Table 1.

Soil Data

Soil samples were taken by using king tube till the depth of 90 cm. Collected profile of soil was divided into 0-15 cm, 15-30 cm, 30-45 cm, 45-60 cm, 60-75 cm and 75-90 cm for further soil analysis. Soil samples collected prior to sowing from each replication were analyzed for soil pH, electrical conductivity, and soil texture. Similarly, samples before sowing and after harvesting were collected to analyzed for NO_3-N, total organic carbon (TOC), available phosphorus and extractable potassium from each study site (Table 2 to 4).

Soil Moisture Content

Water is limiting factor in rainfed agriculture therefore soil moisture determination was carried out before sowing, during crop life cycle and at harvesting of crop. 10 g of soil (< 2-mm) was weighed in metal can with lid and oven dried at 105°C overnight (24 hours). Oven dried soil was reweighed, and following formulae was used to get soil moisture contents.

$$Soil\ moisture\ (\theta) = \frac{wet\ soil\ (g) - dry\ soil\ (g)}{dry\ soil\ (g)}$$

$$Dry\ soil\ (g) = \frac{1}{1 + \frac{\theta}{100}} \times wet\ soil$$

$$Moisture\ factor = \frac{Wet\ soil(g)}{Dry\ soil\ (g)}\ or\ \frac{100 + \%\theta}{100}$$

Soil Texture

Soil texture was measured using following formulas:

$$[Silt + Clay](\%w/w) = (R_{sc} - R_b) \times \frac{100}{Oven - Dry\ soil\ (g)}$$

$$Clay\ (\%w/w) = (R_c - R_b) \times \frac{100}{Oven - Dry\ soil\ (g)}$$

$$Silt\ (\%w/w) = [Silt + Clay\ (\%w/w)] - [Clay\ (\%w/w)]$$

$$Sand\ (\%w/w) = Sand\ weight\ (g) \times \frac{100}{Oven - Dry\ soil\ (g)}$$

$$Sand\ weight\ (g) = [Beaker + Sand\ (g)] - [Beaker\ (g)]$$

After measuring sand, silt and clay percentage the soil was assigned textural class using USDA textural triangle.

Total Organ Carbon (TOC)

In a digestion tube, two g soil of each respective treatment, and 5 ml of potassium dichromate ($K_2Cr_2O_7$) were taken and for a few seconds, mixed well. Ten ml of sulphuric acid (H_2SO_4), while mixing, was added to each tube and mixed for further 30 seconds. After this, these tubes were placed in preheated block digester. Tubes were removed after 30 minutes, allowed to cool, water

was then added to half to the mark, and again mixing was done; Tubes well filled to the graduated mark, after further cooling, with water and increased 3-4 times with thorough mixing. When the suspensions were settled, the same amount was decanted into centrifuge tubes, from each digest solution and centrifuged for 15 minutes. At the same time, standards were prepared. Then, the sample and stand supernatant solutions were run at 610 nm through spectrophotometer meter and their absorbance was measured. Soil total organic carbon (Table 2a and 2b) was calculated using following formula:

$$\% C = \frac{mg\ C}{Oven\ dried\ soil\ weight} \times 100$$

Table 1: Details of crop and inputs used in the study during two years (2017-2019)

Crop	Variety	Seed rate (kg ha^{-1})	Fertilizer applied N-P-K (kg ha^{-1})	Planting date (2017-18)	Harvesting date (2017-19)
Winter Crops (2017 to 2018 and 2018 to 2019)					
Wheat	Pakistan-13	100	100-50-0	15-Nov-17/**10-Nov-18**	1-May-18/**15-April-19**
Lentil	Markaz-09	25	20-60-50	15-Nov-17/**10-Nov-18**	15-Apr-18//**01-April-19**
Summer Crops (2018-19)					
Groundnut	BARI-2011	100	25-80-25	10/6/2018/ **(07/6/2019)**	15-10-2018 **(10-10-2019)**
Mungbean	NCM-257-2	20	20-60-50	10/7/2018 **(07/6/2019)**	18-10-2018 **(10-10-2019)**
Mashbean	NARC Mash - 1	20	20-60-50	10/7/2018 **(07/6/2019)**	18-10-2018 **(10-10-2019)**
Maize	Ageti-2002	40	80-60-50	10/7/2018 **(07/6/2019)**	18-10-2018 **(10-10-2019)**
Sorghum	JS-2002	87	80-60-50	10/7/2018 **(07/6/2019)**	18-10-2018 **(10-10-2019)**

Table 2: Physiochemical characteristics of soil at Islamabad

Determinations	**Units**	**0-15**	**15-30**	**30-45**	**45-60**	**60-75**	**75-90**
pH	1:1	7.5	7.6	8.3	8.2	8.4	8.4
EC	dSm^{-1}	0.24	0.2	0.21	0.21	0.22	0.21
Nitrogen	%	0.04	0.04	0.03	0.030	0.02	0.02
Nitrate-N	$mg\ Kg^{-1}$	7.86	7.28	6.50	6.20	5.24	5.00
AV.P	$mg\ kg^{-1}$	3.64	3.39	3.90	3.72	2.72	2.54
K	$mg\ kg^{-1}$	160	180	210	220	210	240
Organic Carbon	%	0.91	0.87	0.63	0.6	0.44	0.41
Silt	%	33	33	33	33	33	33
Sand	%	35	35	35	35	35	35
Clay	%	32	33	34	35	35	35
Texture		Loam	Loam	Loam	loam	Loam	Loam
B.Density	gcm^{-3}	1.24	1.42	1.46	1.52	1.59	1.65
SLL	$mmmm^{-1}$	0.07	0.09	0.09	0.09	0.09	0.09
SDUL	$mmmm^{-1}$	0.34	0.24	0.25	0.26	0.23	0.23
Saturated SW	$mmmm^{-1}$	0.48	0.40	0.38	0.36	0.33	0.31
Soil Albedo	0.13						

Table 3: Soil physiochemical properties at URF – Koont.

Attribute (2013-14)		Units	0-15	15-30	30-45	45-60	60-75	75-90
pH		1:1	8.1	8.1	8.6	8.8	8.5	8.5
Organic Carbon		%	0.75	0.72	0.67	0.52	0.42	0.31
Slit		%	35	34	35	34	34	33
Sand		%	34	33	35	34	33	32
Clay		%	31	33	30	32	33	35
Texture			Sandy	Sandy	Sandy	Sandy	Sandy	Sandy
			Clay	Clay	Clay	Clay	Clay	Clay
			loam	loam	loam	loam	loam	loam
Bulk Density		gcm^{-3}	1.29	1.45	1.55	1.65	1.7	1.75
SLL		$mmmm^{-1}$	0.061	0.08	0.08	0.08	0.083	0.083
SDUL		$mmmm^{-1}$	0.25	0.18	0.19	0.19	0.18	0.17
Saturated S W		$mmmm^{-1}$	0.48	0.38	0.35	0.31	0.29	0.27

Table 4: Physiochemical characteristics of soil at Attock during 2017-18

Determinations (2008-09)	**Units**	**0-15**	**15-30**	**30-45**	**45-60**	**60-75**	**75-90**
pH	1:1	8.1	8.1	8.2	8.3	8.4	8.4
EC	dSm^{-1}	0.2	0.21	0.23	0.23	0.21	0.22
Nitrogen	%	0.030	0.032	0.038	0.036	0.030	0.026
Nitrate-N	mg Kg^{-1}	2.81	2.82	2.32	2.21	2.20	1.92
AV.P	mg Kg^{-1}	2.13	2	2.16	2.32	2.1	2
K	mg Kg^{-1}	130	120	105	110	115	120
Organic Carbon	%	0.6	0.64	0.75	0.72	0.6	0.51
Silt	%	27	27	28	28	28	28
Sand	%	60	58	56	55	54	53
Clay	%	13	15	16	17	18	19
Texture		sandy loam	sandy loam	sandy loam	sandy loam	sandy loam	sandy loam
B.Density	gcm^{-3}	1.35	1.51	1.59	1.68	1.72	1.77
SLL	$mmmm^{-1}$	0.06	0.08	0.08	0.08	0.08	0.08
SDUL	$mmmm^{-1}$	0.15	0.16	0.16	0.15	0.17	0.17
Saturated SW	$mmmm^{-1}$	0.41	0.36	0.33	0.30	0.28	0.26
Soil Albedo	0.14						

Table 5: Soil Fertility Status before the experiment

Cropping Systems	**Soil NO_3-N (mg kg-1)**			**Soil Phosphorus (mg kg^{-1})**		
	Islamabad	URF-Koont	Attock	Islamabad	URF-Koont	Attock
Wheat-Fallow	4.86	2.06	1.27	3.64	2.64	1.27
Wheat-Groundnut	4.5	2.79	1.28	3.39	2.39	1.35
Wheat-Mungbean	4.2	2.5	1.29	3.2	2.2	1.35
Wheat-Mash	4.24	2.12	1.33	3	2	1.36

Wheat-Maize	4	2.13	1.34	3	2	1.34
Wheat-lentil-Maize	4	2.1	1.4	3	2	1.32
Wheat-Sorghum	4.12	2.1	1.5	3.3	2.3	1.32

Cropping Systems	**Soil Potassium K (mg kg^{-1})**			**Soil Total organic Carbon (%)**		
	Islamabad	URF-Koont	Attock	Islamabad	URF-Koont	Attock
Wheat-Fallow	160	121	89.33	0.44	0.42	0.36
Wheat-Groundnut	165	122	90	0.45	0.44	0.33
Wheat-Mungbean	166	123	85.7	0.5	0.41	0.31
Wheat-Mash	167	122	85.33	0.6	0.39	0.39
Wheat-Maize	169	123	74.67	0.63	0.4	0.35
Wheat-lentil-Maize	165	121	85	0.65	0.42	0.32
Wheat-Sorghum	166	122	82.67	0.66	0.44	0.35

Table 6: Soil Fertility Status before the experiment

Cropping Systems	**Soil NO_3-N (mg kg^{-1})**			**Soil Phosphorus ((mg kg^{-1})**		
	Islamabad	**URF-Koont**	**Attock**	**Islamabad**	**URF-Koont**	**Attock**
Wheat-Fallow	4.13	1.75	1.08	3.09	2.24	1.08
Wheat-Groundnut	5.45	3.38	1.55	4.10	2.89	1.63
Wheat-Mungbean	5.08	3.03	1.56	3.87	2.66	1.63
Wheat-Mash	5.13	2.57	1.61	3.63	2.42	1.65
Wheat-Maize	3.56	1.90	1.19	2.67	1.78	1.19
Wheat-lentil-Maize	3.64	1.91	1.27	2.73	1.82	1.20
Wheat-Sorghum	3.01	1.53	1.10	2.41	1.68	0.96

Cropping Systems	Soil Potassium K (mg kg^{-1})			Soil Total organic Carbon (%)		
	Islamabad	URF-Koont	Attock	Islamabad	URF-Koont	Attock
Wheat-Fallow	135.84	102.73	75.84	0.37	0.36	0.31
Wheat-Groundnut	199.65	147.62	108.90	0.54	0.53	0.40
Wheat-Mungbean	200.86	148.83	103.70	0.61	0.50	0.38
Wheat-Mash	202.07	147.62	103.25	0.73	0.47	0.47
Wheat-Maize	150.41	109.47	66.46	0.56	0.36	0.31
Wheat-lentil-Maize	150.15	110.11	77.35	0.59	0.38	0.29
Wheat-Sorghum	121.18	89.06	60.35	0.48	0.32	0.26

Crop Data

Experiment includes wheat and lentil sowing and harvesting during winter seasons of 2017-19. In summer 2018 and 2019 summer crops were sown and harvested.

Winter crops:

Wheat and lentil were sown during winter 2017 and data was collected.

Summer crops:

Groundnut, Mungbean, Mashbean, Maize and Sorghum were sown in summer 2018 and data was collected from sowing to harvesting.

Wheat data

i. **Wheat Phenology**

Observations regarding crop phenology was made using Zadok's scale (Zadok, 1974), of ten plants per plot. These measurements of the phenological events begin at seed germination and continued until the crop maturity.

ii. **Wheat Biomass (Kg ha^{-1})**

Above ground biomass was recorded at three leaf, anthesis and maturity stages. Sample size consisted of the total plants within 0.25 m x 1 m area.

iii. **Wheat Leaf area index (LAI)**

Leaf area of wheat crop was measured at three leaf, tillering, jointing, flag leaf, anthesis, milky, soft dough and maturity stages. The leaf area was converted to leaf area index after diving with ground area.

$$LAI\ (unitless) = \frac{Leaf\ area\ (LA)}{Ground\ area\ (GA)}$$

iv. **Wheat Plant Height**

Plant height was recorded from ten plants per plot. This data was then averaged across the replicate plots.

v. **Wheat spike length**

Spike length was recorded from ten plants per plot. This data was then averaged across the replicate plots.

vi. **Wheat spikelets per spike**

Number of spikelets per spike was averaged from 50 spikes taken at random from each replication at harvest.

vii. **Wheat seed per spike**

Number of seed per spike was averaged from 50 spikes taken at random from each replication at harvest.

viii. **Wheat tillers per m^2**

One-meter square area was marked randomly in each plot under wheat. Number of tillers from the marked area was counted then the data was averaged.

ix. **Wheat thousand grain weight (TGW)**

Three samples of 1000- grain were randomly taken from the harvested lot of each plot, weighed and then their average was calculated.

x. **Wheat straw Yield (Kg ha^{-1})**

For obtaining biological yield, three samples of above soil plants from one square meter, randomly selected from each plot were separately harvested, sun dried, tied in bundles and weighed. Then it was converted into kilograms per hectare.

xi. **Wheat grain Yield (Kg ha^{-1})**

At harvest, randomly one square meter from each respective plot was separately harvested, and grain yield was recorded. The yield was then converted into kilogram per hectare.

xii. **Wheat harvest Index (HI)**

Harvest index values from each harvest lot were calculated by the following formula:

$$HI = \frac{Grain\ yield}{Biological\ yield}$$

Weather Data

Long term (1961-2019) weather data for maximum and minimum temperature, precipitation, sunshine hours and solar radiation (MJ/M^2/Day) were collected from Pakistan Meteorological

Department (PMD) at Islamabad and also downscaled by SDSM where data was missing. All the daily weather data was formatted as according to the requirements of models.

Statistical Analysis:

Above mentioned data of the crops were collected during first year of project was analyzed using R. The means were compared using LSD at 5% (Steel and Torrie 1980).

MODEL PARAMETERIZATION AND EVALUATION

The field data collected during 2017-18 and 2018-19 was used for model calibration and validation respectively. DSSAT_CERES_Wheat model was used to model the impacts of study sites and cropping systems on wheat crop based upon weather, crop and soil data. Crop phenology, soil analysis, and meteorological data from each site were used as an input for model calibration and evaluation. Weather data was obtained from Pakistan Meteorological Department (PMD) for all the location under study. The comparison of model simulations by CSM-CERES_Wheat and observed values was carried out to assess the Model validity.

Results & Discussions

Wheat Phenology

Wheat phenology depicted significant variability at variable climatic locations. The highest days to flowering and maturity was observed at Islamabad while lowest were at Attock which might be due to variability in climatic conditions during wheat growing cycle (Fig.1). Therfore, in order to minimize the impact of climatic variability and extreme events on crop phenology it is imperative to design ideotype plants which can bring sustainability in crop yield. The main traits that needs to be considered are light conversion efficiency, extended duration of grain filling and optimal phenology. Similar recommendations were made by Ahmad et al., (2015) who concluded that for wheat, sowing (S) and emergence (E) dates were delayed by an average of 9.50 and 1.30 days decade^{-1}, while anthesis (A) (5.30 days decade^{-1}) and maturity (M) (5.40 days decade^{-1}) dates were advanced due to climate warming. Ahmed et al., (1987) reported that crop phenology have significant impacts on total biomass and grain yield and it is important for crops adaptation under climate extremes. Similarly, Fletcher et al., (2015) suggested use of mixtures of wheat cultivars of different duration which can potentially balance the risk of heat stress on yield. Crop growth and development are associated to photosynthates formation and radiation use efficiency (Lázaro et al., 2010). Results of (Álvaro et al., 2008) are in line to our findings in which they concluded that by reducing the source capacity through shading had negative effect on grain yield which could be due to less interception of solar radiation and lower photosynthetic rate. In our findings, Ceres-wheat outcomes adequately predicted phenology of wheat crop (days to anthesis and maturity) in nine different stages. (Sage & Pearcy, 1987) (Asseng et al., 2016) reported that models have the ability to simulate wheat phenology closer to observed values. CERES-Wheat a simulation model for wheat was initially developed and distributed with Decision Support System for Agro-technology Transfer (DSSAT) which simulates crop phenology and growth processes in response to different environmental and management factors. DSSAT_CERES_Wheat model have been applied under wide range of environmental conditions in response to different management practices and climate scenarios (Chardon et al., 2012; Hussain et al., 2018; Salcedo, 2015).

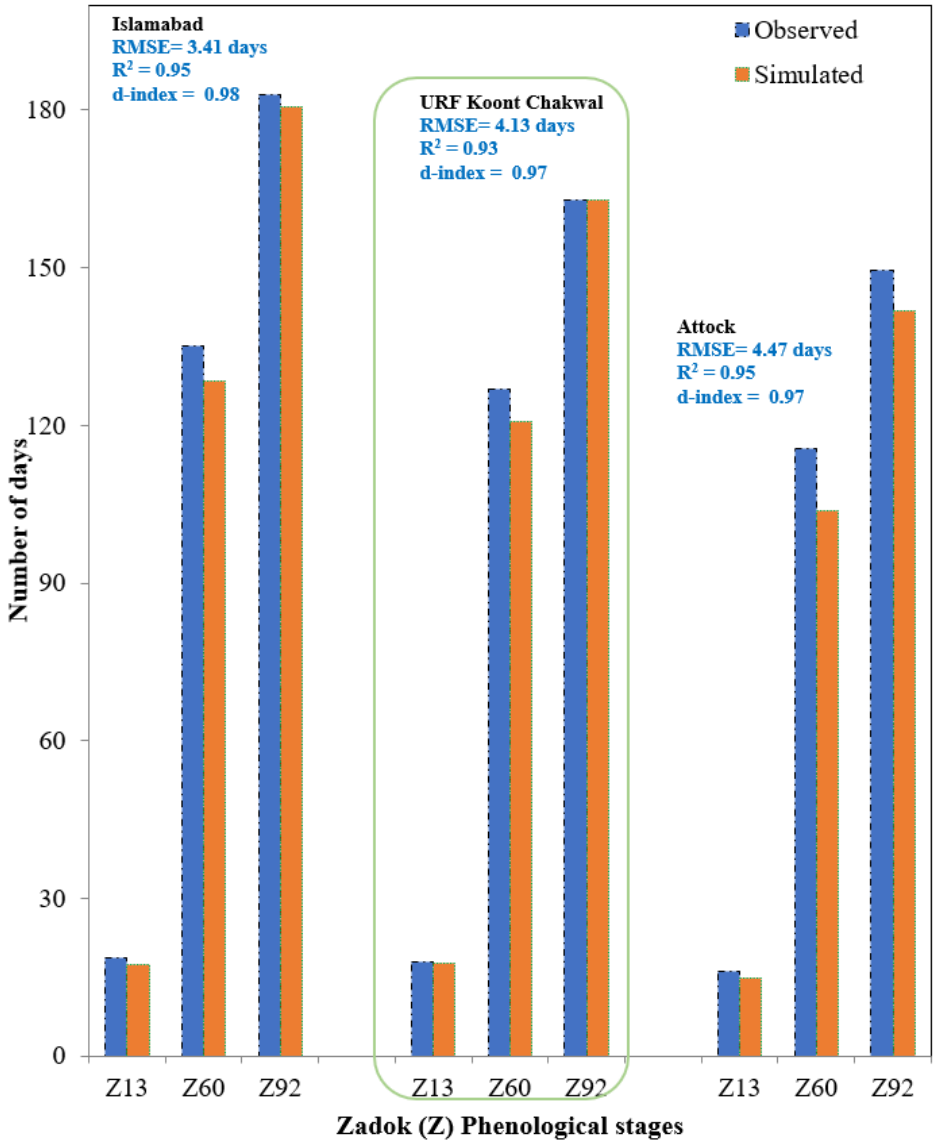

Fig.1. Phenological stages of wheat at three sites of rainfed Pothwar

Wheat Biomass (Kg ha^{-1})

Wheat Biomass under variable climatic locations and cropping systems depicted significant variability. Among locations highest biomass was observed at Islamabad followed by URFK-Chakwal and Attock (Fig.2). This variability in biomass accumulation was due to variable climatic conditions prevailed during crop life cycle. Among cropping systems maximum biomass accumulation was observed under Wheat-Mashbean (WMa) cropping systems which might be due to optimum availability of resources (Fig.3).

Porter and Semenov, (2009) depicted negative impacts of increased climate variability and higher temperature on crop productivity across the globe. Effect of different weather factors on biomass accumulation and yield of crops were evaluated by Monteith and concluded that temperature and

rainfall are main climatic variable which have largest impacts on crop growth and development. Furthermore, impacts of climate variability on crop parameters were reported in the work of Dubey and Sharma,(Ouyang et al., 2014). Comparison between simulated and observed biomass accumulation during different growth stages of wheat has been shown in Fig.4 and 5. that shows close association and accuracy of model in the prediction of wheat biomass under different cropping systems.

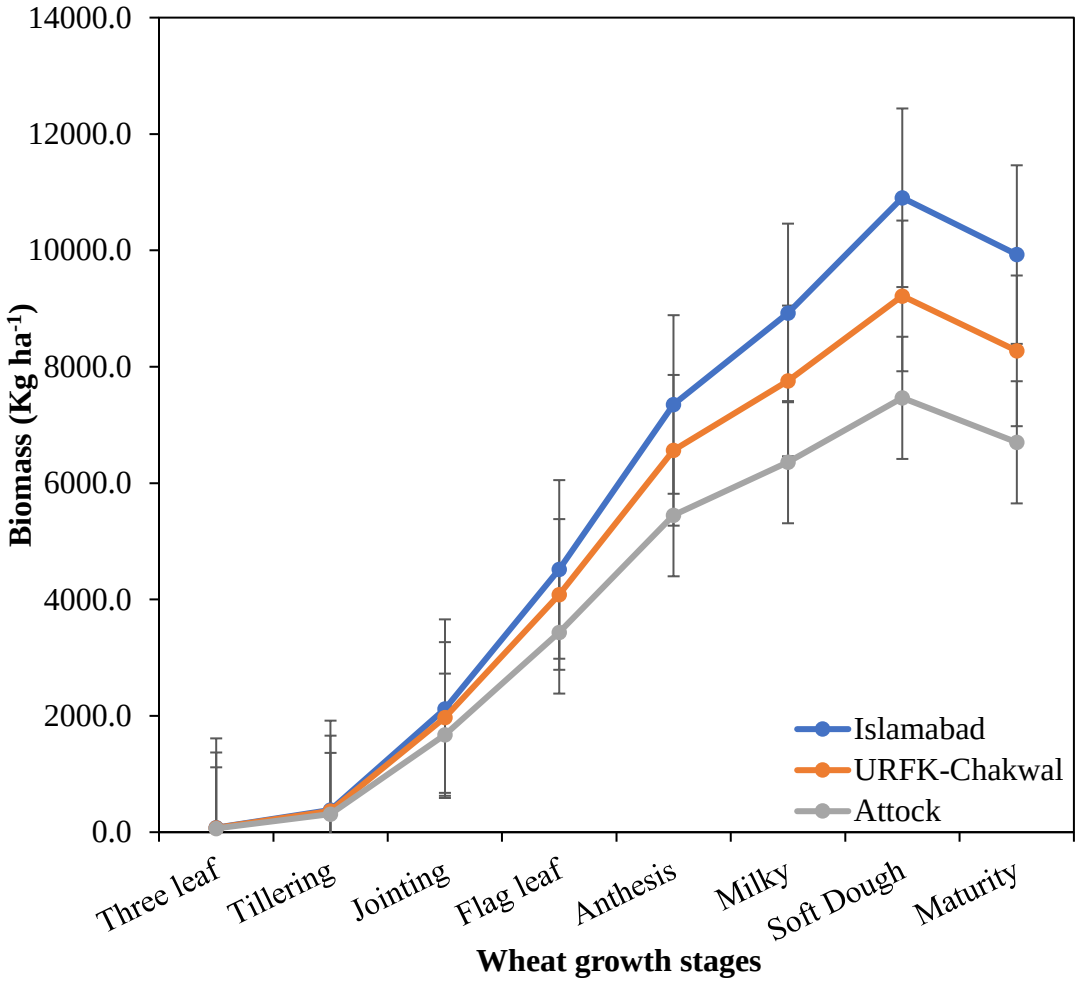

Fig.2. Biomass (Kg ha^{-1}) accumulation of wheat during different growth stages at three sites of rainfed Pothwar

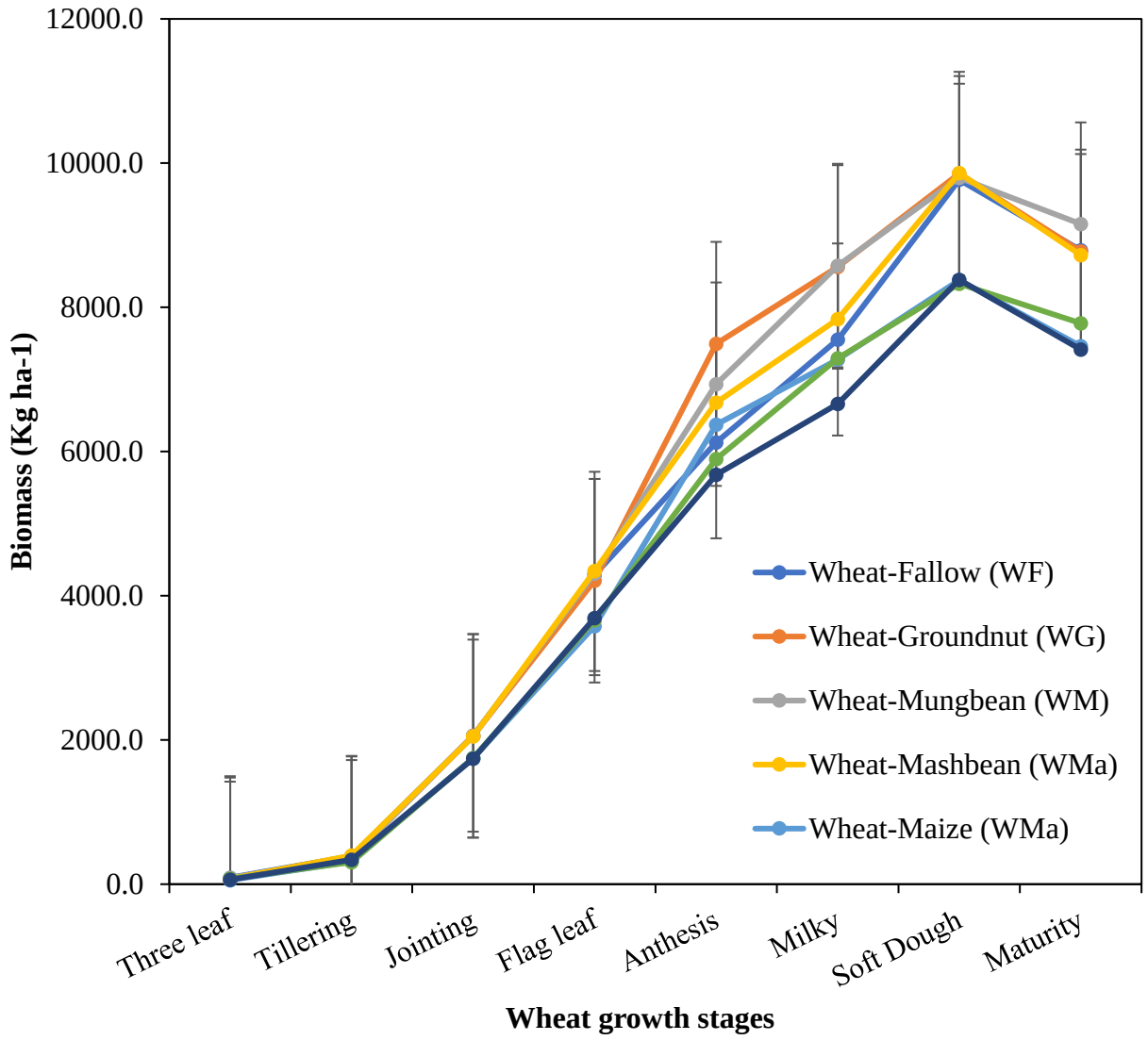

Fig.3. Biomass (Kg ha^{-1}) accumulation of wheat during different growth stages under different cropping systems of rainfed Pothwar

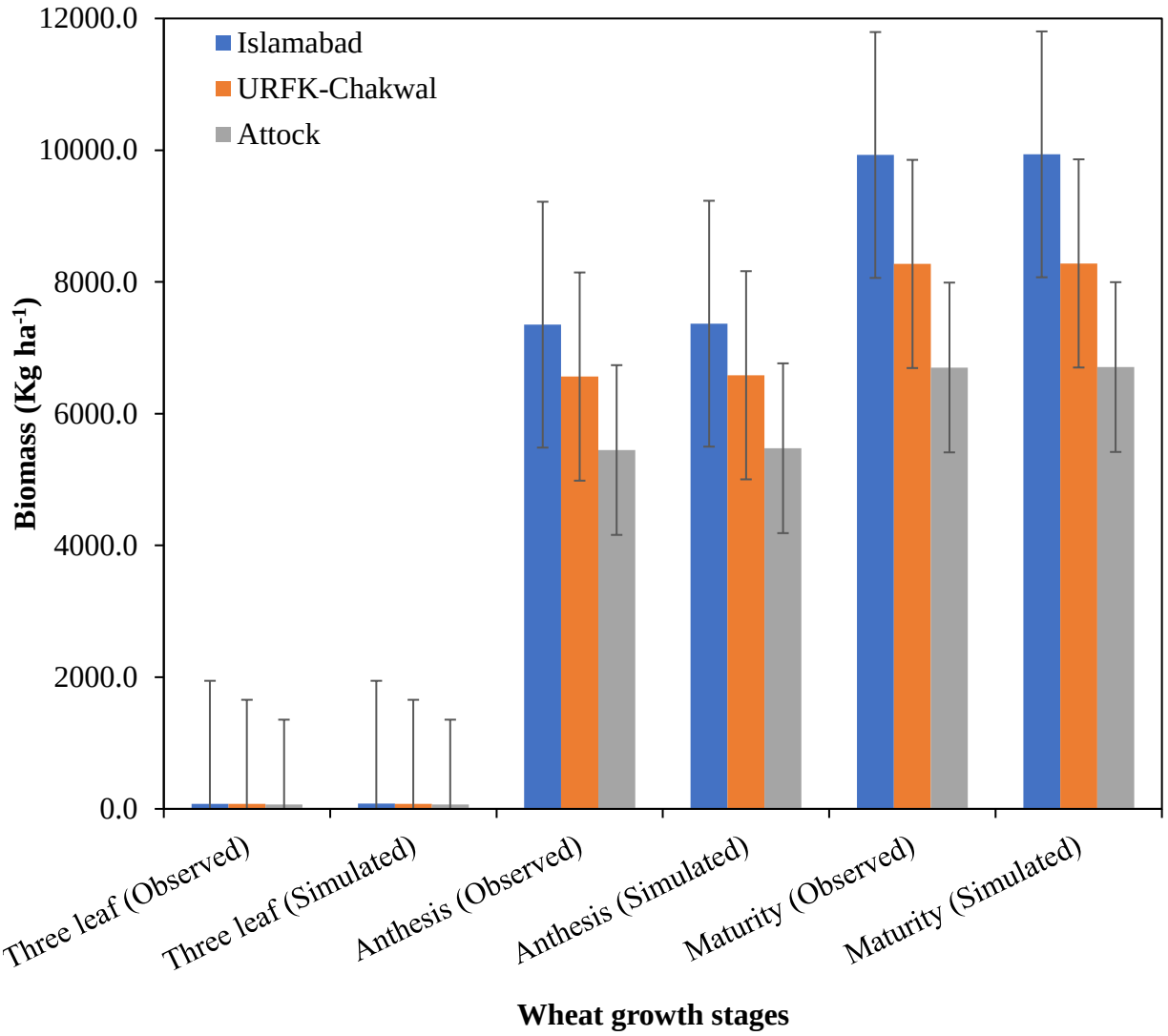

Fig.4. Observed and simulated (DSSAT_CERES_Wheat) biomass (Kg ha^{-1}) accumulation of wheat during different growth stages at three sites of rainfed Pothwar

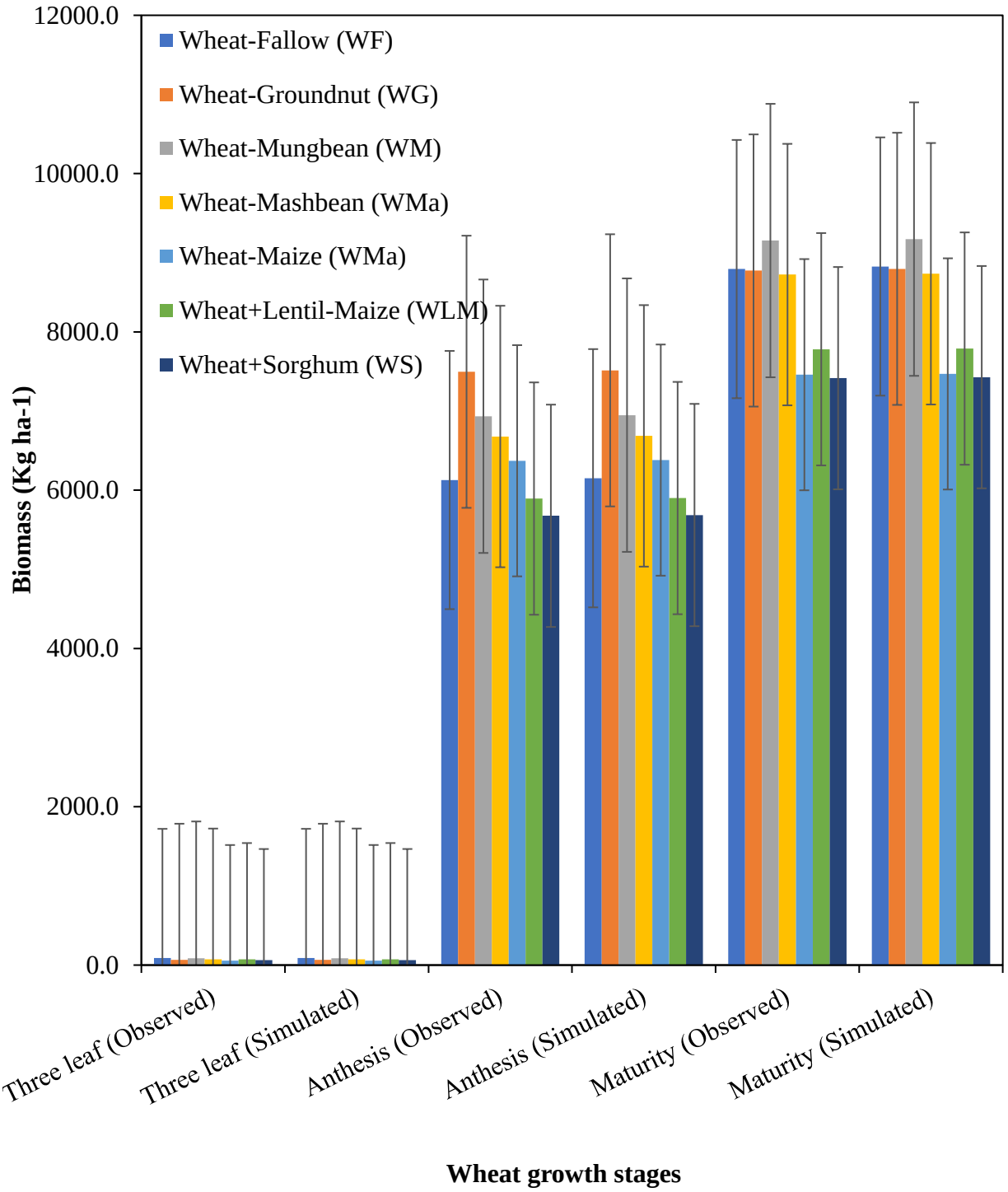

Fig.5. Observed and simulated (DSSAT_CERES_Wheat) biomass (Kg ha^{-1}) accumulation of wheat during different growth stages under different cropping systems of rainfed Pothwar

Leaf area index

Leaf area index under variable climatic locations and cropping systems depicted significant variability. Among locations highest leaf area index was observed at Islamabad followed by URFK-Chakwal and Attock (Fig.6). This variability in leaf area index accumulation was due to variable climatic conditions prevailed during crop life cycle. Among cropping systems maximum leaf area index was observed under Wheat-Fallow (WF) cropping systems which might be due to optimum availability of resources (Fig.7). Observed and simulated (DSSAT_CERES_Wheat) leaf area index of wheat during different growth stages at three sites of rainfed Pothwar have been shown in Fig.8. Similarly, Fig9. shows observed and simulated (DSSAT_CERES_Wheat) leaf area index of wheat during different growth stages under different cropping systems of rainfed Pothwar.

