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PhD Thesis **Fiaz Hussain Shah** **2022**

Climate Proofing Indus Water Treaty: An Instrument of Peace Building in South Asia

By

Fiaz Hussain Shah
(Registration No: NUST201690372PCIPS6116S)

Supervisor:
Dr Muhammad Makki

Department of Peace and Conflict Studies
Center for International Peace and Stability

National University of Sciences & Technology (NUST)
Islamabad, Pakistan
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A thesis submitted in partial fulfillment of the requirements for the degree of

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in Peace and Conflict Studies

Thesis Supervisor: Dr Muhammad Makki

Department of Peace and Conflict Studies (PCS)
Center for International Peace and Stability (CIPS)

National University of Sciences & Technology (NUST)
Islamabad, Pakistan

(2022)

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No part of this thesis has been submitted anywhere else for any other degree. This thesis is submitted to the Department of Peace and Conflict Studies in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Field of **Peace and Conflict Studies,** Department of Peace & Conflict Studies, Center for International Peace and Stability, National University of Sciences and Technology (NUST), Islamabad, Pakistan.

Student Name: **Fiaz Hussain Shah** Signature _____

Examination Committee:

a) External Examiner 1:
Dr. Zulfiqar Ahmad Signature _____
Dean University of Wah,
Wah Cantt.

b) External Examiner 2:
Dr. Atta-Ur-Rahman Signature _____
Chairman & Associate Professor,
University of Peshawar, Peshawar.

c) Internal Examiner: Signature _____
Professor Dr. Tughral Yamin
Associate Dean CIPS, NUST,
Islamabad.

Supervisor Name: **Dr. Muhammad Makki** Signature _____

Name of Dean/HOD: **Professor. Dr. Tughral Yamin** Signature _____

I dedicate my research to the notion of peace in the world, without which humans cannot imagine living with love and respect.

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Besides elite interviews, it involved a host of departments like MoCC, Pakistan Meteorological Department (PMD), Pakistan Indus Water Commission (PIWC), Federal Flood Commission (FFC) and National Engineering Services Pakistan (NESPAK) etc. I acknowledge with deep regards the support provided by these departments, which facilitated my research work immensely. I conducted around two dozen elite interviews in Pakistan and abroad. It needed much time at the respondents' end, for which I am thankful to all of them for sparing time and rendering valuable input. I am particularly grateful to Engineer Shams ul Mulk, former Chairman WAPDA, whom I met more than once for guidance and clarifications. I wish to extend special thanks to foreign respondents Prof. Dr. Ing Martin Grambow, Director

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Abstract

Indus Water Treaty (IWT) between Pakistan and India was signed on 19 September 1960. At that time, climate change was not incorporated since the phenomenon was not known as it came to be known later. While climate change has become a global reality, the uncertain and declining water availability has also impacted significantly. Immense technological advancements have added new dimensions to water availability. Water quantity and quality both are under transition. Besides pressures on water availability such as population growth, urbanization, economic development, extreme climatic events etc., the hydro-politic between arch nuclear rivals has started showing an upward trajectory, a potential threat to regional peace and stability. The emerging water conflict between riparian states can be managed if climate-proofing of IWT is done by incorporating current knowledge, particularly of climate change and its alignment with the current set of international rules and water laws. The qualitative research has been conducted by collecting data through elite interviews. The research proposes an arrangement for climate-proofing IWT with the objective to induce current climate change knowledge and promote harmony for fostering transboundary water resource management. Various physical, socio-economic, and environmental dimensions to mitigate the impact of climate change and minimize the consequences of extreme events have been considered for evolving a set of related findings. The research recommends climate-proofing IWT by integrating fragmented climate change adaptation global practices for equitable utilization of Indus River Waters in a customized manner acceptable to both the riparian states.

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Abbreviations & Acronyms

ADB	Asian Development Bank
AJ&K	Azad Jammu and Kashmir
$BtCO_2$	Billion tons of CO2
CH_4	Methane
CO_2	Carbon Dioxide
COP	Conference of the Parties
CRI	Climate Risk Index
Cmsec	Cubic meters per second
ENSO	El-Niño Southern Oscillation
ERRA	Earthquake Rehabilitation and Reconstruction Authority
EU WFD	European Union Water Framework Directive
FFC	Federal Flood Commission
GCISC	Global Change Impact Studies Centre
GCP	Global Carbon Project
GDP	Gross Domestic Product
GHG	Green House Gases
GIS	Geographic Information System
GLOF	Glacial Lake Outburst Flooding
GNP	Gross National Product
GWh	Gigawatt hours
HCFCs	Hydro-choloro-fluorocarbons
HDI	Human Development Index
HEP	Hydro Electric Power Project
HFCs	Hydro Fluorocarbons
HKH	Hindu Kush – Karakorum – Himalayan
HPP	Hydro Power Project
IBRD	International Bank for Reconstruction and Development
ICJ	International Court of Justice
ICOLD	International Commission on Large Dams
ICPR	International Commission for the Protection of Rhine
IHK	Indian held Kashmir

IIASA	International Institute for Applied Systems Analysis
IIL	Institute of International Law
ILA	International Law Association
ILC	International Law Commission
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IRB	Indus River Basin
IRS	Indus River System
IRSA	Indus River System Authority
IWRM	Integrated Water Resource Management
IWT	Indus Water Treaty
KHEP	Kishanganga Hydro Electric Power Project
KPK	Khyber Pakhtunkhwa
LUCF	Land Use Change for Forestry
MAF	Million Acre Feet
Mha	Million Hectares
MoCC	Ministry of Climate Change
MoFA	Ministry of Foreign Affairs
MoL	Ministry of Interior
MoWR	Ministry of Water Resource
MoWP	Ministry of Water and Power
MoST	Ministry of Science & Technology
MRC	Mekong River Commission
$MtCO_2$	Million tons of CO2
MtCO2e	Million tons of CO2 emissions
N_2O	Nitrous Oxide
NCCP	National Climate Change Policy
NDMA	National Disaster Management Authority
NESPAK	National Engineering Services Pakistan
NIPS	National Institute of Population Studies
NWP	National Water Policy
O_3	Ozone
PFCs	Perfluorinated Carbons

PCRWR	Pakistan Council of Research in Water Resource
PIIA	Pakistan Institutes of International Affairs
PIWC	Pakistan Indus Water Commission
PMD	Pakistan Metrological Department
PPC	Punjab Partition Committee
RS	Remote Sensing
SAARC	South Asian Association for Regional Cooperation
SLR	Sea Level Rise
SRES	Special Report on Emission Scenario
TVA	Tennessee Valley Authority
UBDC	Upper Bari Doab Canal
UIB	Upper Indus Basin
UN	United Nations
UNDP	United Nations Development Program
UNEP	UN Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
UNISR	Vita-Salute San Raffaele University
UNGA	United Nations General Assembly
WAPDA	Water & Power Development Authority
WB	World Bank
WHO	World Health Organization
WMO	World Metrological Organization
WWF	World Wildlife Fund

PART-I
LOCATING THE FIELD

CHAPTER: 1
INTRODUCTION

1.1 Climate Change: A Revealing Phenomenon

Inter-governmental Panel on Climate Change[1] (IPCC) defines climate as an expected weather condition in a particular spatial and temporal setting (IPCC, 2007, IPCC,2014, IPCC 2019). Climate assessment reports by the IPCC claim that climate is in a state of flux due to natural variability and anthropogenic interventions. Climate change has emerged as a phenomenon to be reckoned with and a global reality that can neither be denied nor relegated (Brown et al., 2007; Smit et al., 2014). At global and regional scales, the earth's climate system has considerably changed (Adams, 2017; Boadi & Owusu, 2017). Human-induced climate change is altering the composition of the global atmosphere (Smit et al., 2014). The concept of 'Anthropocene', as described by the Nobel Prize winner Paul Crutzen, for the past three centuries, has escalated by the effects of humans through anthropogenic emissions of carbon dioxide on the global environment (Crutzon, 2002). He further explains that mankind will remain a major environmental force in changing the geological facade of the Earth. It will remain a challenge for scientists and engineers to guide societies towards environmentally sustainable management during the era of the 'Anthropocene'. Although the era of Anthropocene has enriched our lives phenomenally and its developments are inseparable parts of our culture and the very foundation of our civilization, its apparent adverse side effects have begun to take effect to such an extent that re-evaluating our actions has become imperative (Martin Grambow, 2021). It is a reality and melting the glaciers around the world at an alarming rate is prime evidence of it (Chegwidden, 2020; Abubakar, 2020).

IPCC's special report expresses a high degree of evidence and a fair degree of confidence that climate change is an outcome of global warming (IPCC, 2019). According to the IPCC's special report, human activities in the last half of the 20^{th} century, as observed, have led to a change in global and regional surface temperature. Resultantly, the global surface temperature has increased by 0.67^{o} C during the last century.

[1] The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental body of the United Nations that provides the world with objective, scientific information relevant to understanding the scientific basis of the risk of human-induced climate change, its natural, political, and economic impacts and risks, and possible response options.

The highest variability in climate parameters has been recorded from 1910 to 1945 and from 1976 to 2000 (Casper, 2010; IPCC, 2007). The rise of temperature, a significant source of changing climate by IPCC, is attributed to many factors. These factors include the variation in solar output received by the earth from the sun, Green House Gases[2] (GHG) effects produced as a result of travelling of solar radiations through the atmosphere, blockade of part of the outgoing infrared radiations, the effects of El-Nino and La-Nina,[3] Southern Pacific Oscillation[4] and North Atlantic Oscillation[5] on weather affecting the precipitation regime, the sea level rise, and ocean heat contents (Casper, 2010). The concentration of GHG is considered responsible for global warming. An increase in GHG emissions is causing a rise in global temperature at the rate of 0.3%-0.4% per year (Olivier et al., 2017).

The rise in temperature has disturbed the weather systems (Arguez & Vose, 2011). As a result, snow and rainfall regimes have become uncertain and erratic. The climatic disorder impacting every walk of life has started revealing vigorously across multi-sectoral spectrum posing serious consequences for the sustainability of routine life on the face of the earth. The rising temperature is causing metrological and glacial fluctuations (Hissen et al., 2017; IPCC, 2015). Glacial melting, an indicator and precursor of climate change with varying global weather systems, have disturbed the water balance in river basins, particularly where this resource is shared, having transboundary jurisdictions (Travedi, 2007; Cooley et al., 2009; De Stefano et al., 2017). Major challenges ahead for the international community will be to develop the principles, procedures, and institutions for managing and protecting shared water resources (Burra, 2013; Timmerman et al., 2017). Rising temperature leading to glacial fluctuation has increased glacial melting resulting in surface runoff projected to increase in the high latitude and wet tropic regions, whereas in mid-latitude and parts of the dry tropics, it is projected to decrease (IPCC, 2015; Brears, 2018). The IPCC's Special Report reflects that climate change will affect the timings, intensity, magnitude, and duration of water flow in

[2] Green House Gases (GHG) are the gases in Earth's atmosphere that trap heat. They let sunlight pass through the atmosphere, but they prevent the heat that the sunlight brings from leaving the atmosphere. The main GHG are Carbon dioxide, Methane, Ozone, Nitrous oxide, and Chlorofluorocarbons.

[3] El Niño and La Niña are complex weather patterns resulting from variations in ocean temperatures in the Equatorial Pacific. The term El Niño refers to the large-scale ocean-atmosphere climate interaction linked to a periodic warming in sea surface temperatures across the central and east-central Equatorial Pacific. The presence of El Niño can significantly influence weather patterns, ocean conditions, and marine fisheries across large portions of the globe for an extended period. While La Niña episodes represent periods of below-average sea surface temperatures across the east-central Equatorial Pacific. Global climate La Niña impacts tend to be opposite of El Niño impacts.

[4] Southern Pacific Oscillation is an irregularly periodic variation in winds and sea surface temperatures over the tropical eastern Pacific Ocean, affecting the climate of much of the tropics and subtropics.

[5]The North Atlantic Oscillation (NAO) is a weather phenomenon in the North Atlantic Ocean of fluctuations in the difference of atmospheric pressure at sea level (SLP) between the Icelandic Low and the Azores High.

snow-dominated basins like that of Indus River Basin (IRB), higher temperatures will result in earlier peak flows, lower summer flows, whereas winter flows will increase (Lal, 2001).

Similarly, with changing climate, the raining, snowing, and icing patterns have also changed, resulting in variation in groundwater (IPCC, 2014). Pagliero and colleagues (2014) mention that higher temperatures have started to cause considerably more climate variability leading to extreme hydrological events like floods and droughts. Moreover, the frequency, intensity, duration, and magnitude of floods and drought are increasing. Similarly, Richardson (2011) also highlights that the increase in rainfall intensity poses the risk of flood, and the decrease in intensity and frequency in dry regions poses the risk of drought. Alongside water quantity, the water quality is also being impacted. With the increased temperature of rivers, reservoirs, and lakes, lower dissolved oxygen concentrations and more algal and bacterial blooms are expected to increase, which will degrade the quality of water (Backlund et al., 2008). Backlund further opines that intense rainfalls will increase soil erosion and wash more pollutants and toxins[6] into the waterway, leading to a serious risk to freshwater species and humans. To make such water cleaner, costlier treatment will be needed, resulting in more water consumption rates or degraded output (Cooley et al., 2009). The sea level is also rising, pushing saline water into the rivers, deltas, and coastal aquifer; therefore, threatening mangrove habitats[7].

On the one hand, water availability is declining, whereas water demand is increasing due to increased population growth, urbanization, and industrialization (Cooley et al., 2009, IPCC, 2014). Water demand for climate-sensitive sectors like agriculture[8] has also increased as plants now require more water to grow due to warmer temperatures (Basharat et al., 2014). The climate change impacts, and the consequences thereof may be similar in nature but will differ in results due to their effects on the life cycle. Climate Change impacts may appear beyond control, but the consequences are manageable through adaptation and mitigation measures (Rasul, 2014). The consequences of climate change impacts are being experienced in different sectors from different walks of life. The major ones are being experienced in sectors like water security, food security, energy security, military challenges, extreme hydro-meteorological events[9], health, and ecological systems. As the impacts of climate change projections are variable, the consequences are unpredictable in magnitude and severity (IPCC,

[6] From industrial and municipal wastes
[7] Mangroves are special environmental habitats that consist of trees growing in nearly stagnant coastal waters, river banks and estuaries.
[8] Agriculture sector is sensitive to both temperature and water.
[9] Agriculture sector is sensitive to both temperature and water.

2014, Dinar et al., 2015). 'Uncertainty'[10] expected in the availability of fresh water in the face of growing water demand due to enhanced agriculture production, economic development, power generation, human health, population growth, and the environment is posing challenges to both policymakers and managers alike (Cooley & Gleick, 2011; IPCC, 2019).

Uncertainty in the spatial and temporal distribution of water by rains, snow, glaciers, rivers, and aquifers can threaten agriculture production, leading to food security issues (Asharf, 2019; Mahmood et al., 2012). Crop growing cycles and seasons affected by changing timings and volume of water availability will affect the sowing, growing, maturing, and yield of the crops, which can have profound social and economic impacts creating food crises in the country (IPCC, 2019). According to the IPCC Special Report, by 2050, 9 billion people will live on the Earth, whereas crop yields are expected to reduce by 30% in South Asia due to climate change. Food needs would multiply, water demand would increase, and food insecurity[11] would have adverse socio-economic implications. Water, food, and energy security can disturb the social fabric of the society, leading to a race for acquisition of water resources that can initiate confrontation and competition for survival (Kalair et al., 2019; Blaabjerg et al., 2016).

Extreme hydrological events are water-dependent. Glacial and snowpack melting due to warmer temperatures will increase the availability of water, resulting in more flows in rivers leading to floods, whereas when glacial mass will decrease, so will decrease river inflows leading to droughts which are serious socio-economic impediments retarding progress and development in the country (Eckstein, 2020; Ali & Zia, 2017). Linked with hydro-meteorological extreme events is health security which is a serious challenge. Human health maladies, including deaths, can develop due to the variable hydrological cycle ensuing from climate change, especially in lesser developed countries (Furth, 2010; ADB, 2017). Flooding events can cause an explosion of existing sewer and treatment systems, producing water-borne and vector-borne diseases (Fiorentino, 2015; AIPS, 2019). Heatwave in summer is yet another consequence of climate change that can be responsible for many deaths (Baldwin et al., 2019). Climate change affects ecological systems and habitats, which can cause disorder in species from terrestrial biodiversity, making them migrate or perish, posing serious hazard-like conditions (Keith et al., 2008; Ahmad & Suphachalasai, 2014; Smit et al., 2014).

[10] Uncertainty is expected in terms of availability of water with respect to its quantity and quality. In quantity, it is further split for time, magnitude, frequency, and duration.
[11] Food mainly comprises grains and meat, both are dependent on water.

1.2 Water: Vulnerability to Climate Change

Terrestrial life revolves around water (Takei, 2015; Brenner, 2019). Presence, absence, abundance, or scarcity of water outlines the dimensions of natural, socio or economic systems on Earth. World over, freshwater is a scarce resource which by nature, has been distributed unevenly and irregularly across the globe (Hafeez et al., 2012; ADB, 2017). Observational records and climate projections establish with a high degree of confidence that freshwater resource is highly vulnerable to climate change with multiple consequences at social, economic and ecological levels (Bates et al., 2008; Abas et al., 2019). Both parts of the water demand and supply equation are being impacted by climate change. Since the supply side of freshwater is shared, it has implications implicit to transboundary waters. The freshwater sources[12] are exposed to climate change with a high degree of vulnerability. Water has been the most affected element on earth as all its main sources have been adversely impacted (Arguez & Vose, 2011).

Pakistan, mainly dependent on IRB for its freshwater, is no exception in suffering from the implications of climate change (Archer et al., 2010). Pakistan receives 142 million Acre Feet (MAF) of water as river inflows from glaciers and snow, 50 MAF from rainfall, and approximately 48% of surface water from the aquifer. 92% of available water is used in agriculture, 3% for industries, and 5% for domestic use and infrastructure (Asharf, 2019). Due to socio-economic development and an increase in population, the water demand has increased, exerting pressure on declining water availability (Chaudhry et al., 2009). As part of the Hindukush, Karakoram, and Himalaya (HKH) region, Pakistan has the largest number of glaciers on the face of the earth (Dinar et al., 2015; ADB, 2017). Global warming is likely to change cryosphere[13] dynamics, hydrological cycles[14], and atmospheric flows[15] of the region. Except for the Karakorum, about which uncertainty prevails[16], the Hindu Kush and Himalayan glaciers are receding (Q. Z. Chaudhry, personal communication, November 17, 2017).

Uncertain conditions for water availability in different parts regarding water quantity, particularly variations in terms of magnitude, timings and duration, have further accentuated the impact of water scarcity (Alam & Humayun, 2014). According to Ghulam Rasul (personal

[12] Water from ice, snow, rainfall, and groundwater.
[13] Cryosphere is the part of the earth's surface characterized by the presence of frozen water. The cryosphere consists of mountain glaciers and continental ice sheets, seasonal snow and ice cover on land, and sea ice.
[14] The hydrological cycle of the earth is the sum of all processes in which water moves from the land and ocean surface to the atmosphere and back in form of precipitation. The hydrological cycle is dependent on various factors and is equally affected by oceans and land surfaces.
[15] Atmospheric flows are the air flows horizontally at top of the troposphere.
[16] This uncertainty is commonly known as Karakorum Anomaly.

communication, July 26, 2017), the Upper Indus Basin (UIB) is suffering fluctuation in solid and liquid precipitation. The Monsoon water is showered on glaciated ice with a differential of 20^0-25^0C, making glaciers melt faster and adding up to river inflows. A pattern shift has been observed in snowfall as well. Snowfall used to get peaked in December and January, which has shifted to February and March, resulting in more river inflows and a reduction in the glacial budget. Pakistan receives the westerly waves and the Monsoon. Studies have revealed that the temperature rise has disturbed weather systems (Richardson, 2011). Both weather systems have been affected by climate change. From 1960 to 2007, there was decreased rainfall in winter and summer by 10-15% in the arid plains and coastal areas, besides a decrease of 17% to 64% in rainfall during seven strong El Niño events in the last 100 years (Chaudhry et al., 2009).

Similarly, the groundwater being a natural reservoir readily available for consumption on the consumer's doorstep, has also been adversely affected by over-extraction due to higher demand as the consequence of Anthropocene. The water table persistently decreases, entailing exorbitant extraction effort and cost. This has disturbed the overall water availability equation in the IRB (S. Kakakhel, personal communication, December 15, 2017). Presently, communities and countries are experiencing water pressures that were not conceivable in the past (Karar, 2017). These pressures, including population growth, urbanization, economic development, climate change, etc., have altered the water demand and supply equation (Subramanian et al., 2014). It is expected that these pressures will exacerbate in the future rather than lessen as the efforts to control these pressures are meagre, hence, multiplying their adverse impacts. These pressures will increase the tensions in sectors characterized by cooperation in the past (Kalair et al., 2019; Archer et al., 2010).

The main reason behind the shifting of bias from cooperation to the conflict in water-related treaties is that most transboundary water agreements fail to consider hydrological variability of freshwater systems appropriately, thus, missing effective clauses and provisions that can adequately cope up with the changes. The absence of such clauses from the transboundary water agreement leads to the instability of the agreement and the conflictual situation amongst the states (Cooley et al., 2009). Climate change is the most impacting factor of all the pressures that can alter the water demand and supply equation pattern. This factor can alter water quantity and quality by inducing changes in the hydrological cycle. Climate change is the catalyst in inducing variability in water quantity and quality, poses a serious threat to the stability of transboundary freshwater resource agreement (Cooley & Gleick, 2011).

1.3 Indus Water Treaty (IWT): An Instrument of Water Regulation

Water, a shared resource, is divided based on availability (Haftendom, 2000). Over 300 [17]rivers, 100 lakes and yet to be a determined number of aquifers are shared by two or more countries in the world (Solomon, 2007). The British imperial powers, before decolonizing, partitioned the subcontinent into two independent countries: Pakistan and India, on the 14th and 15th of August 1947, respectively (Ali, 1967). However, geographical division delineating the borders of newly born states did not cater to the hydrological dictates of available water resources. Even before the partition, the water disputes between East and West Punjab existed which crystallized and deepened after the partitioning of both the states (Wani & Moorthy, 2014). A detailed account of the historical perspective and genesis has been discussed in Chapter 4. It took about a decade that an agreement between both the states was reached for sharing waters of IRB.

IRB is the lifeline for the economies of Pakistan and Western India. Any threat to its existence is considered challenging for both countries (Ali, 2013). IWT is a wholesome agreement between Pakistan and India crafted under the auspices of the World Bank by the collective effort of experts from multiple related fields. The IWT signed on 19 September 1960[18] The Treaty fixes the jurisdictions of both the countries on different sets of rivers in western and eastern halves by defining the rights and obligations while sharing the water. IWT allocates three eastern rivers[19] to India, whereas three western rivers[20] with permission to use some quantity of water by India are allocated to Pakistan. The Treaty has an inbuilt mechanism of information and data sharing, monitoring, and implementation through the Pakistan Indus Water Commission (PIWC). Although the technical, legal, and administrative arrangements of the treaty are keeping it functional and buoyant, its inadequacies create conflictual situations between India and Pakistan when the internal mechanisms of IWT fail to resolve the issues and the doors of international mediators are knocked for the solution. The Treaty has survived tests of tense times for 60 years but now seems to reach a quasi-functional stage due to its inherent voids and concerns developed by both states. The missing contents are termed here as 'voids'. These voids are those elements that Pakistan wants to be part of the treaty. The list of voids is dominated by climate change.

[17] Inking of over 300 shared water agreements in the world are testimony to the fact that water can be a source of cooperation and not the conflict.
[18] Muhammad Ayub Khan, President of Pakistan and Sri Jawahar Lal Nehru, Prime Minster of India signed the Treaty.
[19] Eastern rivers comprise Ravi, Beas and Sutlej.
[20] Western rivers comprise Indus, Jhelum and Chenab

1.4 Climate-proofing IWT and Peace Building in South Asia

Major freshwater sources lie in transboundary basins, which transcend politically divided borders. The political boundaries breed hydro politics between riparian states, resulting in disputes and conflicts between the states sharing transboundary water resources (Khalid & Begum, 2013). In shared water resources, where the riparian states have carved mutual water utilization agreements, there this shared commodity has become a source of cooperation contrarily to those rivers and basins where the mutual understanding was either missing or was inadequate, it always remained a source of tension amongst the states (Ahmed et al., 2010). Between Pakistan and India, the water tension had started brewing up right after the partition and got only resolved when the treaty was reached between the two states under auspices of the World Bank in 1960 (Akhter, 2015). To regulate the use of water between both the countries, IWT as an international protocol has the space for further up-gradation for enhancing cooperation between the riparian states (WB, 1960). The Treaty has proved itself a longstanding symbol of cooperation between India and Pakistan (Flannery, 2006).

However, when the treaty was framed, the phenomenon of climate change did not exist as it exists now, so it was not incorporated in IWT (Dinar et al., 2015). The absence of this reality[21] from the treaty is now negatively affecting IRB and gravely constraining Pakistan as it has only one river basin to draw water from, whereas India has over a dozen river basins to take water from[22] (Briscoe et al., 2005). The water quantity with different variables[23] like the volume of water, timings, and duration of its flow and frequency with varying intensity has immensely changed in the last sixty years. As a result, with variation in the quantity of water, water quality has also been negatively impacted (Chapman, 1996). Besides quantity and quality issues, the voids identified in the research have emerged as serious issues, particularly as the consequence of Anthropocene that needs to be addressed. So, in the face of water variability, incorporating mechanisms to bring flexibility and introducing climate change-related clauses and provisions to deal with water quantity and quality issues is the way to retain stability in the treaty. To incorporate climate change-related clauses and provisions for ensuring the sustainability of a water agreement is the essence of climate-proofing**.**

[21] Missing of provisions and clauses related to the impact of climate change on transboundary waters is a case in point.

[22] There are around 20 river basins in India. Leading ones include Indus River Basin, The Ganga River Basin, Brahmaputra and Barak River Basin, Narmada River Basin, Tapti River Basin, Brahmani-Baitarni River Basin, Mahanadi River Basin, Godavari River Basin, Krishna River Basin, Pennar River Basin, Cauvery River Basin, Mahi River Basin and Sabarmathi River Basin.

[23] Here the term 'variables' is used to indicate different components of water flow.

The term 'climate-proofing' a transboundary water agreement in this research, means incorporating climate change-related clauses and provisions applicable to transboundary waters in the treaty, which means the way climate change phenomenon is impacting the water resource, should be factored in the treaty for sustainable regulation of water as the consequence of Anthropocene**.** The process of climate-proofing shall provide the flexibility to an agreement with which it can adjust to the consequences of climate change (Cooley & Gleick, 2011).

The dominant climate change-related factors like equitable and sustainable utilization of water resources and avoiding damage and loss to other riparian states are the most important factors to be incorporated in a treaty[24]. Additionally, different climate change-related factors like managing extreme events like drought and floods, maintaining the ecological balance in the basin, management of basin aquifer and groundwater, monitoring and data archiving, data and information sharing, joint institutions for watershed management, amendment and review procedures, dispute resolution and conflict management, etc., if appropriately incorporated in a transboundary agreement can bring the culture of cooperation rather than dispute (Mahmood et al., 2012). This research argues that considering such factors can ensure socio-economic, environmental, and political dividends and will also help manage and respond to extreme events like drought and floods (Dinar et al., 2015). Such mechanisms in the context of the transboundary agreement will create a culture that shall facilitate the process of cooperation leading to peace and stability in South Asia in general and between Pakistan and India in particular.

1.5 Research Inquiry and Argument

Water, national security, and peace building make the most significant matrix. This seems to be being threatened due to the impact of climate change on the transboundary freshwater resource. Boute (2016) believes that mostly the water being a shared commodity involves more than one stakeholder for its utilization and management, so it has always remained a potential source of conflict. Dinar et al. (2015) also impress upon the same notion in a little more specific manner that due to its shared, unequally divided and distributed, finite and scarce nature and potential of being mismanaged, the water resource has always created a competition in riparian states to achieve incompatible goals in its utilization. He further delineates that there have not been many choices except to go for a conflict or cooperate in its utilization, whereas across the globe, mostly water resource has been managed with cooperation rather than conflict. As the

[24] Helsinki Rules, UN Watercourse Framework and Berlin Rules stipulate these clauses.

global economy is growing, so is the demand for freshwater; therefore, the possibility of conflicts arising from its management has also become more probable. According to the warning by Ban Ki-Moon, the UN Secretary-General, "many more conflicts lie just over the horizon and water may be leading" (Michel, 2009).

Incompatible water demand and availability will adversely impact the nation's ability to ensure social and economic development resulting in compromised living standards. Reduced water availability could lead to low agriculture productivity, poor public health, migration and settlement issues, livelihood constraints, and diminishing well-being. Consequently, a race to acquire water resources could initiate confrontation and competition for survival. This could take the shape of a conflict, the severity of which would depend upon the strength and capabilities of the involved riparian (Das, 2016). Sensitivities to water scarcity have made interventions by riparian states in shared water resources more pronounced and impacting. In the case of Pakistan and India, both countries share their freshwater of IRB through IWT. The scenario of incompatible water demand and availability in the case of IWT is also a case in point that needs due consideration for keeping it sustainable in the future. It does not have the provisions related to climate change, adversely impacting the quantity and quality of water. Climate change is likely to severely affect water availability in the desired timeframe, disturbing the demand and supply equation, leading to a conflictual situation that necessitates a plausible solution.

Indeed, IWT was negotiated when knowledge about socio-hydrology, water resources management, transboundary waters, international water laws, conflict resolution and management etc., and above all, the climate change phenomenon was either scanty or non-existent[25]. At that time, the importance of water in the human life cycle was also not that critical as it has attained today due to disequilibrium in water demand and supply equation due to disproportionate population growth, economic development, and highly sophisticated living standards: as the consequence of Anthropocene. While telescoping IWT through the lens of climate change, its reappraisal from a historical perspective, evolution, formulation, implementation, operation, dispute resolution, etc., is mandatory for crafting a sustainable and workable format for incorporating climate change into the Treaty through climate-proofing. IWT has technical, legal and technological gaps which have been aggravated due to climate change, which are being exploited routinely by default and rarely by design by India being

[25] The impact of climate change started surfacing in 80s (Irfan 2017).

upper riparian. To avoid present conciliatory mode between India and Pakistan turning into a confrontational mode, the limitations in IWT need to be reviewed. Review of transboundary agreement amongst riparian states for the Nile (Zeidan, 2018), Rhine (Schmid-Breton, 2016), Mekong (Fox & Sneddon, 2007), Jordon (Young, 2015), Danube (Linnerooth-Bayer & Murcott, 1996), Tigris, Euphrates (Kibaroglu, 2019), Brahmaputra (Barua et al., 2017), and Colorado Rivers (Wolf, 2002), show that it has created an environment of cooperation and amicably avoided conflicting situations. Emulation of such models for IWT is the call of the time this research is endeavoring to focus on.