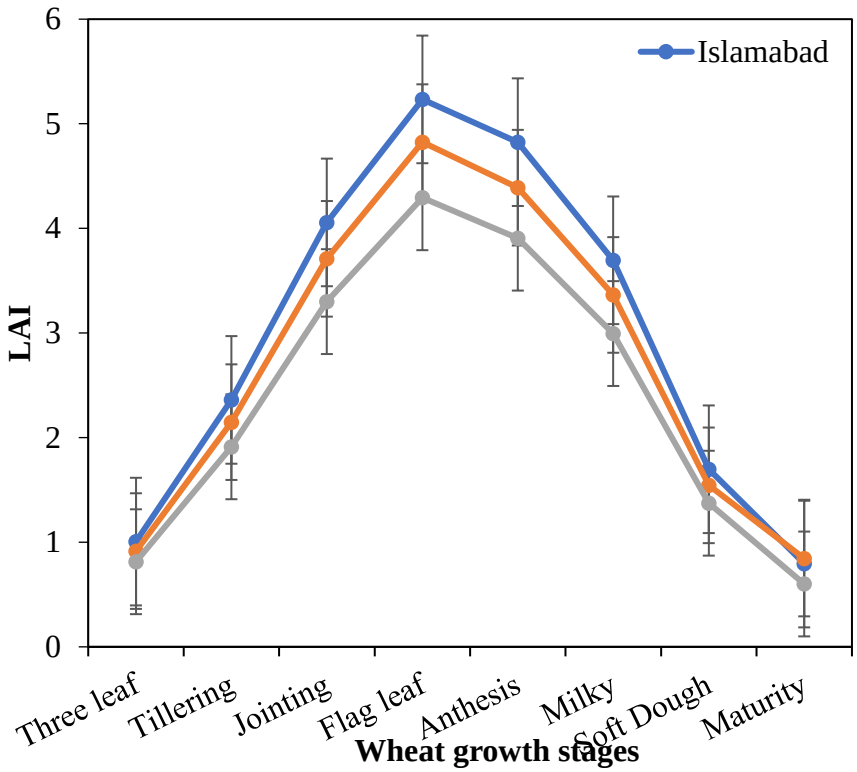

Fig.6. Leaf area index of wheat during different growth stages at three sites of rainfed Pothwar

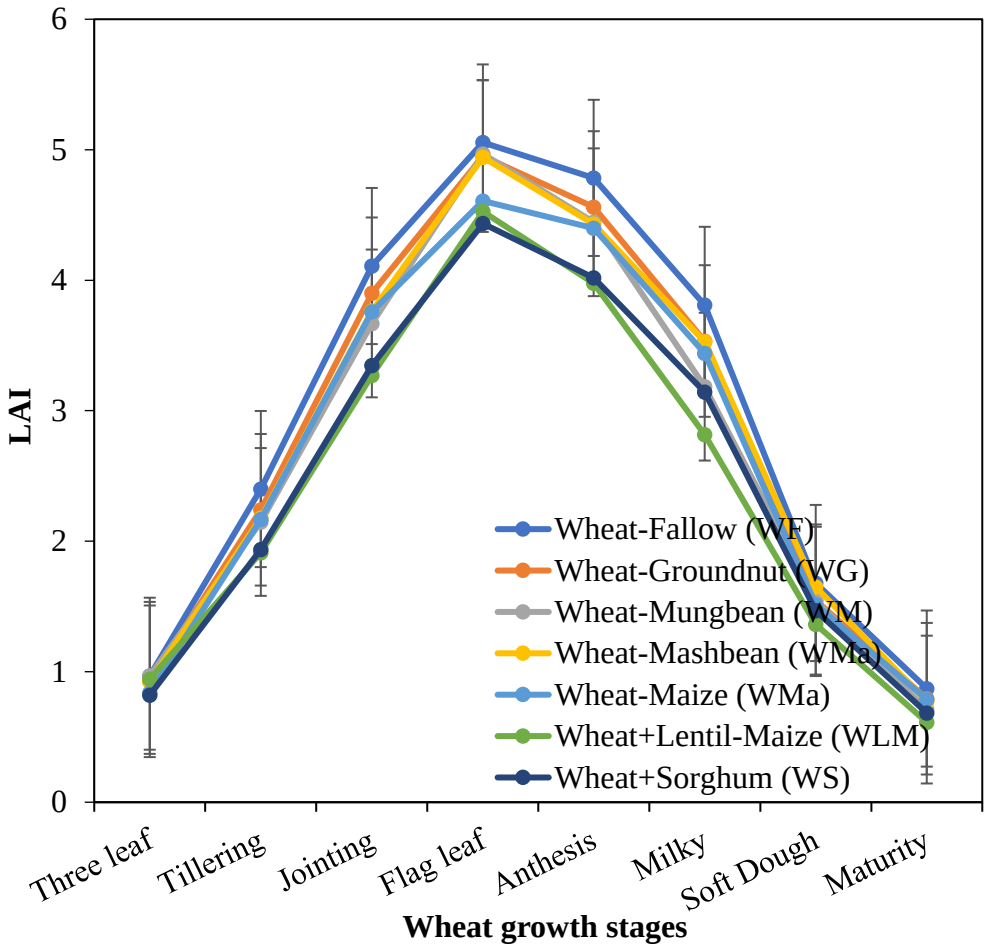

Fig.7. Leaf area index of wheat during different growth stages under different cropping systems of rainfed Pothwar

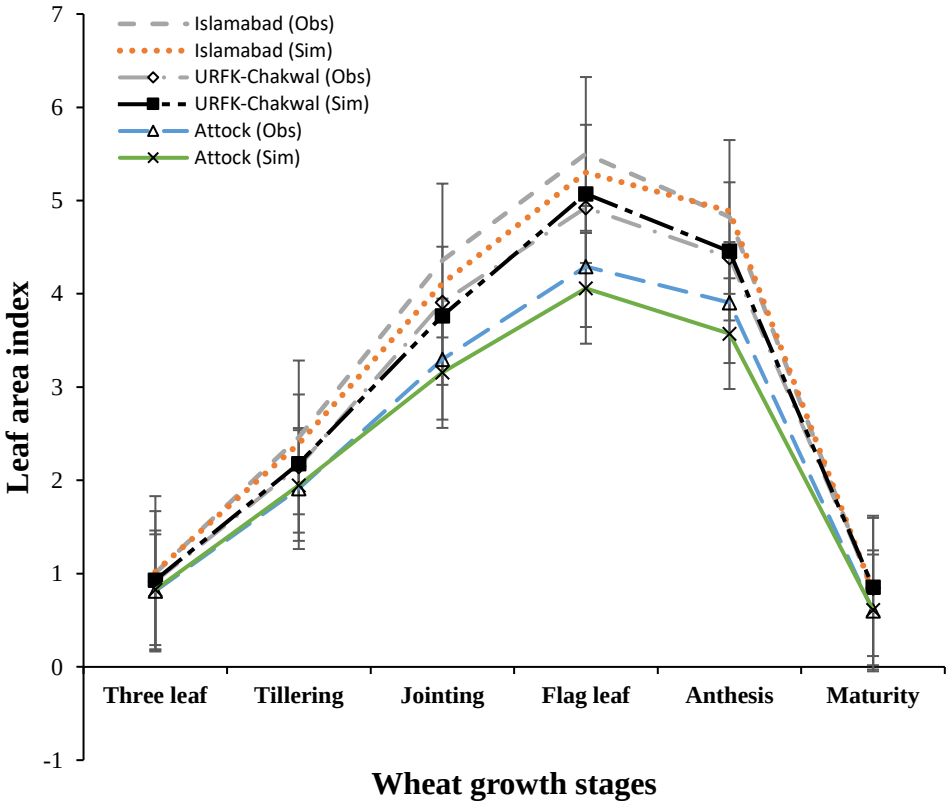

Fig.8. Observed and simulated (DSSAT_CERES_Wheat) leaf area index of wheat during different growth stages at three sites of rainfed Pothwar

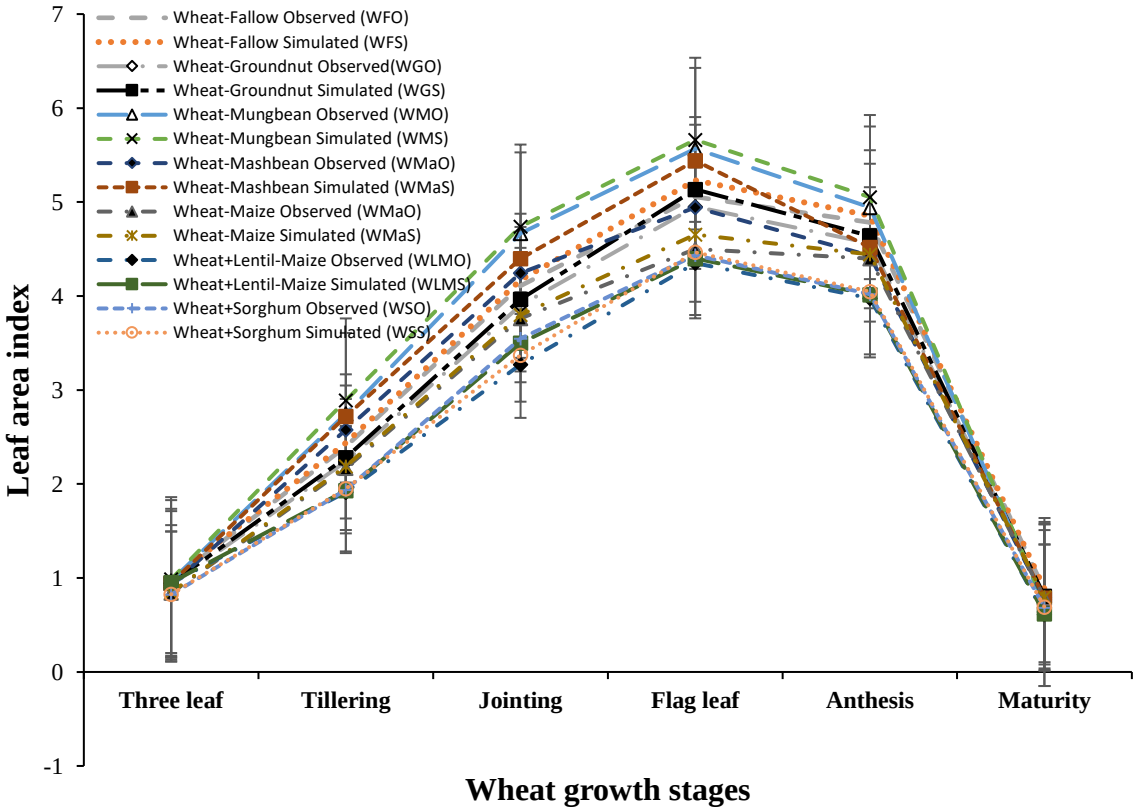

Fig.9. Observed and simulated (DSSAT_CERES_Wheat) leaf area index of wheat during different growth stages under different cropping systems of rainfed Pothwar

Simulation outcomes

DSSAT_CERES_Wheat simulated biological yield of wheat with good accuracy. The highest biological yield was simulated for Islamabad followed by URFK-Chakwal and attock (Fig.10). Simulation outcomes under different cropping systems showed highest biological yield in Wheat-Mungbean while lowest was observed for Wheat-Sorghum and Millet system (Fig.11). This could be due to the additive nature of Mungbean crop which resulted to the availability of nutrients to the wheat crop as compared to wheat after maize and sorghum. Grain yield of wheat was modeled with good accuracy by DSSAT_CERES_Wheat under all three sites and cropping systems (Fig. 12 and 21). Wheat-Mashbean system depicted highest grain yield while lowest yield was observed under Wheat-Maize system. Model application under different cropping system was well documented in earlier work of Abbas et al., (2017).

Climate change impact assessment

Variability in climatic conditions during crop life cycle among treatments resulted to the shorter crop life cycle and less biomass production. Therefore, phenology driven model like DSSAT have potential to accurately simulate biomass accumulation as they uses approach of intercepted solar radiation to calculate biomass production (Tao et al., 2015). Similar to our results Jamieson et al. (1998) stated that predicted and observed biomass were well correlated. Crop biomass have great

association with duration of crop life cycle and temperature is determinant environmental factor influencing crop growth and development (Lu & Zhang, 2000). In our studies decrease in biomass due to higher temperature confirms the earlier researcher findings who concluded that heat stress accelerates crop phenology and crop senescence, which results to earlier crop maturity lesser biomass and crop yield (Ahmed & Fayyaz ul, 2015; Ahmed et al., 2017; Fan et al., 2005; Prasad & Jagadish, 2015) (Fig A52-A55). Increased temperature in future will have negative impact on crops and Piao *et al*. (2012) reported that some varieties will be benefitted from warmer climate while other might disappear. Since phenological characteristics are highly related to the biomass production therefore, cultivars which can sustained higher temperature should be used in future. Use of crop models to explore cultivar adaptations to a particular environment is necessary to provide guidance to breeders to have ideal ideotype under heat stress (Ben Rejeb et al., 2014). In our studies Wheat-Mungbean and Mashbean have showed significant effect on biomass and yield of wheat crop and higher temperature resulted to lesser biomass production. Therefore, it is compulsory to consider sustainable cropping system and genotype under changing climate. In all earlier studies reduction in crop growing season was associated with higher temperature. Hence in future current varieties may not be suitable due to shorter growing season thus new cultivars are needed to mitigate climate extremes (Asseng et al., 2015; B. Wang et al., 2015; Xiao et al., 2010).

Trait modifications

The impact of wheat crop trait modification was simulated using DSSAT model. Results showed that trait modification resulted to higher biomass and yield at all sites and cropping systems (Fig. A56 to 59 only presented results for modification in RUE). The results also depicted that early anthesis and longer grain filling period could lead to higher yield under higher temperature. Furthermore, this effect was more beneficial at a drier site in our study as compared to wet site. Thus, in future we need to have wheat ideotypes that have early anthesis and longer grain filling period, larger RUE, maximum grain size and potential grain filling rate. Wang et al., (2019) designed wheat ideotype to cope future climate change and recommended cultivars with early flowering date and higher RUE. Furthermore, Zhang et al., (2012) concluded that wheat yield could be increased by increasing HI of wheat as compared to above ground biomass. Tao et al., (2017) used process-based ensemble ecophysiological model (i.e. APSIM, CropSyst, HERMES, MCWLA, MONICA, SIMPLACE, Sirius Quality, and WOFOST) to design future barley crop ideotypes to mitigate climate change and its associated extreme weather events. Their work suggested climate-resilient barley ideotypes by considering combinations of several key genetic traits in terms of phenology, leaf growth, photosynthesis, drought tolerance, and grain formation. They further reported that in future we need to have cultivars that can have longer reproductive growing period, lower leaf senescence rate, larger radiation uses efficiency or maximum assimilation rate, and higher drought tolerance. Xio et al., (2020) used APSIM to design maize ideotypes sown at different times to have higher yield and water use efficiency. Their simulated results indicated that future maize ideotypes should have a longer reproductive growing period, faster potential grain filling rate, larger maximum grain numbers and larger RUE. These simulated ideotypes could provide roadmap to choose the ideal target traits for increasing maize production and adapting future climate.

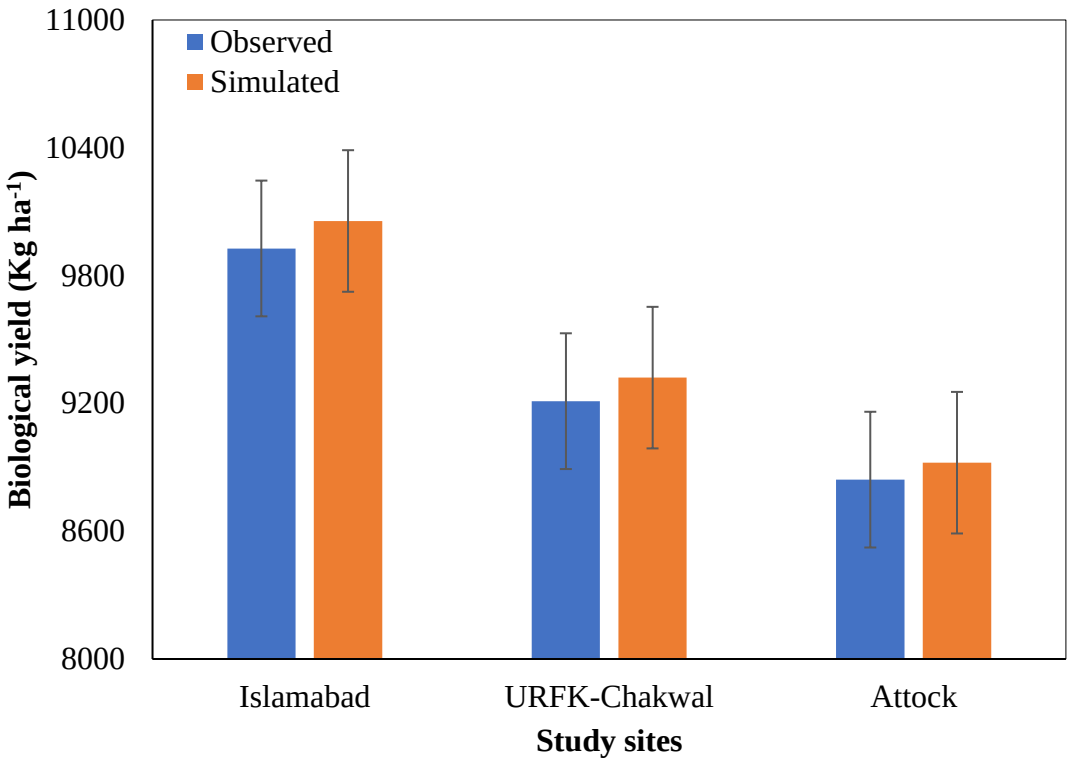

Fig. 10. Observed and simulated (DSSAT_CERES_Wheat) biological yield of wheat at three sites of rainfed Pothwar

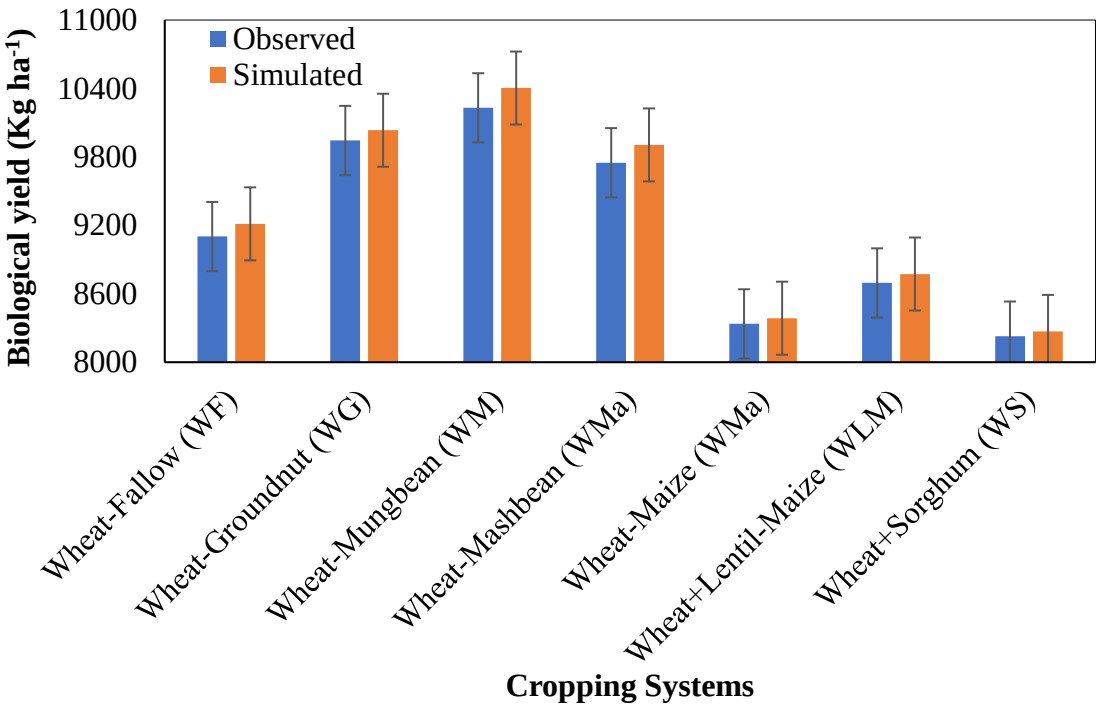

Fig. 11. Observed and simulated (DSSAT_CERES_Wheat) biological yield of wheat under different cropping systems of rainfed Pothwar

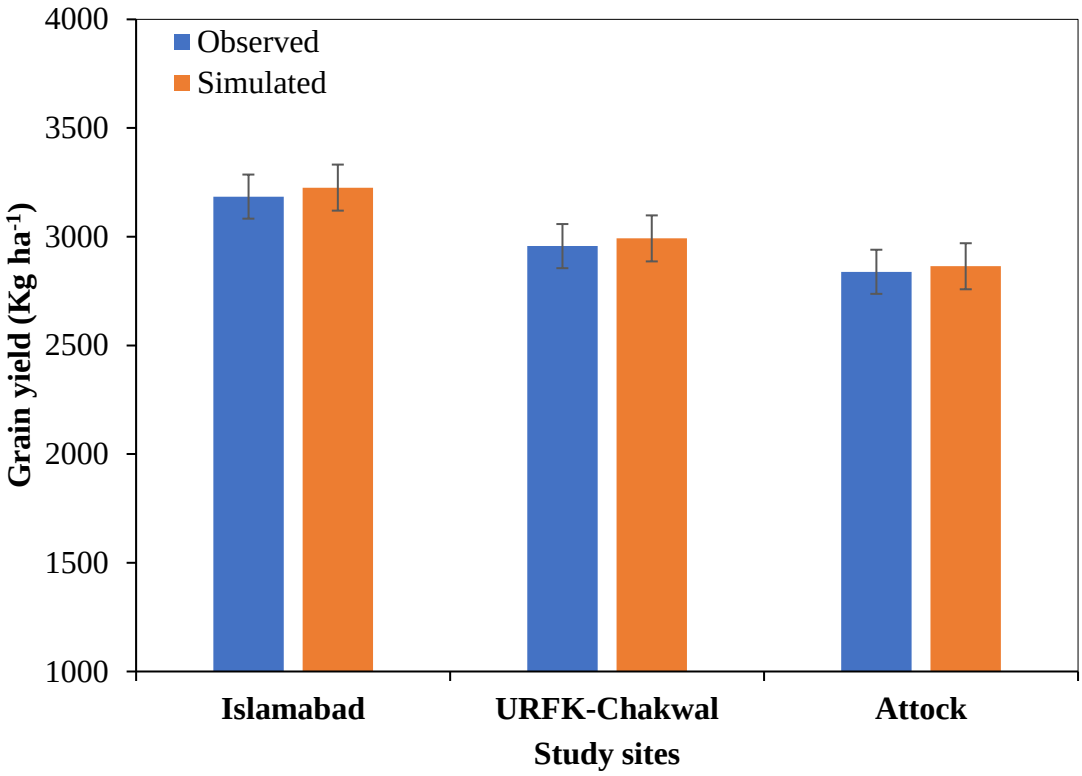

Fig. 12. Observed and simulated (DSSAT_CERES_Wheat) grain yield of wheat at three sites of rainfed Pothwar

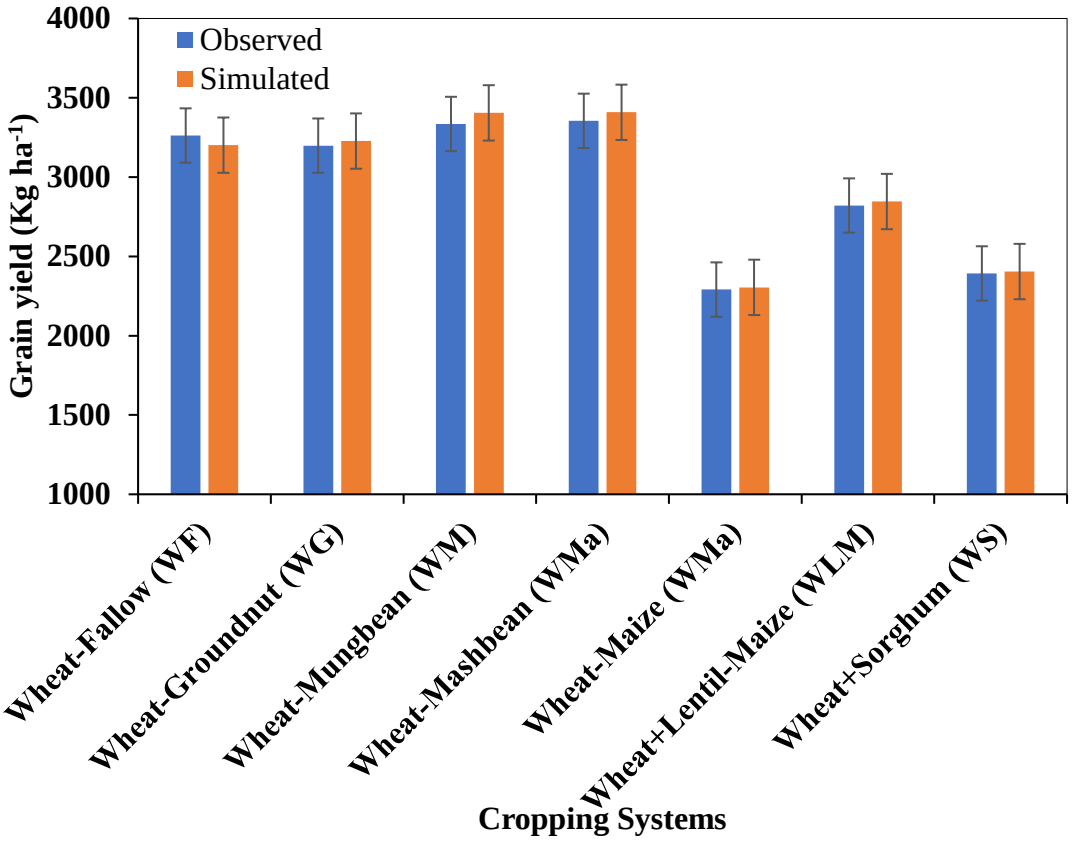

Fig. 13. Observed and simulated (DSSAT_CERES_Wheat) grain yield of wheat under different cropping systems of rainfed Pothwar

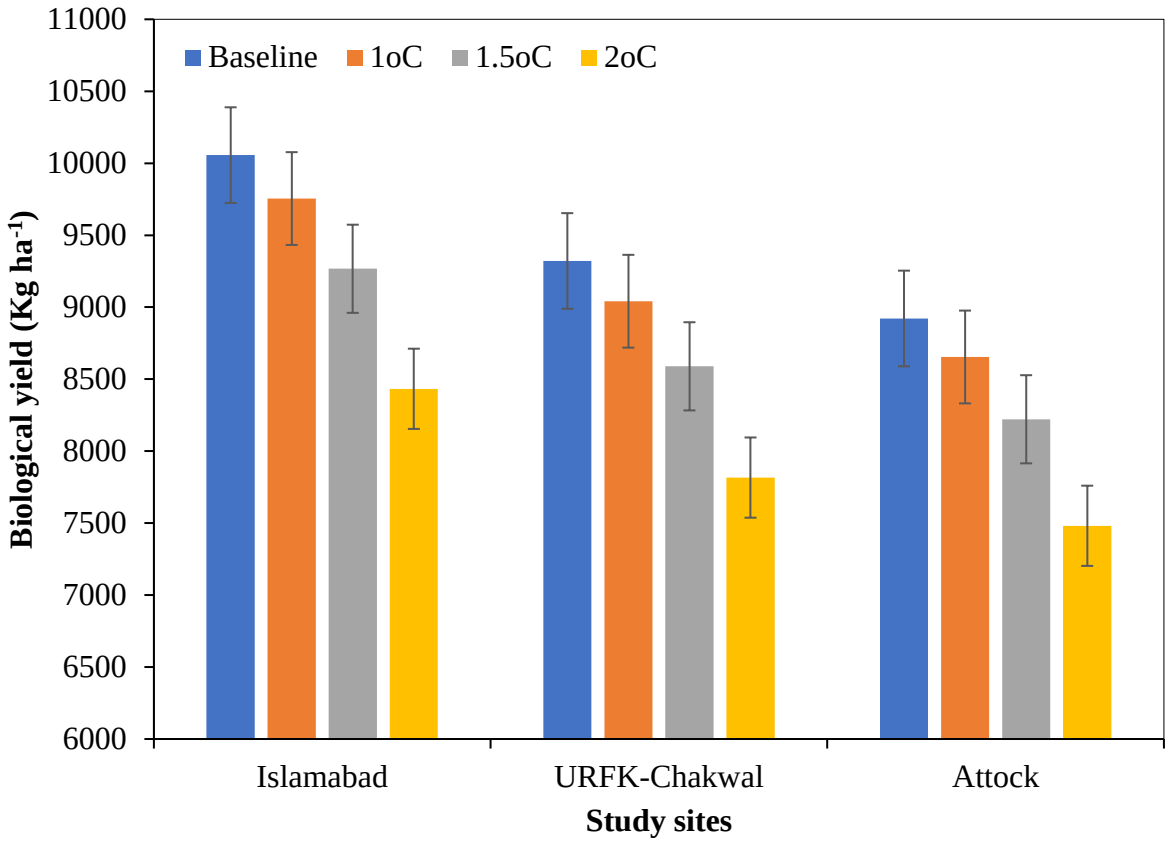

Fig. 14. Impact of rise in temperature on biological yield of wheat at three sites of rainfed Pothwar

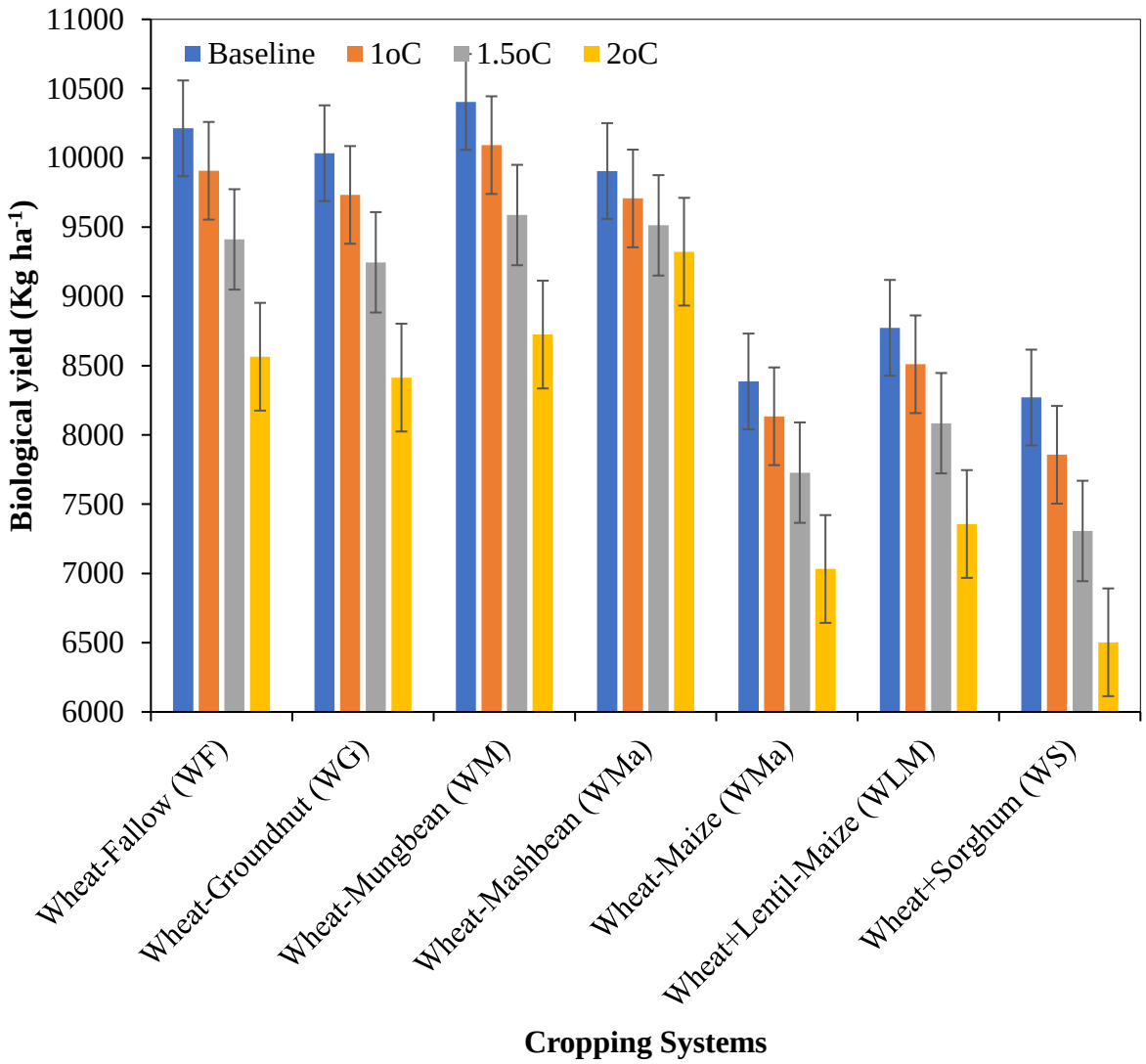

Fig. 15. Impact of rise in temperature on biological yield of wheat under different cropping systems of rainfed Pothwar

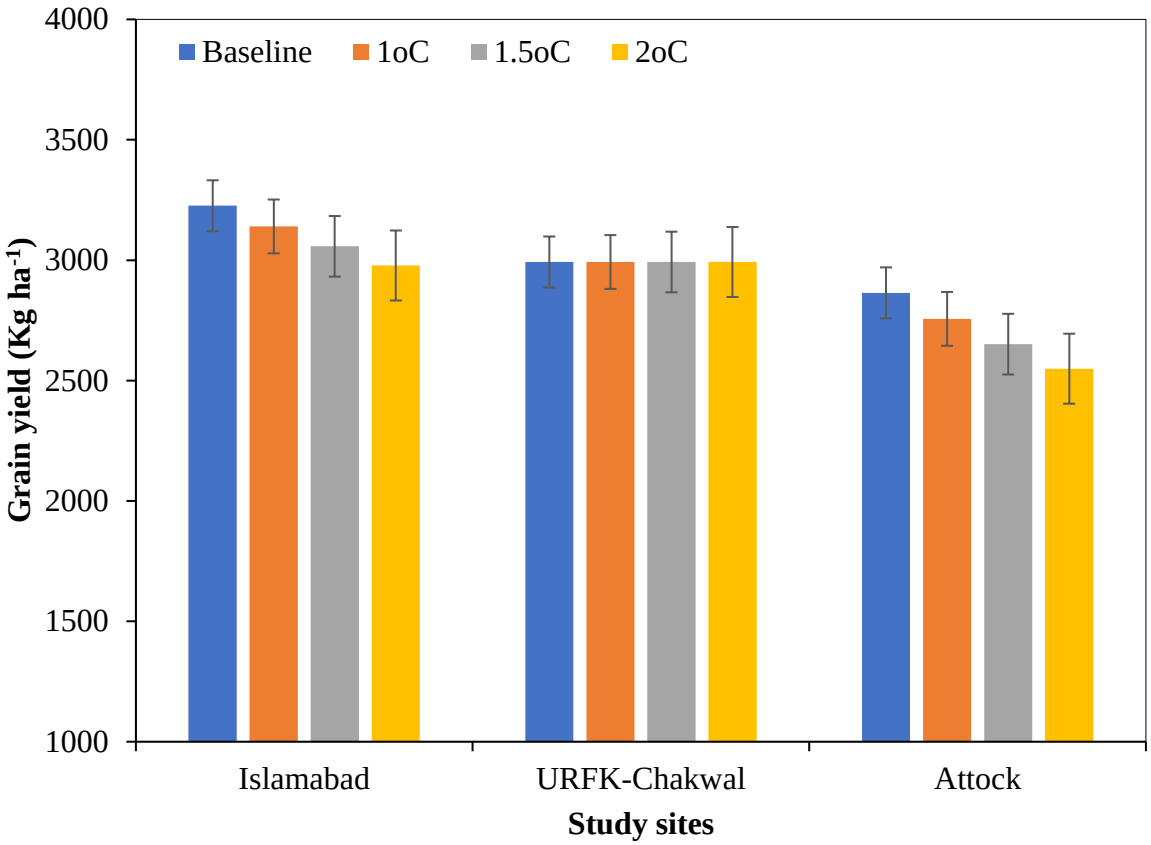

Fig. 16. Impact of rise in temperature on grain yield of wheat at three sites of rainfed Pothwar

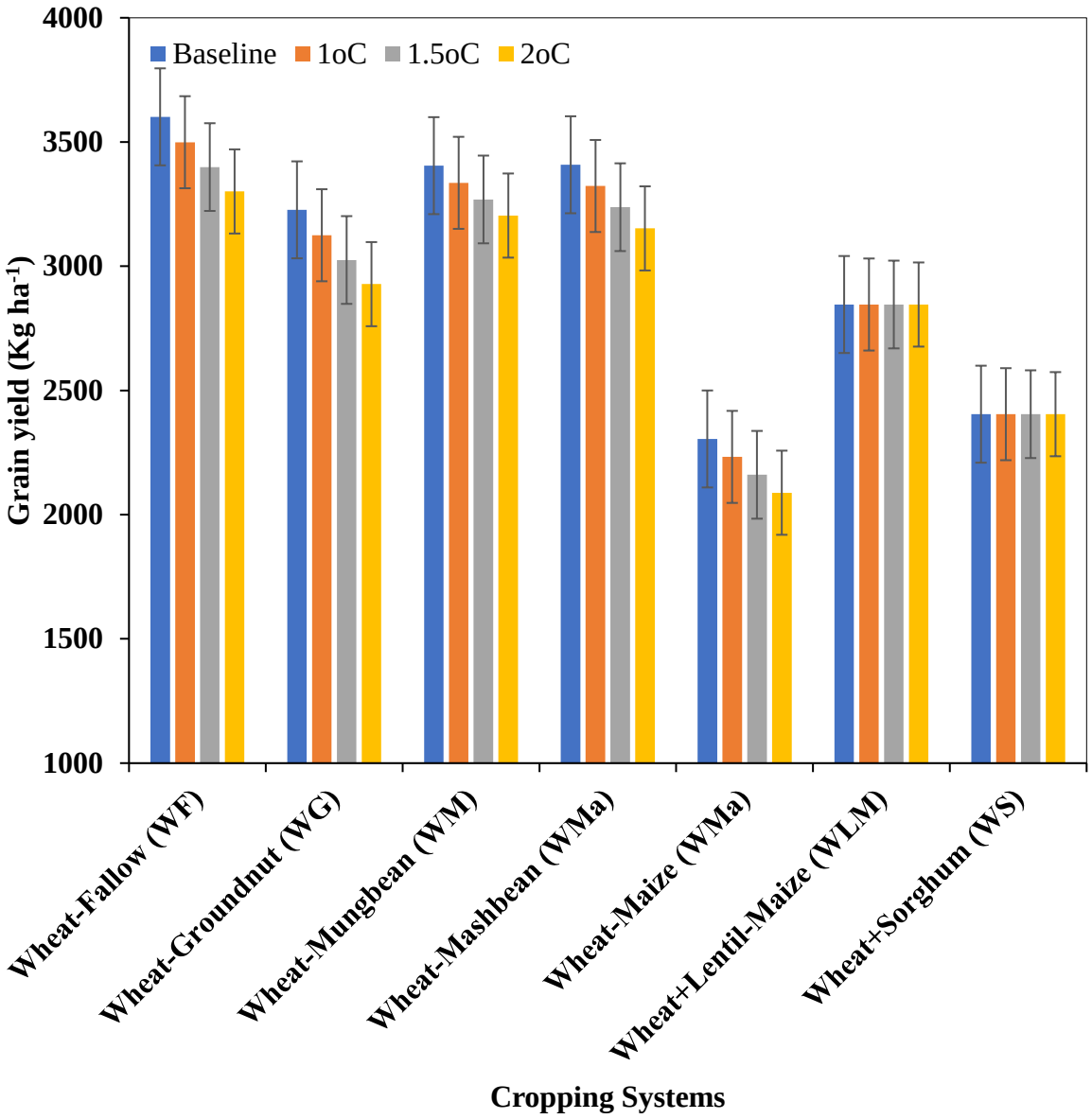

Fig. 17. Impact of rise in temperature on grain yield of wheat under different cropping systems of rainfed Pothwar