The proposed concept of climate-proofing of transboundary water agreements is an institutionalized process that will reduce the climate-based risks to the bare minimum. This process may not be an end; instead, it is an effective mean to bring flexibility in the treaties and agreements which can suitably absorb the negative effects of climate change through capitalizing on technological, institutional, social, and legal innovations rather than waiting for the existing treaties to succumb to the burgeoning future pressures. The climate-proofing of transboundary water treaties has requisite and promising potential to address low probability but high magnitude climate events like floods and can provide a long term sustainable solution to the stresses being caused by climate change in social, political, and economic planes (Kabat et al., 2005). This process of incorporating climate change-related knowledge in the treaty will make it climate-proof, thus providing it sustainability essentially required between rival nuclear countries like Pakistan and India.

The research inquiries for this thesis follows the contours encompassing all related variables[26] like climate change, climate change impacts, IWT and climate-proofing. The thesis proposal led to the research context and its conceptual framework from which the research questions automatically flowed. Highlighting the significance of this research, an elaborate methodology matrix is outlined in Chapter 3 for making the research process smooth and manageable. There are three underlying assumptions considered in this research. Firstly, climate change is adversely impacting freshwater resources. Secondly, variability in transboundary freshwater resources can lead to conflicts. Thirdly, climate-proofing IWT will prove an instrumental means to ensure equitable and reasonable water utilization of IRB, thereby forestalling conciliatory mode conversion into a confrontational one between India and Pakistan. This research fulfills three specific objectives: to analyze IWT with a view of climate

[26] Here the term 'variables' is used to indicate those aspects in the manuscript which have been researched as part of the thesis.

change; assess how climate-proofing IWT will prevent or mitigate water conflicts in IRB; What consequences have the impact of climate change caused on transboundary waters of IRB for riparian states?

1.6 Research Outlook

'Climate-proofing IWT as an instrument of peace building in South Asia is a complex topic. Inbuilt in the issue is a host of variables. Since these variables belong to diverse disciplines, multiple sources for obtaining primary data have been considered. Broadly, the research variables can be divided into five categories: hydrology of IRB, hydro-politics between India and Pakistan, the impact of climate change on Indus River Waters, climate-proofing IWT and peace building prospects in South Asia. Since each variable is loaded with implicit dimensions, a more in-depth research effort was launched to crystallize the thought process to achieve the purpose of the research. Due to the intricacies of the research topic, even for preparing the research proposal, initial understanding from multiple sources like Ministry of Climate Change (MoCC), Ministry of Water (MoW), Pakistan Metrological Department[27] (PMD), National Disaster Management Authority (NDMA) and PIWC, etc., was of paramount importance which was done for keeping the strategic orientation required for the research aligned right from the beginning.

The method of inquiry applied to the research is qualitative. The research integrates the knowledge from multiple social and natural sciences disciplines to formulate a consistent set of findings for climate-proofing IWT. Through the qualitative research method, each variable has been rigorously questioned for focusing on 'why' and 'how' and not just on 'what', 'where', 'when' and 'who'. Through the qualitative research method, the information about climate change phenomenon, the events, the situations, and complex data beginning with grounded theory concept following the phenomenology approach has been collected, which has been applied across different disciplines to find its impact and consequences. Primary data has been collected from concerned departments like MoCC[28], MoW[29], PMD, NDMA[30] and PIWC. Semi-structured elite and key informant interviews with officials from concerned departments, academia and experts have been conducted in Pakistan and abroad. Besides, secondary data has also been acquired from the literature review, previous researches, data

[27] PMD maintains climate data in Pakistan.
[28] MoCC was established in 2012. First ever ministry in the world established by Pakistan for climate change.
[29] MoW recently separated from Ministry or Power.
[30] NDMA is responsible to manage disasters in Pakistan

analysis carried out by experts and conclusions drawn from seminars, conferences and workshops about related subjects and disciplines.

1.7 Research Significance and Contribution

As a result of global warming, climate change is a universal phenomenon and a challenging reality for thinkers, planners, policymakers, and professionals alike. Today it stands not only as a significant environmental issue but also as a multi-dimensional developmental issue. The impacts of climate change are diverse. From water resource, agriculture and livestock, human health, forestry, bio-diversity to various eco-systems like mountains, rangeland and pastures, arid and hyper-arid areas, coastal and marine and wetlands, all are impacted (Thatte, 2008).

A wide variety of natural weather and climate extremes would continue to occur, even if there were no anthropogenic[31] changes in the climate. Global warming because of the rise in surface temperature due to multiple reasons is causing the fast melting of the cryosphere[32] as a whole and the Northern Areas of Pakistan, falling mainly in the center of the HKH region, is no exception to this phenomenon. UIB, mainly comprising a glaciated region, feeds the river from meltwater, which directly bears the availability of water for agro-based economy and energy sources for the country. The research is essentially required to establish the context for protecting water resources available to Pakistan. Since 80% of freshwater[33] is drawn from IRB. Hence, the agreement that binds both India and Pakistan to regulate shared water must be suitably upgraded to absorb the impact of climate change by incorporating requisite transboundary waters provisions and clauses to protect the right of both riparians.

As far as the significance of the research is concerned, it is momentous due to its physical, political, social, economic, and environmental dimensions. The physical dimension of the study is hydrological in nature. It shall include research on IRB water with its physical attributes of availability and utilization like quantity with its timings, magnitude, duration, intensity, frequency, and quality with its chemical, biological, and sedimentary composition for human, agricultural, and ecological applications. Research on the physical dimension of variable water resources as a consequence of Anthropocene will lead to an assessment of IRB water quantification and qualification to complete the climate-proofing matrix of IWT. Research on the political dimension for climate-proofing IWT as the consequence of

[31] Human induced or man made
[32] The cryosphere is an all-encompassing term for those portions of Earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps, ice sheets, and frozen ground. The cold regions of our planet influence our entire world's climate.
[33] Freshwater here is referred to in the context of overall fresh water available in the country.

Anthropocene shall include the relationship between India and Pakistan, the efficacy of IWT with its strengths and gaps, impact of climate change on water resource of IRB and potential consequences of status quo or climate-proofing of IWT between India and Pakistan. This dimension shall lead to understanding the peace and conflict matrix between both rival countries.

The social dimension shall include water, food, energy, and health securities for the people of Pakistan. It shall also include the consequences of extreme events like floods and droughts for the affected people related to their water, food, energy, health, and livelihood needs and how those would be protected if climate-proofing of IWT is done. The economic dimension encompasses national and community interests for contributing to Gross National Product[34] (GNP) and Gross Domestic Product[35] (GDP) regimes of Pakistan in a scenario when climate-proofing of IWT is done and otherwise if the status quo prevails. Lastly, the environmental dimension includes the development of a conducive environment for humans, animals, aquatic life, ecological systems and habitats of all related species, fauna, and flora dependent on IRB.

The proposed climate-proofing intervention is unique in that no transboundary water agreement has yet been climate-proofed in the world. Although segmented and fragmented climate change adaptation practices have been applied on different international treaties[36], integrating all related climate change adaptation practices on IWT, leading to synergistic effects, will be the first of its kind in the world. It is also novel research as there has not been any research done so far that envisions or analyses IWT from the lens of climate-proofing. This research shall generate new dimensions between two nuclear rivals as recourse to conflict mitigation and management. This research will advance knowledge in peace and conflict-related disciplines in three ways. Firstly, climate-proofing of IWT will add credibility to an existing freshwater transboundary treaty about which otherwise many questions are being raised for its efficacy. Secondly, climate-proofing of IWT will add a new dimension in conflict management, conflict resolution and peace building domains. This precedence will become a harbinger in inspiring other countries to apply climate change knowledge to improve the effectiveness of other national or international protocols in light of new technologies and

[34] Gross National Product (GNP) is an estimate of total value of all the final products and services turned out in each period by the means of production owned by a country's residents.
[35] GDP is the total value of goods produced and services provided in a country during one year.
[36] When something is synergistic, it means various parts are working together to produce an enhanced result.

practices. Thirdly, applying internationally accepted freshwater rules like Helsinki Rules[37], UN Watercourse Convention[38] and Berlin Rules[39] (Salman, 2007), and International Commission on Large Dams[40] (ICOLD) rules for managing international waters will add new knowledge and understanding in the field of Peace and Conflict Studies[41].

In the applied concept, this research will help provide regional stability in three ways. Firstly, IWT, the oldest and strongest confidence-building measure between India and Pakistan, will get reinvigorated through its climate-proofing. The instrument of conciliation will retain its cooperative mode instead of turning into a mode of confrontation and conflict. Secondly, the political and social frustration that Pakistan suffers almost every year as a lower riparian due to the extreme flooding events in IRB under the feelings of lack of information sharing and cooperation by India will be addressed after its climate-proofing is done. Thirdly and importantly, Pakistan and India are two rivals that have fought three wars in 1948, 1965 and 1971 before becoming nuclearized and the Kargil War in 1999 after becoming declared nuclear states. South Asia is a nuclear flashpoint[42]. Any instrument of understanding developed through consensus between India and Pakistan as a treaty, protocol, or agreement will add to regional peace and stability by harmonizing mutual relations between the neighboring counters.

At the national policy level, this research will contribute in five ways. Firstly, the importance of mutual bilateral or internationally mediated and brokered treaties, protocols, and agreements will be raised. These cooperation instruments will become more credible, efficient, and effective, thereby becoming promising and delivering in the eyes of dependent and linked populations and concerned courtiers, organizations, and forums. Since both Pakistan and India are now water-stressed countries, they cannot afford to wastewater in any way. They need to undertake adaptation measures to conserve water.

On the other hand, it will also outline the obligations of riparian states to conserve water through adaptation measures. Thirdly, the importance of climate change will emerge more

[37] The Helsinki Rules established the principle of "reasonable and equitable utilization" of the waters of an international drainage basin among the riparian states as the basic principle of international water law.
[38] The UN Watercourses Convention is a global framework instrument that sets out rules and principles for governing international watercourses.
[39] The Berlin Rules on Water Resources is a document adopted by the International Law Association (ILA) to summarize international law customarily applied in modern times to freshwater resources, whether within a nation or crossing international boundaries.
[40] The International Commission on Large Dams or ICOLD is an international non-governmental organization dedicated to the sharing of professional information and knowledge of the design, construction, maintenance, and impact of large dams.
[41] Peace and conflict studies is a social science field that identifies and analyzes violent and nonviolent behavior as well as the structural mechanisms attending conflicts (including social conflicts), with a view towards understanding those processes which lead to a more desirable human condition.
[42] Both India and Pakistan became nuclearized in 1998.

dominantly at the policy level to be factored in all sectors and disciplines of social, economic, and environmental domains. It will also highlight the significance of reducing GHG emissions contributing to global warming and, subsequently, climate change. Fourthly, climate-proofing of IWT will be in line with the national road map of economic growth, social inclusion and sustainable development as given in Vision 2025[43] (MoPD&R, 2019). Lastly and more significantly, climate-proofing of IWT will reflect Pakistan's resolve to implement its Intended Nationally Determined Contributions (INDC) in compliance with the decision taken at the 21st session of COP UNFCCC[44].

Pakistan has taken the lead by setting up the National Ministry for Climate Change. Yet, the realization of its impact on various sectors is still in the transition stage of understanding and application. Moreover, the awareness about glaciers fluctuation as a result of climate change has not been given due attention in relation to the consequential risk this phenomenon has on the water resources of the country. Expectedly, this research work will help develop understanding about the vulnerabilities of our water resources to global warming, assessment of the impending risk, and challenges to overcome its adverse consequences providing sustainable breathing space to future generations.

Besides, advantages visualized from the research include ushering in a new regime of climate-proofing transboundary agreements facilitating policymakers and planners to improve climate change adaptation and water management strategies and providing a foundation to academia for further research on the subject across water-sharing countries. The research outcome will be applicable at global, regional, and national levels in multiple areas like climate variability/change assessment, water resource management, food security assessment, energy security assessment, environment management, flood risk management, disaster risk reduction and climate change adaptation.

At the global level, climate-proofing of IWT will have profound and pronounced effects in conflict management by incorporating climate change phenomena in the transboundary watercourse treaty. It will manifest the resolve shown by world leaders at the 21st session of COP in Paris from 30 November to 11 December 2015. Climate-proofing IWT has direct implications on the application of the Paris agreement. Climate-proofed IWT would imply that climate change as a common concern for humanity has been acknowledged. Moreover, it would

[43] The goal envisioned for Pakistan is to be one of the 10 largest economies in the world by 2047.
[44] The 21st session of the Conference of the Parties (COP 21) took place from 30 November to 11 December 2015, in Paris, France. Paris Agreement 2015 is the outcome of COP 21.

imply that IWT has been made sustainable as the consequence of Anthropocene inspired by its guiding principle of equity. Long-term outcomes envisaged from climate-proofing of IWT will render credence to the process, which will create enviable inspiration for transboundary watercourse riparian states if emulated globally.

Finally, this thesis seeks to commission an effort to prescribe proposed arrangements for climate-proofing of IWT to introduce current climate change knowledge and promote harmony in national water resource management and foster transboundary dialogue and cooperation in IRB for effective implementation of IWT. It will have pronounced effects in the realm of peace building by incorporating climate change phenomena in transboundary water resource management, as strategic objectives of the thesis aim to project climate change abatement, international waters protection, and land degradation prevention. Therefore, the anticipated results of the research would have various physical, socio-economic, and environmental dimensions to mitigate the impact of climate change and minimize the consequences of extreme events through climate change adaptation measures. As a tangible outcome, this research is fully loaded with the potential to help better determine the water, food, energy, health, and livelihood interests of communities of both the counties and will lead to strategies to protect this interest in post IWT climate-proofed scenario.

1.8 Thesis Outline

The dissertation has been broadly divided into four parts: Part I: 'Locating the Field' that encompasses Chapters 1, 2 and 3; Part II: 'Indus Water Treaty - Genesis and Structure' includes Chapter 4 and 5; Part III: 'Climate-proofing – Framework' which constitutes Chapters 6 and 7 and Part IV: 'Carving Sustainable Water Future in South Asia' comprises Chapters 8 and 9. Following Chapter 1, the rest of the chapters have been systematically organized according to research needs. Chapter 2 frames the conceptual nexus between climate change and transboundary waters. It covers a detailed review of the literature to elevate understanding of climate change, climate variability and the factors leading to their impacts. It further outlines the climate change relationship with its impacts and consequences in its manifested form. Climate-proofing as a multi-dimensional concept focusing on global climate change practices in the segmented form is reviewed for creating interlinkages by integrating for synergistic effects. Finally, in this chapter efficacy of the climate-proofing concept is examined with respect to water resource and transboundary dependence highlighting collaborative practices for developing cooperation regimes.