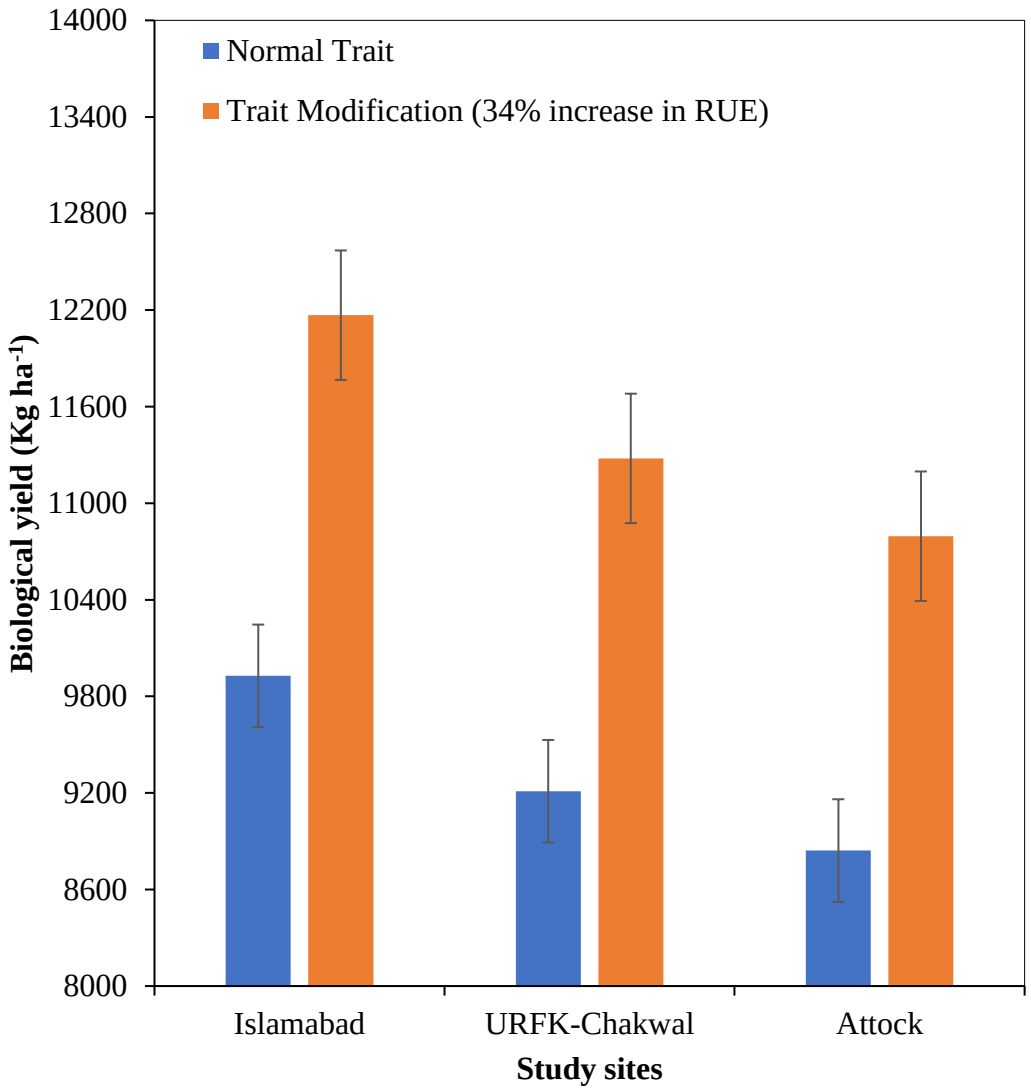

Fig. 18. Impact of trait modification on wheat biological yield at three sites of rainfed Pothwar

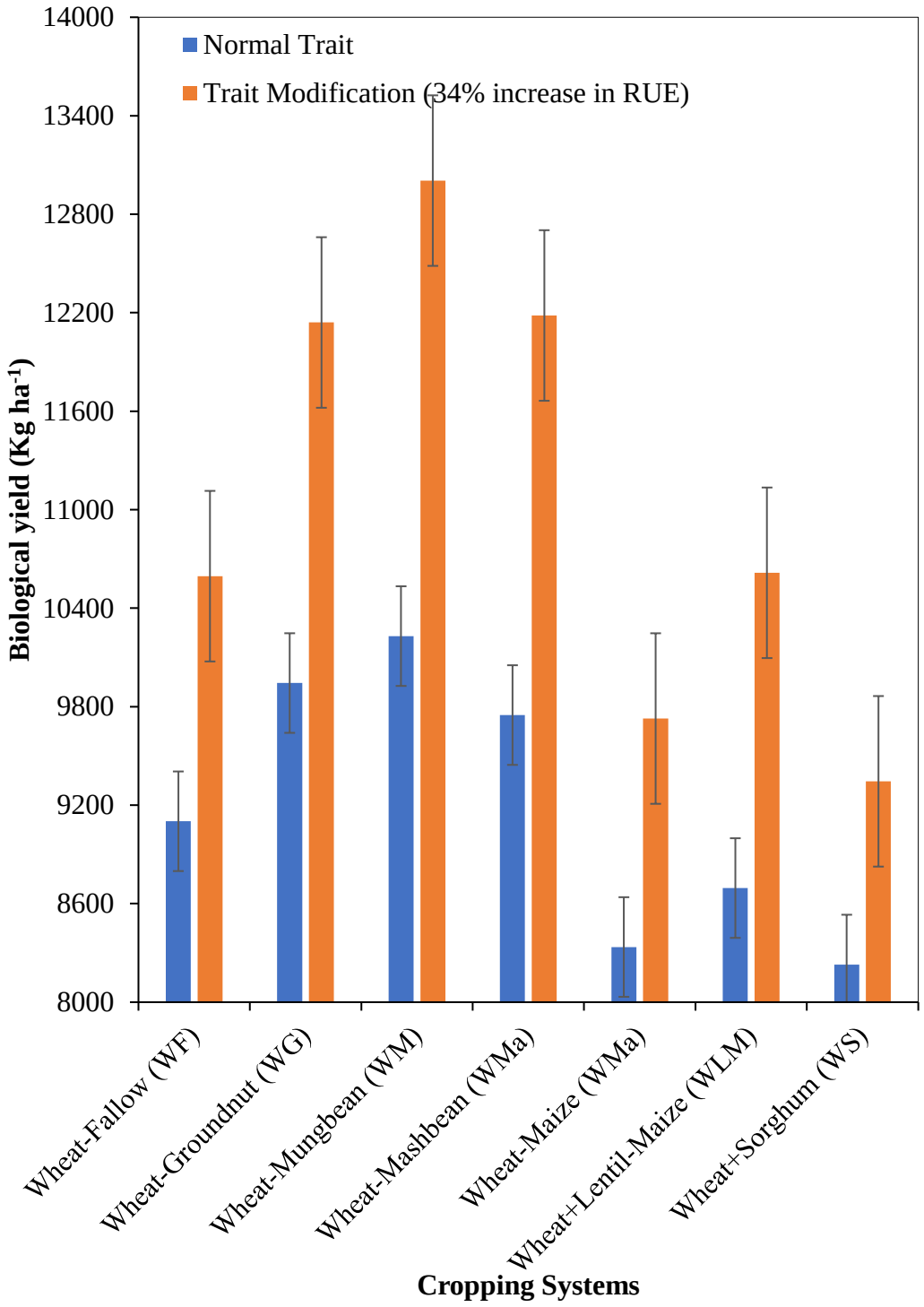

Fig. 19. Impact of trait modification on biological yield of wheat under different cropping systems of rainfed Pothwar

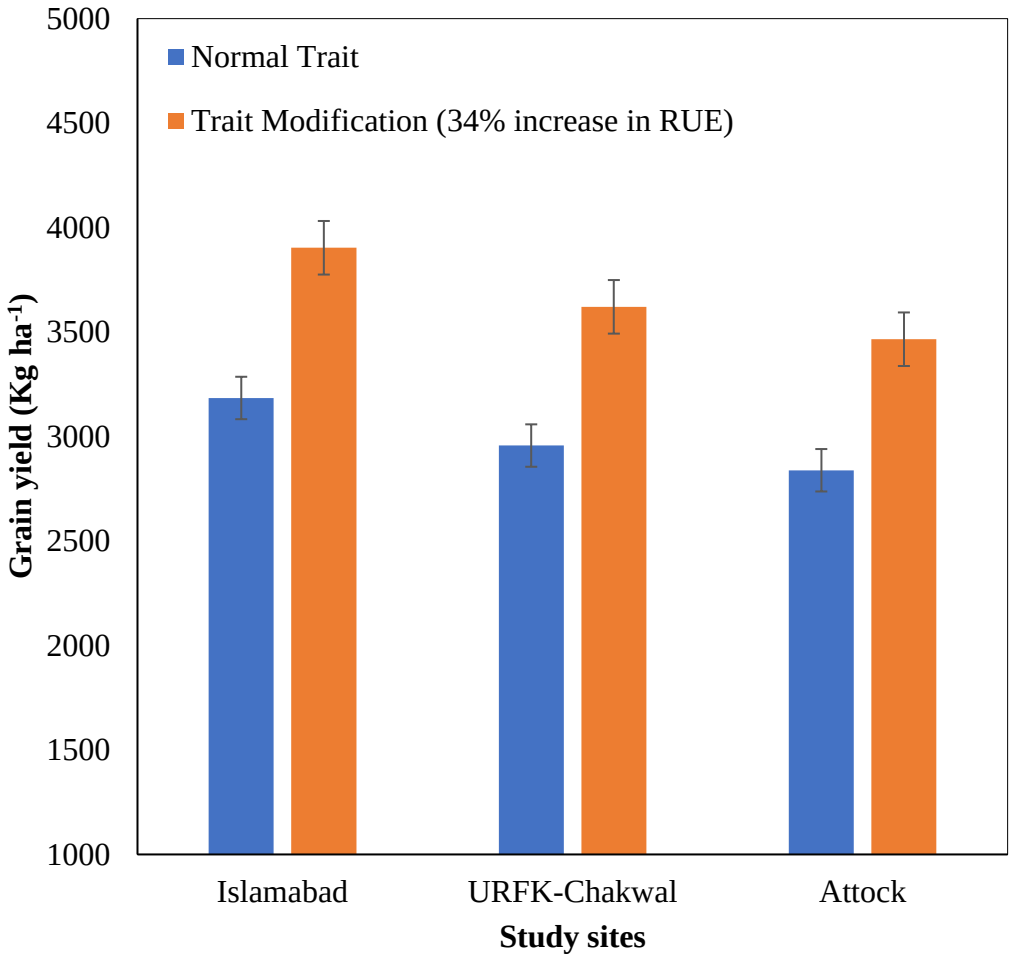

Fig. 20. Impact of trait modification on wheat grain yield at three sites of rainfed Pothwar

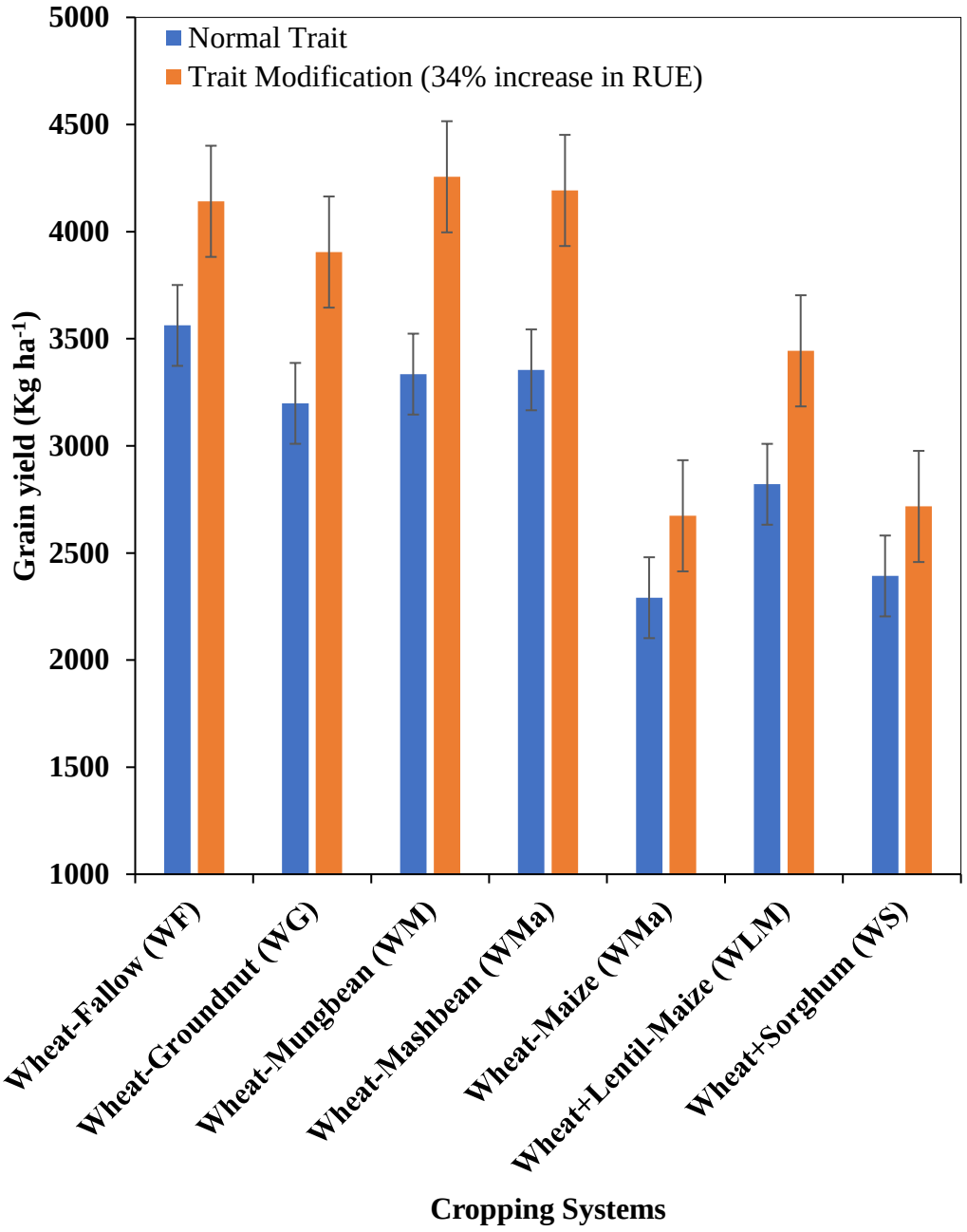

Fig. 21. Impact of trait modification on grain yield of wheat under different cropping systems of rainfed Pothwar

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Issues and Challenges in Flood Management System: A Case Study of Pakistan's 2022 Floods

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Abstract

The study aim was to identify issues and challenges which were faced by flood management s during the 2022 floods in Pakistan. The biggest natural threat on the planet is flooding. Floods cause damage to property, casualties, and bad economic growth. Floods cannot be entirely avoided, but their harmful effects can be significantly reduced with careful planning and adequate preparation by the managing institution. The question that arises here is what are the issues faced by the system in managing floods? And what are the challenges and flaws of flood management in Pakistan? The study through administrative theory with more focus on the concept of departmentalization aims to answer these questions. The study finds out challenges like lack of management institutions and water reservoirs as the main difficulties in managing floods in the country. The researcher provides the following recommendations, like proper departmentalization of institutions at the provisional and district levels for the betterment of the situation.

Keywords: Disaster, Flood, Flood management, Issues and challenges, , NDMA, Pakistan.

Introduction

Flooding is a global issue and a natural hazard. Floods cause massive destruction of life and property and affect the economic development of the affected country. It is not possible to prevent the occurrence of floods, but their destruction can be minimized by proper administration and planning, forecasting, and taking preventive measures against this natural hazard (Asad, 2011). Pakistan is the country that has been badly affected by the flood this year. Massive destruction of life, property, and infrastructure has occurred, and a national emergency was implemented to prevent this measure (Quershi, 2010). The reason is that it is because of poor management of water resources and lack of an effective water policy that has led to this type of massive loss.

The question that arises here is: what are the issues faced by institutions in managing floods? And what are the challenges and flaws of flood management in Pakistan? This flood management is related to public administration, and in 1880, Woodrow Wilson promoted civil service reforms that transferred public administration to academia, and public administration developed as a discipline. According to Wilson (1887), public administration is the detailed and systematic application of the law. Dimmock describes public administration as the execution or enforcement of public policy proclaimed by competent authorities. Public administration is law in action. It is the executive branch of the government. Finally, Leonard D. White stated that public administration includes all actions aimed at fulfilling or enforcing public policy (Marume,

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2016). Public administration plays an important role in society. It is an apolitical bureaucracy that operates in a political context to implement policy decisions made by the government.

In this article, I will be addressing the issue of why there is mistrust among people toward public institutions. The Pakistani state's past performance in managing calamities of various sorts is not abysmal, given existing capacity levels. Why did NDMA fail as an institution, and what were the challenges behind that? Pakistan's vulnerability to natural disasters is a reality and must be managed accordingly. The recent floods have resulted in a human catastrophe with thousands of dead, millions displaced, crops destroyed, and potential price hikes, which will threaten the survival of the 220 million Pakistanis (Dawn, 2022). Therefore, it is high time that the country mobilized its human and material resources.
The reason I am doing research is that it is a common issue that needs to be addressed, and failures of public institutions should be noticed and not politicized. My method of research would be descriptive, and the sources of my research paper would be scholarly articles and data reports issued by concerned authorities. My research would address the above questions, and, in the end, there would be recommendations and a conclusion to the research paper.

Methodology

In this study data was collected using qualitative methods. Both primary and secondary data sources were used to explore the study objective. Our selected study area was issues and challenges in flood management the current review study was conducted for flood management in Pakistan. This study is mainly aimed at rivers and flash floods. This study aims to review the current state of flood management, emphasize the flood challenge, and determine effective and sustainable flood management in Pakistan. The research community in Pakistan has done a lot of work studying all aspects of flood management in Pakistan. This creates plenty of flood knowledge for management. In this study, various studies, technical reports, and papers related to flood management Research and publication by different academic and research institutions and consulting agencies have led to a comprehensive review of the derivation and synthesis of key findings on flood management in Pakistan. Key conclusions and recommendations are also drawn at the end.

Literature review

Floods are one of the major natural disasters that cause massive destruction and have a huge impact on the economies of the affected states. Climate-related risks, such as floods and droughts, have become more common over the last three decades.(Concept Note on the Vulnerability Assessment and Analysis Survey for Zambia, 2006) The survey has continued to be ad hoc and has focused on short-term solutions. Nott (2006:51) claims that the physical causes of floods, such as climatological factors, and human influences, such as the removal of vegetation and urban growth, can be broadly categorized.

Most frequently, rainfall is one of the climate-related causes of floods. Worldwide, extended periods of rainfall are the primary cause of flooding. These occurrences typically span several days or weeks. Important agricultural production areas can result in extensive crop and fence damage as well as livestock loss. Transports issues brought on by flooded roads and destroyed infrastructure exacerbate crop losses caused by rain damage, waterlogged soils, and harvesting delays. As food prices rise as a result of supply limitations, lower agricultural production can

frequently have an influence outside the production area. On the other hand, floods can boost agricultural production over the long term by replenishing water reserves, particularly in drier inland locations, and by restoring soil fertility through silt deposition. (Natural Journal, 2002)

In the context of Pakistan, many scholars have published their articles and research papers regarding flood management and its challenges. The government's formulation and execution of flood policies demonstrate a genuine commitment to efficient and long-lasting flood management. In Pakistan's draught national water policy, which has not yet been approved and put into effect, the need for flood management is acknowledged. According to research, the development of new water storages, improved operational guidelines for reservoirs, improved watershed management, promotion of flood retardation structures, improved upkeep of current flood infrastructure, an improved flood forecasting and warning system, and the enforcement of laws for the protection of flood plains and flood zoning are the main components of flood policy. Three components make up Pakistan's current flood management strategy: (I). flood planning; (II). Flood readiness; and (III). Flood fighting and post-flood operations. Using deployment, the flood strategy is put into action (Arshad, 2014).

Pakistan has recently faced floods in 2022, and many articles have been written on the issues of flood management, but here I found a research gap, which I have identified as the issues of the implications of flood laws, institutional issues, and planning issues. This is done to make the research study more focused and specific. This also enables the study to find out how the higher chain of command in public administration is affected by the political influence of the leaders.

Theoretical framework

The study makes use of **administrative theory** to provide the theoretical framework. This theory is used because Administrative theory is based on the concept of departmentalization, which means that different activities performed to achieve the common goals of the organization should be identified and categorized into different groups or departments so that tasks can be accomplished efficiently. The theory of administration was developed by Henri Fayol, who believed that more emphasis should be placed on organizational management and the human and behavioral factors in management. So, unlike Taylor's scientific management theory, which puts more emphasis on improving workers' efficiency and minimizing task time, here the main focus is on how the management of an organization is structured and how the individuals in the organization are organized to accomplish the tasks given to them.

Another difference between the two is that administrative theory focuses on improving management efficiency first by standardizing processes and then moving to the operational level, allowing individual workers to learn changes and implement them in their day-to-day work. While scientific management theory emphasizes, first of all, improving the efficiency of workers at the operational level and then improving management efficiency, Hence, administrative theory follows a top-down approach, whereas scientific management theory follows a bottom-up approach (Business Jargon, 2020). The focus will be on the flaws in public institutions that failed to manage the 2022 floods and resulted in the massive destruction of infrastructure and the economy.

Data analysis

This study used descriptive analysis to analyze the qualitative data. The descriptive data offered critical information about the prevalence of flood management issues and challenges in the study area.

The data is being analyzed under the theoretical lens of the administrative theory of Henry Fyol. The study focuses more on public institutions related to flood management activities and the challenges they face during flood management.

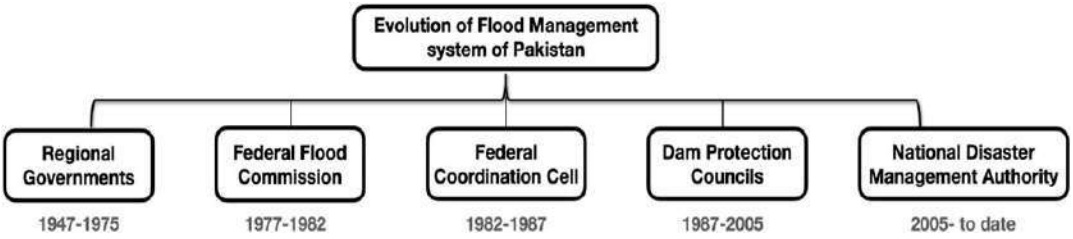
The study has some limitations; **Data availability:** One of the primary limitations of studying flood challenges and issues in Pakistan is the availability of reliable and accurate data. The data collection process in Pakistan can be difficult, and many official statistics may not accurately represent the actual situation on the ground. **Scope of the study**: A research paper on flood challenges and issues in Pakistan may not be able to cover all the factors contributing to flooding, such as climate change, environmental degradation, and land-use practices. Therefore, the scope of the study may be limited, which may affect the conclusions drawn.

1: Evolution of flood management system in Pakistan:

Pakistan had significant flooding in 1973, which prompted the creation of the Federal Flood Commission (FFC) in 1977. The group, which reports to the Ministry of Water and Power, seeks to put flood control in place throughout the nation, but particularly in the Indus River Basin. The primary duties of the FFC are to improve flood forecasting and warning procedures, provide flood protection reservoir management standard guidelines, develop national flood management measures, approve flood management plans created by local governments and federal entities, examine flood damage to public sector facilities and analyses restoration and restoration plans, and examine and approve flood management plans (GoP Annual Flood Report, 2009).

After the FFC was established, the first National Flood Protection Plan (NFPP-I) was created, and its spending plan called for its introduction throughout the years 1978–1988, In 1982, a Federal Coordination Group—now known as the FID Group—was formed to coordinate the activities of the provincial irrigation ministries, particularly in the watershed regions. The Dam Protection Committee was established in 1987 to review new dam applications and DSO WAPDA for completed dams, among other things (GoP Annual Flood Report, 2009).

Levees, tributaries, columns, and sophisticated flood forecasting techniques make up the majority of Pakistan's flood protection measures. To solve local flooding issues, provincial governments have created a variety of flood prevention systems (Baig, 2008). Flood risk mitigation in Pakistan typically needs to be reconsidered to find innovative methods and strategies to counter the threat.



2: Flood Crises managing institution:

The biggest flood crises managing institution of Pakistan is NDMA and it is currently active in the whole Pakistan and is contributing to manage natural hazards.

National Disaster Management Authority

The NDMA is a public institution that manages disaster-related activities. The failure of the NDMA and the Provincial Disaster Management Agency (PDMA) to take precautionary measures following the warning from the Meteorological Department exposed their insincerity and incompetence. The federal and provincial governments, as well as leaders of different political parties, are busy making allegations and counter-allegations on a variety of issues. No one is interested in seeing what is written on the wall. By the time Karachi rains flooded the city in July and torrential rain from the Kirthir Mountains and Koh-e-Suleiman reached Sindh and southern Punjab, it was too late. From late June to mid-July, the situation was not serious, but when the water from the glaciers and mountains of Swat, Kahan, and Gilgit-Baltistan started to flow to Khyber Pakhtunkhwa in early August (K-P), the situation started to deteriorate (Ahmar, 2022).

According to the last major flood assessment, the state's capability for disaster management needed rapid attention because it was constrained at several levels of government. In comparison to the enormous caseload, NDMA experienced a severe resource shortage at the federal level. Despite not having any legal capacity to do so, the public believes it to be in charge of all aspects of planning and implementation for other agencies, such as PDMAs or DDMAs. With the exception of Khyber Pakhtunkhwa, which has recently dealt with humanitarian catastrophes, there was a definite lack of capacity at the province level for the provision of relief (Raza, 2022).

The National Disaster Management Authority (NDMA) is the main government agency responsible for disaster management in Pakistan. It was established in 2005 with the goal of reducing the impacts of natural and man-made disasters on the country's population and economy.

The NDMA works in close collaboration with other government agencies, non-government organizations, and international organizations to develop and implement disaster management policies, plans, and programs. It also provides technical support and coordination for disaster preparedness and response efforts (Yoon et al., 2011). Some of the key responsibilities of the NDMA include:

- Developing and updating the national disaster management plan
- Conducting risk assessments and disaster preparedness planning
- Coordinating disaster response efforts and providing technical support to other government agencies and organizations.
- Conducting public awareness campaigns to educate communities on disaster risk reduction and preparedness
- Providing training and capacity building to government agencies, communities, and other stakeholders involved in disaster management.
- Monitoring and evaluating disaster management activities and programs
- Engaging in international cooperation and collaboration on disaster management

The NDMA is headquartered in Islamabad, with regional offices located in major cities across the country. Despite its important role in disaster management, the NDMA has faced criticism for its slow response and limited effectiveness in managing major disasters, such as the recent 2022 floods.

Flaws in the National Disaster Management Authority:

NDMA has had flaws since it was formed. They are facing a lack of funds; the reason can either be corruption or a lack of interest by the government in the particular institution. The immediate effect of this is that they lack technical tools, vehicles, equipment, and machines that will help them carry out relief operations (Ainuddin et al., 2013).

Secondly, this institution lacks skilled and trained workers. Their workers rely on old-fashioned techniques. They are unaware of modern techniques and methods. NDMA doesn't have any system that can forecast the flood and its magnitude, and due to this, millions of people were affected during the last year, and our government also faces a loss of billions of dollars during the reconstruction and flood management. The response rate of NDMA is also very slow.

It ought to have been sufficient for the federal and provincial governments to implement preventive measures to deal with natural disasters after the floods of 2010 and the earthquake in 2005. However, Pakistan's ad hoc policy culture and the unprofessional and careless attitude of the authorities created a hazardous situation when torrential rains and floods hit the country. Despite the warnings, the relevant departments remained distant and uninformed of the impending catastrophe until the majority of the country was under water last year as well. Every district in Pakistan should have rescue and relief plans under the disaster management framework. All sites where rainwater accumulation was a possibility—dams, barrages, canals, etc.—should have been monitored. It should have been built with proper water canals to release precipitation from hills and mountains. (Ahmar, 2022)

The ability to respond to an emergency may have been aided by scientifically-based planning and resource mobilization to tackle numerous disasters. It would also have provided experience, knowledge, and expertise in handling circumstances causing floods, earthquakes, and other calamities. This is because disaster management models from various nations have been studied. A catastrophe management system is urgently needed in Pakistan (Ahmar, 2022).

The recent 2022 floods in Pakistan exposed several major flaws in the National Disaster Management Authority (NDMA):

Inadequate disaster preparedness: The NDMA was criticized for its inadequate disaster preparedness, including the lack of an effective early warning system and insufficient evacuation plans. This resulted in limited time for evacuation and relief efforts and increased the risk to people and property.

Slow response time: The NDMA faced criticism for its slow response time in the aftermath of the floods, which hindered relief and rescue efforts and increased the impact of the disaster.

Limited coordination and collaboration: The NDMA faced challenges in coordinating and collaborating with other government agencies, non-government organizations, and international organizations in disaster response efforts. This resulted in inefficient and duplicative efforts and a slow response to the needs of affected communities.

Inadequate relief efforts: The NDMA faced criticism for its inadequate relief efforts, including the slow distribution of food, water, and medical supplies to affected communities. This resulted in further loss of life and property.

Lack of community engagement: The NDMA was criticized for its lack of community engagement in disaster management, including the limited involvement of communities in disaster risk reduction and preparedness efforts.

Corruption and mismanagement: The NDMA faced allegations of corruption and mismanagement in the allocation of funds and resources for disaster management, which hindered the effectiveness of relief efforts.

These major flaws highlight the need for the NDMA to improve its disaster preparedness, response time, coordination and collaboration, relief efforts, community engagement, and anti-corruption measures to better serve the needs of affected communities in future disasters.

3: Flood management challenges:

The challenges faced during flood management are as follows:

(a) Absence of flood laws

Pakistan has a history of severe flooding, with many areas of the country being prone to flooding due to its location in a flood plain and the presence of several major rivers. Despite this, the country lacks comprehensive flood laws and policies that would allow it to effectively manage and respond to flood events. This includes a lack of regulations for land use and development in flood-prone areas, insufficient infrastructure for managing water flow, and a lack of emergency response plans and resources. Additionally, the government has not been successful in implementing and enforcing existing flood management policies. These factors contribute to the

country's vulnerability to flooding and make it difficult for Pakistan to effectively respond to and recover from flood events. (Ali, 2022)

(b) Institutional issues:

There are institutional issues. There is no departmentalization of public institutions, and in the event of a flood, the institution from the federal government has to respond. The PDMA and DDMA are just behind; they lack technical knowledge, and there is no effective coordination between them.

The institutional issues in Pakistan related to flood management can be attributed to a lack of departmentalization and centralization of public institutions (Rehman et al., 2019). Specifically, there is no clear division of responsibilities among different government bodies at the federal, provincial, and local levels, which can lead to confusion and inefficiency during flood events. For example, the Pakistan Disaster Management Authority (PDMA) and District Disaster Management Authority (DDMA) are responsible for responding to floods, but they lack the necessary technical knowledge and resources to effectively manage the situation. (Aslam,2017). Additionally, there is often poor coordination between these different institutions, which can further hamper their ability to respond to floods. This lack of clear lines of responsibility and coordination can make it difficult for these institutions to effectively manage and respond to flood events, leading to increased damage and loss of life. In addition, there's a lack of technical expertise and capacity in these institutions, which makes it difficult for them to effectively implement and enforce flood management policies and regulations (Welcome to PDMA | PDMA, 2022). This is particularly true for DDMA, which is responsible for responding to disasters at the local level but often lacks the necessary resources and expertise to do so.

(c) Short of effective planning

Our institutions lack effective planning, and flood management is hardly included in our national policy. Effective planning for flood management involves identifying potential flood risk areas, implementing measures to reduce the impacts of floods, and having a plan in place for responding to and recovering from floods. National policies that address flood management typically include regulations and guidelines for land use and development in flood-prone areas, as well as funding for flood protection and warning systems.

If a country or society lacks effective planning and flood management is hardly included in their national policy, it means that there may be inadequate regulations in place to prevent development in flood-prone areas and insufficient funding for flood protection and warning systems. This can lead to increased flood risk and damage when floods do occur. Additionally, without a plan in place for responding to and recovering from floods, the impacts of floods can be more severe and long-lasting.

(d) A country with a low GDP:

It is not entirely accurate to say that Pakistan is a poor country. While it does have a relatively low GDP per capita compared to many developed countries, it is considered a developing country with a growing economy. Additionally, while Pakistan may have a limited reserve of foreign currency, it is not necessarily true that it is insufficient to meet the needs of the affected people. The use of aid from other countries is generally determined by the government of Pakistan and how they choose to allocate it. It is possible that the $8 billion in aid has been used for various purposes, such as disaster relief, infrastructure development, and poverty reduction programs. Without more information about the specific aid programs in question, it is difficult to say for sure where the money has been used.

(e) Lack of flood infrastructure:

Pakistan has a history of severe flooding, particularly in the Indus River basin. The lack of proper flood infrastructure, such as embankments and canals, is a significant contributing factor to the damage caused by these floods. This is partly due to the fact that such infrastructure was not developed during the early years following independence and also due to the lack of funding for maintenance and repairs in recent years (Munawar et al., 2021). This has led to a situation where the country is ill-equipped to deal with the devastating effects of floods and other natural disasters.

- **Institutions response to flood management is insufficient.**

There are a variety of reasons why an institution's response to flood management may be insufficient and why there may be a lack of effective flood readiness. Some possible factors include:

Flood management and readiness efforts often involve multiple agencies and organizations, and if there is a lack of coordination between these groups, it can be difficult to take effective action.

Management efforts require clear and timely communication with the public, and if an institution lacks the necessary infrastructure or expertise to effectively communicate with the public, it may not be able to take effective action.

(f) Need of Water reservoirs:

There are very few water reservoirs. The current capacity of these reservoirs is very low, which does not meet the standard for flood handling. For quite a long time, dams have been promoted as a method for tending to Pakistan's flood perils. Supporters of the proposed Kalabagh Dam in Punjab, still under arrangement since its underlying origination in 1953, contend that the dam, upon consummation, would assist with directing high flood levels in the Indus Stream. Comparable contentions were additionally made for the Diamer Bhasha Dam in Gilgit-Baltistan, the development of which was introduced in July 2020 after over forty years of arranging. The 2022 floods seem to have indeed set off new discussions on the need to develop extra super dams. Building reservoirs often requires large amounts of land, and if this land is already in use for other purposes, it may be difficult to acquire it for reservoir construction.

(g) Climate change

It is also vulnerability for Pakistan as the glaciers are melting and they create more chances of flooding, which results in ultimate destruction.

Climate change is a major vulnerability for Pakistan, as melting glaciers can lead to increased flooding. As the glaciers in the Himalayas and the Karakoram Mountains melt, they release large amounts of water into rivers and streams, which can cause devastating floods. These floods can cause damage to infrastructure, such as bridges and roads, and can also lead to the loss of life and the displacement of communities (Khan et al., 2021). Additionally, the increased flooding can also lead to soil erosion and damage to agricultural land, negatively impacting food security in the region. It is important for Pakistan to take action to address the causes of climate change and implement measures to adapt to the impacts of melting glaciers.

Conclusion:

Recent flooding in Pakistan has resulted in significant damage to infrastructure, which shows Pakistan's flood management system is not ideal and relies too much on a passive strategy. There are just techniques related to flood control but not flood management, which is also outdated. Flooding danger and vulnerability are made worse by climate change. A sound development and flood management system are required in this situation. Despite the fact that Pakistan currently has flood management and preparedness mechanisms in place, these actions have not improved the outlook for Pakistan in terms of its flood management system. Pakistan is currently dealing with Lack of a comprehensive flood prevention policy, plan, and law, institutional incapacity, a lack of coordination, and inadequate drainage are challenges. Ineffective flood forecasting and early warning systems, inadequate flood preparations, and a lack of a flood management strategy all contribute to inadequate infrastructure operation and maintenance.

Recommendations of the study will be presented to create an all-encompassing and improved flood management system. The system used to manage floods now is poor and takes an inactive approach.

Recommendations:

The following recommendations should be followed by the government in order to manage the flood effectively.

1. There should be a proper team whose task is only to cope with natural hazards such as floods.
2. There should be proper allocation of funds to the institutions managing flood-related activities.
3. Technical assistance should be provided to the workers.
4. They should be equipped with proper instruments.
5. Flood warnings should be issued before the flood hits the area.

6. There should be departments of the institution, such as the NDMA, working on a provisional and district level, which will help the people in relief operations.
7. Water reservoirs should be made according to international criteria, and they should have enough power to hold large amounts of water.
8. Small and large dams should be built in the country, which will also help the country in its production of electricity.
9. There should be a transformation of policies and strategies towards effective flood management.
10. Awareness should be given to the locals about climate change, and they should be made ready to face the situation.
11. The National Disaster Management Authority should provide the specific policy structure and set of water conservation standards against which provincial governments formulate their development plans and water conservation, water improvement, and water management programs.

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Public Health Impacts of Flood Disasters: A Systematic Review

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Abstract

Climate change causes erratic environmental circumstances, which contribute to poor health effects. Every year, floods and extreme weather conditions cause serious disease and death in both poor and developed countries. The impact of floods raises the death rate and poses problems to the survivors' human health. The purpose of this research is to determine the susceptibility and health effects of the disastrous flood by detecting disparities in injuries, death, and poor health patterns. The systematic evaluation included 30 research publications that evaluated the health sector conditions during floods and severe weather. It was shown that disease epidemics such as fever, dengue, pink eye, hepatitis E, leptospirosis, and gastrointestinal sickness are more likely in places with inadequate hygiene and displaced people. Following the flood, survivors' psychological suffering and mental health issues compound their physical diseases. Using the findings of the systematic literature, the research emphasizes the necessity for effective strategies to avoid flood-related morbidity. The efficacy of healthcare strategies is required to improve health conditions during extreme weather events.

Keywords: Flood, Health, Climate Change, Illness

Introduction

Climate change is the most significant challenge in the world. Regardless of one's geography or financial background, it is affecting us by all means like how we generate food, how we get access to water, how healthy we are, where we live, and how many different kinds of plants and animals there are (Adams and Luchsinger, 2009). World's climate scientists and activists believe that the climate is changing and these changes are human-induced (Caney, 2012). Experts predict that some irreversible climate change will occur, potentially having catastrophic effects on the lives and well-being of vulnerable communities around the world (Crowther et al., 2016; Gardiner, 2004). Floods lead to unexpected challenges to human health. Moreover, the devastating effects of floods include human death and social damage. Various political factors also contribute to human loss because floods increase the risks of human health damage. Da Silva et al., (2022) stated that global sensitivity has been raised due to extreme weather conditions and urban policies against floods. Hence, floods create serious social and political challenges and create the risk of health-related issues. The South-Asian Subcontinent, with its great Himalaya Glaciers, remains at primary

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risk. Though currently, the rainy season remains the major reason for the flooding in the region the presence of glaciers and the rise in average temperature remain a permanent threat to the region. Floods are the most common natural disaster in the region with a 40% occurrence rate (Chaudhry, 2017). Pakistan has constantly been ranked among the most affected nations by climate change. People here in various regions of the country are as of now getting drastically affected by climate change, which includes flash floods due to intense glacier melting and intense monsoon season, increased heatwaves, water scarcity, rising sea levels, food shortages, drought in some areas of Southern Sindh and consequently displacement of people. In Pakistan one major reason is the land adjudication and administration system, which is colonial and lacks judicial augmentation, providing a chance for flawed urbanization (Shafi et al., 2022).

The scientific community concurs that floods are the main factor contributing to poor health and major health issues, specifically in poorer regions (Fox and Sheehan, 2019). Climate change causes unpredictable environmental circumstances that harm human health. Annually, a large number of individuals suffer from serious illnesses, and floods raise the death rate and pose problems for the survivors' health. The devastating effects of flood are a worldwide issue that can only be avoided via international collaboration (Bell, 2011). Everyone's contribution is essential in times of climate change. However, the concern of what kind of evaluation and planning should be accomplished (Lockie, 2017). The literature search for this article provides the basis for understanding flood risks and related health concerns and how political influence harms a society's ability to improve its infrastructure.

Methods

For the data collection, the authors assessed the data from selected authentic papers from different online databases, and websites including google scholar, web of Knowledge, Science Direct, and Scopus. More attention has been paid to recent but already well-referenced literature. Relevant literature was selected based predominantly on the following inclusion criteria: (a) peer-reviewed research papers published by impact factor-listed research journals; (b) peer-reviewed scientific reports from world-known publishers; (c) literature was screened by using keywords (flood, climate, health, social impacts, developing countries, floods in Pakistan and (d) preference was given to studies published in the English language. The papers selected were published between 2017 to 2023. For the exclusion criteria, papers, articles, and journals discussing tsunamis, earthquakes, and other disasters unrelated to floods were omitted.

Discussion

On a never-before-seen scale, the floods of 2022 have destroyed people's lives, possessions, and means of subsistence. The disaster was triggered by the country's heaviest and most powerful monsoon rains ever recorded. One in every seven people, or over 33 million people, has been affected, and nearly 8 million have been changed places. An estimated 15 million people are still in danger of floods or live in the surrounding area. Over 1,700 people have died as a consequence of the floods, with children representing one-third of those deceased. Government officials had classified 94 districts as "calamity struck" as of October 11; this represents more than half of all districts in the nation. The provinces of Balochistan, Sindh, and KP are home to the majority (Pakistan Flood, 2022).

The pandemic was the first major natural disaster that happened in the last three years, then followed by flooding. Our political system has been harsh in dealing with these disasters. Floods propose implications for the health sector and human well-being (Rehman, 2022). According to Paavola (2017), extreme weather conditions have an impact on human health due to sensitivity and weather vulnerabilities. For example, people during floods face the challenges of the severity of epidemic diseases and water-borne issues. In this situation, people face issues of social challenges like mobility and migration. According to Baqir et al., (2012), Pakistan is the ninth-most flood-affected country in the world. They studied inadequate sanitary conditions in the camps built to house those affected by the floods. They considered the prevalence of seven main illnesses significantly rises following environmental disasters. Those were divided into acute and subacute settings. Leptospirosis, skin and eye infections and diarrhea were discovered in the acute situation, whereas leishmaniosis, malaria, and respiratory. Bandino et al., (2015) stated that traumatic injuries, communicable infections, chemical exposures, starvation, a reduction in access to treatment, and even mental health issues (Daniel et al., 2021) significantly rise during and after a flood catastrophe. Several reports describe both common and atypical dermatological infections, percutaneous trauma, immersion wounds, non-infectious contact exposures, interaction with wildlife, and escalation of underlying skin illnesses due to flood. According to Khan (2022), among the millions of negatively impacted individuals are at least 650,000 pregnant women and girls in October 2022. According to UNFPA (2022), many of these mothers lack access to the healthcare facilities and assistance they require to safely birth their infants. Many women are unsure where or how they will give birth because healthcare facilities and houses have been destroyed.

Floods also damage the healthcare sectors in developing countries which affect the patient's primary needs related to health efficiencies (Winter et al., 2022; Shah et al., 2020). Flooding creates challenges for the health sector because it results in the destruction of various buildings which minimizes the capacity and ability of the healthcare industry to perform its activities on a full scale. For instance, in flood-affected areas, the homes and medical centers of the region are also damaged thus posing a great challenge to healthcare professionals concerning necessary accessories needed to treat the general public. Floods also destroyed healthy infrastructures like hospitals and healthcare organizations. Peel et al., (2018) stated that floods damage buildings and infrastructure due to their severity. The severity of floods disrupts vital social activities and creates problems in improving poor health conditions. It has been found that during the last 20 years, the flood has damaged the health outcomes of around 2.3 million people all over the world.

Geddes (2022) reported that 10% of Pakistan's healthcare facilities had been destroyed or damaged by flooding in October. The demolished structure means the loss of critical medical equipment and supplies. The sudden demise of almost 2000 hospitals and healthcare facilities in Pakistan, where half of the population already lacks access to primary healthcare, aggravates the country's public health problems. In flood-affected areas, immunizers have adjusted their operations to provide medical aid while minimizing delays to polio immunization. Yet, the absence of healthcare facilities and the mass eviction of so many people increase the risk that the disease will spread and limit the capacity of immunizers to reach unvaccinated populations.

On the other side, Pakistan's political system is troublesome. It has been demonstrated that politics in our nation does not seek to give satisfaction or relief to the average person (Rehman, 2022). The negligence of the government in tackling flood problems in Pakistan, which caused health issues is a prime example of how political factors impact the health sector of the country. According to Pakistan Flood (2022), disastrous floods serve as a warning that systemic changes are required to address the underlying vulnerabilities to natural disasters and how those vulnerabilities combine with other shocks. At this point, a paradigm shift is necessary to mainstream resilience to natural catastrophes in development planning and asset management. According to Nabi (2023), the most important element for Pakistan is, of course, significant post-flood rehabilitation to avoid long-term detrimental repercussions of bad health and economic growth. Priority should be to public health buildings and other infrastructure such as roads, bridges, and schools, as well as the recovery of livelihoods and agriculture. This requires an adequate rehabilitation and rebuilding system. Pakistan requires a proactive and deliberate participatory strategy that integrates the public and commercial sectors, academia, think tanks, and the international community behind a single goal.

Emergency Health Plans and Possible Strategies in Flooding

Plans:

It is important to consider:

- Accommodation of people with medical needs in a temporary shelter;
- Ensuring that chronically sick people have a list of medications required at hand;
- Availability of short and clear instructions on what to do;
- Training of first aid workers to work with vulnerable groups;
- Business continuity plans for primary health care;
- Healthcare for flood victims hence requires not only medical (curative) services but also preventive, promotive, and rehabilitative health services;
- Integration of specific needs of groups in programs for health sector surge capacity, emergency shelter, and quarantine

Strategies:

- The role of government policies is necessary to improve the healthcare condition of people during floods and disaster risk management including providing podiatric mental health services. Health disparities and the well-being of displaced people depend upon proactive and collaborative humanitarian response.
- The impact of floods, which involves political and social variables, on the disappointing performance of the health sector may be reduced by the government through employing mitigation strategies including subsidies, exemptions, and other forms of revenue.
- Ecosystems actively influence the climate, they can serve as a key expression of social resilience and can aid in the adjustment of humans to fast changes in the environment if they are handled appropriately in a manner that is based on biodiversity science.
- Flood risk management approaches can be implemented to control fragmentation. Flood risk management may also be aided by the participation, coordination, and engagement of

both private and public entities as well as by the existence of sufficient formal regulations that strike a balance between legal certainty and adaptability.

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Ravages of War: Environmental Impacts, Analysis, and Global Recommendations

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Abstract

Destruction, toxic substances, and the death of wildlife are the grim realities of war. As time passes, the ability of society to recover its vibrancy and environment becomes increasingly difficult. This, in turn, hinders the transition toward a sustainable economy. Since the impact of war is far more abrupt than greenhouse gases warming the atmosphere, emphasizing it, is crucial to ensure a sustainable future. The purpose of this qualitative research is to elaborate on a) some of the factors that contribute to environmental warfare such as militaries through the use of fossil fuels, nuclear attacks, and testing on different sites, pollution caused by wars and landmines etc. b) the impact of nuclear attacks on health, biodiversity and wildlife, and marine ecosystem c) legal instruments and their failure to restrict environmental warfare with global recommendations at the end. Firstly, the findings indicate that the severity of environmental warfare and the prospects of a sustainable economy are inversely correlated. Secondly, the efficacy of legal instruments is undermined due to geopolitics. Lastly, the study concludes that the absence of reporting mechanisms entailing environmental consequences of military operations has weakened the climate control regime.

Keywords: Environmental Diplomacy, Environmental Warfare, Greenhouse Gases, Landmines, Marine Ecosystem, Nuclear Attacks, Wildlife, and Biodiversity,

Introduction

Warfare has traditionally been measured by the number of casualties among soldiers and civilians, along with the destruction of cities and livelihoods. However, the environment is often overlooked as a victim of war. Throughout history, parties engaged in armed conflicts have deliberately polluted water sources, destroyed crops, deforested vast areas, poisoned soil, and killed animals to gain military advantage. The impact of environmental degradation and destruction caused by war conflicts is not limited to nature but also leads to food and water insecurity and destroys the livelihoods of local communities. This situation further exposes them to long-term vulnerability and poses a threat to their well-being, health, and survival.

The research methodology used in the present work will employ a qualitative research design to examine the impact of war on the environment. The research will also use a case study approach to investigate the environmental impacts of war caused by Ukraine and Armenia. The research will also use secondary data sources, such as academic articles, government reports, and media reports, to examine the factors that contribute to environmental warfare, the impact of nuclear attacks on health, biodiversity, and marine ecosystems, and the legal instruments and failures in environmental diplomacy.

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Hypothesis: The destruction, toxic substances, and death caused by environmental warfare significantly contribute to hindering the transition towards a sustainable economy, with militaries' use of fossil fuels and nuclear attacks being major contributing factors.

Variables:

- Independent variables: Militaries' use of fossil fuels and nuclear attacks
- Dependent variables: Environmental destruction, impact on health, biodiversity, and marine ecosystems

Definition

Ecoterrorism, also known as ecological terrorism or environmental terrorism, is defined as the destruction or threat of destruction of the environment by individuals, groups or states with the aim of intimidating or coercing governments or civilians. The term can also encompass various crimes committed against companies or government agencies aimed at preventing or interfering with activities deemed harmful to the environment.

In addition to the above, ecoterrorism can also take the form of environmental warfare, which involves the deliberate and illegal destruction, exploitation or modification of the environment as a strategy of war, including during times of armed conflict within states. However, the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, adopted by the United Nations General Assembly in 1976, prohibits modifications of the environment during armed conflicts that are likely to have widespread, long-lasting or severe effects.

Certain violent activities of environmental activists have been labelled as eco-terrorism, including criminal trespass on the property of logging companies or other firms, and obstruction of their operations through the sabotage of company equipment or modification of natural resources to render them unusable. This practice, known as "monkeywrenching," can involve plugging factory waste outlets or driving spikes into trees to prevent logging and milling. Other activities described as eco-terrorists include protest actions by animal rights groups, such as property destruction in stores selling fur products or bombings of laboratories conducting animal experiments (Elliott, n.d.).

History

The consequences of war are manifold and devastating. The Second World War, in particular, caused extensive harm to the environment. Even today, unexploded bombs and landmines pose a grave threat globally, while sunken ships continue to release heavy metals and toxins into the ocean, harming marine life. The use of nuclear weapons has also left a lasting impact in the form of radioactive particles. The use of chemical defoliants during the Vietnam War has had long-lasting detrimental effects on those exposed to them, as well as their families and communities. Animals, ranging from pets and livestock to birds and sea creatures, have also suffered greatly in times of war (Fletcher, 2023). When humans engage in conflict, the entire world is affected. Following is some historical evidence of environmental warfare:

1. The use of the toxic herbicide Agent Orange during the Vietnam War raised concerns about the targeting and use of the environment during wartime. The resulting deforestation and chemical contamination caused widespread damage and prompted an international outcry.

2. The 1990-1991 Gulf War saw the deliberate destruction of over 600 oil wells in Kuwait by the retreating Iraqi army, causing extensive pollution. This led to calls for stronger legal protection of the environment during armed conflict, as claims for 85 billion USD in environmental damages were made.
3. Armed conflicts have caused significant environmental damage due to direct and indirect impacts, as well as a lack of governance and institutional collapse. During the Kosovo conflict in 1999, dozens of industrial sites were bombed, leading to toxic chemical contamination.
4. The bombing of the Jiyeh power station during the 2006 conflict between Israel and Lebanon resulted in the release of an estimated 12,000 to 15,000 tons of fuel oil into the Mediterranean Sea (Smith, Jensen, and Partow, 2019).
5. Naval conflicts between foreign nations have varied effects on the marine environment, including the introduction of foreign species through the dumping of ballast waters and the introduction of naval structures or materials into the region. For example, the introduction of the brown tree snake into Guam after WWII through boats salvaging materials from a port in New Guinea led to its invasion of all terrestrial ecosystems in Guam, causing the extirpation of many bird and lizard species and affecting local biodiversity (Lawrence et al., 2015).
6. The United States performed 67 atmospheric nuclear weapons tests in the Marshall Islands from 1946 to 1958, causing environmental devastation that persists today. The Castle Bravo explosion, a 15-megaton weapon over 1,000 times more powerful than the Hiroshima atomic bomb, caused significant damage across Bikini Atoll and created the "worst radiological disaster in US history." The fallout contaminated surrounding islands, leading to radiation sickness and causing long-term effects (‘Environ’, 2017).
7. Chemicals such as phosgene, sulfur mustard, and diphenylchlorarsine were used during wars, causing severe damage to human health and the environment. In September 1917, Germans used diphenylchlorarsine as a "vomiting agent" in combination with lethal gases, leading Allied soldiers to remove their gas masks and be killed by toxic fumes (Fletcher 2023).

Factors Contributing to Environmental Warfare

There are various factors that contribute to environmental warfare. Some of them include

Military

It is estimated that militaries worldwide contribute to about 6% of greenhouse gas emissions, but many governments do not provide comprehensive data on military emissions. Instead, they often report them as part of other categories, such as aviation or public buildings. As a result, policymakers and researchers may not be fully aware of the environmental impact of military activities.

Militaries consume significant amounts of fossil fuels even during peacetime, with the US Department of Defense alone using 40% of its fossil fuel consumption for its numerous buildings, training facilities, and other structures across the world. Other countries, including Switzerland and the United Kingdom, also have high fossil fuel consumption by their defence ministries. Some

countries, such as China, Saudi Arabia, Russia, and Israel, do not report their emissions, but they are expected to follow a similar pattern.

The use of fossil fuels by militaries increases both in peacetime and during conflicts, which intensifies the contribution of military activities to climate change. For example, the US and its allies have fired hundreds of thousands of bombs and missiles over the past two decades, with each detonation releasing additional greenhouse gas emissions and causing the destruction of natural carbon sinks such as soil and trees. The US War on Terror, in particular, has led to the release of 1.2 billion metric tons of greenhouse gases, equivalent to the annual emissions of 257 million cars, according to the Watson Institute at Brown University.

If the US military were a country, its greenhouse gas emissions would rank 47th in the world, higher than Denmark, Sweden, and Portugal combined (McCarthy, 2022). The lack of information on military emissions is largely due to their exemption from reporting to the United Nations, making them one of the few highly polluting industries whose emissions remain largely unknown. This exemption was obtained by a US negotiating team in 1997 under the Kyoto climate accord. Despite global military spending reaching nearly $2 trillion in 2020, little attention is paid to the environmental impact of this spending, regardless of where it is directed.

Although military emissions are now receiving some attention. Despite their considerable resources and political influence, militaries are still behind other major sectors in terms of analyzing environmental warfare and sustainability. This is evident from NATO's recent pledge to develop a carbon-counting methodology for its members in 2021, an area in which militaries lag behind other sectors (Neimark, Weir, and Belcher, 2021).

Pollution

The environmental consequences of war are not limited to greenhouse gas emissions that degrade the atmosphere in the long term. Those who live in war conflict zones experience abrupt pollution rise that affects the air, water, and soil they rely on for survival. In Afghanistan, for example, people are exposed to dangerous fumes from open-air burn pits used by the army to dispose of waste, in addition to constant pollution caused by bombs. This has led to a rise in cancer rates for both locals and veterans. During conflicts, waste management systems often break down, leading to households burning trash and dumping human waste in water bodies and unlined pits.

Tanks and heavy vehicles used in warfare can also release abrasive particles that cause air pollution, while discarded ammunition can leak harmful uranium into water systems. The disruption caused by war can also result in illegal competition over natural resources, leading to activities such as illegal logging, setting forest fires intentionally to clear land, and using highly toxic methods to extract precious metals and minerals. For instance, in Colombia, rebel groups engage in illegal mining that pollutes bodies of water with mercury (McCarthy, 2022).

Landmines

Landmines are weapons of war that can harm both combatants and civilians and persist in the environment for extended periods. They are designed to be buried underground and detonate upon pressure, which makes them difficult to detect and potentially lethal. Between 1996 and 2008, more than 4,000 people were killed or injured by landmines and other unexploded war remnants. Unfortunately, these numbers have not significantly decreased since then, as there were more than

4,000 casualties reported in 2011 alone. Shockingly, 71% of the victims are civilians, and 32% of them are children, as per the International Campaign to Ban Landmines. The mere presence of landmines prevents populations from fully utilizing their land and natural resources (Reports, 2014).

Nuclear Tests

Nuclear testing poses a significant threat to the environment and can also contribute to environmental warfare. The fission chain reaction of nuclear weapons has immediate and long-term impacts on the environment, including the release of radiation into the environment. Radiation exposure can cause health problems such as cancer, birth defects, and other illnesses in both humans and wildlife. The Marshall Islands, for example, were forced to evacuate due to the contamination of the local food supply from nuclear testing. To this day, the northern islands of the atoll remain uninhabitable due to radioactive cesium contamination.

The Bikini people were displaced from their homes, cultural heritage, and traditional customs and skills. Additionally, the radiological effects extended far beyond the Marshall Islands as fallout entered the stratosphere and raised global background radiation levels. Nuclear testing can also contaminate soil and water with radioactive materials, making them unusable for farming, drinking, or other purposes. Deforestation is another noteworthy negative outcome of nuclear testing, which can destroy habitats and contribute to climate change. Apart from these, nuclear testing can release significant amounts of greenhouse gases into the atmosphere, contributing to global warming and climate change. Major accidents at the civilian nuclear power plants of Chornobyl and Fukushima have also demonstrated the dangers of radiation (Lawrence et al. 2015).

Nuclear testing could also be a potential environmental warfare weapon, either directly or indirectly. For instance, a country may conduct nuclear tests close to the border of its neighbouring country to disrupt its agriculture and water supplies or contaminate its water sources. Such actions could have catastrophic impacts on the environment and the well-being of the affected populations.

To prevent nuclear proliferation and reduce the risks associated with nuclear weapons, countries must work together. By doing so, we can help mitigate the severe environmental impacts and prevent the use of nuclear testing as a tool of environmental warfare (Trezza, 2021).

Impact of Environmental Warfare

There impacts include

Society, Health, and Environment

The use and testing of nuclear weapons have been subject to scientific investigation, revealing devastating short and long-term effects on the human body.

a) The World Health Organization (WHO) reported on the detrimental effects of nuclear detonations, noting that health services are not equipped to alleviate these effects significantly.

b) Nuclear attacks can have significant and long-lasting environmental consequences.

c) Nuclear Winter is a period of extreme cold and darkness caused by massive amounts of smoke and debris released into the atmosphere. It can lead to crop failures, environmental impacts, and societal impacts.

d) Long-term radiation, soil, and water contamination, increased use of chemical and biological weapons, and destruction of infrastructure are other significant impacts of nuclear attacks.

e) The threat of nuclear attacks can increase the likelihood of environmental warfare, making it essential to prevent nuclear war and reduce the risk of nuclear attacks.

f) Simulation models are used to calculate the environmental impact of a nuclear attack today, as it is impossible to use Hiroshima and Nagasaki as a precedent.

g) Studies on the environmental side of the nuclear coin have intensified in parallel with the growing nightmare of climate change and the increase of nuclear risks.

h) Emerging evidence and analysis include the differentiated impacts of ionizing radiation on human health, long-term impacts of nuclear weapons testing on the environment, consequences of a nuclear war on the global climate, food security, ocean acidification, and regional preparedness and response measures to nuclear testing.

Currently, simulations are the only way to estimate the environmental impact of a nuclear attack on populated areas and industries. The devastating effects of the atomic bombs dropped on Hiroshima and Nagasaki cannot serve as a reliable precedent since the impact would be much greater if even a portion of the 13,000 nuclear devices currently held by nuclear powers were to be detonated today. Studies on the environmental implications of nuclear weapons have intensified alongside the rising concerns over climate change and nuclear threats. Multiple studies suggest that in the event of a nuclear conflict, the impact would be more dangerous, devastating, and faster than that of climate change.

Biodiversity and Wildlife

The impact of war on wildlife is a tragedy that is often overlooked. Studies have shown that up to 90% of large animals can be lost in an area during times of conflict. Gorongosa National Park in Mozambique is a prime example of this, as it lost 95% of its biodiversity during a civil war that lasted from 1977-1992. The Vietnam War destroyed more than 5 million acres of forest and 500,000 acres of farmland, while marshlands in Iraq were reduced to just 10% of their historic size due to war. Afghanistan has also lost nearly 95% of its forest cover in recent decades.

In addition, nuclear testing also has severe impacts on biodiversity and wildlife. Animals caught within the blast wave can suffer from overpressure injury, which has been demonstrated in several vertebrate species. The extent of damage varies depending on the mass of the animal and the magnitude and duration of the over-pressure exposure. Mortality rates in exposed populations are expected to increase under an actual nuclear detonation, and a large amount of debris and shrapnel carried through the air by the blast can cause injury and death to animals in the surrounding area. This detrimental effect has been observed during nuclear detonations on both humans and other mammalian species.

The loss of wildlife and destruction of habitats due to war and nuclear testing is a serious concerns. Efforts must be made to prevent conflicts and reduce the risks associated with these weapons to protect the environment and preserve biodiversity.

The application of landmines during active ground warfare poses a significant threat to biodiversity, even years after being deployed. However, in some cases, landmines may have the

unintended effect of aiding ecosystem recovery by creating a "no-man's-land" similar to a game reserve or park, as observed with cranes in the demilitarized zone of the Korean Peninsula. It is important to note that landmines do not discriminate between soldiers and wildlife, particularly large mammals, leading to direct harm and death to numerous organisms due to explosions. Landmines have been a contributing factor in pushing vulnerable species closer to extinction, such as elephants in Africa and leopards in Afghanistan. Furthermore, landmines can also have negative effects on ecosystem integrity, as they destroy vegetation and degrade soil structure.

The Russian invasion of Ukraine has resulted in devastating consequences, including loss of lives, displacement, and a global food crisis. Additionally, the environment in Ukraine has been severely impacted by the conflict, demonstrating the destructive effect of war on biodiversity and climate change. Environmental advocates and organizers in Ukraine have recorded numerous environmental crimes, which they argue constitute ecocide and should be prosecuted in international courts. These crimes range from attacks on industrial sites that pollute groundwater and airways to the intentional bombing of wildlife habitats and other ecosystems.

According to Ukraine, the invasion has caused a significant amount of greenhouse gas emissions, equivalent to adding 16 million cars to the UK's roads for two years. The country is gathering evidence of environmental crimes to sue Russia and claims that precious animal and plant life has been destroyed. The war has directly caused 33 million tons of greenhouse gases to be emitted, and rebuilding efforts could increase this number to up to 49 million tons of carbon dioxide. Ukraine believes that Russia should be held responsible for these emissions.

Ukraine has documented 2,000 environmental crimes, including the destruction of forests, the release of toxic gases, and damage to water facilities. The government plans to use this evidence to seek compensation from Russia for the damages caused. Furthermore, the conflict has put around 600 animals and 750 plants and fungi, some of which are endangered species, at risk (Rannard 2022).

Marine and Aquatic Life

Aquatic organisms are highly susceptible to the impact of a blast. Nuclear detonations near aquatic environments have resulted in massive die-offs of fish populations, indicating that the effects are similar to those of conventional explosive blasts but on a larger scale. Teleost fish are particularly vulnerable due to their gas-filled swim bladders, which can rupture when exposed to high-pressure differentials. The same applies to marine mammals, which have large gas-filled lungs, resulting in severe lung damage and high mortality rates in the event of a nuclear blast. Diving birds are also affected. However, invertebrates seem unaffected by pressure waves in aquatic systems, except in the case of warhead detonation over coral reefs, where it can cause widespread coral death (Lawrence et al., 2015).

Naval blasts and sonar operations can also disrupt the daily lives of many aquatic species. Naval sonar devices use the same frequency as that used by dolphins and whales, resulting in ear haemorrhaging and beach stranding. The conventional naval ordinance, such as depth charges and torpedoes, create significant underwater blasts that can cause overpressure and fragmentation injuries to marine life in the blast radius. Recent reports also have linked 120 dolphin deaths in the Black Sea to the war.

Legal Instruments and their Failure

The use of a herbicide during the Vietnam war lead to the creation of leading to the creation of two new international legal instruments. The Environmental Modification Convention (ENMOD) was adopted in 1976 to prohibit the use of environmental modification techniques as a means of warfare. Additional Protocol I to the Geneva Conventions, adopted in the following year, included two articles (35 and 55) prohibiting warfare that may cause "widespread, long-term and severe damage to the natural environment."

The global community increasingly recognizes the significance of safeguarding the natural environment and its essential resources during and after armed conflicts. In recent times, the International Law Commission (IaLC), a United Nations organization composed of legal experts in international law, has made efforts to improve the legal framework in this regard. They have drafted 27 principles for the Protection of the Environment in Relation to Armed Conflict (PERAC), which include measures to prevent environmental damage during conflicts and methods for remediation after the conflict. The proposed PERAC principles are set to be voted on for adoption by the United Nations General Assembly shortly.

The United Nations Framework Convention on Climate Change (UNFCCC) requires 46 countries and the European Union to submit annual reports on their national emissions. The 2015 Paris Agreement eliminated Kyoto's military exemption, but reporting of military emissions remains voluntary. However, under-reporting is commonplace, and the data is often either inaccessible or aggregated with non-military sources. For instance, Canada categorizes its emissions under various Intergovernmental Panel on Climate Change (IPCC) categories, with military flights reported under general transportation and energy consumption for bases reported under commercial/institutional emissions. Furthermore, many countries, including China, India, Saudi Arabia, and Israel, with massive military budgets, do not have to report their military emissions annually to the UNFCCC, and their reporting is even more inadequate.

Despite the potentially catastrophic consequences of environmental warfare, international legal instruments have failed to effectively restrict its use. One reason for this failure is that the existing international legal framework primarily focuses on prohibiting the use of certain weapons and tactics in armed conflicts, rather than addressing the environmental consequences of warfare. For example, the Chemical Weapons Convention prohibits the use of chemical weapons, but it does not specifically address the environmental damage that could result from their use.

Another reason is that environmental warfare is difficult to define and identify. It can be difficult to determine whether environmental damage is a deliberate tactic or an unintended consequence of military operations. This makes it challenging to hold perpetrators accountable and enforce international legal norms. Additionally, enforcement mechanisms for international environmental law are generally weak. International treaties often rely on voluntary compliance and lack effective mechanisms for monitoring and enforcing compliance. This makes it easier for states to ignore their obligations and continue to engage in environmentally destructive warfare.

Overall, the failure of international legal instruments to restrict environmental warfare highlights the need for stronger legal frameworks and more effective enforcement mechanisms to protect the environment from the harmful effects of armed conflicts.

Conclusion

The destructive impact of war on the natural environment has various consequences. It is argued now and then that the forests, grasslands, bodies of water, and other ecosystems are critical to our

well-being and must be protected from the ravages of war. Additionally, environmental destruction can fuel further conflicts by depriving communities of essential resources and livelihoods. The climate crisis has been recognized as a threat to global security, but achieving peace is seen as the most effective means of safeguarding both the planet and our security. Environmental diplomacy and international treaties are inadequate in addressing the environmental impact of war, and there is a need for stronger enforcement mechanisms to ensure compliance with international laws and agreements. The more the level of fossil fuel is consumed by militaries, the more severity of environmental damage is seen. The severity of environmental warfare during conflicts obstructs the possibility of transitioning towards a sustainable economy. There is an inch of partiality in the international legal instruments. It is evident by the way global powers are favoured immensely resulting in environmental degradation. Also, the lack of reporting by militaries confirms the destructive nature and lack of seriousness and sincerity towards the efforts for environmental warfare.

Recommendations

Here are some steps that can be taken to ensure that a war does not promote environmental warfare:

1. Strengthen international laws and regulations: The international community can work together to develop and enforce laws and regulations that prohibit environmental warfare. This can include imposing sanctions on countries or groups that engage in such activities.
2. Promote diplomacy and conflict resolution: Diplomacy and conflict resolution should be prioritized over military action whenever possible. This can involve the use of mediation, negotiation, and other forms of a peaceful resolution to address conflicts.
3. Increase awareness and education: Governments, civil society organizations, and the media can play a crucial role in raising awareness about the environmental consequences of war and the importance of preventing environmental warfare. Education and awareness campaigns can help foster a culture of peace and promote the protection of the environment during times of conflict.
4. Develop and implement international agreements: The international community can work together to develop and implement agreements that promote sustainable development and protect the environment during times of war. This can involve agreements on issues such as the protection of natural resources, the prevention of pollution and environmental degradation, and the provision of assistance and support for affected populations.
5. Promote disarmament: The reduction and eventual elimination of weapons of war can significantly reduce the likelihood of environmental warfare. This can involve promoting disarmament agreements and initiatives, as well as the redirection of military spending towards environmental protection and sustainable development.
6. Develop emergency response plans: Governments and international organizations can work together to develop emergency response plans that address potential environmental disasters during times of war. These plans should involve the coordinated efforts of government agencies, emergency responders, and international organizations to minimize the impact of war on the environment and protect affected populations.

7. Artificial intelligence (AI) can potentially be used to limit or eliminate environmental terrorism, but it would depend on various factors, such as the specific application and the level of human involvement.

Environmental terrorism involves using violence or sabotage to harm the environment, such as damaging infrastructure, contaminating water sources, or destroying natural habitats. AI can be used to detect and prevent such activities by analyzing data from various sources, including satellite imagery, social media, and sensor networks.

For example, AI can be used to monitor and analyze social media to identify potential threats or patterns of behaviour associated with environmental terrorism. It can also analyze satellite imagery to detect changes in the environment that may indicate sabotage or contamination.

However, AI systems are not infallible, and there are limitations to their effectiveness. For example, AI may struggle to detect more subtle forms of environmental damage or to distinguish between legitimate activities and malicious ones. Additionally, AI should not be used as a substitute for human judgment and oversight, as there may be ethical and legal implications associated with using AI to monitor and control behaviour.

In conclusion, while AI can be a useful tool in detecting and preventing environmental terrorism, it should be used in conjunction with human expertise and oversight to ensure its effectiveness and avoid unintended consequences. Moreover, by taking these steps, the international community can work towards preventing environmental warfare and promoting a safer and more sustainable world. It requires a strong commitment from all governments, organizations, and individuals to work together towards this common goal.

Dedications

I dedicate this research to my loving pets ***Stella, Bella and Butterscotch***.

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After COP27: Pakistan's Resilience for Global Climate Justice

Dr. Muhammad Faisal*

Abstract

In the recently concluded COP27, the delegation from Pakistan stressed the global community for implementing the Adaptation Fund which was established in 2001 to generate financial assistance for the countries experiencing the worst climate change impact. It also asked the developed countries and global financial institutions to devise a debt-for-climate swap roadmap for the countries which experience climate change threats every year. The COP27 ended with a major breakthrough agreement for the provision of loss and damage funding for climate-vulnerable states. It is an exemplary development for global climate justice. The delegation from Pakistan played a key role in getting this step on the agenda of the conference. It is considered the major achievement of Pakistan's resilience for global climate justice, as it is considered one of the most vulnerable countries owing to the impact of climate change. This paper tries to briefly analyze Pakistan's efforts to communicate and unite the states on the global agenda of climate justice. This research has worth importance and has argued that in what circumstances, the world joined hands in understanding the global South climate challenges and adopting a framework to overcome the stark implications of climate change. Furthermore, this paper proposes recommendations for stakeholders to establish global cooperation for climate justice in the short as well as in long lane.

Keywords: COP27, Pakistan, debt-for-climate swap, climate justice, climate vulnerable countries

Introduction

The Sustainable Development Goal 13 (SDG 13) under UN Agenda 2030, discloses about the climate action and the protection of human life from climate threats. This statement defines the urgent action to combat climate hazards and their impacts. Primary international and intergovernmental forum for negotiation on global climate change is known as the United Nations Framework Convention on Climate Change (UNFCCC). So far, 27 rounds of negotiations and three climate treaties (Kyoto Protocol 1997, Copenhagen Accord 2009, Doha Accord 2012, Paris Agreement 2016) have been concluded under UNFCCC.

The last round of these negotiations took place in Egypt from November 06-20, 2022. The point for negotiation and adaptation in the previous Conference of Parties 27 (COP27) was the adaptation of a resilience climate strategy, finance for loss and damage owing to the challenges of climate change problems for states which are climate vulnerable. In COP27, it also has been asked to the industrially and scientifically developed countries and global financial institutions to devise *debt-for-climate swap* roadmap for the countries which are experiencing climate change threats every year (World Economic Forum, 2022). The COP27 ended with a major breakthrough agreement for the provision of loss and damage funding for climate-vulnerable states. It is an exemplary development for global climate justice

In research, writing and literature, climate justice has increased dramatically from the last two decades. This concept has many aspects to understand. Sometimes, these aspects are different and

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contested. However, in simplest meanings, climate justice emphasize on fair, transparent and inclusive decision-making and distributive justice in the climate change issues without creating a segregation of who bears the costs of both climate change and the actions taken to address these issues (Newell, Peter et. al., 2020).

The delegation from Pakistan played a key role in getting this step on the agenda of the conference. It is considered as a major achievement for Pakistan's resilience for global climate justice, as it is considered as one of the most vulnerable country owing to the impact of climate change. This paper tries to briefly analyze Pakistan's efforts to communicate and unite the states on global agenda of climate justice. This research have worth importance which has argued that in what circumstances, world joined hands in understanding the global South climate challenges and adopt a framework to overcome the stark implications of climate change. Furthermore, this paper proposes recommendations for stakeholders to establish global cooperation for climate justice in the short as well as in the long lane.

Understanding Global Climate Justice

The idea of the global climate justice has been emerged from the debates on the protection of environment from several environmental dangers which the communities across the world are facing and experiencing now a days. The concept is in debate informally in 1960s and the formal debates on this terminology started emerging in 1990s. An environment movement was started in United States of America in 1980s by the black community. The objective of this movement was to stop the dumping of toxic chemicals in their communities/territories (Tandon, Ayesha, n.d). The concept emerged on racial grounds and expanded into the economically segregated communities/countries with the passage of time. Now a days, most of the developing countries; especially from the African and Asian continents are developing consensus on demanding various kind of cooperation/aid/benefits from industrially developed world.

There are many concepts and definitions to understand the global climate justice. Some are difficult to understand while others are complex in nature. In simplest way, global climate justice is a formal and multilateral way and global mechanism to share the environmental burden. The term climate justice is used to frame global warming as an ethical and political issue (UN Environment Programme, n.d). It addresses the fair sharing, division and the equitable distribution of climate cost by the developed countries for the less developed nations. The global climate justice also calls for fairness in global decision making in climate related policies and debates (Arcaya, Mariana & Gribkoff, Elizabeth, 2022).The SDG 13 set by the United Nations in 2015 is associated with the global climate justice. Under this SDG, five targets are set out to address the climate issues being face by the contemporary world (sdgs.un.org).

Dr. Robert Bullard formally associated with Atlanta University and the founding Director of the Environmental Justice Resource Center is known as the *'father of climate justice'*. He has extensively write on climate justice, housing, transportation, environmental racism, sustainable development, regional equity and community resilience. He is author of 18 books which are written in the domain of global climate justice and environmental challenges (https://drrobertbullard.com/biography/).

The climate change threats are now has been considered in the domain of human rights. Many human right experts in the world have defined, that the arising pollution from the developed

countries is a violation of human rights of the public in developing countries in a way; most of the these developing nations have not sufficient technology to cope with this challenge and the industrial nation also do not provide/equip them with these technological apparatus. These experts ask for the accountability of these developed nations as the industrial activities of G-8 states have disturbed the life of everyone on Earth. A Special Rapporteur in the recent commentary urged the countries and stakeholders within UN environmental and climate governance system to stop all kinds of discrimination with regard to human rights violations related to climate ongoing and emerging issues (UN Human Rights, 2022).

COP27: Agenda, Discussion and Adaptation

The Conference of the Parties (COP) for its COP27 set out an agenda for developing cooperation on climate issues being faced by the developing countries. The objective of this COP was to reach on decision regarding global climate governance for developing fair, equitable, effective and ambitious multilateral climate regime under UNFCCC. It also discussed the measures to enhance international cooperation and the support for developing states which are facing climate injustice due to the industrial development of the developed nations. The substantive progress and the actions which are need to be executed were also analyzed in COP27 which was organized in Egypt in November 2022.

Principle: This conference set out a global principle which agrees by all the nations across the world. This stressed the need for international cooperation which must be agreed by all nation states to mitigate the climates challenges, approaching equitable sharing of the climate resources and fairness on reaching a suitable climate deal for the developing countries which are affected from the climate issues (COP27 Report, 2022).

Agenda: The agenda of COP27 was to make a realization to the developed countries that they must lead on the climate fronts to mitigate the world climate challenges by financial, legal, technological and atmospheric contributions. They are also bind to transfer technology and the creation of opportunities of capacity building in developing nations to address climate damages. The demand for climate finance from the developed nations was the primary part of COP27 (COP27 Report, 2022).

After many round of discussions, following decision was adopted by the COP27;

1. The global goal on adaptation on climate governance should be clearly theorized in the COP28.
2. Climate Finance Grant (CFG) should be established by the developed countries to mitigate the climate issues of the developing countries.
3. A program must devised to deliver the CFG to the developing countries unless and until they become technologically independent.
4. The developed countries must devise a concrete long term strategy to limit the low emission of carbon gases (COP27 Report, 2022).

The establishment of loss and damage fund for climate vulnerable countries has been praised by many stakeholders however some of the observers stressed the need to establish a technological arena for the developing countries to take action against the climate challenges. By

establishing self-sufficiency in financial resources, better governance model and nature based solutions; developing countries can better fight for climate justice.

Pakistan's Perspective in COP27

The World Bank released a country report in 2022. This report has critically evaluated the climate issues and threats being faced by Pakistan. This report is alarmingly very sensitive and call an inclusive action to limit these threats. The report concludes that the standard of living in Pakistan is expected to decline due to the climate sensitivities and carbon intensive scenario by 2050. On the other side, Global Climate Index 2022 has placed Pakistan as the 8th worst affected country due to the impact of climate change in the recent years (World Bank, 2022; Global Climate Report, 2022).

Owing to the climate calamities, Pakistan is one of the worst affected state. The stance and the perspective of Islamabad was greatly appreciated by the developing countries. The Prime Minister of Pakistan vociferously proclaimed for climate justice for the nations which are climate vulnerable and asked for establishing climate finance for these countries as compensation (Donnell, Lynne O., 2022). Among other countries, Pakistan's official stance is vibrant, clear and appealing regarding the climate justice. The developed countries are responsible for climate inconsistency in South and particularly in states which are climate vulnerable (Khetran, Mir Sher Baz, 2022).

The minister for climate change Dr. Sherry Rehman while addressing the COP27 meeting at Sharm el-Sheikh stated that; "Pakistan will be on frontline for asking to the developed countries about the loss and damage fund owing to their unprecedented industrialization which has disturbed the climate scenario in developing states". A career Pakistan diplomat Nabeel Akram repeated a message again and again that; "loss and damage is not a charity, it is all about climate justice" (The Guardian, 2022). Being President of G-77+China, Pakistan brought and tabled the proposal for establishing loss and damage fund. The state did not only tabled this proposal but it also united the G-77 nations while negotiating on this important demand despite the efforts to divide G-77 by some of the rich countries. Pakistan's diplomat Nabeel Akram was the chief negotiator in all this process. Some of the other stakeholders which positively participated for establishing climate justice agenda are described as following;

- The South African and Egyptian diplomats also backed the 'loss and damage fund' proposal and negotiate with many developing states representatives to establish a single agenda.
- As part of global campaign for climate justice, various civil society organizations were putting pressure since COP26 which was held in Copenhagen. When the US was close to stepping away, the US civil society groups lobbied of the US congress leaders and put pressure on US government not to do so.
- The grassroots leaders from USA and European Union also played an important role for taking decision on global climate justice and supported the 'loss and damage fund' campaign of Pakistan.

The proposal was finally accepted by the COP27, but the recommendations for establishing the loss and damage fund will be finalized in COP28 at Dubai. The acceptance for establishment of the fund for the developing countries is one of the historic event for the G-77. Since 2009, G-77 achieved a second milestone by developing consensus for global climate justice which is asked through economic compensation. The Prime minister of Pakistan hailed and applauded the efforts

and development and described that; 'the establishment of loss and damage fund is a pivotal step for achieving the goal of climate justice' for the countries which are climate vulnerable. The climate minister tweeted that; 'the establishment of loss and damage fund took 30 years of 134 developing countries. It is a hope for these nations which are fighting for their survival owing to climate stress'. The foreign minister of Pakistan quoted as 'monumental achievement for the global climate justice (Dawn, 2022).