It is followed by Chapter 3 that outlines the methodology adopted for conducting research. Since climate change has affected water in the most impacting form, understanding its related dimensions has been laid out to follow the correct methodology. Before outlining the methodology adopted, climate-proofing with its untrodden and unfamiliar dimensions has been briefly explained to set the stage to express the required path for research. Following the qualitative research method, a blend of phenomenology and case study approaches have been adopted since climate change (as a phenomenon) is visualized to be incorporated into a particular case of IWT. The interview method appendix sharing all details about elite interviews has also been added to this chapter. While Chapter 4 frames the evolutionary process of IWT gleaning through its historical perspective. The focal lens peeps through South Asia from its glaciated mountains to the Indian Ocean and the Arabian Sea through major river basins while dwelling upon Indus Water Basin in detail. The dynamics of colonial hydrology and partition of the sub-continent have also been briefly explained. The incompatibilities in geographical and hydrological divisions during partition highlighting water resources as an irreconcilable entity with conflictual dimensions at the state level have been briefly laid out. An overview of efforts done to resolve the Indus River water dispute before it is internationalized has also been discussed. The proposals for distributing Indus Water as given by Pakistan, India, and the World Bank have been outlined for developing background to understand IWT. Finally, the fourth chapter closes by outlining details regarding the signing of IWT.

Chapter 5 is dedicated to the overview of IWT. First, the structure and provisions of the treaty for an academic understanding are laid out. The water is divided by dividing the rivers through various articles is highlighted. For implementing the treaty, details about the transition period and replacement works with their implications are outlined. Financial contributions for replacement work by India are also highlighted to establish the context of 'give and take' in the Treaty. In this chapter, the concerns of Pakistan and India that have emerged over the period have been put together. Major controversies which have surfaced between India and Pakistan are discussed for pointing out the nature of voids existing in the treaty and their implications. Finally, the chapter is closed by giving retrospective and prospective views about the IWT. Chapter 6 is about climate change impacts on Pakistan. The co-relationship of climate change with Pakistan in a geographic, physiographic, climatological, demographic, and regional context is given. The vulnerabilities posing climate risk in the spatial domain are identified with a special focus on declining water availability. Climate change impacts are discussed threadbare for drawing relevant findings and conclusions. The expected consequences flowing from the climate change impacts are examined to establish the context for climate-proofing. Finally, in

this chapter, the interplay between national climate change and water policies is highlighted to devise a sustainable way forward in the form of climate-proofing IWT.

Chapter 7 outlines the contours of climate-proofing IWT. In this chapter, after highlighting the co-relationship between IWT and climate change, the voids in the treaty are highlighted. Water allocation strategies, response strategies, monitoring, evaluation and review processes and joint implementation concepts are discussed before outlining the contours of climate-proofing the IWT. In climate-proofing IWT with its salient features is discussed in detail. The challenges vs opportunities predicament of climate-proofing IWT is framed to complete its logic matrix. While Chapter 8 is dedicated to discussion. All dimensions relating to climate change, its impacts, and consequences are discussed to draw relevant conclusions and recommendations. IWT, with its efficacy, voids, flexibility and diminishing myths of its success, is peeped in to draw requisite inferences. Climate-proofing with its versatility, acceptability and applicability are seen to establish desired connections. Transboundary water management as a source of peace and stability is discussed particularly in the case of India and Pakistan. A need for political reorientation is also brought into the limelight. While culminating the thesis, Chapter 9 outlines the key findings and recommendations. Key conclusions are drawn for climate change, its impacts and consequences, IWT, climate-proofing and peace building, whereas the recommendations offered relate to political, institutional, diplomatic, technical, legal and academic domains.

CHAPTER: 2
UNDERSTANDING THE NEXUS: CLIMATE CHANGE AND TRANSBOUNDARY WATERS

This chapter frames the conceptual nexus between climate change and transboundary waters. It covers a detailed review of the literature to elevate understanding of the concepts like climate change, climate variability and the factors leading to their impacts. It further outlines the climate change relationship with its impacts and consequences in its manifested form. A detailed literature review concerning the global context of climate change, particularly its influence on transboundary water treaties, is also discoursed here. With respect to conflicting situations arising from transboundary water agreements, and availability of international water laws to manage such conflicts has been exhaustively reviewed by gleaning through relevant literature. This background is necessary to correctly assess the nexus between climate change and transboundary waters in general and, in specificity, the Indus Water Basin. Climate-proofing as a multi-dimensional concept, focusing on global climate change practices, presently found in the segmented form, is reviewed for creating interlinkages by integrating for synergistic effects. Finally, in this chapter efficacy of the climate-proofing concept is examined with respect to water resource and transboundary dependence highlighting collaborative practices for developing cooperation regimes.

2.1 Climate Variability and Climate Change

Climate change is a nascent phenomenon (Glantz, 2003; IPCC, 2019). The expected weather condition at a given location over time is generally considered as ‘climate’ whereas ‘climate change’ is a long-term change in the earth’s climate, especially due to an increase in the average atmospheric conditions, particularly the temperature (IPCC, 2007; Jayaraman, 2015). The anthropogenic or human-induced changes are referred to as the ‘climate change,’ whereas the natural changes in the climate are generally referred to as the ‘climate variability’ (Glantz,

2003; IPCC, 2014). Climate change is defined by the United Nations Framework Convention on Climate Change (UNFCCC, 1992)[45] as:

> A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and is in addition to natural climate variability observed over a comparable time period.

The UNFCCC's definition is more restrictive in nature and excludes climate variability from its scope. On the other hand, climate change, according to IPCC, is:

> A change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties that persists for an extended period, typically decade or longer (IPCC, 2007).

Climate change may be due to natural internal processes or external forcing or due to persistent anthropogenic changes in the composition of the atmosphere or the land use (UNFCCC, 1992; IPCC, 2007). Common sharing can be expressed as a change in the climate that persists for an extended period spanning over decades or longer, resulting from the causes of a natural process or human activities. Considering any one of the two definitions separately or combined, climate change has emerged as a phenomenon reckoned with and acknowledged as a global reality which can neither be denied nor relegated (Brown et al., 2007; Suhardiman et al., 2017). Climate change, taken as a long-term change in the climate of the Earth, is due to an increase in the average atmospheric conditions, particularly the temperature (Solomon, 2007).

With a high degree of evidence and a fair degree of confidence, the stakeholders agree that climate change has resulted from global warming (IPCC, 2019; Chegwidden, 2020). According to the IPCC Special Report, a change in global and regional surface temperature has been observed since the pre-industrial era. Human-induced activities of the last half of the 20th century are considered responsible for most observed warming. There are a host of factors that contribute to climate change, and the leading one is the Green House Gases (GHG) effect (Rasul, 2008). The concentration of main GHGs has increased; thus, causing a rise in global temperature, which is the major source of climate change. Carbon Dioxide (CO_2), during the period from 1000–1750 AD was 280 ppm (parts per million), which has steadily increased at the rate of 0.3–0.4 % per year and reached 390 ppm by 2005 AD (IPCC, 2007). During the last

[45] The UNFCCC entered into force on 21 March 1994. Today, it has near-universal membership. The 197 countries that have ratified the Convention are called Parties to the Convention. Preventing "dangerous" human interference with the climate system is its ultimate aim.

century, the global surface temperature has increased by 0.67^0 C[46] , whereas during the previous 100 years, as a linear trend from 1906-2005, the temperature rose by 0.74^0 C. In the second half of the last century, during 1955-2005, the temperature rise varied from 0.128-0.177^{0}C per decade, with the 1990s being the warmest decade as recorded since 860 AD (IPCC, 2014; De Bruyne et al., 2020).

2.2 Factors Leading to Climate Change

Most data have been considered since 1861 when the instrumental record became handily available. As per instrumental record, 1998 was the warmest year in the warmest decade of the 1990s. According to the analysis of Northern Hemisphere Proxy Data[47], the most significant increase in temperature was observed in the 20th century. The highest variability has been recorded in two spells. Firstly, climate variability is observed from 1910 to 1945 and secondly from 1976 to 2000 (IPCC, 2007; ADB, 2017). As identified by this fourth report of IPCC, the rise of temperature by 0.670 C in the last century is generally attributed to many factors. According to this report, these factors include variation in solar output measured in terms of irradiance or total radiant power received by the earth from the sun.

The GHG effect is produced as a result of travelling of solar radiations through the atmosphere with the blockade of part of the outgoing infrared radiations or gases like water vapor, CO_2, Methane (CH_4), Nitrous Oxide (N_2O), Halogenated Fluorocarbons (HCFCs), Ozone(O_3), Per-fluorinated Carbons (PFCs) and Hydro Fluorocarbons (HFCs) from the atmosphere to outer space[48]. It is also attributed to the effects of El-Nino and La-Nina[49], Southern Pacific and North Atlantic Oscillations[50] on weather affecting the precipitation regime (Casper, 2010; Olivier et al., 2017). The sea-level rise and ocean heat contents also play their due role in rising temperature and vice versa. According to Arguez and Vose (2011), the temperature rise has disturbed the weather systems. The 'disturbed' weather systems have made the precipitation uncertain, commonly referred to as erratic. As a result of this climatic disorder, each walk of life has been impacted. The most affected commodity by climate change is the water as all its main sources, i.e. ice, snow, rainfall and aquifer, have been disturbed by varying and rising temperatures (Bates et al., 2008; Asharf, 2019).

[46] It is the mean increase in global surface temperature.
[47] In the study of past climates 'Paleoclimatology', climate proxies are preserved physical characteristics of the past that stand in for direct meteorological measurements and enable scientists to reconstruct the climatic conditions over a longer fraction of the Earth's history.
[48] Ref to footnote 2.
[49] Ref to footnote 3.
[50] Ref to footnote 4 & 5.

2.3 Understanding Climate Change Impacts

All the IPCC Assessment Reports establish with a high degree of certainty and confidence that climate change resulting from global warming is an undeniable reality (IPCC, 2007; IPCC, 2014; IPCC, 2015; IPCC, 2019). After the industrial revolution[51] and the World Wars[52], the emissions of GHG mainly dominated by CO^2 due to fossil fuel burning and other human-induced activities have disproportionately increased (Dai, 2016; Field, 2014). These gases with immense warming potential are the primary reason for increasing global temperature. The increased global temperature has resulted in fast glacial melting and disturbed meteorological systems. These glacial and metrological fluctuations have ushered in an era of climate change and variability that the world was unaware of before (IPCC, 2015). Glacial melting, an indicator or a precursor of climate change and varying global weather systems have resultantly disturbed the water balance and river basins in different regions, particularly where this resource is shared and involves transboundary jurisdictions (Travedi, 2007; Dikshit, 2010). According to Brochmann and Gleditsch (2012), one of the major challenges ahead for the international community will be developing the principles, procedures, and institutions for managing and protecting shared resources such as watercourse systems when the Earth is adapting to climate change .

The rise in global temperature, mainly due to anthropogenic reasons, is instrumental in aggravating climate change. With business as usual across the globe, the triggers like continuous emission of GHG are not changing, and therefore, the increase in global temperature is also continuing unabated (IPCC, 2014). Although World Metrological Organization (WMO)[53] in 2011 had shared that out of 16 warmest years recorded, 9 top years were from the first decade of the 21st century, yet finding by IPCC AR5 that an increase of 0.6^0 C in the first decade of the 21st century has been recorded is alarming (Rasul et al., 2012). During the 21st session of the Conference of the Parties (COP) in Paris (from 30 November to 11 December 2015) under the auspices of UNFCCC, it has been highlighted that emission of estimated aggregate GHG from 2025-2030 resulting from the INDC does not fall within limits of least cost 2^0C scenarios rather it will lead to a projected level of 55 gigatons in 2030 (UNFCCC, 2015). The COP has also observed that in order to hold the increase in the global

[51] The Industrial Revolution, now also known as the First Industrial Revolution, was the transition to new manufacturing processes in Europe and the United States, in the period from about 1760 to sometime between 1820 and 1840.

[52] Two major international conflicts that occurred during the 20th century: World War I (1914-18) and World War II (1939-45).

[53] A specialized agency of the United Nations whose mandate covers weather, climate and water resources.

average temperature to below 2^0C above pre-industrial levels by reducing emission to 40 gigatons or 1.5^0C above pre-industrial level, a colossal GHG emission reduction effort will be required vis-a-vis what has been indicated in the INDCs by different nations across the globe (Jayaraman, 2015).

The climate change phenomenon is under continuous research by international organizations like IPCC and UNFCCC. Experts from related national and international departments, researchers and academicians are also researching the subject. With a very high degree of certainty, it is established that surface runoff is projected to increase in the high latitude and wet tropic regains, whereas, in mid-latitude and parts of the dry tropics, it is projected to decrease (IPCC, 2015; UNFCCC, 2015). The report reflects a general agreement that climate change will affect the timings, intensity, magnitude, and duration of water flows. Lal (2001) is also of the view that in the rain dominated basins, the runoff will be affected more than warming temperatures.

Similarly, the groundwaters will also be affected by climate change. Presently understanding groundwater while estimating freshwater quantities is very rare and is seldom included in transboundary water resources; whereas, it is a valuable source that has a bearing on water quality and quantity where extraction from an aquifer is a common phenomenon (IPCC, 2014). According to the IPCC Special Report, the recharging rate of groundwater is though site-specific yet will be affected by climate change. Due to higher temperatures, the evaporation rate will become higher, which will lead to the salinization of groundwater. As a result of reduced surface runoff, the demand for groundwater may increase in some regions, which will cause aquifer depletion putting further pressure on transboundary water resource (IPCC, 2019).

According to Pagliero and colleagues (2014), higher or warmer temperatures will cause more significant climate variability leading to extreme hydrological events[54] like floods and droughts. The research further elucidates that the frequency, intensity, duration, and magnitude of both floods and droughts are likely to increase. Flood due to an increase in precipitation intensity and, in dry regions, the decrease in precipitation intensity may lead to drought-like conditions. In addition, warmer temperatures will cause more rainfall than snow, leading to more floods in winters, whereas higher temperatures in winter also mean that what falls as snow will quickly melt and will not turn into ice, thereby creating a drought-like situation in summer (Richardson, 2011). The impact of climate change on water quality is rarely known

[54] Extreme hydrological events are the one which relate to the phenomenon of water absence or availability.

(Olmstead, 2014). Usually, water quantity remains in focus when the impacts of climate change on water resource are discussed.

Backlund and colleagues (2008) elucidate that due to climate change, the temperature of rivers, reservoirs and lakes are expected to increase, which will lead to lower dissolved oxygen concentrations and more algal and bacterial blooms. With the temperature rising and oxygen declining, the cold-water species may be denied existence by the habitat, and other species of warm water may increase instead, resulting in deteriorated water quality. Intense rainfalls may increase soil erosion and wash more pollutants and toxins into the waterway, leading to a serious risk to freshwater species and humans. To make such water cleaner, more costs will be incurred (Cooley et al., 2009). With a reduction in summer flows, the water quality concerns are likely to be further accentuated. On the coastal side, the rise in sea level is expected to push saline water into the rivers, deltas, and coastal aquifer, thereby threatening their quality and reliability.

Climate change has a direct bearing on water demand. Water demand will increase with increased population growth, urbanization, industrialization, and improved quality of life (IPCC, 2014). Similarly, water demand for climate-sensitive sectors, such as agriculture will increase as plants require more water to grow in higher and warmer temperatures. Globally, agriculture is the leading sector which accounts for about 70% of the consumption of water; more demand in this sector will apply maximum pressure on the water resource (Basharat et al., 2014).