Pakistan's stakeholders played a pivotal role for including the provision of climate justice in tCOP27 to be held in Sharm el-Sheikh Egypt. Being the President of G-77+China, Islamabad's diplomat Nabeel Akram took the charge as the chief negotiator to communicate with the stakeholders of G-77+China while Egypt and South Africa assisted Pakistan during the negotiating process and vociferously the efforts made by Islamabad. The proposal for establishing 'loss and damage' fund was unanimously adopted by G-77 during UN session as a mean to attain global climate justice for developing countries.

Beyond COP27

The UN Climate change summit to be held in Sharm el-Sheikh concluded with as breakthrough agreement for providing loss and damage financial arrangements for the climate vulnerable nations. Most of the world leaders in general and particularly from developing countries welcomed the effort while some of the states stressed on the climate affected states for adopting instinctive values to address this issue. They also talked about better model for governance, nature based solutions and accountability of the stakeholders. Pakistan's efforts for global climate resilience has been emerged in COP27 which needs to be re-framed in accordance with the futuristic trends. The COP27 highlighted Pakistan as champion of global climate justice. Following are the main points which established that Pakistan is resilience for attaining global climate justice;

- The establishment of loss and damage fund has been in debate from the last 30 years but never put on agenda of any COP. It is Pakistan which formally framed it with the support of G-77+China
- The acceleration for global climate justice will take to further height now, as financial compensation will now be decided in the upcoming COPs
- From last two decades, the natural calamities give a lesson, that the developing nations could not alone control these dangers, the multilateral strategy is important under the privilege of climate justice
- By building multilateral steps, the developing countries still needs to empower the local government to control the impact of natural calamities owing to the climate change threats
- The initiatives like green climate funds needs to be expanded. The climate resilient agriculture, aquaculture, livestock, industry, governance and health system is need of the hour for achieving the global climate justice
- It is the mismanagement of the natural resources of the previous generations which threatened the climate of the ongoing and future generations on earth, so, there is need to transform the mind set for preparing the present generation to make resilience for climate friendly solutions of ongoing climate threats.

Conclusion

As G-77 chair, Pakistan successfully presented the case for global climate justice at the platform of COP27 to be held in Egypt in November 2022. All the developing countries, unanimously built consensus to present the demand for establishing a loss and damage fund for the countries which are experiencing climate threats. With many hard talks, negotiations and consensus, the COP27 established loss and damage fund for the climate vulnerable countries as a mean of establishing global climate justice.

This success highlighted the importance of Pakistan being a climate vulnerable state since three decades. The formation of loss and damage fund has been in debate from the last 30 years but never put on agenda of any COP. It is Pakistan which formally framed it with the support of G-77+China. By all means and efforts, the developing countries still needs to empower the local government to control the impact of natural calamities owing to the climate change threats. For global climate justice, Pakistan's efforts cannot be abandoned.

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Environmental Diplomacy and Climate Justice

Ahmad Nazir Warraich*

Abstract

This paper will explore two related aspects of climate change; multilateral negotiations and equity in regard to who pays for the damage done to the climate. In this regard, the paper will focus on Pakistan as a case study while looking at it from a global perspective. This paper involved a descriptive methodology and consulted secondary research. Climate change has seen a significant rise in global temperatures since the 19th century onwards, however, the polluters are not the one's suffering the most as a result of it. The sufferers are mostly the developing world like Pakistan. For the purposes of this paper environmental diplomacy is taken to mean climate diplomacy. The paper will explore the intricacies of multilateral negotiations nature of power dynamics and state interests and the consequent difficulty of multilateral negotiations which is further compounded in the case of climate diplomacy. The paper will explore how a middling power like Pakistan can leverage its position amongst the comity of the nations to respond to this challenge of getting justice in the environment of climate diplomacy.

Keywords: Climate change, Climate change negotiations, Climate justice, Multilateralism, Realpolitik.

Introduction

Pakistan faced almost unprecedented losses during the summer of 2022 due to unusually high rainfall and flooding. This left almost one-third of the country under water and more than 1700 people dead, with a huge loss of cattle heads, which is both a lifeline and a great economic loss for a farmer and rural population and large-scale destruction of houses. The loss to the economy has been calculated to be close to 30 billion dollars (WB, 2022).

This massive loss left the country reeling and struggling to cope with its aftermath. The scary thing is that there is no way to predict it won't happen again. There is an urgent need for us to be prepared for any such future disasters. Climate change is caused by Green House Gas Emissions, such as Carbon dioxide. The injustice is that Pakistan only contributes less than 1 % to these gases in global terms, however, it is ranked by many studies as one of the top 10 most vulnerable countries with regard to devastation and losses caused due to it. Scientists tell us that there are multiple ways the world can deal with this global phenomenon, but primarily two kinds of steps are required. One is mitigation and the other is adaptation. However, both of these require massive funding, which is not available. Developing countries like Pakistan don't have the fiscal space, whereas the developed world is unwilling to pay its share. Developing countries are hit in two ways: the cost of dealing with the losses suffered due to it and the cost of taking these measures. The debate is further complicated by the fact that the polluters have mainly been the developed countries that

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starting with the Industrial Revolution in the mid-19th Century have been the main emitters of Green House Gases(GHGs), but the main sufferers in most cases are developing countries like Pakistan, who had very little role in emissions. This raises the complicated question of 'climate justice'; in other words of who should pay for it, those who contributed to it or those who did not. The main international treaty regulating global cooperation on climate change is the United Nations Framework Convention on Climate Change (UNFCC) (Bodansky, 1993). Under it, to monitor progress on implementation of its objectives an almost annual conference is held, termed the Conference of parties (COP). Amongst these the Paris Agreement (2015) is a key pact. It came up with three pillars; Mitigation, Adaptation and Climate Finance (Kuyper, Schroeder, & Linnér, 2018). This paper will explore how Pakistan can in the give international political and legal framework maximize its interest by better negotiating through multilateral agreements and pacts, both as part of Groups and Blocs and in its individual capacity at the international negotiating table.

As part of this debate, this paper will also discuss the domestic level awareness and efforts in this regard and the particular constitutional federal structure with most subjects having been devolved to the provinces

It is important to understand that Climate change is different from environment, as the latter deals with things like air pollution, water pollution, etc., whereas Climate change refers to long-term shifts in temperatures and weather patterns(UNO, 2021). The UNFCC, defines climate change as, "Climate change" means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods"(Weerasinghe, 2021). In this paper environmental diplomacy refers to climate diplomacy.

The Industrial Revolution blossoming in the 19th Century ushered in an era that led to rapid industrialization and burning of fossil fuels, leading in turn to GHG emission, which in turn led to the Green House Gas Effect, which is the puncturing and thinning of the Earth's protective ozone layer at places. This in turn led to warming temperatures. In this regard, the average Earth surface temperature has risen by 1.3 degree C, in the last over 170 years. Given the increasing awareness about climate change and its effect on Earth's climate and raising temperature and to assess the science related to climate change, the UN set us an Inter-Governmental Panel on Climate Change (IPCC) (Houghton, 1986). This body has now provided sufficient scientific evidence to convince even most of the Naysayers about the effect and impact of human activity on the Earth's climate. This has disturbed weather patterns and led to extreme and unusual weather patterns which in turn has led to floods, heatwaves, heavy rainfalls, drought and their consequent effect of food security, internal migration, livelihood losses, conflict, water shortage etc. This has potentially disastrous effects for a country like Pakistan.

In geological time scale, scientists tell us that climate has never changed this rapidly and never due to human factor. This is why some commentators call this human activity induced climate change as 'Anthropocene'. This highlights the challenge we are facing now. Which is the rising pace of global climate change and its consequences. This highlights the urgency and need for interstate action on it and the need to enhance and further develop the international framework in which steps can be taken by the world as a whole to control the negative impact of climate change and to slow down the process of climate change, and rise in temperatures. The main issue now is to negotiate international agreements in a just and effective way which ensures controlling rise in

global temperatures while at the same time make provision of finances for the developing country to assist them in their efforts of not just mitigation, which is the priority of the developed world, but also of adaptation, which is the need of the developing world.

The methodology through which countries can come together and negotiate agreements based on equity and justice, which will effectively ensure measures to control climate change, unfortunately work in the background of the harsh and hard reality of power politics and self-interest of states, sometimes referred to as *Realpolitik* (Warraich, 2014*).* However, in this backdrop the International community through various conclaves held on the subject of climate change over the decades has set certain goals, including a very important one of capping the global temperature rise at 1.5 centigrade. To achieve this goal certain steps, need to be taken to control carbon emissions. This includes the target of Net Zero Emissions, by 2050, established in 2015 at the Paris Agreement. This implies creating a balance between how much GHG are emitted, and how much are absorbed(Holta). If this is achieved then global temperature rise can be controlled. To be able to reach this goal a set of policies need to be adopted and implemented by each country at its own domestic level as well, which are at times very difficult to implement in practice. This has made achieving these targets very challenging.

One of the main issues in regard to international consensus on actions required to be taken on climate change is that of 'definitions', be it of 'adaptation', loss and damage fund' etc. Adaptation which as we discussed above is one of the pillars in the fight against climate change still lacks a consensus and comprehensive definition As we shall see in international agreements that require action to be taken by state parties to a treat, clarity on definitional issues is important as it can be problematic because state obligations flow from it.

The IPCC definition that is;

The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects (IPCC, 2014).

This definition indicates that this is a broad range of steps across a range of levels; policy practical, international and national, that need to be taken to address the issue of adaptation. And this is what why adaptation is so difficult to understand to notice and to take into account into policies at the international level and at the national level, and even local level. It's also a matter of adapting natural systems or to enjoy or to make the most of natural capacities to adapt to it. And at the same times to have human societies, to be as resilient as possible into planning, into drafting policies that help societies to be resilient, to have early warning systems to have some solutions implemented on the ground to prevent the main effects of loads, of course, but also of heat waves or so of hurricanes.

The need and extent of steps needed for adaptation vary from country to country depending in part on its vulnerability. Pakistan for example is on the higher end of the scale of vulnerability due to its geographical position and also because it has a wide range of landscape; such as highest mountains, fertile lands, semi desert, desert, down to coastal belts. This exposes Pakistan to being

vulnerable to various types of damaging climactic impacts. In addition, we are a middle-income country which is struggling with high population figures and low economic indicators.

It requires good planning, sound governance, empower local governments, cohesive inter-governmental reworking relations between various tiers of government as well as between various ministries in the same level of government.

In the collective global effort to fight climate change, finance is one of the most difficult issues. In 2009 Copenhagen Summit, a framework was adopted regarding finance, with a $100 billion pledge by 2020 for climate finance. An important pillar of tackling climate change is Finance. There is a cost element attached to taking steps to dealing with disasters that occur due to climate change as well as for mitigation and adaptation measures. Equity and fairness demands that the developed countries, who are historically the main emitters of GHGs should put sufficient and substantial money in climate funds established for this purpose. However this is not the case. Firstly, the finances available through international mechanisms are insufficient, secondly they are hard to access, many are tied, and some are available for mitigation purposes which is a greater concern of the developed world rather than for adaptation, which is a greater concern of developing countries.

Article 2(2) of the Paris Agreement (COP 21)2015;

This Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances(UNO, 2015). An agreement back in 2009 was made regarding $1 billion pledge by developed world for setting up a climate finance fund. Those funding arrangements were aimed to be provided by a wide variety of sources: public and private, bilateral and multilateral, including alternative sources of finance.

There is a discrepancy between where finances are available and where they are needed. The IPCC says in a report that the access to finance is not only about the pledges and the commitments of states, it's also about the ability, of local institutions, or cities, or even households and even individuals to be able to access it. Finance flows do not flow in the same way in all of the regions, and this has impacts on effective response to the climate disaster and to the climate prevention.

The Paris agreement did provide the targets, but we are far from achieving them. At the international level we are setting only targets, incentives, road maps and policy frameworks. But what matters in the end is the ability of countries and domestic action taken in this regard, because international provisions cannot substitute national actions. And international law, broadly speaking, is all about the national will of implementation. Domestic policy level is perhaps as important as international treaties not only with regard to policy but equally with regard to implementation.

The threat to life as we know is much greater than most people realise. If global temperature rise is not capped at 1.5 Centigrade, then most of the staple crops would be likely affected, people living on small islands on the one end and those dependent on melting of glaciers at a certain rate would be severely affected by even a rise to 2 degree Celsius, let alone a higher rise. This is why it is imperative that the world recognises this danger and comes together and does whatever is needed to tackle it (Vaillant, 2023).

Since those times and up to 2023 these 100 billion pledges has not been reached by developed countries. Meanwhile some organisations working in the field now estimate the required figure to be much higher than this. This shows the gap in funding. Many people working in the field argue that climate justice demands that the developing world make these contributions to such funds earmarked for climate change purposes. However, it may be noted that in interstate negotiations the term climate justice is not used, this term is more used by scientists and activists.

That's why we need to consider all the difficulties even at the domestic level for those countries to deliver finance, because if you just consider the United States, you can say they are not delivering their fair share and this needs to be addressed. But if you consider the US domestic politics, you know that there are some really tough difficulties for the executive government to pass legislations on climate, even regarding climate finance and this is one of the explanations of this lack of finance providing.

The $1 billion pledge has not been met yet, however a recent report published right before the last COP 27 by a UK think tank, estimated the need as far beyond these 100 billion pledges. In this report it is estimated that by 2030 the real need in developing countries of finance is considered to be approximately at one trillion dollar per year. So international finance is not aligned with those needs. We need to assess what were the hopes and aspirations from various COPs and what has been the reality to gauge if the international arrangements put in place due to international agreements are sufficient to deal with the negative effects of climate change (Khan, 2023).

Various studies done including by IPCC inform that the World is already dangerously behind on the steps that need to be taken to stop rise in Earth's surface temperature, and the damage being caused in some cases is irreversible, all we can do is minimise the damage and try to control it (Vardy, Oppenheimer, Dubash, O'Reilly, & Jamieson, 2017). Whenever we negotiate through International treaties and agreements we need to keep this reality foremost in our deliberations. IPCC has said it, very clearly that we are now in a dangerous position. Secretary General Gutierrez has said that we are on a highway to climate hell. By some estimates we are looking at 2.5 degrees Celsius warming by the end of this century and perhaps even more catastrophic impact before.

The achievement of COP 27 is considered to be the Loss and Damage Fund. However at the moment it is just a piece of paper, which at the moment lacks any material benefit and only shows a moral victory by the developing countries including China. At the international negotiating table there is a lot of time spent on drafting a piece of agreement building upon previous agreements and strengthening language here and there. It has yet to be operationalised, but it is still a success in part due to Pakistan's diplomacy.

One problem in the nature of International climate change negotiations seems to be that there is no accountability for lack of action by a state. If a state has made a commitment to contribute a certain sum of money for a fund and it does not deliver upon it, then there is not much that the other states can do about it. Another problem is that inspite of the fact that the scientific evidence is mounting, and there is a consensus within the scientific community, but the citizens, and particularly in the rich country are still divided on the urgency of the issue. Important parts of the political class of some countries seems to be still skeptical or not fully aware of the imminent nature of the danger. And that is perhaps the Reason why one sees the number of countries still having or not being able

to put up the kind of climate action that is needed from the large countries. There is no denying the fact that, the kind of action that is needed is not there.

International negotiations are always complex, however the climate change negotiation are particularly complex. In this background global events like the war in Ukraine has added to geopolitical uncertainty. There is a reduction in cooperation. The financial and human resources in such situations tend to shift towards military ends or again on fossil fuels.

With perhaps every new day the adaptation window is closing while the world is putting too much emphasis on processes and textual negotiation(Khan, 2023). There is too little emphasis on outcomes. While we are talking about financing, perhaps talking about which country should do now with climate change and should we change the NDC's etc., we are failing in a response at the global level, considering there is a threat to life as we know it; food security, energy, stability of society, conflict, water shortage etc., these crises are cascading into one big disaster, while diplomats struggle to put a comma here and there (Khan, 2023).

Common but differentiated responsibilities and respective capabilities, is a principle which is contested by the west as an old principle and some analysts think that, and they want to create a new principle which creates similar obligations for the developing countries. Climate agenda is perceived to be mostly driven by the West, because of their economic interest and they want to safeguard their economic interest because the cost is huge for them and they want that the new emerging economies should share the burden of the climate action. Countries like China, have staged their involvement in climate change negotiations in an incremental manner after they had developed their domestic infrastructure, policy framework, investments, and thereby once they had confidence that what all they can achieve from their domestic actions they signed on to different international obligations. Pakistan needs to learn from this. Actions by the developing countries remain voluntary, they are not obligated to take action without international support, and this is one of the important element we must always keep in mind. Pakistan should do its homework well based on meaningful stakeholder consultation before sitting on an international negotiating table (Warraich, 2022).

The next aspect is concessional and preferential trade regimes, EU-GSP plus is an example. Under it Pakistan comes under their compliance framework. Pakistan has submitted a Nationally Determined Contribution (NDC), under the Paris Agreement. This is a voluntary commitment on actions a state determines it will take to tackle climate change. However, even though it is voluntary, now it has to give compliance not only under the compliance framework of the UNFCCC or the Paris agreement, but also under the GSP implementation mechanisms or review or monitor mechanism. If a country is taking paid concessions, then it is obligated to respond to the questions and queries with regard to implementation.

Paris agreement requires all financial flows and investments have to have climate consideration; be international or domestic. It's a principle arrangement, its operational details are still being worked out, but the push remains every financial flow or investment, it has to be climate sensitive. There is enhanced focus on blending between development and the climate finance.

It creates stress on our limited resources, fiscal space and also exacerbates our existing challenges; like water, food security, disaster debt, sustainability sector and it constitutes a national security threat if some of these aspects are combined. So addressing climate change is a national priority. We have legislative policy, institutional frameworks and initiators and targets which exist, but there is a lack of implementation on many accounts, especially because of the lack of availability of finances.

In this background if one looks at Pakistan's NDC, which it submitted in 2021, it was an updated NDC. The current NDC shows Pakistan's commitment, but to some observers, it seems ambitious. Pakistan's targets under it are 50% emission reduction by 2030 and we have stated that 15% would be covered from the domestic resources and 35% with international finance. There is a proposed shift to 60% of renewable energy, 30% to E-vehicles by 2030. Pakistan has imposed ban on the import of coal, the adaptation needs are estimated at $7 to $14 billion(Pakistan, 2021). This indicates the sort of targets Pakistan has set(Pakistan, 2021).

Pakistan does not have an obligation to take these actions, these are nationally determined, but it does have to report on the obligations as of now are reporting under the Paris agreement and we have to submit updated NDCs every five years. EU GSP Plus compliance is an area which Pakistan has to reflect on given that this can be used by the European Union to enforce compliance. This highlights the need to do our homework well, carry out a realistic assessment of what we can deliver upon, carry out meaningful stakeholder consultation and then commit at the international level.

In Pakistan foreign office leads the climate change negotiations and the climate finance issues in close coordination with climate change ministry and also other stakeholders. Pakistan's profile is very active internationally and it is recognized as a significant player. It has memberships of a number of climate change mechanism and funds and plays an important part in them. We also have strong leadership credentials. Pakistan was the chair of the G-77 and China at the last COP, which actually led to the creation of the loss and damage fund and by many account it was a contribution with Pakistan made internationally bringing all the developing countries together to seek the establishment of the fund, given there were very divergent views within the developing countries, including China and others with respect to the structure of the fund, which is to be created(MOFA, 2022). So Pakistan's role has been critical in bringing all the developing countries together and seek the establishment of this one.

Recommendations/ Conclusion

Climate change scientists estimate that almost four billion people are vulnerable in various degrees to effects of climate change. The enormity of the danger requires immediate, collective action to tackle to life on Earth as we know it. We are is some ways already on borrowed time, there is no time to work at the pace and in the typical negotiating style of international treaties formation, which is laborious, time consuming and works within the framework of realpolitik and safe guarding national and commercial interest *uber alles*. The almost existential nature of the threat requires the states to see the mutuality of humanity's interest and tackle the issues involved accordingly. At the same time, states have to realise that it is not just the International treaty formation that is important but also national and sub national level commitments to control GHG

emissions and take urgent steps for mitigation and adaptation to control negative fallout of climate change.

Domestically, Pakistan needs to establish a climate change authority and improve better inter-ministerial coordination and inter-governmental cooperation. Then there is an implementation gap in the policies and the targets that Pakistan has set. The coordination among the ministries and provinces remains weak, which should be significantly strengthened. The idea is to have enabling international frameworks, but also domestic planning and policies.

Access to climate finance is competitive, it is competition among countries that they have to access from different windows and most of the opportunities remain untapped, have we managed to get the maximum out of the windows of finances available? So there are a number of opportunities that exist but have not been benefited. Some observers feel that Pakistan has a significant international profile but unfortunately we are unable to translate that into domestic benefit, especially because of the lack of absorptive capacity and the institutional orientation.

Pakistan needs to adopt a *systematic, consistent and coordinated national approach* if it wants to deal with climate change and attract climate finance. There is a need to have structured engagements with key countries and also to have bilateral arrangements rather than only leveraging multilateral or international financial institutions. There are a number of opportunities that exist in the bilateral partnership engagements. There has to be the ability to utilize finances within the country. Unless there is absorptive capacity in Pakistan for climate finance, it is not going to be possible channel the international influence to Pakistan in this regard. The international bodies work in a certain manner, and Pakistan will have to understand the different institutions(Warraich, 2022). We cannot have our approach imposed on the international financial institutions.

Developed countries leverage their position to shape the climate agenda and also secure economic benefits with every succeeding international agreement they try to secure the large economic benefit. Least Developed Countries and Small Island Development States are prioritized for support by the developed countries, and Middle Income Countries like Pakistan, have to struggle. This is why we need to further improve upon and leverage our international presence and position to better negotiate and get concessions for Pakistan through playing a leading role in various blocs/group as it did in the COP 27 at Sharm El Sheikh.

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Fuelling Climate (In)action: Why Climate Change Scepticism Persists in United States

Mominyar Khalid Butt*

Abstract

United States witnessed a rising wave of environmentalism in the 1960s. It sought to increase regulation by the government to protect the natural environment. It led to the passage of the Clean Air Act of 1963 and the creation of the Environmental Protection Agency (EPA) in 1970. Resultantly, climate sceptic machinery came to the fore to oppose such environmental gains. Since then, climate action has systematically been opposed by the climate sceptic machinery in United States. The sceptic machinery consists of fossil fuel industries, conservative politicians and media, right-wing libertarian think tanks, contrarian scientists and front groups. Despite striking evidence on climate change, scepticism still exists in United States. It became evident when US rejected Kyoto Protocol and withdrew from Paris Agreement. Many factors are responsible for fuelling such scepticism including corporate greed for profit, the rise of far-right leaders and climate denial propagated by conservative media and contrarian scientists. This paper thus aims to dig into and discuss those factors fuelling climate inaction in United States.

Keywords: Environmentalism, climate sceptic machinery, scepticism, climate change, Paris Agreement, United States.

Introduction

The wave of anti-environmentalism was set off as a result of increasing environmentalism in United States. The latter called for strict regulations from the government to safeguard the natural environment. 'Silent Spring' marked the genesis of such environmentalism when it was published in 1962. It cautioned against the environmental harm caused by using DDT as an insecticide. The Clean Air Act of 1963 was enacted by the US Congress as a result of the widespread environmental awareness it generated. The watershed moment for the early environmentalists coincided with the promulgation of the National Environmental Policy Act (NEPA) in 1969 and the establishment of the United States Environmental Protection Agency (EPA) in 1970. Last but not least, in 1988, the Intergovernmental Panel on Climate Change (IPCC) acknowledged that greenhouse gas emissions were increasing global warming. This brought environmental issues to a global level.

Anti-environmentalists emerged in the United States in response to those developments. They were largely funded by fossil fuel industries. The latter depends on oil and gas drilling, thereby leading to the release of toxic gases in the atmosphere. The climate is warming as a result of those gases. If any sort of restriction is placed by the government on the usage of fossil fuels, it would seriously jeopardise corporate interests. Therefore, the establishment of think tanks inclined towards the right-libertarianism that could promote their cause was inevitable. It includes Heartland Institute, Heritage Foundation and Cato Institute in the 1970s which marked the genesis of the sceptic machinery. It is pertinent to mention that fossil fuel lobbies have always been the proponents of a

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neo-liberal economy coupled with limited government. By serving as an alternative source of information for the general public and policymakers, these think tanks have maintained their effectiveness in promoting scepticism regarding climate change.

When Ronald Reagan took office, there was a clear division between supporters and opponents of climate change. The climate sceptic machinery became more efficient and well-organized over time. It started with conservative politicians who were anti-environmentalists to stop environmental laws from being put into effect. It is important to note that the majority of these opponents of climate change are members of the Republican Party and are funded by fossil fuel industries. Consequently, the sceptic machinery soon established a strong connection with rightist politicians. It led George W. Bush and Donald Trump to take anti-environmental positions which became evident when US rejected Kyoto Protocol and withdrew from Paris Climate Agreement respectively.

The climate sceptic apparatus went beyond the aforementioned actors. By incorporating front groups, contrarian scientists and conservative media into the denial campaign, it grew. In a similar vein, scientists inclined towards climate scepticism have had leading roles to make the sceptic machinery effective. Using their own climate models and graphs, contrarian scientists such as Fred Singer, Patrick Michaels and Roy Spencer have written a number of books that challenge the scientific consensus on global warming. Major corporations like the Edison Electric Institute, the American Petroleum Institute, ExxonMobil and the Western Fuels Association have continued to provide funding for the entire climate sceptic machinery.

The world is currently witnessing climate catastrophes as a result of weak climate action and ineffective climate treaties. Extreme weather events like frequent wildfires, prolonged droughts, increased floods, stronger hurricanes, severe heat waves, massive sea level rise, and the melting of ice sheets will cause major areas of the Earth to become uninhabitable if the world is unable to maintain a global average temperature well below 2 degrees Celsius below the level it was at before industrialization, as stipulated in the Paris Climate Agreement. This will result in a lack of food and water, mass displacement, the spread of diseases and conflicts.

Research Methodology

For the topic at hand, descriptive and exploratory research approaches have been employed by the author to gain an in-depth understanding. While the exploratory approach best deals with problems by answering how and why questions, the descriptive approach complements it by emphasising on what questions. A qualitative research design has been chosen throughout the research. As far as sources of data collection are concerned, primary as well as secondary sources have been employed. Significant sources have been derived from secondary sources including books, journals, think tank reports, newspapers, magazines, official documents and broadcast interviews on YouTube. On the other hand, primary sources comprise of two semi-structured interviews were taken on the basis of convenient and purposive sampling to gain fresh insights and expert opinions. The following was considered while selecting respondents:

- The respondent must possess international expertise on the politics of climate change
- The respondent must possess PhD in the respective field.

Factors Fuelling Climate Change Scepticism in United States

Various factors have been dug out by the researcher by using a multi-dimensional approach to explain the reasons behind climate change scepticism.

Economic Factors

Greed to Generate Profit in Fossil Fuel Industries

In order to maximize profits, all of the major corporations engage in corporate avarice. Since governmental regulations restrict their capacity to generate profit, the fossil fuel industries including the Western Fuel Association, the American Petroleum Institute, the Edison Electric Institute and ExxonMobil strongly counter governmental efforts to combat climate change. Naomi Oreskes has written as to why those big organizations are at the very front of climate sceptic machinery. Her book, "Merchants of Doubt," says that the fossil fuel industry depends on oil and gas drilling, thereby leading to the release of toxic chemicals. The climate is warming as a result of those chemicals. If any sort of restriction is placed by the government on the usage of fossil fuels, it would seriously jeopardise corporate interests (Oreskes & Conway, 2010).

In a similar vein, the fossil fuel industries stand to gain the most from the land, air and water which are not regulated by the government since the majority of their activities including mining, onshore and offshore drilling, burning fossil fuels and removal of large areas of land contribute to the release of harmful gases. They opposed the Kyoto Protocol as a result, and they continue to provide funding to politicians who oppose the scientific consensus on climate change. As a result, they are contributing significant resources to conservative think tanks and scientists who support scepticism regarding climate change. In addition, they have successfully maintained relationships with politicians from the right in order to oppose climate-related legislation in the US Congress. (Goodell, 2010)

Al-Gore-founded Climate Reality Project's report says that five big corporations, including Total, Chevron, ExxonMobil, Royal Dutch Shell and BP have invested approximately $1 billion USD over the course of three years to deceive the public about climate change (Rojas, 2019). It is pertinent to mention that in accordance with the research that Exxon carried out in 1977, the emission of carbon dioxide raises the temperature of the Earth. However, they decided to launch a climate change denial and disinformation campaign in order to maximize their profits and corporate benefits from burning fossil fuels. (McKibben, 2015)

Economic Disadvantages to American Workers and Businesses

The United States withdrew from Paris Climate Deal due to the unfair economic disadvantages it placed on American people and businesses. It is alleged that it could slow down their economic growth and increase unemployment. According to a paper that was released by Heartland Institute, the Paris Climate Agreement would result in a loss of $2.5 trillion in GDP and the loss of approximately 45,000 manufacturing jobs in the United States by 2035. In addition, it would put China and India at an advantageous position as compared to United States in terms of economy. (Loris, 2019) The study by LSE economists found that while the risks of climate catastrophe outweigh the benefits to the economy in the short term, the cost of clean energy has significantly decreased over the past few years. The United States' economy would suffer greatly if the global average temperature increased significantly beyond 2 degrees Celsius (Harvey, 2020).

According to the researcher, in today's capitalist system, a nation's economy must have an ongoing supply of energy resources in order to grow and compete with other nations. Its economy will

suffer severely in the short term from any kind of interruption in its constant supply of energy. In nations whose leaders adhere to the far-right ideology, the debate between environmental protection and economic growth is even more intense. In fact, these far-right candidates are elected on the platform of expanding the economy for the greater good of the working class.

Increasing Unemployment for the Working Class

The majority of climate treaties require nations to comply with environmental regulations in order to reduce their carbon emissions. In order to achieve the goals that have been set, governments must limit factory and industrial production. All of these governmental regulations will first have an effect on the manufacturing sector, which is primarily made up of working-class people. If such regulations are followed, factories and industries will be forced to lay off some of their workers by restricting output. Therefore, climate-related policies will have a short-term negative economic impact on the working class.

Donald Trump in one of his assertions said that Paris Agreement unreasonably treats many American people working in coal, steel, oil, assembling and development areas. They are positively impacting the US economy. They can't be fired all at once when China and India, for example, are expanding their coal-based power plants. The Heritage Foundation's report says that the Paris Climate Agreement would cost American families an additional $30,000, which would raise their cost of living. (Doescher & Moore, 2017)

In a similar vein, George W. Bush and his Republican administration rejected Kyoto Protocol owing to the aforementioned worries regarding the rise in unemployment among white working-class people as a result of the closure of high-carbon industries. In addition, the rejection was largely motivated by the fact that it only requires developed nations to reduce their carbon emissions, giving advantage to India and China. (Borger, 2001)

Political Factors

Re-emergence of Far-right Politics in United States

Because the ideology of the far right tends to be inclined towards anti-environmentalism, the resurgence of far-right politics in the United States has severely undermined climate action. The tendency of Donald Trump and his administration towards the far-right could never allow US to look for global participation on an environmental issue as ultranationalist generally puts their own people first. More poignantly, conservative lobbies like the fossil fuel industry and conservative think tanks tend to have a greater influence on far-rightists. Dr Bernhard Forchtner said while in conversation with the researcher,

> *Far-rightists usually appeal to those workers who are associated with manufacturing industries such as coal, mining and construction. They constitute their major vote bank. So, it is always political interests that trump environment*. (Forchtner, 2021)

As a result, Donald Trump initiated a number of anti-environmental measures in 2017 to appease his large voter base, which primarily consists of people who lean toward the far right. These measures included appointing Scott Pruitt, a climate change denier, as administrator of the

Environmental Protection Agency (EPA) and Rex Tillerson, a former CEO of ExxonMobil, as Secretary of State. It's interesting to note that Scott Pruitt helped speed up the United States' exit from the Paris Climate Agreement. In addition, he resumed oil and gas drilling on federal land in the United States. (Kumar, 2019)

It is evident that big lobbies hold considerable sway over White House as manifested by US withdrawal from Paris Agreement. In order to win the elections as the Republican nominee, Donald Trump largely relied on the far-right's strategy of portraying elites as "others," which is a powerful weapon. Trump sees the white working class in the Rust Belt, coal miners, and people who work in the fossil fuel industry as the pure opposition to the corrupt elite (Roberts, 2018). Dr Matthew MacWilliams opined while in conversation with the author that there is a powerful connection between your political orientation and climate change scepticism. The more you are on the right, the more you will deny the existence of climate crisis (MacWilliams, 2021).

Additionally, because Republicans are a conservative party, they are more likely to support the climate sceptic machinery. James Inhofe, a Republican Senator, has called global warming the biggest lie. By calling sceptic scientists to speak against climate change during committee briefings, he transformed the Committee of Environment and Public Works into a hub for the sceptic machinery during both the Bush administration and Trump administration. In addition, Bush's ascendancy as the Conservative President of US standardized the environmental distrust in the most elevated platform of policymaking in US (Dunlap & Mcright, 2011).

The research that was carried out by the Adelphi Institute, which is based in Germany, found that 18 of the 21 European far-right political parties either do not care about climate change at all or simply oppose it. In addition, Brazil's President Jair Bolsonaro, also known as the "Trump of the Tropics," opposes climate action as well (Beauchamp, 2019). These far-right populist leaders all have a few things in common: they don't like multilateralism, are obsessed with ultra-nationalism, and rely on the working class to win elections (McCright & Dunlap, 2011).

Influence of Big Money on Conservative Politicians

In the National Geographic documentary "Before the Flood," it was shown how big businesses like Chevron, ExxonMobil, Shell and others are giving a lot of money to conservative politicians' campaigns to help them win elections. In the United States, the fossil fuel industry and far-right politicians have a strong connection. The relationship began when Ronald Reagan, the Republican President, appointed an outspoken environmentalist to important ministerial position. Republicans have been noted to be more inclined towards corporate influence and funding which was further solidified under Bush and Trump. Indeed, fossil lobbies and conservative politicians empower each other.

Figure.1 Oil and Gas Political Contributions in US

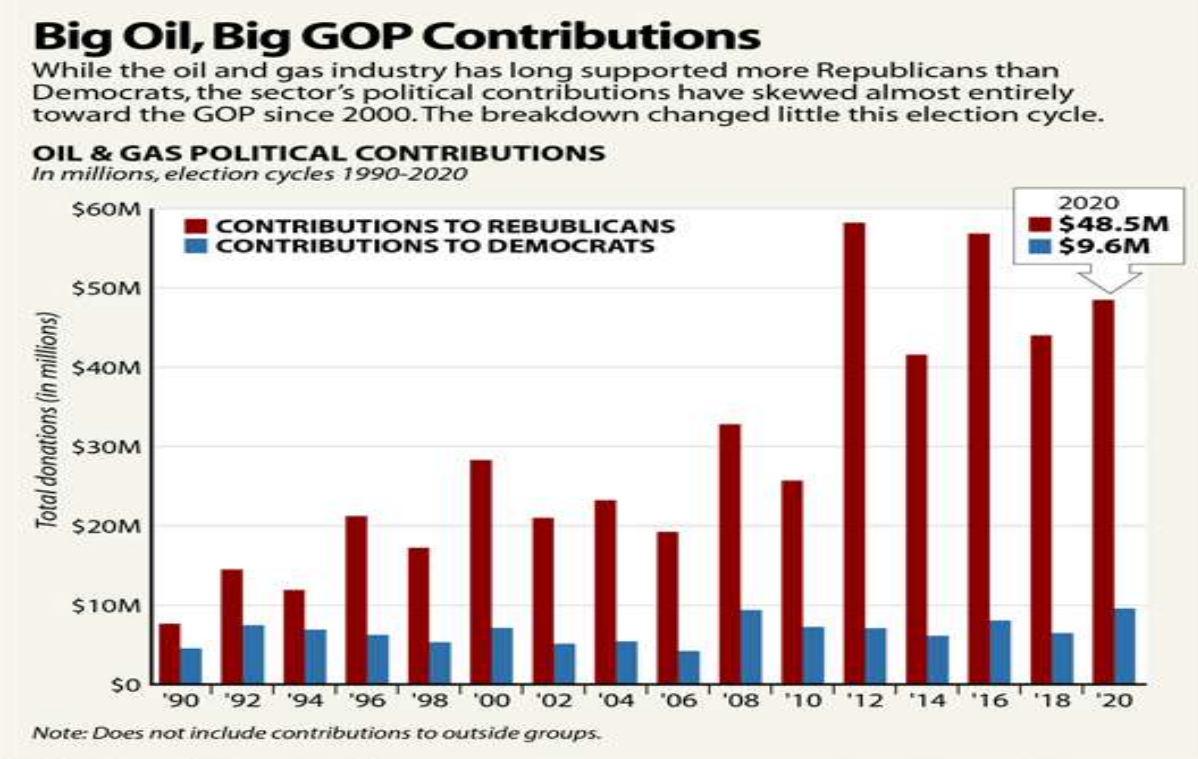

Figure 1 demonstrates a significant pattern regarding the flow of outside funding in US politics. According to information gathered by the Center for Responsive Politics, corporate contributions to the Republican Party have steadily increased since the 1990s. Although Democrats have also received contributions to their campaigns from oil and gas companies, these contributions are significantly less than those given to Republican Party. The aforementioned statistics demonstrate that the fossil fuel lobbies have strong ties with politicians from Republican Party.

According to a report that was published by The Guardian, half of the Republican nominees for the 2015 presidential run received a funding of $62 million for election campaigns from entities that had strong links to the fossil fuel industries. It is pertinent to note that these big corporations have made climate scepticism a requirement for a Republican presidential candidate (Pilkingston, 2015).

Senator Sheldon Whitehouse from the Democratic Party and the author of the book 'Captured: The Corporate Infiltration of American Democracy' gave an interview that was published by Yale School of the Environment. He is of the opinion that the constant flow of big money towards Republican Party has stifled climate action by United States. There is another party (Koch Brothers) that is much stronger than Republican Party. It is not directly involved in politics but has much greater influence on policymaking (Whitehouse, 2017).

Perceived Loss of Super Power Status as a Result of Climate Policies

Reducing carbon emissions would have a significant negative impact on the US economy, which was one of the reasons the Bush administration cited for rejecting the Kyoto Protocol. There were inherent flaws in the Protocol's functions, such as obligating only industrialized economies to reduce carbon emissions while excluding other major polluters like China and India, which remain

on the list of developing nations. Consequently, China benefitted from it. In the years that followed, China tripled its GDP and doubled its carbon emissions. Bush's decision made some sense as it sought to maintain its position as the dominant power in a realist world. China would not have become the second most powerful political and economic player in the world, acting as a counterweight to US hegemony, if it had been forced to reduce its carbon emissions.

Each nation is required to establish targets for reducing its carbon emissions in accordance with the Paris Climate Agreement. During the Obama administration, the United States set a goal of reducing its carbon dioxide emissions by 26 to 28% by 2025 from 2005 levels, while China set a goal of first reaching a peak of emissions by 2030 and reducing emissions by 60% to 65% per unit of GDP by 2030. Simply put, one of the objectives outlined in the Paris Agreement is to achieve a peak in global emissions of greenhouse gases as soon as possible—the point at which emissions begin to fall from high to low. Limiting global warming becomes more difficult the longer the peak is delayed. US has previously accomplished its top in 2007, though China is yet to accomplish its top by 2030 (Levin & Rich, 2017).

Trump explained why he let the United States leave the Paris Agreement in the final Presidential Debate in 2020. According to him, US had to be pulled out of this agreement due to unfair treatment towards it; the country had to sacrifice its businesses, jobs and companies while China and India take advantage of it (News, 2020).