According to Thomas, most treaties and international agreements do not incorporate the economic, social, and political impact climate change has on transboundary water resources (Thomas, 2017). Particularly in those treaties framed during the time period when knowledge about climate change was either nonexistent or rudimentary, the absence of factors relating to climate makes those treaties short of meeting standards as laid out for examples in international water law documents like Berlin Rules. The significance of the impacts of climate change is so glaring that its incorporation in transboundary water treaties is unavoidable (McCaffrey, 2003). According to Fischhendler (2004), legal and institutional adaptation to climate change uncertainties in transboundary watercourse treaties is essentially required to make it sustainable.

According to Rivera and Wamsler (2014), climate change adaptation and disaster risk management for hydro-meteorological hazards are two sides of one coin. Their research establishes that climate change has an intrinsic relationship with glaciers, whereas water with unpredictable timing and magnitude can turn into a disaster. Fourth Assessment Report of

IPCC projects that climate change results into three major impacts (IPCC, 2007). The first is physical, as it changes the natural physical environment like land erosion due to gushing melting water from glaciers. The second is ecological, as the changes in the ecosystem as elimination of forests or an increase in water levels. Third is socio-economic; the adverse effects on human or social conditions and assets. Hochrainer-Stigler et al. (2014) counter-argues that the impacts of climate change may not necessarily always be negative; these can be positive as well. They argue that flood inducing rains can be crop productive, and similarly, an intense freeze may cause a reduction in pests, thus benefiting the subsequent year harvest. Moreover, Khailani and Perera (2013) argue that whether an extreme event due to climate change leads to an extreme impact on the people or society shall depend upon the degree of exposure, vulnerability, and the magnitude of the hazard.

2.4 Climate Change Consequences

Climate change impacts lead to inevitable consequences[55]. There is a subtle equation between the impacts and the consequences thereof. Climate change consequences sprout from its impacts, so they are similar in nature but different in results. Climate Change impacts are beyond control, but consequences are manageable through adaptation and mitigation measures (Rasul, 2014). The consequences will be experienced in different sectors in physical, social, economic, political, and environmental walks of life. Climate change and its predicted impacts continuously trigger huge extreme events putting major pressure on water and the environment like the loss of species and biospheres. The loss of healthy environments and decline in biodiversity has become a recognized problem across the globe. These Anthropocene developments, both positive and negative, are impacting every walk of life. Both who consider climate change the primary global crisis and those who call this hysteria, the Anthropocene teaches us that climate change is the leading threat disturbing our environment through a water crisis, the alarming changes in biodiversity and the increasing social tensions (Grambow, 2021).

Establishing a nexus between climate change impacts and consequences will facilitate contextualizing adaptation and mitigation measures in IRB and IWT. This understanding will lead to correct conclusions and recommendations for climate-proofing of IWT. Six significant consequences result from climate change which shall be considered here for establishing nexus:

[55] Consequences result from the climate change impacts.

water security, food security, extreme events, health security, ecological system, and national security.

2.4.1 Water Security

Observational records and climate projections established by modeling and research provide immense evidence that freshwater resource is vulnerable to climate change with numerous wide-ranging consequences on societal and ecological structures[56] (Bates et al., 2008). The findings in IPCC Technical Paper are easily understandable as almost all-natural and human environments are intimately linked to the hydrological cycle. As the impacts of climate change projections on water resources will be variable, the consequences will be unpredictable in magnitude and severity (IPCC, 2014). Uncertain climate change-related variability expected in the availability of fresh water in the face of growing water demand due to enhanced agriculture production, economic development, power generation, human health, population growth and the environment is a challenging scenario for both policymakers and managers alike (IPCC, 2019). That is the reason that climate change proponents and experts are now warning the world that severe freshwater crises are in the offing (Ritchie, 2019). As reported by IPCC, the annual average river runoff and water availability in subtropics and mid-latitudes will fall by 10-30 % by the mid-21st century, whereas an increase of 10-40 % is expected in tropical regions and higher altitudes. Pachauri anticipates in his paper in the Fourth Assessment Report by IPCC that if the global average temperature rises by 2^0 C, then it will cause 20-30 % more flooding of the land area as it is being inundated by current seasonal deluges (IPCC, 2014). From the data, one can easily infer that uncertainty about water availability will lead to the water security situation.

2.4.2 Food Security

Water security and agriculture are closely interlinked. Agriculture production is dependent on the regularity and reliability of the hydrological cycle (IPCC, 2014). Uncertainty in the spatial and temporal distribution of water by rains, snow, glaciers, rivers, and aquifers variability can threaten agriculture production, hence, leading to food security (Rasul et al., 2012). Over one-sixth of the world, the population lives in basins, and during the dry season, their dependence on glacial melting is critical. Any change in the sensitive hydrological balance can adversely affect the ability of farmers and nations to produce a sustainable level of food and fiber to meet their routine dietary needs (Biba, 2016). Crop growing cycles and seasons are linked with

[56] Societal structure deals with humans whereas ecological structure deals with all other beings.

timings and volume of water availability; a variation in both will affect the sowing, growing, maturing, and yield of the crops, which can have deep social and economic impacts on the country (IPCC, 2019). According to the IPCC Special Report, by 2050, the world is likely to house 9 billion people, whereas, in South Asia, crop yields are expected to decline by 30% due to climate change. Their food needs would multiply, and similarly, water demand would increase, leading to food insecurity.

2.4.3 Extreme Events

Extreme hydrological events are directly related to the availability or non-availability of water. Glacial and snowpack melting due to warmer temperatures will cause variation in water availability, resulting in more flows in rivers and leading to flooding (Ali & Zia, 2017). Uncertainties of climate change models notwithstanding, their findings are overwhelmingly consistent. Temperatures, precipitations rate and consistency of precipitation events around the world will be impacted by climate change, which will bring more climatic variability and change, leading to extreme hydrological events like floods and droughts (Bocchiola et al., 2011). Firstly, due to decreased accumulation and increased melting periods, there will be more water in the rivers, and secondly, warmer temperatures will cause precipitation as rainfall instead of snowfall which will deny rebuilding of glaciers and snowpack (IPCC, 2014). This will again result in more melting, leading to more flooding. It is expected to have more flooding for the initial half of the century, whereas subsequently, more drought-like situations will emerge as the snowpack would have been exorbitantly melted. The consequences of floods and drought will impact water, food and energy securities with wide-ranging social, economic, political, and environmental implications (IPCC, 2019).

2.4.4 Health Security

Another worrisome consequence of the impact of climate change relates to human health. As scientists and United Nations (UN) experts expected, human health maladies, including deaths, can develop due to the variable hydrological cycle ensuing from climate change, especially in lesser developed countries (Furth, 2010. IPCC. 2014). Flooding events result in an explosion of existing sewer and treatment systems which cause water-borne and vector-borne diseases[57]. According to World Health Organization (WHO), annual deaths of 5.62 million children occur

[57] Water-borne diseases are the ones caused by pathogenic microbes spread via contaminated water. Transmission of these pathogens occurs while using infected water for drinking, food preparation, and washing clothes, among others. Vectors are mosquitoes, ticks, and fleas that spread pathogens. A person who gets bitten by a vector and gets sick has a vector-borne disease.

under the age of five due to malnutrition. 1.8 million young children die every year due to diarrheal diseases that will exacerbate due to variation in water quantity and quality under climate change. Similarly, about three million deaths annually occur due to inadequate and improper water, sanitation, and hygiene conditions (Fiorentino, 2015).

Cyril opines that a temperature rise can cause vector-borne diseases like malaria and dengue fever even in those areas which had been inhospitable to them before. Extreme flooding and drought conditions also have the potential to adversely affect the health of people. Heatwave in summer is yet another phenomenon that has increased due to climate change and is responsible for many deaths the world over (Baldwin et al., 2019; Caminade et al., 2019; Stanke et al., 2013).

2.4.5 Ecological Systems

Ecological systems and habitats are also vulnerable to climate change. Predictions reveal that under climate change in the next 50 years, 15% to 37% of species from terrestrial bio-diversity will become extinct (Keith et al., 2008). A study predicts that by 2070, the loss of fish bio-diversity in 52 rivers worldwide would be as high as 75% due to the reduction in river water flows (Xenopoulos et al., 2005). The consequences of projected climate change on ecosystems, habitats and species are wide-ranging and catastrophic. This may include disturbance in physical, chemical and biological characteristics of freshwater eco-system, retreating ice-cover resulting in the elimination of cold-water species and intrusion of warm water species and drastic effect on, especially environmentally sensitive, flora and fauna leading to extinction (Rolls et al., 2017).

Hosseini projects that warmer water temperature and more rainfall will result in water pollution due to sedimentation, nutrients, agricultural chemicals, and dissolved organized substances altering the sensitive balance of eco-systems and habitats (Hosseini et al., 2017). Heavy rains and fast voluminous flows will result in soil erosions that will transport pathogens and dissolved pollutants to surface and sub-surface aquifer water; therefore, deteriorating its quality and leading to socio-economic and environmental implications (Sasakova et al., 2018).

2.4.6 National Security

Since water and national security are intimately linked; therefore, the transboundary freshwaters resource has always remained a potential source of international conflict (Boute, 2016). Transboundary water and peace make the most significant matrix which becomes threatened due to the impact of climate change on a shared freshwater resource (Dinar et al.,

2015). United Nations realized its importance well in time and highlighted the vulnerability of freshwater resource to climate change at different global forums. Manish Bapna highlights that in 2001, the then-UN Secretary-General Kofi Annan had said, “fierce competition for freshwater may well become a source of conflict and wars in the future,” but even two decades later, the efforts to act on water issues are still being undercut by their complexity and inherently local nature (Bapna et al., 2018).

According to the UN press release in 2016, Secretary-General in Security Council stressed the promotion of water-resource management as a tool to foster cooperation and prevent conflict. He reiterated, “Population growth will make the problem worse, so will the climate change? As the global economy grows, so will its thirst. Many more conflicts lie just over the horizon” (UNSC, 2016). Incompatible water demand and availability will adversely impact the nation’s ability to ensure social and economic development, resulting in their living standards being compromised. Water, food and energy security will disturb the social fabric of society. Consequently, a race to acquire water resources could initiate confrontation and competition for survival. This could take the shape of a conflict; it may lead to war, the possibility of which will depend upon the strength and capabilities of the involved riparian states (Blaabjerg et al., 2016).

2.5 Global Context: Transboundary Water Treaties

Water is one of the major sources of disputes and conflicts amongst states (Burra, 2013). As a natural resource, hydro-politics also has a long history of conflicts in the world arena. Transboundary river basins that have led to the inking of over 300 mutual water agreements across the globe are testimony that timely management of future supply and demand matrix is necessary for peace and stability in the region in general and within the riparian states in particular. Review of transboundary agreements amongst riparian states for Rhine, Jordon, Danube, Tigris, Euphrates, and Colorado Rivers etc., show effective cooperation and coordination at play which have been suitably applied to create an environment of cooperation.

The studies by Wolf (2011) and Daoudy (2010) reveal that the conflicting situations between the riparian states have been amicably avoided with the help of transboundary agreements acting as institutional mechanisms. Water, the foundation of human life, is a finite and shared resource divided based on availability. IRS is the lifeline for the regional economies of Pakistan and Western India. Any threat to its availability is considered challenging for both countries (Khalid & Begum, 2013; Haftendom, 2000).

2.5.1 Transboundary Agreement and Conflicting Pressures

According to Boulding (2000), conflict is a struggle for values and claims over scarce status, power, and resources. The lack of agreed rules, defining the equitable distribution of shared resources, or the absence of effective monitoring and implementation mechanism intensifies the efforts to attain desired goals (Brochmann & Gleditsch, 2012). Brochmann and Gleditsch believe that if the agreed rules are established with an inbuilt mechanism to monitor and implement the distribution of scarce resources but its governance is weak to be effective, then the dominant party takes advantage of the void. Jeong (2008) argues that this breeds discontent and frustration in a relatively weaker party.

In a particular conflict situation, actions and counteractions lead to attempts to control the outcome of interventions. Since the aspirations of all stakeholders cannot be met simultaneously; therefore, the goals and activities become incompatible. When the action threatens one's interests, the conflicting pressures start developing. In a competitive environment, the stakeholders with divergent or opposing interests endeavor to deny the desired objectives. This leads to different outcomes or disagreements on the means to attain the same end, which results in tensions (Pruitt & Kim, 2004). Pruitt and Kim further mention that efforts to control each other choices and perceived goal incompatibilities result in a conflictual situation. If the sources and causes of discontent are left unresolved, then the conflict garners potential to affect negatively interdependent relationships, which otherwise would have been advantageous to both the parties (Lulofs & Cahn, 2000).

2.5.2 International Water Laws[58]

At the global level, to regulate the shared waters through a set of rules and regulations, three international organizations have crafted rules for effective governance and management of shared water resources across the globe (Petersen-Perlman et al., 2017). Petersen-Perlman and colleagues explain that the Institute of International Law (IIL) and the International Law Association (ILA) are two scholarly non-governmental organizations whereas the International Law Commission (ILC) belongs to the UN. Besides other general offerings related to water issues, IIL and ILA have immensely contributed to crafting the set of rules for the transboundary water resource. Shah says that the resolutions of IIL revolve around the emphasis of not causing significant harm to lower riparian while applying the right of water utilization. On the other hand, ILA framed the famous Helsinki Rules in 1966, which

[58] International water law is the law of non-navigational uses of international watercourses. The laws argue that a nation state has absolute rights to all water flowing through its territory.

established the principle of 'reasonable and equitable utilization' as the basic principle of international waters law (Shah, 2018).

To evaluate the appropriate and equitable allocation of water for each riparian state, Helsinki Rules have specified those factors that need to be considered. Some of the important factors to be considered include the geography and hydrology of the basin. Climate affecting the utilization of water clearly forms part of it. The economic and social needs of each dependent state concerning the dependent population have also been included. The comparative cost of meeting the economic and social needs of the dependent population through alternate means and the availability of other resources are also well addressed. Besides, the avoidance of unnecessary waste for utilization of shared waters, compensation for conflict adjustment and the probability of harm or damage avoidance to other co-basin states while applying the right of water utilization have also been included in Helsinki rules (ILA, 1966). ILC, under the UN Watercourse Convention, framed a set of rules which aim at ensuring the utilization, development, conservation, management, and protection of international watercourses (Libert, 2015). The framework given by ILC promotes optimal and sustainable utilization of shared water resource. It is needless to mention that United Nations General Assembly adopted the UN Watercourse Convention (UNGA) and opened it for signatures on 21 May 1997 and closed on 20 May 2000, with only 16 signatories in three years, as most of the upper riparian countries were reluctant to join since their status of unbridled interventionist has been streamlined in it. It entered into force on 17 August 2014 (IISD, 2014).

Like Helsinki Rules, the Convention also identifies the principle of reasonable and equitable utilization of shared water resources as the leading principle. The Convention almost considers the same factors for determining reason and equitable water utilization as has been considered in Helsinki Rules. The Convention also focuses on the principles of not causing significant harm to other riparian states while utilizing its water and advocates appropriate measures by the watercourse states for preventing damage and harm to co-basin states (Fitzmaurice, 1997). Notwithstanding little difference in expression and the language, like Helsinki Rules, the Convention also subordinates the principle of not causing harm to the principle of reasonable and equitable utilization of water. Convention advocates undertaking appropriate measures to avoid damage to other co-basin states, and in case the harm has happened to other riparian states; then the Convention creates space for the compensation for the affected riparian (Salman, 2007).