Social Factors

Climate Denial Propagated by Conservative Think-tanks

One important part of the climate sceptic machinery are conservative think-tanks (CTTs). Their primary objective is commitment to a neo-liberal economy coupled with limited governmental regulations. They believe that climate policies harm the interests of large corporations. Consequently, CTTs are engaged in spreading climate sceptic material. (Lahsen, 2008)

It is pertinent to note that in the 1970s, there was a rise in such anti-environmental think tanks in the United States, most of which were funded by owners of large fossil fuel industries. One such Washington-based conservative think tank is the Cato Institute, which was founded in 1974 by libertarians Ed Crane, Murray Rothbard, and Charles Koch. It was opposed to government regulations on the environment. In addition, it produced books, periodicals, and research papers that challenged the science of global warming. (Mayers, 2020) It laid the groundwork for the establishment of numerous additional conservative think tanks, which ultimately proved to be the most powerful instrument utilized by the climate sceptic machinery.

George C. Marshall Institute has been using graphs, figures, and charts to refute the claims made by the scientific community regarding climate change. Those reports are being misrepresented and have never gone through the peer review process. In a similar vein, the Heartland Institute has long promoted scepticism regarding climate change. Their work paved way for the creation of Nongovernmental International Panel on Climate Change (NIPCC). It challenges the reports of IPCC and attempts to ignite a significant climate controversy (Plehwe, 2014).

Role of Environmental Cynics in Scientific Community

A number of books written by scientists who disagree with mainstream science have denied the existence climate change. It's important to mention Patrick Michaels here. He is a prominent contrarian scientist and senior fellow at the Cato Institute. He asserts that the impacts of global warming will not be as detrimental as the scientific community portrays them to be. Instead, they will be insignificant and might even be advantageous. He has written a range of books on environmental change. Sound and Fury is an example of such a book. Similarly, this conservative attitude toward global warming is reflected in The Science and Politics of Global Warming. In point of fact, the fossil fuel industries have largely continued to provide funding for his academic attacks on climate science and ozone depletion. (Jacques & Dunlap, 2013)

Additionally, Roy Spencer is a well-known contrarian scientist. He is an American meteorologist who has remained employed as a climate scientist by the National Aeronautics and Space Administration (NASA). Additionally, he was one of George C Marshall Institute's board members, whose sole objective was to propagate climate denialism. Spencer has also written a number of books that deny and challenge climate change models. "The Climate Confusion" stood out among them. He has vehemently argued in this book that climate change is not as catastrophic as depicted. In addition, he has argued that the global obsession with climate change has resulted in billions of dollars in governmental expenditures for climate research that have been paid for by taxpayers. (Gelbspan, 2004)

Other than this, Fred Singer has remained a main voice among the environmental change cynics in US. He established the advocacy group known as the Science and Environmental Policy Project (SEPP) in 1990, with the goal of disputing and challenging the scientific findings regarding ozone depletion and global warming. SEPP contends that human activities are not to blame for global warming and that the computer models predicting the rise in temperature are flawed. Fred has remained associated with Shell and other major fossil fuel companies. He has written a number of books that question global warming's severity. These include: Global Climate Change, Global Effects of Environmental Pollution and The Greenhouse Debate Continued. Last but not least, he is referred to as the "godfather of global warming denial". (Plehwe, 2014)

Rise of Conservative Media fuelling Anti-Environmentalism

Naomi Oreskes has shed light on how conservative media influence public opinion. It's important to mention Fox News here. Around eighty percent of the climate-related segments on Fox News focus on arguments against climate science. In that platform, such claims are provided significant space and time to reach the masses (Howlett & Morgan, 2010). In their talk shows, numerous well-known Fox News commentators, including Bill O'Reilly, Glenn Beck, and Sean Hanity have frequently criticized the science of climate change and attacked the IPCC's findings by giving invitation to anti-environmentalists (Jamieson & Cappella, 2008).

Additionally, numerous conservative media personnels run channels on YouTube that promote scepticism regarding climate change. Bill O'Reilly is a known figure who has remained related with Fox News and presently uses YouTube channel to spread his views. While hosting his show 'No Spin' in YouTube, he said,

> *When you listen to power grabbers like Elizabeth Warren, Bernie Sanders and leftists talk about climate change, they are basically talking about socialists' control over how we live, eat think and get*

> *around. They want full federal government's control over our lives and economy (Rielly, 2019).*

In addition, Tim Dickinson asserts that prominent conservative magazines are increasingly expressing scepticism regarding climate change. Among them are the American Spectator, the Weekly Standard, and National Review, all of which are engaged in presenting anthropogenic climate change as a fabrication. The media has been a powerful weapon of the climate denial machinery, able to reach a large number of people in a short amount of time. (Dickinson, 2010)

Conclusion

In response to growing environmentalism in 1960s, the climate sceptic machinery was established. The passage of the Clean Air Act in 1963 marked the beginning of such environmentalism. It raised public awareness of the need to preserve the natural environment for the first time. Finally, the turning point for early environmentalists was the promulgation of the National Environmental Policy Act (NEPA) in 1969 and the establishment of the US Environmental Protection Agency (EPA) in 1970. Most importantly, it made environmental issues a national concern that needed to be addressed.

Because of those turns of events, anti-environmentalism was inevitable. It first took the form of right-libertarian think tanks that were funded by fossil fuel companies. Their commitment to a free-market economy coupled with limited government resulted into books, periodicals, and research papers that challenged the science of global warming.

Over time, the climate sceptic machinery became more organized. It grew and included new allies like conservative and far-right politicians, contrarian scientists, front groups and conservative media. They have not only written a number of books that argue against global warming, but they have also continued to work in various capacities with the aforementioned think tanks to make their climate sceptic claims even more persuasive. If climate change scepticism is examined through the lens of the capitalist economy, corporate profiteering and the global race to maintain economic dominance are at the top. Any form of government regulation regarding drilling, mining, and extraction of fossil fuels would be detrimental to the corporate interests of the fossil fuel industries.

The majority of Republican presidents, from Ronald Reagan to Donald Trump, have remained opposed to climate change and global warming. Climate change scepticism became evident in their political outlook and policies when they cut the budget for the EPA, repealed environmental laws, appointed staunch environmentalists to key positions, rejected Kyoto Protocol and withdrew from Paris Climate Agreement. Even more poignant is the fact that politicians and the entire climate sceptic apparatus have remained employed by fossil fuel companies like ExxonMobil, Chevron, Shell, the American Petroleum Institute and Koch Industries.

As a result, it is reasonable to believe that the climate sceptic machinery uses climate scepticism as a powerful tool. In the eyes of policymakers and the general public, it has made the science of climate change unsettling and controversial. As a result, climate action has been stifled and climate treaties have only been partially implemented.

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Connection Between Climate Change and Social Perception: A Case Study of Lahore City

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Abstract

Climate Change is no longer a myth and has become a stark reality; it has become more evident for the people of Pakistan since the devastating floods of 2022 caused extreme destruction and homelessness among the populace. In this paper, interviews of the population of Lahore City were held through a standardized questionnaire, and then the results were recorded on how the people perceived climate change. The way it is perceived among the population is due to a lot of contributing factors such as literacy rate, cultural preferences, the poverty level of the interviewees, psychological factors, visible impacts of climate change, and awareness spread by the government, to name a few. Lahore City has been cited time and again by various international agencies during the past few years as one of the most polluted cities of the world. Lahore is the second most populated city of Pakistan and is populated by approximately 12 million inhabitants. The city is not only a cultural hub but also serves as the home for many factories, and thus contributes a lot to the economy of the country. Thus, the working of industries cannot be put at halt, and the carbon emissions cannot be fully curbed at least in the shorter run. The Environment Protection Department is doing its job by regulating the working hours of factories, and by regulating the size and design of the chimneys but this has not produced significant results due to the issues of poor governance issues and corruption. The inhabitants of Lahore City have mixed reviews when it comes to the menace of climate change. There were glaring differences among the views of the population when interviewed from the developed and less developed regions of Lahore. The primary concern for the majority of people right now is their livelihood, and being able to survive in these difficult economic conditions.

Keywords: Carbon Emissions**,** Climate Change, Environmental Protection Department, Poor Governance, Social Perception

Introduction

Climate change can be described as a wide range of global phenomena caused primarily by the combustion of fossil fuels, which emit heat-trapping gases into the Earth's atmosphere. These phenomena include the increased temperature patterns described by global warming, as well as changes such as rise in sea level, ice mass loss in Greenland and the Arctic, and mountain glaciers around the world. The shifts in flower/plant blooming, and extreme weather events. Climate change is one of the most pressing and immediate issues confronting the world today. Pakistan, despite being one of the world's lowest CO2 emitters, is one of the countries most affected by the consequences of climate change. Climate change impacts in Pakistan are multifaceted and multilayered. Climate change has implications not only human life in Pakistan, but also for the flora and fauna of the Pakistani ecosystem. Pakistan's agriculture sector is critical to the country's

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future prosperity as the country is an agrarian economy. However, as a result of climate change, its agricultural sector has become extremely vulnerable. Other sectors, such as health, transportation, water, and energy, are also significantly affected by the effects of climate change. To combat this threat, Pakistan must pursue a both adaptation and containment policies at the same time. Despite the fact that Pakistan has established institutions and protocols to address climate change, the awareness among masses is still not sufficient for reasons more than one.

The Social perception regarding climate change is very crucial to understand for counties like Pakistan. In order to make it more specific, the research was conducted in Lahore City in order to make our research more specific. Pakistan is an under developed country and as stated by the IPCC (2007), the underdeveloped countries will suffer more than developed countries from climate change. Pakistan is especially vulnerable to climate change — especially its India delta, which serves as its lifeline. The population density in the region that surrounds Indus delta is much dense than in other regions of Pakistan. The Indus delta is already in the heat zone and therefore, the rising temperatures will have a direct impact on human health, leading to increased cases of heatstroke, diarrhea, and cholera, among other things. It is also anticipated that by 2100, the temperature in the basin's surrounding areas will rise by 4 degrees Celsius. The policies that are made in Pakistan are mostly the aspirations of the public sentiment. Thus, for a country like ours it is very essential to know that whether people are sensitized related to the climatic changes that are occurring, because if people are not concerned than there's very bleak future for the residents of Pakistan.

Combating and responding to the menace of climate change necessitate the transformation of the behavioral patterns of millions of individuals, who make individual and collective choices on a daily basis that have a significant impact on the amount of greenhouse gas emissions. Thus the aspirations of public that eventually results in policy making and behavioral patterns of the individuals result in a circular relationship where increased public attention and awareness tends to favor the activation of policies, which in turn leads to more awareness in public which will then further link itself to a more disciplined behavior of the individuals. When there will be increased awareness among the public related the climate change, they will worry more about the repercussions of it. As a result, the policies will be made to minimize the effects, which in turn will reduce the worry of a bigger section of the population. This research paper looks at the residents of Lahore and by doing primary research at the grass root level which has enabled us to finally comment on what needs to be done in order to sensitize the population to a greater extent when it comes to the catastrophic effects of climate change.

Methodology Opted for the Research

In order to investigate the connection between climate change and social perception of Lahore City, a questionnaire was prepared that had two different sections. The first section was regarding the personal information about the participant. The gender, age, employment status and education of the participant was asked in order to build a relationship of their education and employment status with the knowledge they had acquired about climate change. The second section dealt with questions related to the perception of the participants regarding climate change and what do they think promotes climate change. The participants were asked whether they belong to developed or developing areas of Lahore. The direct impact of climate change on their lives and how are they trying to fight this menace on personal level was also asked by them in the questionnaire. Finally,

the participants were asked whether they know about the workings of the Environmental Protection Department, and if they knew about it their trust in the working of the department in Lahore City was also questioned. The population size that we had for this research was of 200 people belonging to Lahore City, due to the limitations of time and resources we couldn't reach out to more people.

Social Perception Regarding Climate Change

a. Awareness about Climate Change:

According to the data that was collected during the research, the awareness about climate change had a lot to do with the age, education and the areas the participants resided in. The people who were educated knew about what climate change was and they knew that it is impacting their lives directly. In addition to tis, the people who resided in the more developed areas of Lahore too knew more about the menace of climate change. However, there were a few people who were not educated yet knew about climate change due to the media. Some people who were not educated and belonged to elderly strata of population were even of the view that it's just a hoax that is being created by the developed countries in order for us to not prosper. There were arguments of all sorts but the majority of population who was aware about the menace of climate change were literate people. This entails that much needs to be done in order to make the masses aware about this menace.

Besides this, when the participants who knew about climate change were asked what according to them is the reason for this. The answer which most of them gave as a first option was deforestation, the participants said that the race of building societies at fertile lands has contributed immensely to this menace. In Lahore alone, the societies have gone up to the banks of Bambawali-Ravi-Bedian (BRB) which was once occupied by fertile lands on its both sides. In addition to the building of societies, the majority of the construction that is taking place in the region of Lahore is horizontal development and not vertical which has added more burden on the fertile lands of the outskirts of Lahore. This deforestation was linked with population explosion in Pakistan by most of the participants as a probable reason for the climate change. It is because there are already scarce resources in the country, but the pressure that this growth of population adds to the limited resources is immense.

b. Impacts of Climate Change on Daily Lives of People:

People who knew about climate change were very much concerned about how it has impacted their lives. Most of the people listed more ways than one in which it has had direct impact on them. The majority of the population pointed out to the food scarcity that has risen exponentially due to this catastrophe. The crop yields have decreased due to untimely rainfalls, floods, and droughts in the country, as a result of which the prices of the commodities have increased. Besides this, the issues of respiratory system was the second priority of the participants. The presence of smog has caused a lot of people especially those with a family history of asthma and respiratory problems more susceptible to the breathing difficulties. People have also felt that the temperatures have risen exponentially, and the heat waves are impacting people in ways more than one. People stated that it becomes increasingly difficult for them to ride motor bicycles in the month of June and July due to the sweltering heat of summer.

People also listed that due to the climate change and the impending threat of the country being listed as water stressed country has started to shown its affects in the urban centers from now.

There are times when people have to wait for water to come in their taps, and the frequency of water not coming in their taps has increased in the last two years. The most interesting observation that was made during the research was from the people who resided in Daroghawala which is also an industrial area due to presence of a huge number of iron factories. The residents told that the pollution and climate change has impacted them to an extent that they can no longer put their clothes out in the sun to dry. In case if they put their clothes in the sun to dry, a black layer appears on their clothes which is sticky and greasy in nature and they have to wash their clothes once again.

c. Action Taken By People on Personal Level:

This question was left unanswered by a lot of participants because most of them felt clueless, and did not know how actions on taken on a personal level can make a significant impact. Again, the literate individuals were doing things that they could do in their capacity to minimize the effects of climate change. Some of the participants mentioned that they recycle bottles, papers, and use environmental friendly products. The re-use of paper bags, and of long lasting water bottle was also listed by some participants. However, the majority of the participants were not concerned with the actions that they can take on personal level to reduce its impact. This shows how the psychological attitude of people towards climate change needs to be changed, and for this a lot of governmental support is required which will be discussed ahead in this research paper.

d. Environment Protection Department and People's Trust:

Majority of the participants were very shocked to hear that such a department has been existent and is working in the country. The ones who knew about this department and its working were too not very confident about the workings if this department. The participants of the view that the department lacks vision, clear guidelines, and most importantly a leadership that stays true to its cause. During our research, we also conversed with some factory owners and they said that the department mostly tries to become active during the smog season, and the officials of the department are involved in all sorts of vices which includes corruption and bribery. The participants also stated that the department has miserably failed to counter environmental degradation with rising index of bad environmental conditions in Lahore. The people who were a part of our population during our research, only a few of them said that they trust the workings of the department and the results will be procured in time. However, the majority didn't show any trust in the department and blamed it as another parallel institution that works as a 'waste management agency' and not an environmental one.

Climate Change Adaptation

Climate change adaptation is a response to climate change. It describes the measures taken to adapt to the changes brought about by climate change. In a nutshell, it is the government's response to the challenges posed by climate change. Pakistan's adaptation to climate change changes is still in its early stages. There have been numerous impediments to Pakistan's response to climate change. Some of the adaptation technologies that can be adopted to adapt to the ramifications of climate change especially in Lahore City are listed below.

a. Education:

As shown by the research that was carried out by us in Lahore City, we came to know that the more educated the people were, the more they knew about the problems related to climate change. Thus, this tells us that education and awareness about climate change have a direct relation.

Government should work towards making policies that can help increase the literacy rate of the population. As per Human Capital Index (HCI) report that was published by the World Bank indicates that gross secondary school enrollment rate is only 45%. This shows us that literacy is a big problem in Pakistan owing to many factors such as culture, and poverty, to name a few. Thus, government needs to ensure that it provides conducive environment for the education of its citizens. The only way through which citizens can be enlightened and made to understand their responsibility towards education is through education.

b. Media's Role:

There are numerous media houses in Pakistan but the advertisements that are played on media related to climate change are very few in number. The state needs to take the onus of responsibility on itself and should invest in drama serials that are made on issue of climate change. The state can collaborate with numerous private media houses because these shows will have huge impact and will be able to sensitize the population accordingly. The government has to take these measures before the problem of climate change becomes worse; this will also be helpful because television is watched by every kind of audiences. The illiterate people, and the women who are home makers will especially benefit from this and this can help the state in ways more than one because people will start conserving electricity, water and other things to name a few at personal level. This will also help a great deal in shifting the attitudes and perception of people when it comes to climate change and its repercussions.

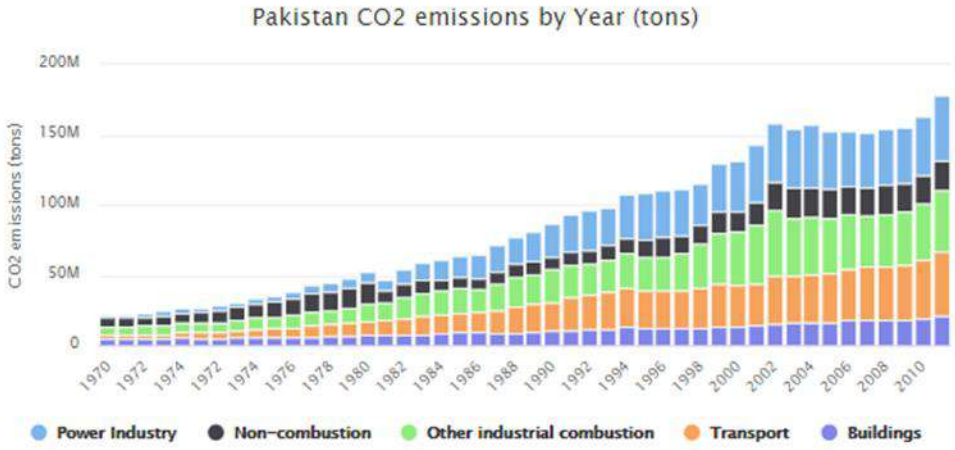
c. Sewerage Systems:

The water and sewage systems of urban areas should be improved so that they can accommodate and cope with increased rainfalls and flash floods. The rural to urban migration has increased tremendously due to increases opportunities when it comes to education, health and job opportunities in urban areas. The sewerage system's capacity should also be increased so that it can accommodate the entire population that is expected to migrate to urban areas as economic opportunities in rural areas dwindle.

d. Water Problem:

In order to combat the problem of decreased water flow, the government should consider improving the current water distribution system. Water losses should be minimized, and land should be laser-leveled to prevent water waste. Small water reservoirs should be constructed to store water, which can then be used for energy production and agriculture. Another significant advantage that these water reservoirs will provide is that they will reduce water waste.

e. Decreased Carbon Footprint:



Lahore City is an urban center and has a lot of factories. The government should ensure that these factories are not using coal or carbon for the workings of their factories. The government should incentivize the renewable energy resources so that people get more interested in the buying of such resources. Another plan which is a long term but will definitely procure good results is the shifting of the factories that are in Lahore by forming an industrial area in the outskirts of Lahore which is run by renewable energy sources. By following such methods,

f. Research Deficiencies at Governmental Level:

The government has made departments like Environment Protection Departments but the government also needs to ensure that these departments are taking ground realities into consideration. Most of these departments do not indulge into research and rely on models that have been applied in developed world, which most of the times do not suit the circumstances we live in. The primary issue is that there is little or no data on the changes observed and the repercussions of climate change. There should always be data available which addresses recent changes caused by climate change. Aside from that, there is no climate monitoring mechanism in place, so the government's response is often reactive rather than proactive.

g. Climate Sponsorship and Funding Mechanism in Pakistan:

Climate change has multiple costs, including human, cultural, and social costs, in addition to financial costs. Countries must redirect their resources towards financing initiatives aimed at combating these changes. Financial resources are required not only to combat these changes, but also to rehabilitate all those who have been impacted by climate change. Pakistan is a developing country with limited financial resources; therefore, acquiring and then spending resources to combat climate change is huge task for the country. Climate funding and financing is still in its infancy in Pakistan. There is no specialized financial institution in place to mitigate the effects of climate change. Even though government is aware of the sensitive nature of the situation, it is hampered by numerous obstacles. Many players, both inside and outside the government, are involved in this mechanism. The federal government's two apex planning and coordination bodies are the Planning Commission and the Ministry of Finance. They make budgetary recommendations. As the project's cost grows, a higher authority is required to approve it. We

need an integrated cross-sector approach to combat climate change. The response must be rapid and swift and it should be liberated from any kind of bureaucratic red tapism.

h. Poor Governance:

This issue is the root cause of most of the problems in Pakistan. The government has made institutions and a lot of parallel structures as well for combating a lot of problems in Pakistan. Same goes for climate change, but the trust deficit of people in these structures is highly visible and we came to know about this in our research as well. The government departments keep on delaying stuff, and most of the time they do not take the onus of responsibility on them. In order to solve these issues, the government must take stringent measures to keep a check on the working of these departments, and should also work on digitalizing these departments and their data so that they can be made more assessable to people. In this way, transparency of the workings of the department can also be ensured by publishing reports on the internet about the workings of these departments.

Conclusion

When one looks at the primary data that was collected during our research, one sees that there is so much to do at every level before it is too late. The social perception and attitudes regarding climate change need to change. Majority of the people living in Pakistan are illiterate; although, we conducted our study in an urban center which is Lahore City but our research showed that most of the people in Lahore City who are illiterate also do not think of climate change as the real problem and many of them do not know about this phenomenon as well. The government needs to take swift and rapid steps by collaborating with private organizations that are also working to combat the menace of climate change. To combat climate change, we need a collective effort, particularly from the world powers that have made this world inhabitable for many others in pursuit of their own interests. After the Paris Treaty restored some faith, the dream of a collective effort appears to be a distant dream. Many people still do not believe that climate change poses a threat to life on Earth. By joining hands, and by working together we can bring a shift in the attitudes of the people because the work needs to be initiated at the grass root level. Although this process will take time, but it will procure beneficial results in the longer and right now government needs to see that it needs to make policies that have benefits in the longer run. The sensitization of masses also requires government to collaborate with media houses nationwide and make dramas and films which shows the effects of climate change and how a person can work on individual level to mitigate those effects. At the end of the day, fighting this menace is a collective effort and whole nation should work together in order to emerge victorious against this peril of climate change.

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Appendix 01:

Questionnaire

Participant's Information:

- Gender
- Age
- Employment Status
- Education

1. What do you understand when I use the word 'climate change?'

2. If you know about climate change, what do you think causes it?

3. Do you belong to a developed or a less developed area of Lahore?

4. At a scale from 1-10 (10 being the highest) how much do you think climate change has affected your life?

5. If it has affected your life, list any two ways it has had a direct impact on you.

6. Any action that you have taken on a personal level to fight the menace of climate change?

7. Do you know about the workings of Environmental Protection Department? If yes, how much trust do you have in the working of this department?

Climate Change and Human Influence on The Environment

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Abstract

Human activities have had adverse effects on the environment. Environmental pollution, which is a direct reason for human actions, is an issue that has affected a myriad of environmental aspects. Despite the fact that many people may fail to understand the long-term impacts of pollution like global warming, its short-term impacts are easy to understand. These impacts include diseases or death of both animals and human beings. Human actions that cause environmental pollution have effects on biodiversity, water, soil, and land. It is concluded that human activities cause to environmental pollution, which has numerous undesirable effects on biodiversity and the environment. Climate changes are hazardous because they affect all the living things in the world. There is increasing evidence that climate change is directly affecting human beings such as the social, economic, and human development of the nations. Droughts can severely harm to human health and food production. Flooding has the potential to spread illness and harm infrastructure and ecosystems. Human health issues may raise mortality, have an impact on the supply of food, and reduce worker efficiency. Since the negative impacts of pollution are frightening, everyone should have responsibility for making sure that pollution amounts are kept as low as feasible.

Keywords: Climate Change, Environmental Pollution, Globally, Human beings, Human Influence.

Introduction & Background

The environment of the semi-enclosed Baltic Sea and its catchment could also be significantly impacted by both climate variability and human activity. However, little is known about the long-term geographical and temporal scope of hypoxia and its potential relationships to these variables. By altering land use and population density in the drainage basin, human forcing may have indirectly impacted the marine/brackish environment as early as the Late Holocene. Numerous long-term investigations of lake sediments in Northwest Europe have shown that cultural eutrophication of lakes has a longer history than simply a few decades or centuries and that population growth and agricultural development have affected lakes for thousands of years. (e.g. Fritz, 1989, Renberg et al., 2001, Bradshaw et al., 2005). Additionally, according to the International Panel on Climate Change (IPCC) and current research, cyanobacteria blooms will intensify with global warming, and the IPCC has acknowledged that hypoxia is a matter of growing concern with anticipated climate change. Therefore, it is crucial to increase our

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knowledge of the timing, severity, and mechanism(s) generating hypoxia on millennia scales in order to comprehend the whole spectrum of natural variability and to propose practical solutions to improve the Baltic Sea's ecology in the future. To comprehend contemporary environmental concerns, it is also crucial to place the recent human effect in a historical perspective (Jain et al., 2015).

The effects of climate change on the sea receive fewer resources than those on the environment and land, despite the fact that they have far-reaching effects on civilization. It takes a varied corpus of research in the physical, biological, social, and humanities to comprehend these effects as well as society's different perspectives and multiscale reactions to the transforming seas. This may make it possible for the concerns of marine societies and industries to be addressed in important adaptation and mitigation talks as well as guarantee that the investigation that drives environmental policy reflects a diversity of views and opinions (Allison and Bassett 2015).

Human cultural expansion and decrease are influenced by a wide range of variables. It is clear that humans and nature react. Environmental archaeology is now a well-known university discipline throughout the world as a result of this interplay. It has been established that one of the primary drivers of cultural growth is climate. It is viewed as deterministic by archaeologists, which frequently has an adverse image. Examining the history of human growth and any potential links to climate change, yet, is of significance. Wendland and Bryson (1974) statistically correlated radiocarbon-dated Holocene environmental changes with cultural changes on a worldwide scale and discovered a roughly synchronous relationship, with a shift in culture delay of 50–100 years. The dating system at that moment, however, was not very accurate (Berglund. 2003).

Environmental changes are influenced by a number of different elements in addition to human activity. The relationship of the two forces results in intricate processes that have a significant impact on the environment. Natural archives, such as lake sediments, river sediments, colluvial and soils, speleothems, peat, and coastal sediments, can be used to rebuild the trajectory of environmental change. Yet it is challenging to determine how much of the modifications that have been noticed are caused by nature and how much by human intervention. To address these issues, the priority initiative "Changes of the Geo-Biosphere" was created (Litt, 2002). The focus of Time Slice II, or the period between approximately 9000 and 5500 cal BP, is the beginning of farming in central Europe, which is dated to the Neolithic Bandkeramik culture at about 7500 cal BP. It is completely reasonable to concentrate on this element given that the advent of agriculture brought with it the first real possibility of significant human impact on the environment (Warner et al., 2010).

Fluvial systems are susceptible to changes in the environment, which can be brought about by both climate forcing and human effects. Changes in greenery that alter river discharge, sediment load, or bank stability, and consequently the geographic distribution of sedimentary surroundings, can be brought on by both climate fluctuations and human activities. Therefore, fluvial deposits and facial units may exhibit laterally and horizontal trends that represent the sedimentary reaction of fluvial systems to allogenic influences (Vandenberghe. 2003).

With people moving from rural areas, urbanization trends have been rising. As a result of evolving lifestyles and increasing masses densities globally, people's actions & behaviors' have

turned as a consequence. Increasing urbanization, industrial development, and the discharge of greenhouse gases from housing developments are the major reason for environmental pollution. As a consequence, the air gains gradually polluted. These problems add to the natural problems that endanger life on land, in the water, and in the air by harming the environment and changing the temperature of cities. Unplanned communities have recently been affected by a number of earthquakes and floods. Numerous people die, suffer injuries, and become homeless as a result of these disasters. In the aftermath of such occurrences, people move to new towns, their attitudes change in the wake of natural disasters, and they pursue new jobs and aspirations. It was impossible to deny how climate change was affecting agriculture. The world's agricultural sector is significantly impacted by variations in temperature, precipitation, and levels of carbon dioxide (CO2) as well as by the escalation of these factors in global warming. People lose out on the fruits of their labor and have their aspirations dashed as a result of the decline in agricultural yield and the alteration in the land's structure. This causes people to pursue various objectives and professions. In summary, the lives of individuals are significantly changing due to climate change, which negatively impacts all spheres such as health, social mobility, agriculture, economy, industry, and tourism (Celik, 2020).

The number of elements that impact the amount of energy that gets and stays in the environment of the land is counted. These effects are included greenhouse gases, which retain radiation heat, aerosols, which reflect incoming light and influence cloud formation, turned in solar rays, changes in the visibility of the Earth bring on by modifications to earth use, as well as numerous additional factors. In fact, the IPCC's implicit initial estimate was that people were responsible for about 110% of the observed increase in temperature (ranging from 72% to 146%), with the natural environment alone contributing to a modest cooling over the past 50 years, which indicated that human action was answerable for 93%-123% of the measured warming between 1951 & 2010. Although natural climate change brought on by eruptions and solar radiation will have probably led to a modest cooling over the previous 50 years, offsetting part of the warmth brought on by human actions, a human involvement of more than 100% is feasible (Pile).

Greenhouse Gases

The four main gases responsible for human beings are (CO2), (CH4), (N2O), and halocarbons. All of the aforementioned gases have experienced substantial rises during the industrial period. The rises are all a result of human activity (Lagos, 2009).

The consumption of deceased fossils for shifting, housing temperature and cooling, and the use of cement and other things have led to a rise in CO2. As a consequence of fewer plantations, fewer plants are able to absorb CO2. Additionally, natural processes like the decomposition of plant matter emit carbon dioxide (Sims, 2004). Human actions related to agriculture, natural gas dispersion, and soil have led to a spike in CH4. Methane is emitted through organic processes that take place, like in wetlands. Although population increases have slowed over the past twenty years, the atmosphere's methane concentrations are not now rising. (Saunois et al., 2020).

The activity of humans is the key factor contributing to the increase in halocarbon concentrations in the atmosphere. A little quantity also results from natural procedures. Of the main halocarbons are the chlorofluorocarbons (such as CFC-11 and CFC-12), which were frequently used as cooling chemicals and in other industrial processes before it was recognized that their presence in the atmosphere led to stratospheric ozone depletion. Chlorofluorocarbon emissions are

becoming less common as a result of international regulations aimed at protecting the ozone layer. (Zhang et al., 2010).

Ozone gas that is continues produced and destroyed by chemical processes in the environment. Despite the discharge of gases such as carbon monoxide, hydrocarbons, and nitrogen oxide, which are organically related form ozone, human actions have raised ozone in the troposphere. As was already mentioned, the ozone hole over Antarctica is the result of halocarbons created by human activity, which degrade ozone in the stratosphere (Crutzen, 1979).

Aerosols are tiny pieces that get into the environment and have a big size and made-up chemicals. Although certain aerosols are created from substances that are discharged into the air. Black carbon (soot) and organic substance aerosols have risen due to the combustion of fossil fuels and biogas. (Boucher and Boucher, 2015).

Radioactive Forcing of Factors Affected by Human Activities

The impacts made by some of the human-influenced variables to radioactive forcing. The values represent the overall forcing as of around 1750, when the industrial period began. The forcing for all greenhouse gas increases, which are the well-understood of those brought on by human activity, is positive because each greenhouse gas absorbs outgoing infrared radiation in the atmosphere. The biggest forcing throughout this time span has been induced by CO2 levels between the gases. Enhanced in ozone in the troposphere and declines in ozone in the stratosphere have play role to global warming. Through the reflection and absorption of solar and infrared light in the atmosphere, aerosol particles have a direct impact on radioactive forcing. Although others provide an adverse enforcing other aerosols produce a positive forcing. When all aerosol kinds are combined, the direct radioactive forcing is negative. By the modifications they make to the cloud's characteristics, aerosols also effectively produce a negative radioactive forcing. With approximately less heat and high moisture, airplanes leave behind determined, linear precipitation as "contrails." Global aircraft operations have made the Earth's atmosphere cloudier, and they are thought to have had a minor positive radioactive forcing (Betts et al., 2007).

Objectives

- To examine the impacts of climate change
- To investigate the human influence on the environment
- To identify the reasons of human influence that cause the climate change
- To suggest some recommendations to reduce the impacts of human influence and control the climate change

Methodology

Reviewing the literature on climate change and human influence on the environment served as the main methodology for this study. Only academic works with a comparatively high level of evidence or viability were targeted in the search for information. The articles on this subject that were studied were located using the Google Scholar search engine. To guarantee that the knowledge offered in the materials is still relevant to how humans affect the environment and contribute to climate change, all of the materials had to be at least five to ten years old. There is

no restriction on the kind of solution that was used to allow for a diversity of solutions and the potential combination of them as long as their methods are not incompatible.

Results and Discussions

Effects of human activities on biodiversity

As was already said, biodiversity suffers as a result of environmental contamination that is primarily brought on by human activity. For example, aquatic life typically faces when water quality is compromised. Water pollution most frequently results from chemical pollutants. Water becomes harmfully acidic as a result of it. In addition to making life for other animals living in this ecosystem difficult, it kills some aquatic animals. Heat pollution is another type of water pollution that renders the water useless for the species that inhabit there. Although some creatures are compelled to move or endure extremely harsh conditions, others may perish if they cannot tolerate high temperatures. Heat-polluted water typically has less oxygen, making it difficult for living organism breathes. This is due to the fact that cold water often contains greater amounts of oxygen and that the heat of the water may degrade organic stuff in the water, resulting in low quantities of dissolved oxygen. Additionally, the water will evaporate, causing people and animals to breathe in the chemical compounds that are dissolved in it. Acidic rain, which has the same impact as water pollution, will also be produced by this evaporation. In addition to water, thermal pollution can also exist in the air. This is typically brought on by human behavior, such as battles that may result in bombings, carelessly started fires like forest fires, or even climate change, to name a few. Human action during the Second World War had an impact on Hiroshima and Nagasaki. Thermal pollution can cause the mortality of species that cannot withstand the temperatures, which is one of its impacts, as well as the redistribution of animals and other organisms following the pollution.

Previous research has demonstrated that animals' ability to reproduce is adversely affected by the slow heat fluctuations brought by global warming and pollution. Some proofs include records of rising temperatures, sputtering smoke, and the loss of animals as a result of unfavorable weather. Similar to its equivalents in thermal and aquatic environments, air pollution harms biodiversity. Global warming and air pollution go hand in hand. This is due to the fact that air pollution, specifically the emission of greenhouse gases into the atmosphere, is the primary contributor to both global warming and sickness. These gases can cause lung difficulties in people when they inhale them in and out.

The consequences of air pollution and global warming on biodiversity are the same. Among these repercussions such the extinction of little species, the mass movement of creatures that influence biodiversity in the regions the living beings are moving from, animal mortality that decreases the many animals, and a lack of food that prevents animals from reproducing effectively. Global warming has an effect on people as well. In addition to increased illness incidences brought on by climate change, hunger, and drought are further repercussions of global warming. Children gasping, seemingly out of hunger, perfectly portray the impact of hunger and inadequate nutrition. Air pollution caused by human actions like burning fossil fuels and driving cars has a negative impact on people's health. Large amounts of gases discharged into the sky create a blanket that traps pollutants and temperature in the lower atmosphere (Vayda, 2009).

Effects of human activities on air, water, and land

As was said, human activities have a variety of harmful consequences on water, such as thermal pollution. High water temperatures brought on by thermal pollution cause a reduction in oxygen levels, which causes aquatic species to either perish or move to cooler regions. These temperatures could be a result of heated industrial effluents being dumped into the ocean or even the occurrence of marine mishaps that could cause unanticipated fires. Acidic water pollution from industry and other human activities results in acidic rain, which has an impact on both aquatic and terrestrial life. The soil is harmed by human activity as well. Whenever chemical pollution results from industrial water waste, the soil becomes contaminated. Because it is unfit for farming, humans are negatively impacted. The removal and recycling of plastic bags and other materials that are not biodegradable is a well-known problem. When these are buried in the ground, they remain there until they are removed. They consequently have an impact on economic activities that take place on the land, such as farming. Mountain glacier melting has been linked to global warming, a long-term effect of greenhouse gas emissions into the earth's atmosphere. This has a significant impact on the immediate surroundings and the environment of such mountains. Polluting greenhouse gases like carbon dioxide and methane are released into the environment and contribute to global warming.

How human activities are affecting the climate

Human-caused environmental pollution is one of the main factors contributing to global climate change. As was mentioned above, pollution is the primary contributor to global warming. Climate change brought on by global warming affects temperatures, the intensity, and duration of droughts. Because of the numerous negative effects of climate change and, more specifically, global warming, it is crucial that pollution levels are kept to a minimum. Long-lasting droughts, hurricanes, and earthquakes are some of the effects of climate change that make it difficult for humans and other creatures to survive as they did before the changes in the climate happened.

Conclusion:

Human activities put up to climate change reason to turn in Earth’s environment in the number of greenhouse gases, aerosols, and cloudiness. The amount made by largest known contributor is the discharge of fossil fuels that releases carbon dioxide gas into the air. Greenhouse gases and aerosols impact climate by alarming the coming solar heat and outgoing infrared rays that are part of Earth’s energy equation. Today's climate is substantially more influenced by human activity than it is by recognized changes in natural processes like solar variability and volcanic eruptions.

It is obvious that human activity causes environmental pollution, which has a number of negative effects on the ecosystem and biodiversity. Humans develop a thorough awareness of the negative impacts that environmental contamination has on life, allowing for the creation of effective legislation to lessen these consequences.

Suggestions & Recommendations:

Despite the potential of its detrimental effects, it is the obligation of both individuals and the government to ensure that pollution levels are kept as low as feasible. It is concluded that the world would undoubtedly be a better place if pollution were greatly decreased since there would be less global warming, which means fewer famines and droughts. Additionally, there will be

less air pollution, which will result in fewer respiratory problems in people, and less chemical pollution in water bodies, which will result in fewer aquatic animals dying.

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Comparative Analysis of Climate Change in Eastern and Western Media: A Corpus-Based Ecological Study

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Abstract

This study aims to examine the facticity of the language used in Eastern and Western media to describe climate change by analyzing the use of model verbs. The study was based on Potter's (1996) theory of fact construction and Stibbe's (2015) facticity model. The research methodology is mixed and involves collecting climate change data from newspapers over a five-year period (2017-2021). More than 200,000 words of data were collected through judgment sampling, followed by a lexical category analysis using the Baker (2006) model of concordance and Antconc software. The findings revealed that Western media used a higher frequency of model verbs in the media discourse compared to Eastern media. The language used in Eastern articles was more factual in comparison of Western media articles. The study concludes that Eastern media use stronger model verbs to describe climate change, and it is hoped that this research will encourage future studies on lexical categories like nouns, adverbs, and adjectives and the importance of establishing the facticity of texts.