After issuing the Helsinki Rules in 1966, the ILA continued its work on the subject unabated. From 1966 to 1999, the ILA adopted various sets of rules and articles related to Flood

Control and Rules for Administration for International Water Courses (Salman, 2007). The scholarly work by ILA on international watercourses was revealed through Conferences at Belgrade in 1980, Montreal in 1982 and Seoul in 1986, which clarified the Helsinki Rules (Chauhan, 2015). Although ILA is a non-governmental organization and its rules do not have binding over the national states for implementation, its wide acceptance at a global level encouraged the Association to refine its work on the subject. In 2000, ILA issued Campione Consolidated Rules consisting of 67 rules in one instrument, which did not bring anything new; it consolidated the work in one document. Meanwhile, adoption of an almost complete set of Helsinki Rules by ILC under the UN Watercourse Convention in May 1997 raised the scholarly status of ILA, and in the year 2000, it decided to revise the Helsinki Rules, which took the form of Berlin Rules as issued in 2004 (Salman, 2007; Bogdanović, 2019).

Berlin Rules, heavily drawn from existing Helsinki Rules and UN Watercourse Convention, comprise 73 Articles which are quite comprehensive as these incorporate the experience of over four decades after the issuance of Helsinki Rules in 1966. The document is divided into 14 chapters covering a wide range of related issues on water resources. The aspects covered are beyond the rules as enunciated in Helsinki Rules and UN Watercourse Convention. The most significant aspect where Berlin Rules differ from Helsinki Rules and UN Watercourse Convention is establishing a relationship of two fundamental principles of international waters law: 'reasonable and equitable utilization' and 'obligation not to cause harm'. According to Helsinki Rules, the UN Watercourse Convention, and its endorsement by the International Court of Justice (ICJ), the principle of obligation not to cause harm is subordinated to reasonable and equitable utilization.

In contrast, in Berlin Rules[59], this status has been altered the other way round (Bourne, 2004). The Helsinki Rules and UN Watercourse Convention establish and emphasize the equal right of each riparian state to reasonable and equitable utilization. On the other hand, Berlin Rules emphasizes managing the shared water resource on a reasonable and equitable utilization basis (Lever, 2017). Berlin Rules define the term 'manage' in Article 3(14) as "the development, use, protection, allocation, regulation and control of waters." After elevating the principle of obligation not to cause significant harm over the principle of reasonable and equitable utilization in Article 12, the Berlin Rules addressed the significant harm separately in Article 16. Article 16 requires the riparian states while managing international waters, should

[59] Due to preference of 'reasonable and equitable utilization' and 'obligation not to cause harm' clauses, Belin Rules attains higher status in the International water laws.

refrain from and prevent acts or omissions within their territory that cause significant harm to co-basin states having due regard for the right of each riparian state to make reasonable and equitable use of the waters (ILA, 2004).

2.6 Climate-proofing: A Multi-Dimensional Concept

The impacts of climate change on the water are revealing. Due to global warming, the glacial melting will increase, increasing the surface water runoff or river flows (IPCC, 2007; Bates et al., 2008). Climate change will affect groundwater recharge rates. Recharge rates will increase at places, whereas in other areas, they will decline. Higher evaporation rates will salinize groundwater. Sea level rise will increase saltwater intrusion in coastal aquifers. Demand for groundwater will increase when water flows decrease. This resultantly will put pressure on transboundary groundwater systems (Kundzewicz et al., 2007; Harrison et al., 2017). Climate models predict that rising temperatures will likely increase the risk of extreme hydrologic events like floods and droughts. The frequency and intensity of floods and droughts are expected to increase (Meehl, 2007; IPCC, 2019). Water quality is also likely to be deteriorated due to water temperatures rising in lakes, reservoirs, and rivers, resulting in more algal and bacterial blooms and lower dissolved oxygen concentrations. The temperatures rise, and oxygen levels decline will disturb the habitat equation, reducing water quality (Brochmann & Gleditsch, 2012).

Water quality is also likely to be compromised due to increased erosion rates washing more pollutants and toxins into waterways, reductions in summer flow exacerbating water quality concerns, and in coastal systems, rising sea levels could push saltwater further into rivers, deltas, and coastal aquifers, threatening the quality and reliability of these systems. There is an intimate linkage between climate change and water quality (Eckstein, 2020). The effects of climate change on water demands are far less studied than impacts on hydrology. Warmer temperatures will also increase cooling water requirements for power plants and industrial operations (therefore, multiplying the water demand). In shared transboundary water resource this pressure will have implications under uncertain water availability scenarios (Smit et al., 2014).

Glantz first used the phrase ‘climate-proofing’ to describe a dual faceted phenomenon that explains a way of protecting human activities against extreme climatic conditions and limiting the climate-sensitive activities from translating into climatic or weather-related hazards (Glantz, 2003). However, over the years, the term has been distilled to be more diversified and used for different meanings related to water and land use (Hay et al., 2005).

According to Hahn and Forde (2010), it is the integration of climate change policies and measures for development planning to ensure the sustainability of investments and development. Over the years, the climate-proofing concept has evolved as an adaptive water management paradigm or futuristic framework applied to foundational water management paradigms to address climatic dictates (Veraart & Bakker, 2009). The concept is further delineated for application on water bodies like rivers and lakes, where the water is distributed to multiple consumers. Its application becomes more subtle and elusive when it comes to transboundary or shared water resource with options to be conceptualized by national, sectoral, local and project level stakeholders resulting in more resilient and efficient development measures (Cooley et al., 2009).

Climate-proofing as an idea is yet not commonly known at policy or academic levels. Like climate change itself, the concept of climate-proofing is also passing through the process of evolution as well as reliability. Broadly, climate-proofing is applied in three ways. Firstly, as a policy objective or an additional standard for sustainable water use, secondly, as a decision support system for interventions in water management to address uncertain conditions emanating from the consequence of Anthropocene and thirdly as a new planning paradigm for water management, taking into account future risks, opportunities, and associated uncertainties. Assessing and dealing with future uncertain risks remain central to all interpretations relating to climate-proofing (Hay et al., 2005; Kabat et al., 2005). Climate-proofing transboundary waters agreement is a political, technical, and legal process wherein the climate change-related provisions and clauses applicable to shared waters are appropriately added to the document to facilitate its implementation and make it more sustainable (Dinara et al., 2019). Cooley says that the process is not an end; instead, it is an effective means to bring flexibility in the treaties and agreements (Cooley & Glecik, 2011). He further expounds that applying the concept can suitably absorb the adverse effects of climate change by capitalizing on technological, institutional, social, and legal innovations.

Shah (2018) contends that the aforementioned concept, being proactive in nature, enables the stakeholders to sustain climate change dictates rather than waiting for the existing treaties to succumb to the burgeoning future pressures. He further dwells on his argument that climate-proofing is a wholesome concept wherein climate change adaptation practices that may be found in fragmented or segmented forms[60] are integrated to multiply its dividends by

[60] When climate change adaptation practices are used as standalone and not part of a system or a framework. This per say does not create synergy.

creating synergistic effects. The concept of climate-proofing is applied to transboundary agreements after establishing its feasibility and practicability. The concept is allowed to endure through a comprehensive monitoring mechanism, which gives it sustainability to meet intended future needs and dictates. The whole concept thereby results in a synergy of effort and outcome (Solecki et al., 2011). Maryam Jafroudi (2020), in her article, expounds that it is instead a legal obligation to adapt transboundary agreements to climate change. According to her the nature of disruptions caused by climate change may make it imperative for the riparian states to take all possible measures that allow them to modify their water practices under an agreement to the implications of climate change in order to comply with principles of the equitable and reasonable use of water.

The primary focus of transboundary agreements adopted during the 20th Century had been water allocation, hydroelectricity, flood control, industrial uses, navigation, pollution, and fishing (Cooley et al., 2009). On several occasions, it is realized that some aspects of the hydrological cycle, like the quantity of water in specified form, are missed out from the IWT and without considering the quantity of water, the rivers are divided. Such omissions have proved otherwise problematic, and as a consequence of Anthropocene the situation has aggravated further. In such situations, the need for climate-proofing to address the existing voids and visualize expected future problems becomes the focus climate-proofing is meant to address (Veraart & Bakker, 2009).

There are numerous examples at the international level where riparian states have practiced climate change adaptation for transboundary waters. This has led them to draw immense benefits from their outcomes. United Nations Economic Commission for Europe (UNECE) and International Network of Basin Organizations (INBO) have jointly documented 63 lessons learned from transboundary climate change adaption practices applied across basins around the world (Sanchez & Roberts, 2014). These provide a deep understanding for other riparian states which aspire for their emulation. Shah, in his paper, "Climate-proofing Indus Water Treaty: Synergistic Integration of Transboundary Waters Climate Change Adaptation Practices," tabulates leading practices adapted for shared waters by riparian states (Shah, 2018). Some of the examples include the International Commission for the Protection of Rhine (ICPR) conducted a study on 'Impacts of Climate Change on the Rhine River Basin' in 2015, recommendations of which have been implemented (Schmid-Breton, 2016). The International Commission for the Protection of Danube River (ICPDR) prepared a strategy in December 2012 to incorporate institutional mechanisms and structures in the existing legal framework for

the complete basin to address climate adaptation in the Danube basin, particularly flood risk management (Pagliero et al., 2014).

In 2009, the International Federation of Red Cross and Red Crescent Societies and National Red Cross Societies of all riparian states established Zambezi River Basin Initiative developed an effective body forging an integrated and comprehensive long-term strategy to reduce vulnerability to flooding and other risks brought about by climate change (Beilfuss & Brown, 2010). In 1995, the Mekong River Commission (MRC) signed an agreement for cooperation on the sustainable use of the Mekong River. In 2009, MRC created the Climate Change Adaptation Initiative which supports member countries to integrate climate change in development planning aspects and design frameworks that guide adaption and monitoring of implemented measures and mechanisms (Boer et al., 2016). There are several adaptation practices implemented in various transboundary waters like environmental planning in Dniester River (Libert, 2015), joint integrated assessment and eco-system adaptation strategy in Great Lakes by the US and Canada (Creed & Laurent, 2015), the Sava River Basin protocol (Komatina & Groseli, 2015), Bugesera initiative (Tenge et al., 2015) and protection of water quality in transboundary waters between China and Kazakhstan (Ho, 2017).

It is proposed in Shah (2018) research that if all the segmented practices are integrated, it can climate-proof a transboundary water treaty creating synergistic effects as a collective outcome. Climate-proofing can best deliver when flexible water allocation strategies, water quality standards, a response strategy for extreme events, improved amendment and review process and developing joint institutions are aptly incorporated in a transboundary water treaty (Cooley et al., 2009).

2.7 Efficacy of the Climate-proofing Transboundary Water Agreement

Climate change adaptation in water management falls in the water governance domain. Climate change and water both do not respect national borders; therefore, the adaptation to climate change cannot be made in isolation by one riparian state; all would have to take responsibility (Timmerman et al., 2017). Transboundary water management, in essence, is more complex than national water management because the water management regimes usually differ more between riparian states than a single country (Kalair et al., 2019). When clauses and provisions related to impacts of climate change are incorporated in a transboundary water treaty, all stakeholders become obliged to contribute to adaptation and mitigation regimes (Cooley et al., 2009; Veraart & Bakker, 2009).

Water demand has considerably increased with increased population, urbanization, industrialization, and improved quality of life in warmer temperatures. Olmstead believes that most of the treaties and international agreements, particularly those which were framed when knowledge about climate change was either nonexistent or rudimentary, do not incorporate economic, social and political impacts which climate change has on transboundary water resources, if this knowledge gap is made up, it will create more effectiveness and sustainability in the protocols (Olmstead, 2014). Blaabjerg and colleagues (2016) also believe that the absence of climate change-related factors makes those treaties fall short of the perceived sustainability standards as set out in international water law documents like the Helsinki Rules, the UN Watercourses Convention, and the Berlin Rules. The significance of the impacts of climate change is so glaring that its incorporation in transboundary water treaties is unavoidable (McCaffrey, 2003).

Fischhendler (2004) insists that legal and institutional adaptation to climate change uncertainties in transboundary watercourse treaties is essentially required to make it sustainable. At the global level, Jayaraman elucidates that climate-proofing of IWT will have a profound effect in conflict management by incorporating climate change phenomenon in transboundary watercourse treaty (Jayaraman, 2015). Climate-proofing a treaty will mean the manifestation of the resolve shown by world leaders at the 21st session of COP in Paris in December 2015 (Jafroudi, 2018). Climate-proofing of a treaty will mean that concerns expressed in the Paris Agreement[61] about acknowledging climate change have been practically applied as a common concern of human beings (Brears, 2018). By incorporating climate change as a factor in a treaty will configure it to become a sustainable instrument, particularly as the consequence of Anthropocene inspired by its guiding principle of equity and common but differentiated responsibilities and respective capabilities in the light of different national circumstances (Cooley & Gleick, 2011; IPCC, 2019; Timmerman, 2020; Wu et al., 2020).

Studies have illuminated that if water quantity in a treaty is focused without incorporating the knowledge related to climate change, it is bound to compromise sustainability under daily revealing climatic conditions (e.g., Shah, 2018; Cooley & Gleick, 2011). The aquifer is an integral part of a basin; if that is not included in the Treaty, it will remain incomplete (Asharf, 2019). Boadi and Owusu (2017) argue that provisions regarding water quality, pollution, environment, aquatic life, ecological systems, and extreme events with immense political, economic, social and environmental values are relevant for the treaty to be durable. A

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treaty should not be a standalone effort. Instead, it should be built on internationally established and accepted transboundary watercourse rules under international water laws (Barua et al., 2019). It has been further argued that the frameworks provided by international laws like Helsinki Rules (1966), UN International Watercourse Convention (1997) and Berlin Rules (2004), which are the outcome of later timeframe, if aptly incorporated, can make a treaty more efficient and effective.

Cooley and Gleick (2011) show high confidence that a treaty after becoming climate-proofed will prove sustainable due to Anthropocene. The authors reiterate that applying current climate change knowledge on a treaty can become a recourse to future transboundary water conflict management and peace building between the riparian states. Similarly, according to Kabat and colleagues (2005), the climate-proofing of transboundary water treaties has promising potential to address low probability[62] but high magnitude[63] climate events like floods and droughts by providing a long-term sustainable solution to the stresses being caused by climate change on social, political, and economic planes. Therefore, the best preposition to manage cross border climate impacts is to make it part of the mutual protocols (Benzie et al., 2019).

2.7.1 Water Resource and Transboundary Dependence

Besides the widespread impact of climate change, the impacts of increased global temperature mainly manifested in fast glacial melting and disturbed meteorological systems have been deeply felt on water (Fowler & Archer, 2005). Around 60% of global freshwater flows across politically divided borders (Rivera, 2015; Akhter, 2015). While, 40% is governed by transboundary water treaties, encompassing frameworks in the management of transboundary waters which are required to prevent or reduce the negative impacts of unilateral interventions by the riparian states (Cooley, 2009). This facilitates the application of structural and non-structural climate change adaptation and mitigation measures at the basin level. The transboundary waters cooperation framework enables the integrated development of intervention as a cost-effective solution (Thomas 2017). The cooperation framework can help synergize the hydrological effects of interventions applied by riparian states in their respective areas. Subramanian also contends that collaborative and integrative arrangements will broaden the knowledge base, enlarge the range of adaptation measures, and reduce social inequalities. As a result, the process shall promote sustainable development (Subramanian et al., 2014).