Keywords: Climate change, ecosystem, Eastern media, Facticity model, fact construction, modal verbs and Western media.

Introduction

Climate change is a pressing global issue that requires concerted action from governments, businesses, and individuals worldwide (Intergovernmental Panel on Climate Change [IPCC], 2021). Media discourse plays a crucial role in shaping public understanding and attitudes towards climate change (Boykoff, 2011). As such, it is important to examine how climate change is represented in different media contexts and across cultural and linguistic boundaries. This study aims to compare the representation of climate change in Eastern and Western media using a corpus-based ecological approach. Drawing on the Stibbe facticity model and other ecological linguistic tools (Stibbe, 2015; Fill & Mühlhäusler, 2001), we analyze a corpus of news articles on climate change from major media outlets in China, Japan, the United States, the United Kingdom, Russia, Pakistan, India, Australia, Turkey, Canada, Italy etc. We investigate the linguistic features used to construct facticity and frame climate change in the media discourse of these countries. Our analysis sheds light on the similarities and differences in the representation of climate change in Eastern and Western media and highlights the implications of these discourses for environmental communication, policy, and action. By providing a cross-cultural and interdisciplinary perspective on climate change discourse, this study contributes to the growing field of ecolinguistics and advances our understanding of the role of language and media in environmental issues.

The media plays a crucial role in shaping the public's perception of facts, often using linguistic features that can contribute to distorted information. Social media platforms like Twitter and

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Facebook have amplified the spread of false information, particularly in the context of scientific topics, for the benefit of companies. For example, following the Hurricane Sandy in 2012, Twitter saw a trend of climate change being portrayed as a government conspiracy. The Climategate incident in 2009, where scientists were accused of falsifying data and misleading the public, is another example of fake news spread through linguistic means. However, multiple studies conducted in England and the United States found no evidence of wrongdoing by the scientists.

Misinformation spread through language can harm our ecosystem, including its various species and habitats. As humans are considered migrants on this earth, it is our responsibility to preserve its original inhabitants. The language used by society has become polluted, similar to the air, water, and food we consume, and lacks the liveliness and humanity it once had. According to Gross (1969), language acts as the nervous system of society, and its pollution can harm the entire ecosystem.

Language distortion can create confusion and problems for humans and the environment. Medimorec and Pennycook (2015) discussed how language distortion, particularly through techniques such as modality, call for expert authority, quantifiers, hedges, and presuppositions, can be used to manipulate the language and harm the ecosystem. The study of the impact of language on the ecosystem is known as ecolinguistics, and is considered a central field in terms of the scale and significance of the debate.

Theoretical Framework

The theoretical framework for this study is based on two complementary theories: fact construction theory by Potter (1996) and facticity model by Stibbe (2015). Fact construction theory suggests that facts are not objective entities that are discovered, but rather are constructed through discursive practices and social interactions. According to this theory, facts are produced and maintained through language use, and they are influenced by the social, cultural, and political contexts in which they are constructed.

Stibbe's (2015) facticity model builds on the concept of fact construction and focuses on how facts are evaluated for their truthfulness or facticity. The model proposes that facticity is not a fixed property of a statement or belief, but rather is a dynamic and context-dependent process that involves multiple criteria, such as coherence, relevance, plausibility, and evidence. The model also highlights the role of language and discourse in shaping facticity, as well as the importance of considering the social and cultural factors that influence the evaluation of facts.

Methodology of the Study

The study aimed to investigate the language used in climate change media coverage through a mixed-method approach that involved three distinct phases. In the first phase, the Baker (2006) model of concordance in corpus for model verbs was used to extract data on the frequency of modal verbs in climate change media language. The second phase involved analyzing the data using Stibbe's (2015) model of facticity to determine the degree of truth or factual accuracy of media language and its linguistic features. The data was collected from newspapers and news websites through purposive sampling from 2017 to 2021, focusing on seven countries each from the Eastern and Western worlds. A total of 210 articles were selected for analysis using Antconc

version 3.5.9 software. The study employed the concordance model to identify different linguistic characteristics, such as modal verbs, and Stibbe's facticity model to categorize the data into different levels of certainty. The aim was to provide insights into the linguistic features and facticity of media discourse on climate change in different regions.

Sampling of the Study

To collect data for the study, a non-probability sampling technique known as judgement sampling was used. The target population was articles related to climate change published in newspapers and news websites from 2017 to 2021. Relevant data was collected using specific keywords, including climate change, ecosystem, ecology, global warming, emission of greenhouse gases (GHG), carbon emission, deforestation, and species extinction. This approach allowed for a targeted data collection process from newspapers and news websites.

Data Analysis

Baker model of concordance analysed the frequencies extracted from the media discourse using AntConc software. Stibbe's (2015) facticity model was chosen as the most suitable approach for analyzing the collected data from the newspapers regarding climate change. This model was selected because it provides an evaluation of the text's reality with regards to climate change in the world. To tailor the model to the specific needs of this study, it employed only modal verbs used by Stibbe (2015). The 210 articles from the two worlds were then analyzed using the facticity model and classified into four categories: absolute truth, certain, uncertain, or absolute falsehood.

Limitation of the Study

The limitations of this study include the restriction to seven countries and three newspapers, the limitation to lexical categories (modal verbs) rather than grammatical categories, some technical issues with the Antconc software, and the restriction to articles on the environment and climate change. The study's focus is further limited to a five-year period, from 2017 to 2021, which was a crucial time for climate change awareness. The data is limited to media discourse on climate change, even though media discourse covers many different topics. The study's findings, therefore, may not provide a complete picture of the facticity of climate change in media language.

Literature Review

Multiple studies have been conducted to understand the problem of misinformation and distorted facts related to climate change in the media discourse. Cook (2019) in his article "Understanding and fighting misinformation about climate change" discussed the different types of misinformation such as refutation, inoculation, agnotology, fact-checking intervention, cherry-picking, logical fallacies, fake experts, and conspiracy theories.

Farrell (2019) conducted a study on the growth of climate change disinformation in U.S. philanthropy using natural language processing. The study found that the impact of fossil fuel funding continues to play an important role in spreading misinformation about climate change. It revealed that power and money are significant factors in manipulating the facts of scientific experiments. This suggests that there is a need to address the sources of funding for organizations that spread climate change disinformation in order to combat the issue.

Lewandowsky (2020) published an article on combating climate change mis/disinformation. The article lists various factors that could be used to stop climate change mis/disinformation, including

education, correction, inoculation, culturally appropriate messages, consensus messages, debunking, changing attitudes, and political objectivity. The author highlights that education is an important tool to combat climate change mis/disinformation. Correcting misinformation through fact-checking and providing scientifically accurate information can also be effective. Inoculation, which involves preemptively exposing people to small doses of misinformation to build their resistance to it, is another potential approach. Additionally, culturally appropriate and consensus messages that are tailored to the audience's values and beliefs can be used to combat climate change mis/disinformation.

Cacciatore (2021) conducted a study on misinformation and public opinion on science and health. The study suggests that misinformation can be stopped by using different approaches, such as warnings, evidence presentation, recency, primacy, extensive processing, and social monitoring. The author highlights that warnings can help reduce the impact of misinformation by signaling that the information is not trustworthy. Evidence presentation, such as providing scientific evidence to refute misinformation, can also be an effective approach. The timing of the information can also be important, with recent information being more persuasive than older information. Additionally, primacy effects can be utilized by providing accurate information before the misinformation is encountered. The study suggests that extensive processing, such as providing detailed explanations and additional information, can help combat misinformation. Lastly, social monitoring can be used to identify and respond to misinformation on social media platforms. These findings highlight the need for more research and education to tackle the problem of misinformation related to climate change in the media discourse.

Fact Construction Theory

Potter (1996) in "Representing Reality" argues that there is no clear line between fact and fiction and that the same resources used to create fiction can also be used to create truth. He examines theories that aid in the construction of reality, including social study of science and ethnomethodology, as well as semiology, post-structuralism, and postmodernism. These approaches challenge the assumption that language mirrors reality and emphasize the importance of considering larger forces in the creation of facts.

Facticity Model

Stibbe (2015) introduced the facticity model which is a concept in the field of linguistics. The facticity model aims to understand how text (written, spoken or visual) influences readers' beliefs or mental narratives about the depictions of reality. The model evaluates the facticity of world descriptions on a scale from absolute truth to extreme lies, with a variety of ambiguity levels in between. It shows how texts supply claims and depict them as true, inaccurate, certain, or uncertain, and have the power to shape people's perceptions of reality. The model is based on Mori's (2014) study of climate change and its findings which showed that respondents in different countries based their opinions on the books they had read rather than actual temperature data or ice core samples.

A study by Mori (2014) looked at global opinions on climate change and its cause. According to the results, 93% of Chinese respondents believed that human activity was primarily responsible for climate change, compared to 64% in the UK and only 54% in the US. The majority of respondents based their opinions on texts they had read, rather than actual data or observations. Texts, in various forms, have the power to shape people's beliefs about reality, from absolute truth

to extreme lies, with levels of ambiguity in between. This highlights the impact of written and spoken language on shaping public opinions on important issues like climate change.

Data Analysis

This section provides a comprehensive analysis of data collected from both Western and Eastern media articles, specifically focused on the topic of climate change.

Comparison of Modal Verbs in Eastern and Western Data

The study compared the usage of modal verbs in the media discourse related to climate change in the Eastern and Western worlds. The results of the analysis showed that the frequency of primary verbs was higher in the Western world as compared to the Eastern world. The table 1 provided in the study indicates that the Western media used 9544 primary verbs while the Eastern media used only 5587 primary verbs.

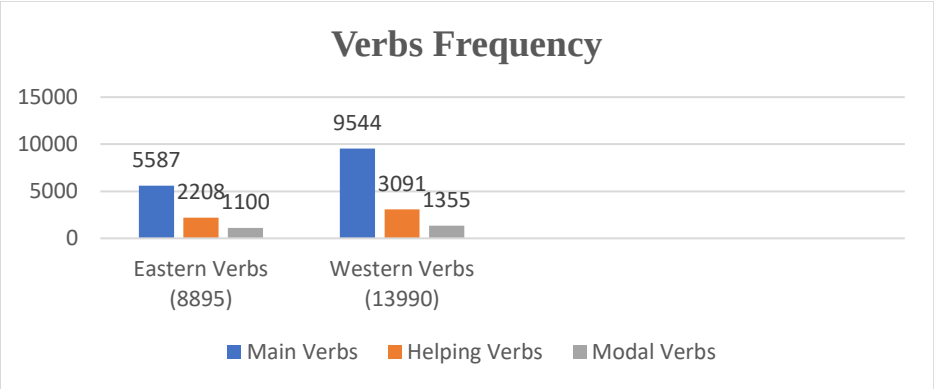
Table: 1

Frequency of Modal Verbs between Eastern and Western world

Verb	**Eastern Data Freq 8895**	**Western Data Freq 13990**
Modal Verb	1100 N= 12.36	1355 N= 9.68

This table provides a frequency of modal verbs used in articles from both Eastern and Western sources. The first column lists the verb category, with "Modal Verb" being the specific type of verb analyzed. The second column displays the frequency of modal verbs used in articles from Eastern media discourse, with a total number of 1100 modal verbs with a net percentage (N) of 12.36. The third column lists the frequency of modal verbs used in articles from Western sources, with a total number of net percentage (N) of 9.68 with 1355 modal verbs. From this table, we can see that the total frequency of modal verbs used in Eastern articles are 8895 while 13990 modal verbs in the western media data. The eastern percentage is higher than the Western articles. However, the data collected for the study was higher in western discourse than the eastern discourse.

Figure1: *Verbs Frequency in Eastern and Western World*



Verbs are crucial components of sentences as they provide the necessary action or description. Figure 1 displays the total frequency of verbs in the corpuses from the Eastern and Western worlds. The graph illustrates a clear breakdown of the verb types, including main verbs, helping verbs, and modal verbs, with a particular focus on the latter. The Eastern dataset contains 8,895 words, while the Western data comprises 13,990 words. Modal verbs are significant in both datasets and play a crucial role in determining the facticity of media language related to climate change.

Facticity Measurement Index

Stibbe (2015), who is an expert in ecological linguistics, introduces a model of facticity in his book titled "Ecolinguistics: Language, Ecology, and the Stories We Live By". This model is particularly useful for analyzing the linguistic features employed in articles that range from expressing absolute truth to conveying absolute falsehood, with different degrees of certainty and uncertainty in between.

Figure 2: Measurement Index for Facticity Model

Absolute truth Certain Uncertain Absolute Falsehood

The facticity model includes four criteria for categorizing statements as absolute truth, certain, uncertain, or absolute falsehood.

Therefore, the modal verbs are placed among the four principles of Stibbe (2015) facticity modal as follows:

Modal Verb: These are examples of modal verbs categorized based on their facticity level:

Absolute truth: shall, must, have to, ought to

Certain: will, can, could, would, should

Uncertain: may, might

The Construction of Facticity through Modal Verbs

Verbs play a critical role in determining the facticity of media discourse, and the facticity measurement scale provides an important tool to assess this. Stibbe (2016) has identified five

linguistic devices to evaluate facticity, while in this study, the focus was on using lexical categories to analyze data and determine facticity. Modal verbs were of particular interest, and the table below displays their frequency in both Eastern and Western media discourse related to climate change. The results indicate that "will, can, would, and could" are the most frequently used modal verbs, with "will" appearing 412 times in Eastern data and 453 times in Western data. The usage of "can" showed a significant variation, with just 187 occurrences in Eastern media compared to 307 in Western media.

Table: 2

Comparison of modal verb between Eastern and western Data

Eastern Media

Modal Verbs	Frequency in Eastern Corpus
1. Will	412
2. Can	187
3. May	62
4. Must	60
5. Shall	0
6. Would	157
7. Should	99
8. Could	111
9. Might	25
10. Ought to	1

Western Media

Modal Verbs	Frequency in western Corpus
1. Will	453
2. Can	307
3. May	97
4. Must	39
5. Shall	1
6. Would	198
7. Should	73
8. Could	191
9. Might	30
10. Ought to	0

Comparison of Mean Facticity Scale

Table 3 shows a comparison of the facticity of data from Eastern and Western articles. The Eastern articles have a higher facticity scale compared to Western articles. The mean of Eastern data in the absolute truth category is 1.84% which is higher than the Western data with a mean of 1.59%. Eastern media also shows lower levels of uncertainty with a mean of 3.85% compared to Western

media's 4.45%. This indicates that Eastern media has a higher level of certainty in their data compared to Western media.

Table: 3

Comparison of Mean Modal Verb Frequencies in Eastern and Western Media Discourse

Facticity Scale	Modal Verb	Eastern Data	Western Data
Absolute Truth	shall, must, have to, ought to	1.84%	1.59%
Certain	will, can, could, would, should	17.14%	17.3%
Uncertain	may, might	3.85%	4.45%

Table 3 shows that the eastern media has a higher level of certainty in their reporting on climate change compared to the western media. The eastern media has a mean facticity of 1.84% in absolute truth, while the western media has a mean of 1.59%. The eastern media also has a lower mean of uncertainty, with a facticity of 3.85% compared to the western media's 4.45%. However, both worlds have a similar level of certainty, with a mean facticity of 17.14% and 17.3% respectively. Despite the larger number of publications and scientific research in the western world, the presence of fake news and corporate influence has created doubts in the minds of the people.

Examples of Eastern Media Modal Verbs

In the following examples, I have provided instances of modal verbs used in the corpus of Eastern media, with only one example selected from each facticity scale. These examples have been taken from the data that contains modal verbs.

*We have already changed our planet, and some of those changes we will **have to** live with for centuries and millennia to come, said IPCC co-author Joeri Rogelj, a climate scientist at Imperial College London.* (Absolute Truth)

The sentence analyzed from the Eastern media corpus demonstrates the use of robust helping verbs and "ed-verbs" in conjunction with a potent modal verb, which indicates the absolute truth of the statement. This example is just one instance of numerous such cases found in the Eastern media corpus, highlighting its high facticity scale due to the frequent use of strong modal verbs.

*...he expects China **will** achieve the goal even ahead of the date.* (Certain)

On the facticity scale, this example from eastern media is categorized as certain because the writer employs the weak modal verb 'will,' which indicates a lower level of truth. As a result, the sentence is considered certain rather than absolute truth.

*But the motives **may** be less important than the implications.* (Uncertain)

In this sentence, the writer employs the modal verb "may," which is associated with low facticity as it expresses uncertainty. When the speaker or writer is not certain about a fact, they use the "may" modal verb. However, in the eastern media data, writers tend to use modal verbs that are less weak, resulting in higher facticity in the text.

*This **might** appear to be a minor quibble over semantics, but a large amount of evidence is required to force such a shift.* (Uncertain)

The usage of the modal verb 'might' in the sentence demonstrates low facticity in the media text. The writer employs the passive voice in the second part of the sentence, further adding to the uncertainty. These instances highlight the writer's skill and versatility in choosing appropriate words to shape the text's facticity level. It is the writer's discretion to create a work of either absolute truth or absolute falsehood, as they possess the necessary knowledge and capability.

Examples of Modal Verb from the Western Media

*We **have to** bring as many voices as possible to the table to talk about climate change: to practice what we call inclusive multilateralism.* (Absolute Truth)

The sentence is made absolute truth by the use of a strong modal verb, and further reinforced by the to-infinitive verb "to practise" and the base verb "call." The analysis of modal verb usage shows that the eastern media corpus has a higher degree of facticity than the western media corpus.

*We **will** not fight climate change with a virus.* (Certain)

In this example, the sentence includes the modal verb 'will,' which expresses the possibility of an action, making it less certain on the facticity scale. To increase the level of facticity in this sentence, the writer could replace 'will' with 'have to' or 'must.' This reflects a common trend in the eastern media corpus, where weaker modal verbs are often used, resulting in lower facticity levels compared to the western media corpus.

*The study **might** offer incentive for policy makers to pursue reforestation.* (Uncertain)

The writer's use of 'might' as a modal verb decreases the facticity of the sentence and introduces uncertainty for the reader. Even though the writer also uses the strong verb 'to pursue,' the weak modal verb obscures the strength of the verb and ultimately decreases the overall facticity of the sentence.

*…which means the developed world **may** actually meet its original target in three years' time.* (Uncertain)

The writer of this sentence employs the modal verb 'may' to introduce uncertainty in the minds of those who prioritize environmental concerns. The use of 'may' leaves them unsure about whether the goal of reducing carbon emissions will be met within the set timeframe of three years. Despite the target being set by developed countries, the writer's choice of 'may' serves to reduce the facticity of the sentence, thereby undermining people's trust in the matter.

Result of the Study

The results of the facticity model developed by Stibbe (2015) are noteworthy. The average score for the first principle, "absolute truth," shows that Eastern media data is more factual with a score of 1.84%-1.59% compared to Western media data. The second principle, "certain," also indicates a higher facticity score for Eastern data with a score of 17.14%-17.3% compared to Western data. However, the third principle, "uncertain," reveals a lower facticity score for Eastern data with a mean score of 3.85%-4.45% compared to Western data, suggesting more uncertainty in the writing of Eastern writers. The fourth principle, "absolute falsehood," has no data to score as there are no

modal verbs that can suggest absolute falsehood in the data. Overall, Eastern media data has a higher facticity score compared to Western media data.

Discussion

The facticity model, which categorizes language as absolute truth, certain, uncertain, or absolute falsehood, has been applied to media discourse through an analysis of lexical categories. While Stibbe (2015)'s book "Ecolinguistics, Language, Ecology, and the Stories We Live By" introduces five linguistic devices for checking facticity, including modality, adverbs, and quantities, it lacks a framework for analyzing lexical categories. Therefore, rules were established for investigating the facticity of media language using modal verbs, which are a particularly dynamic type of verb. While Stibbe briefly touches on the use of verbs, he does not provide explicit explanations beyond modal verbs. Similarly, while Richardson categorizes modal verbs by level of commitment, no guidance is provided for placing them within the four principles of facticity. In this study, eleven modal verbs were categorized into three principles of facticity: absolute truth, certain, and uncertain, with a higher frequency of use in western data compared to eastern data.

Recommendations

The emergence of climate change and global warming as critical issues in ecolinguistics has led to a need for researchers to explore the usage of adjectives and establish a reliable scale of facticity measurement. Further research is necessary to refine the modal verb scale and explore other areas of the facticity model, including expert opinion and stake. To better understand the impact of less factual text on humans and other species, researchers should examine the text of the Paris Agreement and UN protocol on climate change, as well as the speeches of political leaders at international organizations. The facticity model provides a tool for measuring the accuracy of any text based on linguistic features such as lexical categories, opening up new avenues for research.

Conclusion

In conclusion, the results of the facticity model developed by Stibbe (2015) indicate that Eastern media data has a higher facticity score compared to Western media data. The first principle, "absolute truth," shows Eastern media data to be more factual, while the second principle, "likely truth," confirms the same. However, the third principle, "uncertain," reveals more uncertainty in the writing of Eastern writers compared to Western writers. The fourth principle, "absolute falsehood," has no data to score. The overall results suggest that Eastern media data is more factual than Western media data.

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Modeling Imapct of Climate Change on Wheat Yield Under Different Agro-Climatic Zones in Pakistan

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Shakeel Ahmad[****]

Abstract

In Pakistan, a valuable reduction of wheat yield would cause a widespread impact on food security. The key component behind the reduction of wheat yield was climate change like rise in temperature. The current century is viewed as being highly concerned with climate change. Due to climate change, wheat phenology and yield are highly affected. Understanding how long-term daily temperature variability affects the phenology of the main agricultural crop like wheat is critical to develop targeted adaptation strategies to near and future climate impacts. The supreme objective of carrying out the study was to use crop phenology and yield as a major factor to study the impact of a long-term temperature variability series (1980-2020) on wheat, at varying locations i.e., Islamabad (33.6701◦ N and 73.1261 ◦ E) and Chakwal (32.9328 ◦ N and Longitude 72.8630 ◦ E). To examine the long-term impact of temperature on wheat phenology wheat yield data, the minimum (Tmin) and maximum (Tmax) daily temperature for Chakwal and Islamabad, from 1980 to 2020 were used. The cardinal temperature concept was used to consider the maximum, minimum and optimum temperature of wheat crop which was afterwards used to calculate seasonal growing degree days (GDD). The findings of the analysis demonstrated that the decline in wheat yield is correlated with an increase in the number of days during the maturity stage when the temperature is over 35 °C (April). Depletion of groundwater and a reduction in surface water for irrigation during the wheat growing season were caused by a reduction in monsoon rainfall (November–April). The decline in yield also seems to be impacted by higher temperatures.

Keywords: Wheat yield, Wheat Phenology, Climate Change, Growing Degree Days

Introduction

In recent years, climate change and its impact on the environment is one of the main concerns facing societies globally. There are many reasons behind this gap but the emerging and rising issue is climate change i.e., increase in temperature, changing rainfall patterns, higher extent and severity of droughts (Mukhtar, Aslam, & Ma, 2012). Sudden temperature increases have a direct impact on production, but rapid increases and decreases in rainfall patterns at crucial phases (flowering and maturity). Throughout the growth season, a 1°C increase in the average wheat temperature will result in a 6% reduction in wheat output (Asseng et al., 2015). The production and phenology of the wheat crop have been directly impacted by the recent global rise in temperature. Climate change is causing a shift in crop phenology around the world(Ahmad et al., 2017; Walther et al., 2002). A warmer environment influences crop productivity and enhances

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crop phenology (Fatima et al., 2020). Due to warming Craufurd and Wheeler (2009) reported earlier flowering and crop maturity under warming temperature conditions. Due to warming resulted in a shrinking of growing season, promoted leaf aging/senescence and reductions in biomass and yield (Figueiredo et al., 2015; Liu et al., 2018).

Wheat (*Triticum Aestivum L.*) is a rabi season crop sown in October–December and harvested from April-May. It is cultivated over 22 million acres and accounts for 7.8 percent of the value added in agriculture and 1.8 percent of GDP (Economic survey of Pakistan, 2022). At rainfed regions of Pakistan wheat has been cultivated at the start of the winter season or when temperature is lowered to fulfill the chilling requirement of the crop. Wheat is cultivated over 98 acres in irrigated and 40186 acres in un irrigated area in Rawalpindi division (Crop reporting service, Punjab). Wheat crop comprise of more than 20 % of calories and protein in human nutrition (Shiferaw et al., 2013; Curtis and Halford, 2014). Wheat demand increased during the last decade due to increase in population size from 2010 to 2020 (Aslam, Ahmed, Stöckle, & Higgins, 2017).

The final yield may be reduced by this high temperature, and global warming is increasing the likelihood of high temperatures (Dias & Lidon, 2009)(Modarresi, Mohammadi, Zali, & Mardi, 2010). For wheat during anthesis and grain filling, the ideal temperature range is between 12 and 22 C. Pre- and post-anthesis wheat exposure to temperatures above 30 C causes a drop in the grain filling rate, which in turn lowers grain production and quality (Barnabás, Jäger, & Fehér, 2008). Many study depicted that high temperatures (above 30 degrees Celsius) during anthesis are harmful, but brief exposure to extremely high temperatures (above 35 ◦C) during anthesis and grain filling can significantly reduce grain production in wheat (Randall & Moss, 1990). Hussain and Mudasser (2007) conducted an experiment in the rainfed area of Pakistan to investigate the effect of high temperature on growing season length. They reported that a 1.5 ◦C increase in temperature shortened the crop life cycle and lowered grain yield by 7%. However, a temperature increase of 3 ◦C reduced wheat yield by 24%.

Based upon above scenario it is now well documented that climate change is showing great impact on crop yield. Hence present study was conduction with the objectives of quantification of impact of rise in temperature on phenology and yield of wheat crop. The possible outcomes are expected to be important for informing management practices that can maintain normal wheat production with increased stress from a changing climate.

Materials and Methods

Study Sites

The study was carried out at two varying sites of rainfed region of Pakistan i.e., Islamabad (33.6701◦ N and 73.1261 ◦ E) and Chakwal (32.9328 ◦ N and Longitude 72.8630 ◦ E). Wheat is vastly growing crop around the Pakistan mostly at the rainfed regions of the Pakistan. The both sites classified as semi-arid Pothohar regions of Pakistan having annual rainfall 250-750 mm. Wheat is the staple crop and it ensures food security of the country. However, production of wheat crop in this region has been threatened due to extreme climatic events such as rise in temperature. The texture of soils at NARC Islamabad and URF-Koont Chakwal were loam and sandy clay loam respectively.

Wheat yield data

The long-term wheat yield for both locations during 1980-2020 was obtained from the Economic survey of Pakistan, FAOSTAT, Agriculture Marketing Information System (AMIS), previous published articles and thesis. A linear relation between wheat yield and GDD was calculated for both locations.

Climate data

Daily Temperature Data

Daily temperature maximum and minimum data was collected from Pakistan Metrological Department (PMD) from 1980-2020 during the wheat growing season for both locations.

Precipitation

Daily average precipitation data from 1980 to 2020 was collected from the Pakistan Metrological Department (PMD).

Growing Degree Days

Cardinal temperature concept was used to consider maximum, minimum and optimum temperature of wheat crop which was afterwards used to calculate seasonal GDD. Wheat sowing time vary in different regions of Pakistan, so GDD was calculated from 15 October to 30 April to obtain total heat units from sowing to harvest. The wheat growing season in Pakistan is approximately 196 days (from 15 October to 30 April of the next year). The maximum temperature greater than 35 ◦C shall not be considered for calculation of GDD by Applying limits. Following equation (1) was used to calculate GDD by using 4 ◦C as a base temperature:

$$GDD = \frac{(T_{max}+T_{min})}{2} - T_{base} \qquad (1)$$

Where,

Tmax = Daily maximum Temperature (◦C)

Tmin = = Daily minimum Temperature (◦C)

Tb = Base Temperature (4◦C)

Results and Discussions

Long-term data Trend

Long term data shows that seasonal mean temperature of wheat in Chakwal has been increased from 19 to 20, while in Islamabad it has been increased from 17.6 to 19.6 respectively. Long term data analysis showed that wheat crop seasonal temperature has been increased by 1% at Chakwal during the wheat growing season 2021-22, while at Islamabad it has been increased by 2%. Variability in rainfall is also visible in long term data and it has been decreased by 39% at Chakwal while 30% at Islamabad.

Wheat Yield Variation

Wheat yield across the Pakistan region has enhanced almost respectively from 1980–2020, as show in Figure 1, due to adoption of latest technologies. However, there seems to be an inter-decadal variability embedded in this long-term increase. By removing the linear trend of wheat yield, the detrended pattern shows a marked decline followed by a prolonged pause during 2006–2016, as shown. This reduction in wheat grain yield reflects a reduction of about 500–300 kg/ha. Since little

to no drastic change in management practices or cultivation practices could last for this long duration (almost ten years), environmental conditions such as climate change could play a key role in producing such a negative impact on wheat yield.

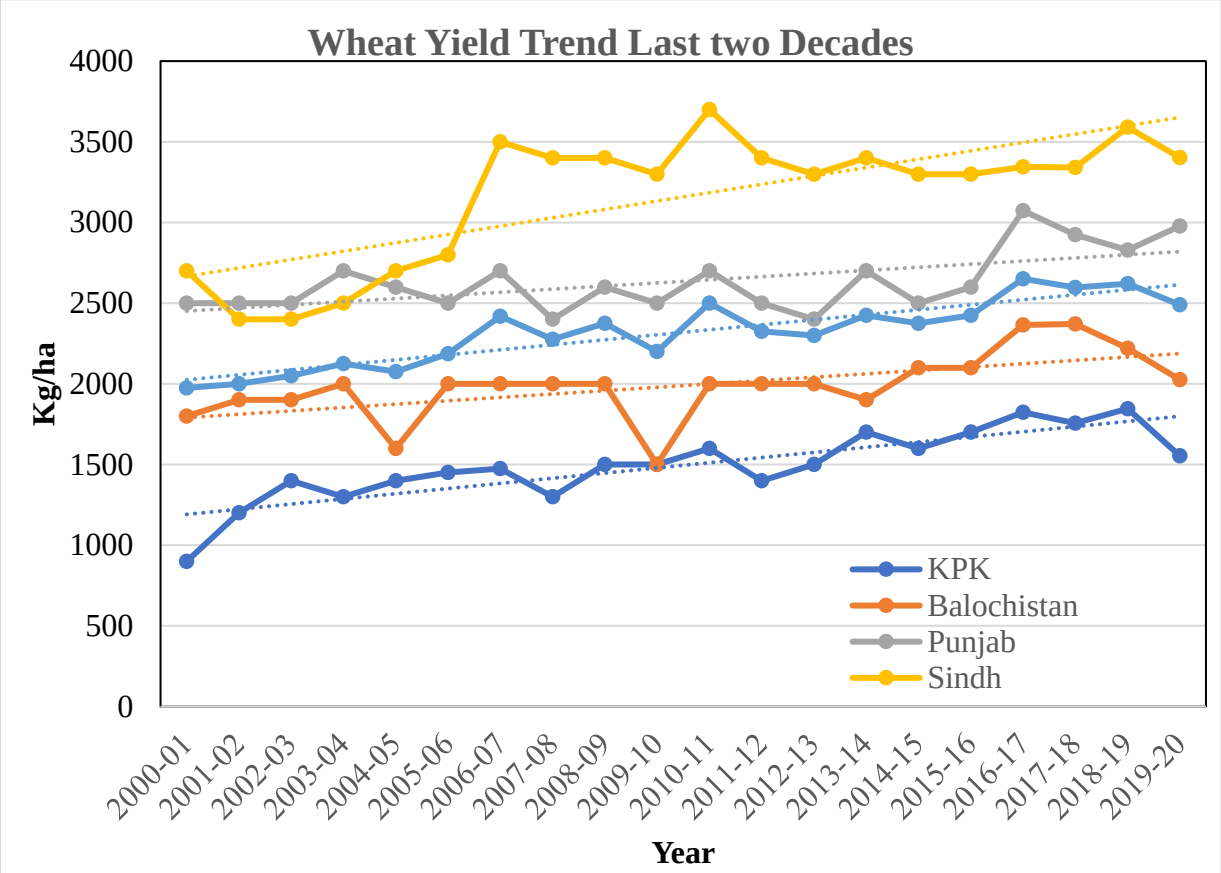

Figure 1: Wheat Yield Trend Last Two Decades

Temperature

Temperature directly impacted on wheat crop yield depicted by GDD and the frequency of extreme temperatures above 35 °C during the wheat growing period. Figure shows normalized GDD timeseries and indicates a general high-GDD period during 2006–2018. A high-GDD environment can either decrease the days to flowering as well as days to maturity, or directly harm crop growth when the temperature rise above the critical threshold. A high GDD promote the early maturity which directly impacted on wheat growth and yield. The temperature above the 35 °C thresholds negatively impacted during the grain filling and physiological maturity. Wheat crop during the recent last two decades expressed to temperatures above thresholds 34 °C after the anthesis phase has a significantly less yield due to promoted senescence, decreased rate and duration of grain filling, and reduction in grain weight. By quantifying the number of days with temperatures above the thresholds 35 °C in March, at the flowering and maturity, we found that the frequency of extreme stress (above 35 ◦C) conditions during flowering and maturity stages can cause significant yield reduction.

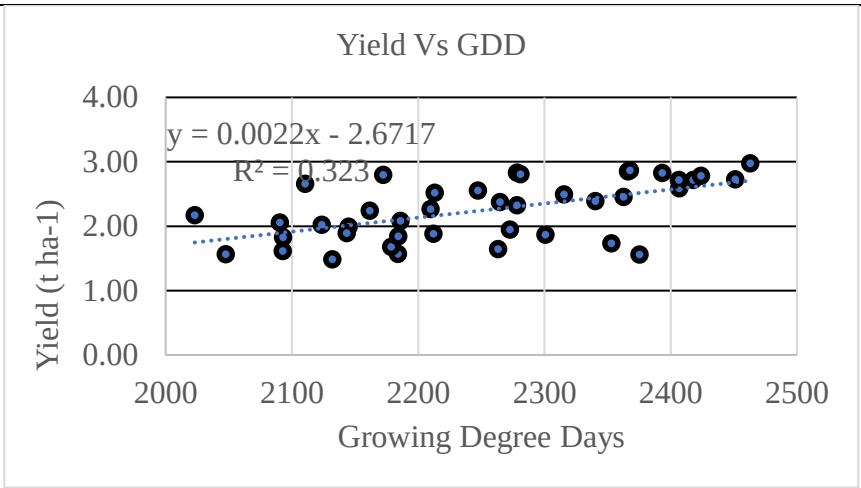

Figure 2: Yield Vs GDD (Islamabad)

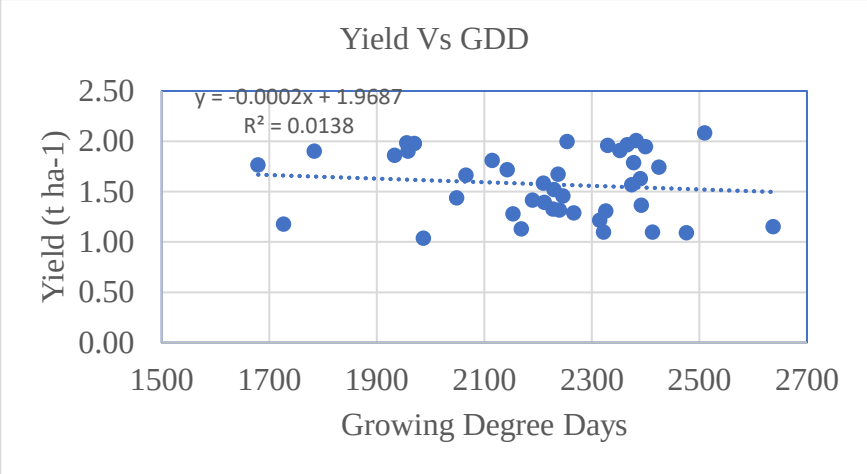

Figure 3: Yield Vs GDD (Chakwal)

Conclusions

The agro-climatological factors linked with the pronounced wheat yield reduction during 2006–2016 over northwest Pakistan were examined in this conducted study. By keeping eyes on the two-wheat growing rainfed regions of Pakistan, Chakwal and Islamabad, our analysis shows that the yield loss is directly linked to climate change. More than 30 % variability trends of rainfall, and the rise of average wheat season temperature were found during the 2006–2020 period, and these variations combined contributed to a negative impact on wheat yield. Frequently, the rise in frequency of days with extreme temperatures above 35 ◦C thresholds during the flowering and maturity stage has significant factors affecting grain sterility and seed weight. Only adoptive measure to overcome this issue is maintain wheat yield under climate change in the Pothohar region, such as accurate prediction of phenology can help to improve management operation in the field and early, medium and late maturing cultivars can be selected based on crop phenological.

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Policy Dialogue Session

Session Chair: Dr. Ishtiaq Ahmed, Professor Emeritus, Stockholm University Sweden

Co-Chair: Prof. Dr. Khalid Manzoor Butt, Dean, Faculty of Humanities and Social Sciences

Moderator: Dr. M. Usman Askari, Assistant Professor/Secretary Conference

Participants: Attendance enclosed

Date: 16 March, 2023

Time: 16:30-18:30 hours

Venue: Conference Hall, UCP

At the end of two days conference, the Policy Dialogue was held which chaired by Dr Ishtiaq Ahmed and attended by experts of climate change, practitioners, academicians and representatives of civil society. In the opening remarks, the Chair welcomed the participants and congratulated the organizers on arranging a timely and quality conference in which foreign and Pakistani academics and researchers took part. During the discussion, the participants talked about numerous efforts and solutions for addressing the problems caused by climate change such as tree plantation, sustainable development, renewable energy, carbon-neutral measures and international cooperation. The Policy Dialogue provided a forum for fruitful discussion and exchange of knowledge. It was expected to have effective and meaningful climate change policy responses. During the discussion, the participants came up with their perceptions and knowledge about climate change;

Dr. Bilveer Sing, Associate Professor of National University of Singapore raised some thought-provoking questions regarding Plan of Action to tackle with the emerging catastrophe of climate change. His main proposals were the following:

- Since we know the issues of pre, actual and post crisis, how do we move forward?
- How do we send this message to the policymakers and urge them to comply?
- We need policies to implement regarding climate change.
- What strategies and techniques can we develop to assist people who are going to be affected by climate change?
- Is there any action research?

Ambassador (R) Nadeem Riyaz, President Institute of Regional Studies (IRS), Islamabad **suggested** that both public and private sectors need to work hand in hand. Government cannot tackle this problem alone. Awareness needs to be spread at mass level among people to cope with this issue. His points were revolving arounds:

- The time for action is now.
- Research needs to be done in our country.
- Design small environment friendly initiatives.
- Public-private partnership is required.
- Civil society needs to be included in discussions and actions.
- Run public-awareness campaigns and educate the people.
- Changing the attitudes of people is necessary.
- All sections of the society have to be included and mobilized.

Ms. Aisha Khan, Head of the Civil Society Coalition for Climate Change presented global, regional and national perspectives on climate change and crux of her speech was that Pakistan should demand Climate Justice. She highlighted the following points;

- South Asia is a climate change hotspot.
- At national and provincial levels, there should be timelines for the implementation of frameworks
- South Asia needs to supplement climate change with adequate governance structures.
- Collaboration among group of G77 countries.
- Elect people who worry about their national safety in climate perspective.
- We need an implementation framework for the policies.
- Capacity to implement is the core issue along with lack of transparency in Pakistan.
- Demand should come from the people to make that shift.