[62] Frequency of happening is less
[63] Quantum is more

Cerkasova and colleagues (2018) believe that climate-proofing will accrue huge economic benefits as well, as the cooperation framework has the potential to lead to shared costs and benefits of adaptations. Therefore, water supply from a shared water resource can have phenomenal economic impacts for riparian states, particularly the lower ones (see also Eamen et al., 2019). Karar (2017) identifies another dimension in which water governance is considerably improved when climate change is properly factored in a treaty (see also Hedlund et al., 2018; Hissen et al., 2017). Kolokytha and Skoulikaris (2019) highlight that dependencies of transboundary water on climate change can be best managed by managing its impact in a mutual protocol.

Kahsay and colleagues (2017), while expounding their views on economic and water resource availability effects of trade liberalization for Nile River, highlight that application of climate change adaptation measures on a transboundary treaty enhances economic growth and welfare in the basin. Focusing on the role of upstream changes, upstream availability (i.e. less natural runoff or increased water consumption) was identified as the dominant driver of changes in net water availability in most downstream areas. Munia and colleagues (2020) conclude in their research on 'Future transboundary water stress and its drivers under climate change: a global study' that an increased number of people will be living in areas dependent on upstream waters by the mid-21st Century. And, to sustain these people, the treaties will have an increasingly crucial role in these hot spot regions to ensure appropriate management of transboundary water resources. To this end, the up-gradation of transboundary treaties in the light of climate change was proposed as it will act as a catalyst for sustainability.

2.7.2 Collaboration Leading to Cooperation

Water is a cross-cutting element for civic amenities and merits multi-sectoral and multi-discipline attention by all stakeholders at all levels (Libert, 2015). According to Komatina and Groselj (2015), the civic requirement transcends physical, political, institutional, disciplinary, and jurisdictional boundaries. Dinar et al. (2015) insist that transboundary level cooperation shall always be necessary to address core issues. These issues shall invariably include water allocation and distribution, pollution sources, water abstraction, infrastructural development, over exploitation of scarce water resource and bearing the financial burden of water management, which shall help improve cooperation. Subramanian et al. (2014) contend that the transboundary waters cooperation framework consequently contributes to reducing poverty and inequities which accrues economic benefits through efficient and sustainable use of water resource. Daoudy (2010) believes that efficient water utilization will facilitate the exchange of

data and information and promote sustainable natural resources management of water and the eco-system and the species dependent on that waterbody.

Although awareness of the nature of water conflict and cooperation has improved over time, the likelihood of water conflicts could increase as populations continue to increase and climate change continues to reveal. If, on the one hand, climate change is posing challenges, on the other hand, its apt management is offering opportunities as well (Petersen-Perlman et al., 2017). The transboundary waters cooperation framework can prove a catalyst in reducing geopolitical pressures and build needed trust amongst the riparian states. Shah, in his research, has quoted the examples of Rhine, Danube, Mekong, Zambezi, Dniester and Sava Rivers Basins[64] etc., where cooperation between riparian states has led to the reduction of tensions (Shah, 2018). Dinar and colleagues (2019) contend that treaties are effective in the context of transboundary hydro-politics and impact water relations among riparian states and lay down the groundwork for more targeted additional treaties that can ensure sustained cooperation. Young (2015) also configures the same thinking by opining that for sustained transboundary water management, the water treaties should account for water variability and include flexible water allocation mechanisms, which are only possible if climate change-related clauses and provisions are included in the treaty.

Mgquba and Majozi (2020) illuminate that water security is of critical importance. The increased population and water demand will stress the available water resources. This is likely complicated issues of equitable water allocation and distribution. Therefore, fostering cooperation and managing conflict will become fundamental in transboundary water management. Climate change will add new challenges to pre-existing dynamics in transboundary systems that riparian states need to handle aptly and proactively. Abas and colleagues (2019) have identified that hydro-power nexus in basins are becoming new elements in power geopolitics due to the threat of 'aqua bombs' to downstream regions. The incorporation of water laws can limit such perceived water wars. De Stefano and colleagues (2017) have pointed out in their research that those river basins which do not cater for new water infrastructure, particularly as the consequence of Anthropocene, there is a high probability that political, environmental and socioeconomic factors could exacerbate hydro-political tensions, which could be addressed by incorporation of related provisions and clauses into the treaties. Gupta (2016) believes that hydro-hegemonic approaches need to be countered by applying institutionalized frameworks like the UN Watercourses Convention of 1997, which would

[64] In these protocols, the climate change adaptation practices are applied in fragmented form.

ensure that agreements become living treaties[65] and their actual influence in addressing the evolving problems in transboundary river basins remains minimal.

Khan (2018) has categorically warned South Asia that water is to fight over in the future, which could be avoided by managing its contributing drivers and movers effectively. Mahmood and Jia (2016) contend that timely assessment of impacts of climate change on the transboundary water resources and applications of remedial measures thereof can lead to a collaborative and cooperative environment (see also Qamar et al., 2019). Drawing inspiration from the Mekong River, as Sebesvari and colleagues (2017) highlighted, mainstreaming climate change adaptation into shared water resource management promises effectiveness and sustainability. However, collective action is often hard to initiate and challenge to sustain. However, it is central to addressing the water governance challenge of delivering sustainable development and regional environmental benefits in shared waters which can be done by balancing interests and focusing on common goals, whether for local water interface, watershed management or international basin cooperation (Suhardiman et al., 2017).

Timmerman (2020) impresses upon a singular factor: transboundary water resources management building resilience, the 21st-century imperative. Yang et al. (2018) indicate that alternative options for holistic water management and participatory water allocation mechanisms are norms that future frameworks need to deliver sustainable results. Zamfir (2019) identifies that the international legal framework on transboundary use of rivers and cooperation on adaptation to climate change needs to be aligned for incorporating future dictates. While Zawahri and Michel (2018), in their research, conclude that there is a need to address the voids of IWT to make it sustainable through cooperative and collaborative regimes between two nuclear rival states

2.8 Transboundary Waters

The consequence of Anthropocene poses multiple risks to transboundary waters with an inbuilt probability factor of triggering tensions within and across the nation-states (Subramanian et al., 2014; Shah, 2018; Shiklomanov, 2019). The devastating effects of flooding, drought, the rise of sea levels, the depletion of aquifer, etc., as a result of global warming, a catalyst to climate change, will not be restricted within the boundaries. Instead, it will transcend the boundaries and envelop the contiguous states under its impacts and the consequences thereof (Lehner et al., 2006). Transboundary resources are under threat of being scarce. Due to an increased

[65] Living treaty is the one which shall be revised and upgraded periodically to meet the dictates of evolving needs.

population with enhanced quality of life standards, the demand for freshwater has disproportionately increased (Mehra, 2016). This phenomenon has made the tending trajectory for creating mutual conflicts between the states very steep. The tendency to develop legal, political, and technical disputes covered through bilateral or multilateral agreements and protocols, yet uncertainty, skepticism, and vagueness has bred a sense of insecurity, leading to deepening conflicts transboundary resources (Michel, 2009). This aspect is being manifested in shared waters more emphatically.

Transboundary resources have a unique dimension of diversification of thought[66] about the issues related to its sharing, which are invariably incongruent in nature and normally, the warring factions remain skeptical about the implementation of mutually agreed decisions in an agreement. This aspect is more pronounced in the case of freshwater since it relates to day-to-day utility regimes (Wolf, 2011). Another aspect is that the commonly shared waters lack joint research as required institutional capacity does not exist at desired level mainly where political conflicts already exist on other issues (Petersen-Perlman et al., 2017). Collaborative studies and research, although on shared waters under hostile environments, are seldom conducted, but when done, they positively take riparian states towards cooperation (McCaffrey, 2003; Zawahri & Michel, 2018; Zamfir, 2019).

[66] Due to competition and incompatible goals and objectives.

CHAPTER: 3
METHODOLOGY

This chapter outlines the methodology adopted for conducting research. Before setting the methodology in motion, an insight about climate change has been afforded with its mythologically[67] perceived and manifested dimensions for laying the foundation to outline required contours for research methodology. Since climate change has affected water in the most impacting form, understanding its related dimensions has also been laid out to follow the correct methodology. Finally, before outlining the methodology adopted, climate-proofing with its untrodden and unfamiliar dimensions has been briefly explained to set the stage to express the required path for research.

Following the qualitative research method, a blend of phenomenology and case study approaches has been adopted since climate change is visualized to be incorporated into a particular case of IWT. All aspects related to elite interviews, the selected approach for data collection, sample framing, questionnaire framing, data collection and recording, the response rate with 'Cold Call' vs 'Snowball' and response saturation dimensions, consistency, reliability, and data reporting[68] have been elaborately outlined. The interview method appendix sharing all details about elite interviews has also been added to this chapter.

3.1 Climate Change: Myth or Reality?

The uncertainty of the climate change phenomenon has created unpredictability about its existence (Bates et al., 2008). The role of a leading country like the USA in pulling out from the Paris Agreement 2015 has further accentuated the gravity of the situation and has thrown a virtual reality of climate change into an abyss of myth in at least some minds (Tribune, 2017). Lack of understanding about climate change in most cases and uncertainty about the phenomenon in some cases is instrumental in dragging this reality into the domain of mythology (De Bruyne et al., 2020). The unpredictability of water availability has further exacerbated the uncertainties about the phenomenon of climate change (Boadi & Owusu, 2017; Mgquba & Majozi, 2020; Eamen et al., 2019).

[67] The understanding about climate change is still evolving from myth to reality.
[68]The research terminology like data collection, sample framing, questionnaire framing, data recording, response rate with 'Cold Call' vs 'Snowball' and response saturation dimensions, consistency, reliability, and data reporting etc. will be used and explained in this chapter in succeeding paragraphs.

The respondents generally had a fair idea about the subject, but in some cases, either correct understanding was lacking, or the misplaced understanding existed. Both the situations led to conclusions that helped conduct meaningful research about this new process of climate-proofing. The views about the consequences of the Anthropocene were though diverse, yet convergence could be traced when responses were put into an order. Since policy level[69] respondents from though varying yet related fields were engaged in conducting elite interviews, the sense about the climate change phenomenon, its impacts, its consequences, the process of climate-proofing of IWT and possible reservations by the riparian states has well precipitated in the course of research which led to a healthy analytical discussion.

3.2 Transboundary Waters Research Dilemma

Transboundary resources, water with no exception, lack joint research and an authentic knowledge base for analysis which becomes a major impediment in conducting research (Van Beek & Arriens, 2014). IWT comprises six rivers emanating from different geographical regions, has its peculiar layout, watershed, the morphology of the terrain it flows through, ecological settings, and the environmental setting. On none of the river basins, joint research has been conducted at state, institutional or academic levels (Rasul, 2014). The study revealed that, broadly, respondents understood the impact of climate change on IRB, but no one was sufficiently equipped to view deeper discussions, mainly when it came to an argument on watershed management.

For developing a meaningful dialogue during the interview sessions, in most of the cases, the knowledge base of the respondents had to be aligned through additional input for sharing views on deeper technical and political issues. Even those respondents, who were believed to have sufficient information about aspects relating to other riparian states, exhibited a void in the response which was covered through either additional questions or additional input. The positive element finally emerged that the dots got correctly connected to develop the matrix at the end of the session.

3.3 Climate-proofing Transboundary Agreement: An Untrodden Research Path

Although stand-alone climate change adaptation practices are incorporated in different transboundary water protocols, no transboundary water agreement has yet been climate-proofed

[69] For this research, policy level respondents are the one who are heading climate change related departments now or had been associated in the past.

internationally (Veraart & Bakker, 2009; Cooley et al., 2009; Cooley & Gleick, 2011; Shah, 2018; Timmerman, 2020). This element of its rarity made the research on the subject a little more subtle and elusive. In the process of research, it revealed that none of the respondents had such a comprehensive understanding of the subject that in one go, it could result in a satisfactory interactive session. The discourse always needed prompting and providing additional information to respondents to connect the dots for a clearer picture.

The understanding of incorporating climate change adaptation practices in IWT appeared abstract to the respondents during the conversion process because at least nothing has been done before in Pakistan. The absence of even a single wholesome example of climate-proofing a water treaty at the international level made the research little abstract for the respondents. However, they easily picked up the threads when provided with requisite context and content for more profound understanding based on their relevance with the subject and background knowledge they inherited under their position. Finally, the discourse always made sense. Almost all respondents were found supportive of the concept when they were shared with details about the process, and how it will accrue for the people across the divide in Pakistan and India. The specific question which pertained to climate-proofing was always placed in the mid of the discussion, and before that, impacts of climatic change were discussed, which could build the foundation for answering this exclusive question correctly even if there was a lack of detailed knowledge about the subject.

3.4 The Research Methodology

It is important to choose the correct method for conducting research proficient, cost-productive, and consequential (Cohen et al., 2007). Both categories of research, i.e. qualitative and quantitative, have their explicit features, each of which suits the research according to its nature and type (Bryman, 2007; Kabir, 2016; Yang et al., 2018). The primary purpose of qualitative research is to develop a broad picture of the research topic by usually exploring the details (Guest et al., 2013). It mainly collects verbal and non-numerical data rather than gathering measurable entities. The collected data is then interpreted and analyzed. General hypotheses or assumptions are best researched through qualitative research, particularly in an initial or early research phase when conclusive knowledge about the subject is not available (Williams, 2007). It is, instead, ideal for earlier phases of research projects. It is primarily subjective in its approach as it explores to uncover human understanding and opinion about a phenomenon or a process. Furthermore, it unveils the people's trends in thought and opinions and dives deeper into the problem for extracting the essence and core of the subject. Consequentially qualitative

research provides insights into the problem or helps to develop ideas or hypotheses for potential quantitative analysis (Defranzo, 2011). In this type of research, a researcher invariably tends to become subjectively immersed in the subject matter for developing a wholesome picture.

3.4.1 Phenomenology and Case Study Approach

Since this research pertains to the concept of climate-proofing based on the phenomenon of climate change, qualitative research is considered the appropriate method for exploring policymakers' opinions. Out of five categories of qualitative research, which include 'Ethnography', 'Biography', 'Phenomenology', 'Grounded Theory' and 'Case Study', the most relevant one found for this research was a mix of 'Phenomenological Study' and 'Case Study' (Sauro, 2015). Primary reliance is placed on respondents' perspectives to provide insight into their logic and motivations (Padilla-Diaz, 2015). Like other qualitative methods, a well-formed hypothesis or assumptions are developed. In a phenomenological study, often many interviews, usually between 5 and 25, build a sufficient dataset to look for emerging themes and use other respondents to validate the researcher's findings are conducted (Schuemann, 2014). A phenomenological study would aim to understand the respondents' experience better and how that may impact comprehension of the content at the conclusion level to develop an insight into a comprehensive picture about the concept and methodology of the practice (Neubauer et al., 2019).

Complimentary to 'phenomenology', 'case study' is considered relevant for this research. Phenomenology will cater for the discussion about the phenomenon of climate change, looking at describing the essence of this real event taking place at the global level in a protracted time frame, whereas 'case study' approach will explore the details about the concept of climate-proofing IWT by focusing at each of its aspects. A case study involves a deep understanding through multiple types of data sources (Harrison et al., 2017). Sauro (2015) contends that case studies can be explanatory, exploratory, or describe an event. Primarily, interviews and existing documents are used to achieve climate-proofing from the collected data through a case study approach. To better develop a concept, integrated samples of phenomenological study are applied for a particular case chosen for the study of IWT. Since climate-proofing a transboundary water treaty as a concept entails incorporating all clauses and provisions related to climate change related to shared waters in a treaty, both categories of qualitative research will help develop a wholesome picture about the subject.