Dr. Khalid Manzoor Butt, Dean FHSS, UCP presented Case of Lahore with reference to impact of population explosion on climate change and highlighted the existing reality leading to scarcity of food, basic needs and facilities. He suggested the following to deal with climate change:

- Preventive measures.
- Regulative measures.
- Rehabilitative measures.
- Preservation of resources.
- Interdisciplinary Research.
- Personal level effects should be encouraged.
- There has been a big rise in population, so we should start from personal and family level to have appropriate family size.
- Policy to stop converting agricultural land into urban installations.
- For food security, a comprehensive mechanism should be developed.
- Empowering local governments.
- One man one tree policy should be adopted.

Dr. Butt stated that a city which is meant for 2 million people, how can it accommodate and facilitate 15 million people. So, this population explosion has resulted in massive urbanization, construction, unplanned industrialization, unmanageable traffic, noise, and shortage of water, electricity, gas, and other civic facilities. Consequently, these things have placed Lahore at the top of Air Pollution Index (API), so its people have been paying the price by having different physical, psychological, security, and economic issues.

Concluding the discussion, Dr Ishtiaq Ahmed (Session Chair) shared that Pakistan should have cordial relations with neighboring countries and focus on social development. There should be female participation in all spheres of life and gender equality should be ensured. At least, the recommendations should be sent to policymakers and relevant stakeholders so they can get benefits from the findings of this conference in order to make meaningful policy. During the discussion, divergent responses from the participants were received. Various problems were also highlighted and their solutions were suggested. The following recommendations are made with consensus:

- Consistent tree plantation campaigns at all levels should be undertaken.
- Deforestation should be banned.
- Pakistan should demand climate justice.
- Government should work on Carbon-neutral measures.
- People should be held accountable for Eco-Terrorism.
- Need for gender inclusivity in climate change discourse and policy.
- The Individuals should play a role in terms of population explosion, leading to rural-urban migration and generating pollution of all kinds.
- There should be intensive Climate change research.
- Focus should be on regional cooperation for environment-oriented rather than a traditional military competition among states.
- Empowering women to effectively combat the climate challenge and population explosion.
- Courses on climate change should be started.
- Empowerment of local governments to improve resilience. Local bodies empowerment should support and supplement national efforts.
- Efforts should be made for peace in the region. And investment should be made in social development and saving the environment.
- Population control should be made a priority.
- Circular economy model should be introduced based on recycling and reusing.
- Encouragement of renewable energy resources instead of non-renewable.
- Science-society dialogue should be held regularly.
- Fasten the role of the diaspora to influence and change perceptions regarding climate change
- Investments in human capital should be increased.

Summing up the session, the Chair appreciated valuable input and deliberations from the participants. He also thanked and congratulated Dr. Khalid Manzoor Butt, Conference Chair and his team on arranging this important conference successfully.

At the end a vote of thanks was passed for the chair.

Following were present in Policy Dialogue Session:

1. Prof. Dr. Ishtiaq Ahmed
2. Ambessodor (R) Nadeem Riyaz
3. Prof. Dr. Khalid Manzoor Butt
4. Dr. Bilveer Singh
5. Ms. Aisha Khan
6. Prof. Dr. Shazia Hasan
7. Dr. Waheed Ahmed Khan
8. Dr. Arslan Tariq
9. Dr. Ilyas Ansari
10. Dr. Usman Askari
11. Dr. Sadia Rafique
12. Dr. Qaiser Khalid Mahmood
13. Miss Mubeen Ashraf
14. Dr. Abida Rafique
15. Miss Nimra Javed
16. Miss Nida Riaz
17. Miss Zaryab Fatima
18. Mr. Zohaib Altaf
19. Dr. Muhammad Ikram
20. Dr. Sawaira Rashid
21. Miss Zainab Bashir
22. Miss Syeda Ayesha
23. Miss Ayesha Nasim
24. Mr. Umer Shaoor
25. Mr. Muhammad Farooq
26. Mr. Ameer Hamza
27. Mr. Mominyar Khalid Butt
28. Mr. Sanwal Hussain Kharl
29. Mr. Hassan Arshad Gondal
30. Muhammad Mehran Iqbal
31. Miss Nida Shiekh
32. Mr. Adnan Khan
33. Mr. Kamil Shahzad Bakhsh
34. Miss Arfa Ghaffar
35. Mr. Riaz Ahmed Sial
36. Muhammad Ateeb
37. Mr. Amjad Rana
38. Mr. Ahmed Faraz

Concluding Session

CONFERENCE REPORT

Prof. Dr. Khalid Manzoor Butt
Dean, Faculty of Humanities and Social Sciences (FOHSS)
University of Central Punjab, Lahore, Pakistan

Mr. Kamran Lashari, DG Walled City Authority, Lahore, Ambassador Nadeem Riaz, delegated, Deans, Directors, Guests, and dear students Assalamu Alaikum and very warm welcome.

First of all, I extend my gratitude to Mr. Kamran Lashari. I always call him the beautifier of Lahore. Thanks for sparing your valuable time for the conference from his busy schedule. Though he is a bureaucrat yet he has put significant marks where ever he served like as Director of Punjab Horticulture Authority, DC Lahore, Chairman CDA, Secretary of Environment, and finally DG Walled City Authority, Government of Punjab. He is the most dynamic bureaucrat and to his credit, there are so many celebrated projects like Gawalmandi and Fort Rood food streets, and the presentation of Old City. In Islamabad, he made Monal restaurant, Saidpur village and finally he is Incharge of preserving Walled City, Dehli Gate, Masjid Wazeer Khan, and Lahore Fort.

Let me thank to His Excellency, Ambassador Nadeem Riyaz who is a career diplomat and has a huge interest and expertise in the environment. He has come all the way from Islamabad to attend the conference. I extend very warm welcome to him.

I am glad that the topic of the conference, we chose about three months back and today, it has been materialized. When we started deliberating on the topics of the conference, many topics came under discussion like Women's Rights, Governance, Justice, and local self-government, however, consensus emerged on climate change.

The purpose of the conference is, to collect opinions and experiences of different intellectuals, researchers, and experts on a challenging issue.

Pakistan is known as one of the most vulnerable countries regarding the effects of Climate Change. In recent devastating floods, 1/3 area of Pakistan and 5 million people have been affected, 35% of standing crops were ruined and other damages if counted, in terms of money are about 30 billion dollars. Many people died, were injured and became homeless in this calamity.

Just look at the phenomena of smog, high Air Quality Index (AQI), droughts, heatwaves, and excessive rainfalls and prolonged summer which have been causing so many healthy, psychological, economic, and social problems. These are just signals if we could foresee catastrophic changes taking place in the climate of our region.

In fact, a country like Pakistan does not have the sources and capacity to coop with such challenges so it would cause multiple effects. If we would not take preemptive measures then such kind of calamities are just beginning and we would face un-imaginative consequences in the future.

As far as the conference is concerned, we received more than 100 research papers from Pakistan and abroad and shortlisted about 40 papers. We had 8 academic sessions, which were chaired by Dr. Ishtiaq Ahmad a renowned scholar from Sweden, Dr. Bilveer Singh from National University, Singapore, Dr. Shazia Hasan Head Psychology department, Ms. Aisha Khan, environment expert and activist from Islamabad, Mr. Ahmad Rafay Alam prominent lawyer and expert on Climate Change, Ambassador Nadeem Riyaz, Mr. Ahmad Nazir Warriach Dean, Public Policy. Most of the session chairs and paper presenters took part in Policy Dialogue and came up with realistic suggestions for stakeholders. It was chaired by Dr. Ishtiaq Ahmad. We are glad that Secretary of Environment, Government of Punjab, Dr. Sajid Mahmood Chauhan also attended one of a session which shows that Government is serious about this problem.

Ladies & gentlemen, we have tried something new and environmentally friendly things, indeed it is symbolic. For example, we have prepared a few things, made with organic material and we have avoided the use of steel, plastic, and synthetic material. This time, we are giving souvenirs to our guests and paper presenters "living plants in clay pots" instead of souvenirs made with steel or plastic material which are of course not environment friendly. You will be pleased to know that we have specially prepared souvenir laptop bags, made with cotton and organic material remembrance.

I am grateful to Pro-Rector sb, and UCP Administration to extend their valuable support. I am thankful to the Conference organizing teams who worked very hard for this conference. I appreciate all leads of different committees and other team members for their sincere support and hard work.

I am thankful to all paper presenters, experts, academicians, guests and faculty members for their presence today.

In the end, I thank you all Ladies & gentlemen.

GUEST OF HONOR'S SPEECH

Ambassador Nadeem Riaz
President, Institute of Regional Studies, Islamabad

Dear Khalid Manzoor Butt, Honorable Chief Guest, Respected teachers and students, a very good evening.

The most important recommendation which we formulated in policy dialogue session is awareness, which is the most important thing – the change of lifestyle, and introspection. We all have to contribute, and do our best to save this planet. From what it is being subjected to, Crop rotation, climate-smart agriculture, population control, the nexus between the government and civil society to mitigate the harmful effects of climate change.

Issues of governance and accountability, regional cooperation, and most importantly, what you did today, and over the last two days, discussion, deliberation, talking about the subject, seeing the pitfalls, and finding the way forward. Because unless and until you don't deliberate, you don't gather the data. You don't analyze it. You cannot come up with concrete recommendations.

I am very thankful that the specialists and all the participents who spent their valuable time doing what they did best to talk about the challenges and to find a way forward. These recommendations will be formulated, chiseled and then forwarded to the concerned stakeholders and policymakers of Pakistan.

But the key message, which I think has to be delivered from this platform is that you are the future of the state. Our generation has done what it could best for you as the future architects of Pakistan. Running the country is in your hand. You can either make it shine in the community of nations, or you can continue what we have already. And I think you as young, intelligent, young men and women will make the right choice. You will take the reins in your own hands, you will find a path that is best for Pakistan, because there is no substitute to independence and there is no substitute to having your own motherland.

Thank you all.

CHIEF GUEST'S SPEECH

Mr. Kamran Lashari
Director General,
Walled City of Lahore Authority, Lahore, Pakistan

Respected Khalid Manzoor Butt, Ambassador Nadeem Riaz and dear participants, *Aslam o Alikum.*

Sometimes we get depressed about things, but certain good things also keep happening around you. And they keep giving you a kind of tonic or oxygen to keep going and going with some positivity. One of those things that I see is the culture of debate and discussion has taken place.

You see, we were getting sick and tired of these TV channels – the way they kind of infighting, you could see the level of a bizarre discussion. Even if you look at the politicians – who do not get a proper, authentic debate, logic, argument or discussion where issues are debated and discussed.

And then, that's where I say I see a ray of hope, recently in all cities of Pakistan, major cities at least and particularly Lahore, in the last one and a half months that the society of Lahore has risen out and entered into some very authentic literary debates. And I observe and see that the motto is, "let's say" – from agriculture to industry and from villages to the towns, cities, and that has changed the entire gamut of things.

We as a nation, have grown rich in materials, but our purposes and in a way, it is like sitting on a branch and cutting it all the time. That's what we are doing because this so-called progress is delusional in many ways, and it has a huge cost. We are eating away our agricultural land, we are consuming more than what we are producing. And we are bearing more children- Pakistan has more accelerated population rate in the world – seven to nine is the family size. Which is probably the largest in the world and then the largest number of children that are out of school are also in Pakistan.

And then I don't see any leader, any person even talking about the population as an issue and this is very strange. And in fact, many people portray that this is our strength, a strength that cannot be a product or a material, which is like let's say human resources. But if it cannot be used or put to productive use, it's a liability. So, till we become, let's say industrialized, or we become so much of our economic growth going at the level, maybe then later we can catch up with our population but look at countries who have been growing at a much higher pace around us. They have put a check on this. And that's how they have one reason why they have come from an underdeveloped country to develop like China, India, and to some extent even Bangladesh.

At last, I would like to say that one of the basic things or starting point of the whole discussion is that we need to bring this sensitivity among our people and that will lead to a solution in the end.

Thank you so much and so kind of you.

IC4R-2023

Dr. Nassar Ikram
(Pro-Rector, UCP)

Prof. Dr. Khalid Manzoor Butt
(Conference Chair)

Justice Jawad Hassan –
Judge of Lahore High Court
(Keynote Speaker)

IC4R-2023

His Excellency Mr. Jakob Linulf (Ambassador of Denmark to Pakistan)

Mr. Michael Rossman (Deputy Mission Director USAID)

Group photo of Keynote speaker, Session chair and and Guests of honour

IC4R-2023

Dr. Nassar Ikram presents souvenir to Justice Jawad Hassan (Keynote Speaker)

Dr. Nassar Ikram presents souvenir to Mr. Michael Rossman (Guest of Honor)

Dr. Nassar Ikram presents souvenir His Excellency Mr. Jakob Linulf

Guests are witnessing the poster/paintings exhibition

IC4R-2023

Guests

Syeda Ayesha Noor (Moderator)

Participants

Delegates

Campus tour

IC4R-2023

Dr Ishtiaq Ahmed (Session Chair) along with paper presenters of Session I-A

Prof. Dr. Bilveer Singh (Singapore)

Group photo of Session I-A with Dr. Khalid Manzoor Butt

Session I-B

Ambassdor Nadeem Riyaz (Session Chair)

Dr. Khalid presents souvenir to Ambassdor Nadeem Riyaz (Session Chair)

IC4R-2023

Dr. Bilveer Singh is chairing the Session II

Miss Javeria Qais is presenting the paper

Dr. Shazia presents souvenir to Dr. Bilveer Singh (Session Chair)

Rapporteur of Session III Miss Ayesha Kashif is conducting the session

Dr. Khalid presents souvenir to Mr. Rafay Alam (Session Chair)

Group photo of Session-III

IC4R-2023

Mr. Ahmed Nazir Warraich (Session Chair) along with paper presenters of Session IV-A

Mr. Ahmed Nazir Warraich (Dean, EDI, National School of Public Policy Lahore)

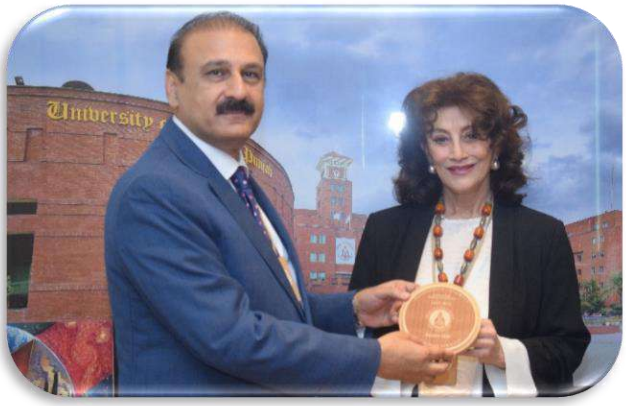
Mr. Sohail Ali Naqvi (Paper Presenter)

View of Audorium during Session IV-A

Dr. Khalid presents souvenir to Session Chair

IC4R-2023

Group photo of Session IV-B

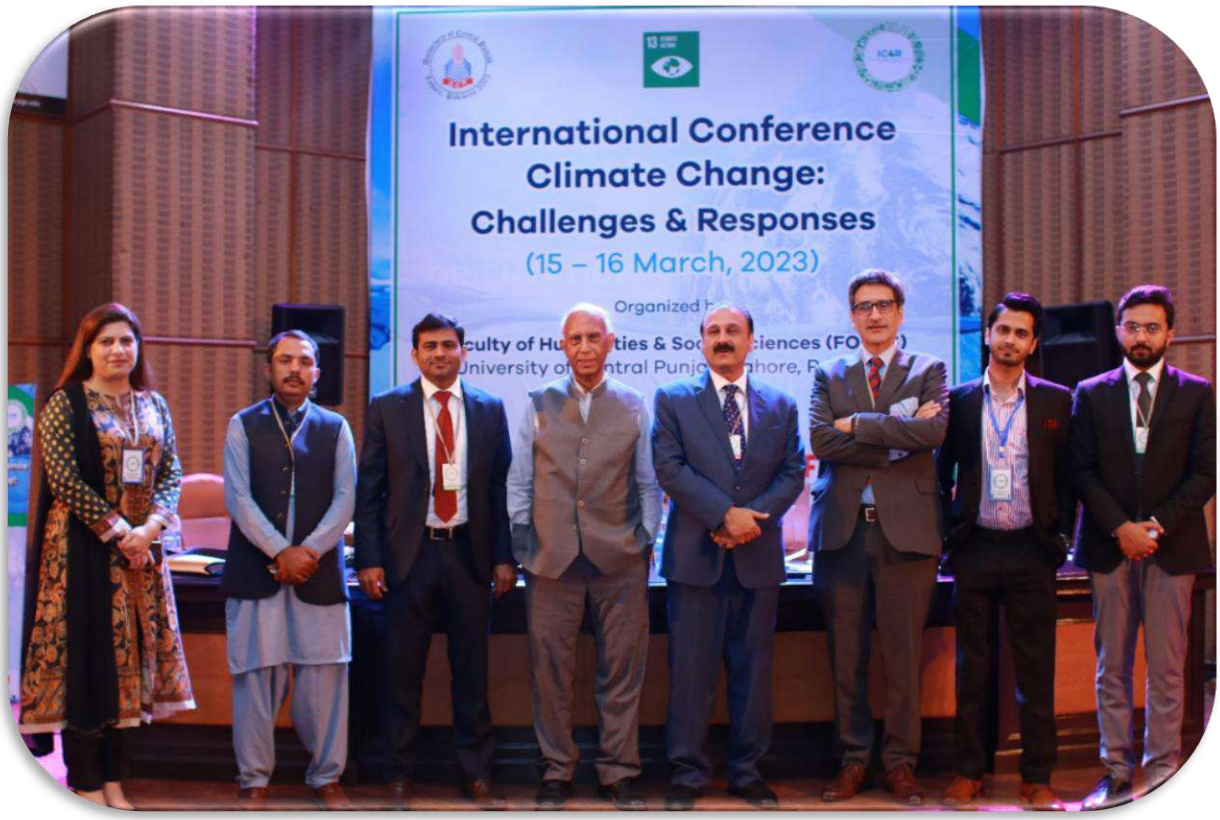


Dr. Khalid presents souvenir to Ms. Aisha Khan (Session Chair)

Ms Aisha Khan (Session Chair) addressing the participants

Dr. Khalid presents souvenir to Dr Sajid Chauhan (Secretary Environment, Punjab)

Dr Ishtiaq Ahmed (Session Chair) along with paper presenters of Session V



Group photo of Session V

IC4R-2023

Dr. Bilveer Singh (Session Chair) addressing the participants of Session VI

Group photo of Session VI

Participants of Session VII

Ahmad Faraz is presenting the paper in Session VI

Group photo of Session VII

IC4R-2023

Policy Dialogue Chaired by Dr. Ishtiaq Ahmed

Participants of Policy Dialogue Session

Dr. Khalid presenting his suggestions/recommendations

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Dr. Waheed (HOD Political Science & IR) presenting his remarks

Dr. Bilveer Singh presenting his views

Participants

Participants

Policy dialogue at Conferene Room

IC4R-2023

Prof. Dr. Khalid Manzoor Butt is presenting conference report in concluding session

Mr. Kamran Lashari (Chief Guest, Concluding Session)

Mr. Kamran Lashari (Chief Guest) is presenting sovouneir to Ambassdor Nadeem Riyaz (Guest of Honor)

IC4R-2023

Dr. Khalid presents living plant to Mr. Kamran Lashari

Zainab Bashir (Moderator)

Ambassdor Nadeem Riyaz (Guest of Honor) is presenting cerficate to Dr. Khalid (Chief Orgainzer)

Mr. Kamran Lashari presents certificate of apprecition to Dr. Ishtaiq Ahmed

Ambassdor Nadeem Riyaz (Guest of Honor) is presenting cerficate to Dr. Usman Askari (Secretary Conference)

Mr. Kamran Lashari presents certificate of apprecition to Dr. Bilveer Singh

IC4R-2023

Ambassdor Nadeem Riyaz is presenting cerficates to paper presenters

Group photo of organzing committee

IC4R-2023

Media Coverage

روزنامہ 92 نیوز لاہور، جمعرات، 16 مارچ 2023ء

یوسی پی میں عالمی ماحولیاتی کانفرنس کے موقع پر جیکب لینوف اور مائیکل رومین، جسٹس جواد حسن پروریکٹر ڈاکٹر نصرا کرام اور ڈاکٹر خالد منظور بٹ، ڈین فیکلٹی آف ہیومنٹیز اینڈ سوشل سائنسز سٹیج پر موجود ہیں

یوسی پی میں ماحولیاتی تبدیلیوں اور چیلنجز پر کانفرنس کا آغاز

تقریب میں جسٹس جواد حسن، مائیکل رومین، جیکب لینوف ودیگر کی شرکت

لاہور (پ ر) یونیورسٹی آف سنٹرل پنجاب (یوسی پی) کے زیر اہتمام ماحولیاتی تبدیلیوں چیلنجز اور رسپانسز پر دوروزہ انٹرنیشنل کانفرنس کا آغاز ہوگیا۔ افتتاحی تقریب میں لاہور ہائی کورٹ کے جج جسٹس جواد حسن، گیسٹ آف آنرز یو ایس ایڈ کے ڈپٹی مشن ڈائریکٹر مائیکل رومین، ڈنمارک کے سفیر جیکب لینوف، پروریکٹر یوسی پی ڈاکٹر نصرا کرام، ڈین فیکلٹی آف ہیومنٹیز اینڈ سوشل سائنسز اور کانفرنس کے سربراہ ڈاکٹر خالد منظور بٹ سمیت سویڈن، سنگاپور، بھارت اور دیگر ممالک سے سکالرز اور پریزینٹرز، یوسی پی کے اساتذہ اور طلبہ نے شرکت کی۔ لاہور ہائی کورٹ کے جج جسٹس جواد حسن کلیدی مقرر تھے۔ انہوں نے موسمیاتی تبدیلی کے شعبے میں اپنے تعاون کے بارے میں بتایا۔ مائیکل رومین اور جیکب لینوف نے اپنے خطاب میں ماحولیاتی تبدیلیوں اور اقدامات پر پاکستان اور اسکے اداروں کے کردار کو سراہا اور پاکستان کو ہر ممکن تعاون اور مدد کے عزم کا اظہار کیا۔ پہلے روز پروریکٹر ڈاکٹر نصرا کرام اور ڈاکٹر خالد منظور نے مہمانوں کو کانفرنس کے خصوصی سوونیئرز پیش کیے۔ کانفرنس آج بھی جاری رہے گی۔

نامہ جنگ لاہور (2) 16 مارچ 2023

یونیورسٹی آف سنٹرل پنجاب کے زیر اہتمام ماحولیاتی تبدیلیوں پر کانفرنس کا آغاز

لاہور (پ ر) یونیورسٹی آف سنٹرل پنجاب (یوسی پی) کے زیر اہتمام ماحولیاتی تبدیلیوں چیلنجز اور رسپانسز پر دو روزہ کانفرنس کا آغاز ہوگیا۔ کانفرنس کی افتتاحی تقریب میں لاہور ہائی کورٹ کے جج جسٹس جواد حسن، گیسٹ آف آنرز یوایس ایڈ کے ڈپٹی مشن ڈائرکٹر مائیکل رومین، ڈنمارک کے سفیر جیکب لینوف، پروریکٹر یوسی پی ڈاکٹر نصرا کرام، ڈین فیکلٹی آف ہیومنٹیز اینڈ سوشل سائنسز اور کانفرنس کے سربراہ ڈاکٹر خالد منظور بٹ سمیت سویڈن، سنگاپور، بھارت اور دیگر ممالک سے سکالرز اور پریزینٹرز، یوسی پی کے اساتذہ اور طلباوطالبات نے بڑی تعداد میں شرکت کی۔

روزنامہ ایکسپریس، لاہور، جمعرات، 16 مارچ 2023ء

یوسی پی میں دوروزہ عالمی ماحولیاتی کانفرنس کے موقع پر ڈنمارک کے سفیر جیکب لینوف اور یو ایس ایڈ کے ڈپٹی مشن ڈائریکٹر مائیکل رومین، جسٹس جواد حسن، پروریکٹر یوسی پی ڈاکٹر نصرا کرام اور ڈاکٹر خالد منظور بٹ، ڈین فیکلٹی آف ہیومنٹیز اینڈ سوشل سائنسز سٹیج پر موجود ہیں

یوسی پی میں ماحولیاتی تبدیلیوں اور چیلنجز پر عالمی کانفرنس

افتتاحی تقریب میں جسٹس جواد حسن، یوایس ایڈ کے مائیکل رومین ودیگر کی شرکت

لاہور (پ ر) یونیورسٹی آف سنٹرل پنجاب (یوسی پی) کے زیراہتمام ماحولیاتی تبدیلیوں چیلنجز اور رسپانسز پر دو روزہ انٹرنیشنل کانفرنس کا آغاز ہوگیا۔ کانفرنس کی افتتاحی تقریب یوسی پی آڈیٹوریم میں منعقد ہوئی جس میں لاہور ہائی کورٹ کے جج جسٹس جواد حسن، گیسٹ آف آنرز یوایس ایڈ کے ڈپٹی مشن ڈائرکٹر مائیکل رومین، ڈنمارک کے سفیر جیکب لینوف، پروریکٹر یوسی پی ڈاکٹر نصرا کرام، ڈین فیکلٹی آف ہیومنٹیز اینڈ سوشل سائنسز اور کانفرنس کے سربراہ ڈاکٹر خالد منظور بٹ سمیت سویڈن، سنگاپور، بھارت اور دیگر ممالک سے سکالرز اور پریزینٹرز، یوسی پی کے اساتذہ اور طلباوطالبات نے بڑی تعداد میں شرکت کی۔ لاہور ہائی کورٹ کے جج جسٹس جواد حسن کلیدی مقرر تھے۔ انہوں نے موسمیاتی تبدیلی کے شعبے میں اپنے تعاون کے بارے میں بتایا۔ انہوں نے لاہور میں سموگ اور آلودگی سے متعلق ایک اہم کیس کی صدارت کرتے ہوئے پنجاب حکومت کو ہوا کے معیار کو بہتر بنانے کے لیے ضروری اقدامات کرنے کی ہدایت کی۔ گیسٹ آف آنرز یوایس ایڈ کے ڈپٹی مشن ڈائرکٹر مائیکل رومین اور ڈنمارک کے سفیر جیکب لینوف نے اپنے خطاب میں ماحولیاتی تبدیلیوں اور اقدامات پر پاکستان اور اسکے اداروں کے کردار کو سراہا اور پاکستان کو ہر ممکن تعاون اور مدد کے عزم کا اظہار کیا۔ کانفرنس کے پہلے روز ماحولیاتی تبدیلیوں اور قومی سلامتی گلوبل اکانومی اور ریسپانس سمیت اہم موضوعات پر ریسرچرز نے پیپر پیش کیے اور پینل ڈسکشن میں حصہ لیا۔ اسٹاک ہوم یونیورسٹی سویڈن کے پروفیسر اشتیاق احمد، نیشنل یونیورسٹی سنگاپور کے ڈپٹی ہیڈ آف پولیٹیکل سائنسز ڈاکٹر بلوبرسنگھ، ایسوسیٹ ریڈیم ریاض اور معروف ماہر ماحولیات احمد رافع عالم نے سیشنز کو چیئر کیا۔ کانفرنس کے چیف آرگنائزر اور فیکلٹی ڈین ڈاکٹر خالد منظور بٹ نے مہمانوں اور شرکا کو خوش آمدید کہا اور کانفرنس کے اغراض و مقاصد بیان کئے۔ پروریکٹر یوسی پی ڈاکٹر نصرا کرام نے ماحولیات کے اہم ترین موضوع پر کانفرنس کے انعقاد پر ڈاکٹر خالد منظور بٹ اور انکی ٹیم کی کاوشوں کو سراہا۔ انہوں نے ماحولیاتی چیلنجز، یوسی پی کے فلڈ ریلیف پروگرام اور دیگر اقدامات پر روشنی ڈالی۔ پہلے روز پروریکٹر ڈاکٹر نصرا کرام اور ڈاکٹر خالد منظور نے مہمانوں کو کانفرنس کے خصوصی سوونیئرز پیش کئے۔ دو روزہ کانفرنس میں چالیس سے زائد ریسرچ پیپرز پیش کئے جائیں گے۔ کانفرنس آج بھی جاری رہے گی۔

روزنامہ جناح لاہور (2) 16 مارچ 2023ء

یوسی پی میں دوروزہ عالمی ماحولیاتی کانفرنس کے موقع پر ڈنمارک کے سفیر جیکب لینوف اور یوایس ایڈ کے ڈپٹی مشن ڈائریکٹر مائیکل رومین جسٹس جواد حسن، پروریکٹر یوسی پی ڈاکٹر نصرا کرام اور ڈاکٹر خالد منظور بٹ، ڈین فیکلٹی آف ہیومنٹیز اینڈ سوشل سائنسز سٹیج پر موجود ہیں

یوسی پی: ماحولیاتی تبدیلیوں اور چیلنجز پر دوروزہ انٹرنیشنل کانفرنس

کانفرنس میں سویڈن، سنگاپور، بھارت، چین اور جنوبی افریقہ سے سکالرز کی خصوصی شرکت

لاہور (سٹاف رپورٹر) یونیورسٹی آف سنٹرل پنجاب کے زیراہتمام ماحولیاتی تبدیلیوں چیلنجز اور رسپانسز پر دو روزہ انٹرنیشنل کانفرنس کا آغاز ہوگیا۔ کانفرنس کی افتتاحی تقریب یوسی پی آڈیٹوریم میں منعقد ہوئی جس میں لاہور ہائی کورٹ کے جج جسٹس جواد حسن، گیسٹ آف آنرز یوایس ایڈ کے ڈپٹی مشن ڈائرکٹر مائیکل رومین، ڈنمارک کے سفیر جیکب لینوف، پروریکٹر یوسی پی ڈاکٹر نصرا کرام، ڈین فیکلٹی آف ہیومنٹیز اینڈ سوشل سائنسز اور کانفرنس کے سربراہ ڈاکٹر خالد منظور بٹ سمیت سویڈن، سنگاپور، بھارت اور دیگر ممالک سے سکالرز اور پریزینٹرز، یوسی پی کے اساتذہ اور طلباوطالبات نے بڑی تعداد میں شرکت کی۔ لاہور ہائی کورٹ کے جج جسٹس جواد حسن کلیدی مقرر تھے۔ انہوں نے موسمیاتی تبدیلی کے شعبے میں اپنے تعاون کے بارے میں بتایا۔ انہوں نے لاہور میں سموگ اور آلودگی سے متعلق ایک اہم کیس کی صدارت کرتے ہوئے پنجاب حکومت کو ہوا کے معیار کو بہتر بنانے کے لیے ضروری اقدامات کرنے کی ہدایت کی۔

روزنامہ نوائے وقت لاہور (2) 16 مارچ 2023ء

یوسی پی کے زیراہتمام ماحولیاتی تبدیلیوں، چیلنجز پر کانفرنس

افتتاحی کانفرنس میں سویڈن، سنگاپور، بھارت، چین، جنوبی افریقہ سے سکالرز شریک

لاہور (نمائندہ خصوصی) یونیورسٹی آف سنٹرل پنجاب کے زیراہتمام ماحولیاتی تبدیلیوں چیلنجز اور رسپانسز پر دو روزہ انٹرنیشنل کانفرنس کا آغاز ہوگیا۔ کانفرنس کی افتتاحی تقریب یوسی پی آڈیٹوریم میں منعقد ہوئی جس میں لاہور ہائی کورٹ کے جج جسٹس جواد حسن، گیسٹ آف آنرز یوایس ایڈ کے ڈپٹی مشن ڈائرکٹر مائیکل رومین، ڈنمارک کے سفیر جیکب لینوف، پروریکٹر یوسی پی ڈاکٹر نصرا کرام، ڈین فیکلٹی آف ہیومنٹیز اینڈ سوشل سائنسز اور کانفرنس کے سربراہ ڈاکٹر خالد منظور بٹ سمیت سویڈن، سنگاپور، بھارت اور دیگر ممالک سے سکالرز اور پریزینٹرز، یوسی پی کے اساتذہ اور طلباوطالبات نے بڑی تعداد میں شرکت کی۔ لاہور ہائیکورٹ کے جج جسٹس جواد حسن کلیدی مقرر تھے۔ انہوں نے موسمیاتی تبدیلی کے شعبے میں اپنے تعاون کے بارے میں بتایا۔

روزنامہ اوصاف، لاہور، جمعرات، 16 مارچ 2023ء

یونیورسٹی آف سنٹرل پنجاب میں ماحولیاتی تبدیلیوں اور چیلنجز پر 2 روزہ کانفرنس کا آغاز

جسٹس جواد حسن سمیت سکالرز کی شرکت

یوایس ایڈ کے مائیکل روہمین، ڈنمارک کے سفیر جیکب لینوف، پروریکٹر ڈاکٹر نصرا کرام، ڈین ڈاکٹر خالد منظور بٹ و دیگر شریک ہوئے

سویڈن، سنگاپور، بھارت، چین اور جنوبی افریقہ سے بھی سکالرز آئے، ماحولیاتی تبدیلیوں سمیت اہم موضوعات پر ریسرچرز نے پیپر پیش کیے

لاہور (نامہ نگار خصوصی) یونیورسٹی آف سنٹرل پنجاب (یوسی پی) کے زیر اہتمام ماحولیاتی تبدیلیوں چیلنجز اور رسپانسز پر دو روزہ انٹرنیشنل کانفرنس کا آغاز ہوگیا۔ کانفرنس کی افتتاحی تقریب یوسی پی آڈیٹوریم میں منعقد ہوئی جس میں لاہور ہائی کورٹ کے جج جسٹس جواد حسن، گیسٹ آف آنرز یوایس ایڈ کے ڈپٹی مشن ڈائرکٹر مائیکل رومین، ڈنمارک کے سفیر جیکب لینوف، پروریکٹر یوسی پی ڈاکٹر نصرا کرام، ڈین فیکلٹی آف ہیومنٹیز اینڈ سوشل سائنسز اور کانفرنس کے سربراہ ڈاکٹر خالد منظور بٹ سمیت سویڈن، سنگاپور، بھارت اور دیگر ممالک سے سکالرز اور پریزینٹرز (باقی صفحہ 5 نمبر 7)

یوسی پی میں دوروزہ عالمی ماحولیاتی کانفرنس کے موقع پر ڈنمارک کے سفیر جیکب لینوف اور یوایس ایڈ کے ڈپٹی مشن ڈائریکٹر مائیکل روہمین، جسٹس جواد حسن و دیگر سٹیج پر موجود ہیں

IC4R-2023

Media Coverage

Daily Times Thursday, March 16, 2023

UCP moot discusses pressing issues related to climate change

The Faculty of Humanities and Social Sciences at the University of Central Punjab organized inaugural ceremony of the International Conference on Climate Change: Challenges and Responses. The conference, which was begun on 15th March 2023, brought together esteemed guests, policymakers, academicians, climate change activists and researchers from around the globe to discuss the pressing issues related to climate change.

The conference focused on various themes including Climate Change and National Security, Impacts of Climate Change on Global Economy, Climate Change and Social Transformation, Impact of Climate Change on Mental Health and Emotional Wellbeing, Climate Change and Global Environmental Politics, Global Responses to Climate Change, Environmental Diplomacy and Climate Justice, Climate Hazards and Policymaking, and Climate Change and SDGs.

Justice Jawad Hassan, a judge of Lahore High Court, was the keynote speaker. [illegible]

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The Nation
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UCP holds two-day int'l conference on climate change challenges and responses

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LAHORE

A two-day international conference on climate change challenges and responses has started at University of Central Punjab. Lahore High Court Judge Justice Jawad Hassan, guest of honors USAID's Deputy Mission Director Michael Rossman, Danish Ambassador Jacob Linulf, Proctor UCP Dr Nassar Ikram and Dean Faculty of Humanities and Social Sciences and Conference Head Dr. Khalid Manzoor Butt were also present at the opening ceremony of the conference.

On the first day of the conference, researchers presented their papers on important topics including climate change and national security, global economy & response. Researchers also participated in the panel discussion. Professor Ishtiaq Ahmed from Stockholm University Sweden, Dr. Balvir Singh, Deputy Head of Political Sciences, National University of Singapore, Nadeem Riaz, Ambassador and renowned environmentalist Ahmed RafayAlam chaired the sessions. Dr Khalid Manzoor Butt, chief organizer of the conference and Faculty Dean, welcomed the guests and participants and explained the objectives and objectives of the conference. Pro Rector UCP Dr Nassar Akram appreciated the efforts of Dr. Khalid Manzoor Butt and his team for organizing the conference on the most important topic of environment. He highlighted environmental challenges, UCP's flood relief program and other initiatives. Guest of Honors Michael Rossman, Deputy Mission Director USAID and Ambassador of Denmark Jakob Linulf in their address appreciated the role of Pakistan and its institutions on climate change and initiatives and pledged all possible cooperation and assistance to Pakistan. On the first day, Proctor Dr. Nassar Ikram and Dr. Khalid Manzoor presented special souvenirs of conference to the guests. More than 40 research papers will be presented in two-day conference. The conference will continue today.

The News International, Lahore, Thursday, March 16, 2023

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روزنامہ دنیا لاہور، جمعرات، 16 مارچ، 2023ء

لاہور، یو سی پی میں عالمی ماحولیاتی کانفرنس میں ڈنمارک کے سفیر جیکب لینوف، ڈپٹی مشن ڈائریکٹر یو ایس ایڈ مائیکل روسمین جسٹس جواد حسن، پرو ریکٹر ڈاکٹر نصرا کرام، ڈاکٹر خالد منظور بٹ و دیگر سٹیج پر موجود ہیں

یونیورسٹی آف سنٹرل پنجاب میں ماحولیات پر عالمی کانفرنس شروع

جسٹس جواد حسن، یو ایس ایڈ کے مائیکل روسمین، ڈنمارک کے سفیر کا خطاب

ڈاکٹر نصرا کرام، ڈاکٹر خالد منظور بٹ، سویڈن، سنگاپور کے سکالرز بھی شریک

کانفرنس میں 40 سے زائد ریسرچ پیپرز پیش کئے جائیں گے، آج اختتامی دن

لاہور (دنیا نیوز) یونیورسٹی آف سنٹرل پنجاب (یو سی پی) کے زیر اہتمام ماحولیاتی تبدیلیاں چیلنجز اور رسپانسز پر دو روزہ انٹرنیشنل کانفرنس کا آغاز ہوگیا۔ کانفرنس کی افتتاحی تقریب یو سی پی آڈیٹوریم میں منعقد ہوئی جس میں لاہور ہائی کورٹ کے جج جسٹس جواد حسن، گیسٹ آف آنرز یو ایس ایڈ کے ڈپٹی مشن ڈائریکٹر مائیکل روسمین، ڈنمارک کے سفیر جیکب لینوف، پرو ریکٹر (صفحہ 4 بقیہ نمبر 1)

بقیہ نمبر 1 **یو سی پی**

یو سی پی ڈاکٹر نصرا کرام، ڈین فیکلٹی آف ہیومینٹیز اینڈ سوشل سائنسز اور کانفرنس کے سربراہ ڈاکٹر خالد منظور بٹ سمیت سویڈن، سنگاپور، بھارت اور دیگر ممالک سے سکالرز اور پریذینٹرز، یو سی پی کے اساتذہ اور طلبا وطالبات نے بڑی تعداد میں شرکت کی۔ لاہور ہائی کورٹ کے جج جسٹس جواد حسن نے کلیدی خطاب میں کہا کہ لاہور میں سموگ اور آلودگی سے متعلق ایک اہم کیس کی صدارت کرتے ہوئے پنجاب حکومت کو ہوا کے معیار کو بہتر بنانے کے لیے ضروری اقدامات کرنے کی ہدایت کی ہے۔ گیسٹ آف آنرز یو ایس ایڈ کے ڈپٹی مشن ڈائریکٹر مائیکل روسمین اور ڈنمارک کے سفیر جیکب لینوف نے اپنے خطاب میں ماحولیاتی