3.4.2 Elite Interviews

Interviews offer a potentially valuable source of evidence in the process of qualitative research (Jamshed, 2014). Jamshed further expounds that the veracity of this source becomes even more authentic and reliable when a true representative sample is collected; the information obtained is accurately recorded and documented and squarely presented and reported. In phenomenology and case studies, two major categories of qualitative research, interviews are considered reliable sources of data collection (Aspers & Corte, 2019). The number and type of interviews notwithstanding, the information obtained is diversified and wide-ranging, which develops a comprehensive picture based on the considered opinions of the respondents. For this research, a semi-structured interview style has been employed. The research topic has four variables that warranted a deliberate response from the respondents. Climate change is a phenomenon about which an opinion by the subject experts was necessary to establish its impacts on Indus Water Treaty. The second variable related to the water resource in Pakistan with its transboundary and shared dimension necessitated opinion by the related experts, particularly with its social, economic, political, and environmental dimensions. The third variable relates to the concept of climate-proofing a transboundary agreement. The fourth one was about peace building, which is geo-political in nature and mainly focused on hydro-politics in the Indo-Pakistan scenario. All four variables called for different respondents, which are rarely found in the same department and academic discipline.

Scoping method of elite interviews in an informal, unstructured, flexible, and relatively formless way was employed (Mitchell, 2018). Characterization of potential respondents was done to prepare the set of questionnaires, refine and contextualize themes in the context, in the light of the diversity of the research topic. The scoping process took place with all those individuals who had broad knowledge about the subject. These conversations were used to establish rapport for semi-structured interviews. In this process, individuals were approached several times for evolving the set of respondents. Although no standard interview protocol was used yet, the conversation would remain focused on in-depth understanding and deeper information related to impending interview questionnaires and protocols. Through scoping method[70], a set of questionnaires was prepared with the possibility of moving from variable to variable, discussing inter and intra variable issues with flexibility of conversation maneuvering vertically and horizontally in search of deeper understanding and information with a semi-

[70] Scoping studies are a method to comprehensively synthesize evidence across a range of study designs. Scoping studies (or reviews) may be defined as "exploratory projects that systematically map the literature available on a topic, identifying key concepts, theories, sources of evidence and gaps in the research".

structured interview protocol. After completing the scoping process, when the interview protocol was prepared, the stage for identifying the respondents came. This was a challenge. The respondents could not be selected randomly. It had to be a deliberate selection of those individuals who could give their opinion about each variable or set of variables, and their argument is credible. For this purpose, the elite interview was considered the most suitable way of collecting the data. Elite interviews necessarily do not mean the interview of those people who are chosen because they occupy some high social, economic or political position instead here by this term it is meant a person who is selected by name or position for a particular reason rather than randomly or anonymously (Liu, 2018).

However, in this research, in most of the cases, the persons interviewed would belong to high official positions by the appointment they were holding at the time of the interview. Elite interviews have been conducted with three purposes in mind. Firstly, the research identifies the process-tracing studies of policy enactment or implementation, particularly in technical, legal, social, economic, and political domains. Secondly, to categorize and discern which institutions or processes should be carefully studied through some other means such as content analysis, formal modeling, or statistical manipulation for developing the concept. Thirdly and most importantly, to give substance and meaning to prior analyses of the phenomenon, policy formulation, and practice adaptation. Interestingly, in the process of data collection by this approach, it revealed that elite interviews complemented by the literature has an intellectual potential to lead to new concepts and alternative strategies for managing shared water resource.

3.4.3 Sample Frame

Sample framing is the most crucial data collection stage for interview-based research (Ranney et al., 2015; Robinson, 2014; Jha, 2017). Jha believes that the relevance of the sample will guarantee the correctness of the data, representativeness will promise credence to the data, and the knowledge base of the respondent will render currency to the information. In a research topic where research variables are inter-disciplinary, the subject is rare, and the resource, e.g. water under research transboundary or shared, the importance of correct sample frame attains even more significance (Mora, 2019). The second important aspect in framing the sample for research is the number, the swathe, or the expanse of canvass for choosing the respondents. The criterion for the selection of numbers is flexible and straightforward. All facets related to the research topic should be covered with a set of opinions by the minimum number of respondents required to complete the picture (Lewis & Ritchie, 2013). In the case of research, there are four main variables: climate change, climate-proofing, IWT and peace building in South Asia, about

which there can be diverse opinions. So, the sample frame has to comprise individuals from all those fields related to these variables. These facets can be political, technical, legal, environmental, and diplomatic.

Choosing a sample frame that aptly covers all related fields helps collect correct data essentially required to complete the picture in a comprehensive manner (Brannen, 2007). A sample frame is a source from where the data is collected (Sauro, 2015). In the case of this research, five main areas covering political, technical, legal, environmental and diplomatic domains were selected. Each domain is relevant in developing a wholesome picture for climate-proofing IWT. Actors of each domain have their own perspectives based on theoretical and practical motivated considerations. Construction of this sample frame explicitly catered for taking opinions from all those stakeholders who would directly influence the outcome of any change or modification or developing a separate protocol to the treaty for addressing the impacts of climate change. For example, political perspective is the most relevant domain for laying down the direction and spelling out strategic orientation to deal with a global phenomenon of climate change impacting transboundary waters. Then is the technical domain, which expounds upon the technicalities related to IWT, climate change and the process of climate-proofing. It is then followed by the legal domain, which explains legalities pertaining to local, regional and international levels for adding or incorporating clauses and provisions related to climate-proofing IWT.

The environment domain is the relevant area that shall elucidate the impact of climate change phenomenon on water, ecological systems and the consequences thereof. Finally, the diplomatic domain provides the guidelines for handling the issue of climate-proofing IWT between the states by mustering support from mediators and facilitators. The number of respondents from whom the opinion is sought through the interviews determines the size of the sample frame. The sample size depends upon five factors: the necessity or requirement for the data, affordability by the researcher, suitability of the respondent, availability of the respondent and the accessibility of the respondent by the researcher (Martínez-Mesa et al., 2016). The accomplishment of all five factors for determining the numbers in sample size is ideal, which is rarely possible in a practical sense. Though simple in understanding, the factors are loaded with the complexities in manifestation. The data necessary for the research; is it possible for the researcher to acquire or not would depend upon the time, resources, and effort available (Marshall et al., 2013).

Supposedly, the researcher can afford a collection of required data than in case of rare and specialized research that touches upon the policy and concept level issues; it is to be seen

whether suitable respondents to render such an expert opinion are available or not. If appropriate respondents are available, the researcher can access them in the available time frame, and resources will directly influence the sample size in the elite interview approach (Kindsiko & Poltimae, 2019). Considering all factors, fifteen respondents were finalized for conducting elite interviews. As the interviewing process started, the respondents seeing the relevance of the subject, did identify those specialists who were not part of the initial list but could be productive if engaged for the interview. With this snowballing effect (Lewis-Beck et al., 2011), the number grew to twenty-two. Opinions rendered by twenty-two respondents are finally included in the data for discussion.

3.4.4 Questionnaire Framing

Semi-structured interviews revolve around a set of questions framed into a questionnaire (McIntosh & Morse, 2015). Michele contends that framing research questionnaire after sample frame is the most critical instrument to gather information from respondents. She further expounds that the nature and number of questions depend upon the type and number of variables about which the information is required for completing the research. The questionnaire design, sequence, and mode of its sharing with the respondent are also important for acquiring information logically and consistently (Krosnick & Presser, 2009). Krosnick explains that the questionnaire design caters for covering all the research variables, whereas logical placing of questions in an orderly manner ensures a sequential flow of information from respondent to the researcher. Mode of questionnaire delivery to the respondent, whether through email prior to the meeting, physically handing over in a hard form in person or asking questions verbally during the interview, would also contribute to developing a flow of information. A combination of all three yields typically the best results.

The questionnaire was designed based on research variables. There are four research variables: climate change, climate-proofing, IWT and peace in South Asia. The questionnaire was designed around the core theme and a central question of whether IWT should be climate-proofed or not. The central question was asked from all the respondents. To reach the core theme conceptually, several questions were framed prior and post main questions, which were essentially required to build and conclude the concept during the interview. The first questions related to climate change as a phenomenon, its impacts in spatial and temporal domains and consequences. With that much discussion in place, the respondent would be confident to talk about IWT and the concept of its climate-proofing. At this stage, when technically or academically, the necessity has been established for climate-proofing of IWT, then the

respondent would be able to agree or disagree with the concept. In the last part of the questionnaire, the discussion revolved around two aspects. Firstly, will the stakeholders agree to climate-proof IWT? Secondly, how would it be done? There were certain respondent-specific questions asked from the specialists only, so the questionnaire remained flexible and modular. As a whole, the number of questions varied from eight to fifteen. Maximum questions were asked from academic and technical respondents, whereas lesser questioning happened with the public sector officials from political and diplomatic domains due to obvious reasons of specificity.

3.4.5 Data Collection

Since the method of inquiry applied for the research is qualitative in nature; therefore, the research integrates the knowledge from multiple disciplines of social and natural sciences to formulate a consistent set of findings for climate-proofing IWT. In the qualitative research method, each variable is rigorously questioned for focusing on 'why' and 'how' and not just on 'what', 'where', 'when' and 'who' (Whitehead & Annells, 2016). Applying qualitative research method, the information about climate change phenomenon, the events, the situations, and hard data beginning with case study concept following phenomenology approach has been collected which has been applied across different disciplines to find its impact and consequences. Primary data has been collected from concerned departments like MoCC, Ministry of Water (MoW), PMD, NDMA and PIWC. Semi-structured elite and key informant interviews with officials from concerned departments, academia and experts have been conducted nationally and abroad. Besides, secondary data has also been acquired from literature review, previous researches, data analysis carried out by experts and conclusions drawn from seminars, conferences and workshops about related subjects and disciplines.

Data collection in elite interviews from designated respondents is challenging (Sutton & Austin, 2015). After finalizing the sample frame, sample size and questionnaire design, the engagement process of respondents normally start through cold calls with no previous understanding or affiliation (Bryman, 2007). First, the respondents from policy levels are generally engaged through their aides and rarely directly. After their consent for the interview, the questionnaire is shared through email, mail, or hand-delivered means. After the respondent absorbs the questionnaire, the date and time for the interview are fixed, which usually keeps shifting due to their impromptu pre-occupations leading to intense coordination. Depending upon the location of the respondents, data collection involves long-distance air and road travel with outstation boarding in waiting for the time of interview (Barrett & Twycross, 2018). Barrett

shares that in the case of local respondents, accessibility and connectivity remains relatively convenient and flexible. For this research, semi-structured interviews invariably started in an informal and semi-structured way, leading to formal discussion from general to specificities. There were occasions when respondents got busy; the interview got delayed by weeks and months. The interviews with foreign respondents took their time. The longest time taken for responding to the questionnaire by a foreign respondent was over four months, and the top local official of water-related organization respondent was around six months.

An average, three-quarters of the hour duration of the interview proved sufficient to complete the discussion; however, in some cases where discussion remained limited or protracted, the interview duration varied. Jamshed (2014) explains that the quality of information obtained from a respondent depends on his knowledge about the subject and the intent of sharing accurate and complete information. He expounds that, on the other hand, it also depends on how the researcher channels the discussion through appropriate questioning and facilitation. Usually, it was found during the interview; very few respondents could answer all the sets of questions. Since the questionnaire comprised a series of questions related to four variables, i.e. climate change, climate-proofing, IWT and peace in South Asia, depending upon the respondent every time, the questionnaire would be instantly customized to complete the discussion. The response to the core question was always critical, which all the respondents except one odd gave categorically completing the question matrix amicably and aptly.

Typically, four ways are employed for recording data while taking interviews: video recording, audio recording, taking notes during the interview and taking notes after the interviews (Lotame, 2019). Except video recording, which was not affordable, otherwise, probably the best option to record the data with facial expressions, remaining all three options were employed for recording the data for this research. Mainly for recording data, the audio device was used. Before switching on the audio recorder, each respondent's formal permission was sought for recording and reporting verbatim.

3.4.6 Consistency and Reliability

Qualitative research is based on subjective, interpretive, and contextual data (Sauro, 2015; Barrett & Twycross, 2018; Lotame, 2019). The findings from this data are more likely to be questioned for their consistency and reliability. Both have a deep relationship. Consistency means evenness, constancy and lack of deviation, whereas reliability implies the quality of being trustworthy, credible and dependable (Leung, 2015). Leung opines that reliability is the result of consistency. In qualitative research, consistent results are reliable results. Consistency builds

harmony, coherence, and rationality in qualitative research, whereas reliability makes it dependable and trustworthy (Middleton, 2020). Middleton is of the view that both consistency and reliability are intertwined. She further expounds that reliability refers to consistency with which the research will produce the same results if repeated. She further argues that reliability is consistency across time, theme, and stakeholders. In reliable research, its form and manifestation may change, but the results remain the same.

In this research, there are four elements that need either denial or confirmation. Firstly, is the impact of climate change real? Secondly, is water being impacted by climate change? Thirdly, should IWT be climate-proofed? And lastly, will India agree to this intervention? All respondents, without exception, proffered consistent replies with an only variation of expression and context. Had the number of respondents been multiplied, the research would have yielded the same results. This consistent response renders the research desired reliability, a degree to which the research method produces stable and consistent results, essentially required to make it dependable. Both consistency and reliability testify that the respondents and not the researcher indeed shaped the findings. Response to key questions by each respondent reflective of consistency and reliability indices manifested during the process adopted for this qualitative research is shown in Annexure A. The response to each key question is over 90% which reflects a high degree of consistency and reliability.

3.4.7 Response Saturation

Saturation in qualitative research is accepted as one of the leading methodological principles (Saunders et al., 2017; Barrett & Twycross, 2018; Lotame, 2019). Saunders and colleagues (2017) believe that with widespread acceptance, response saturation is taken to reflect that further data collection is not required based on collected data and its analysis hitherto. Response saturation further refers to a point in the qualitative research process where no new information is revealed in data analysis. This redundancy of effort by the researcher generates a message that the data collection process may be ceased. In other words, data or response saturation also refers to the sufficiency of quality and quantity matrix of information in qualitative research. As discussion and exploration in research move on, the response saturation creates a condition in which an additional quantity no longer responds to some external influence; (thereby), no new findings emerge, and previous conclusions start getting reinforced (Turner, 2016).

In this research, response saturation occurred in all four thematic elements in horizontal and vertical planes. The response required was sufficiently achieved which met the dictates of the research. There were fifteen respondents initially engaged for elite interviews, five were

snowball or referral interviews, and two were impromptu interviews. Almost all the respondents gave similar responses at the conceptual level with slight variation in the operational aspects of climate-proofing IWT and the extent to which an inductive or a deductive logic is adopted. By adding the number of respondents, the response would remain the same as the saturation point had reached in collecting data-based information. The concept of saturation in the research was operationalized in a manner that was in line with the questionnaire, theoretical framework and conceptual perspective adopted for the research. The coherence and potency of research objectives were allowed to lose at no cost due to response saturation. The response saturation generated a positive message for capping the data collection process and analysis to keep the research-focused, relevant and pragmatic.

3.4.8 Data Reporting

In qualitative research, the data is collected through a variety of methods like observations, textual analysis from books or internet sources, visual analysis from videos and interviews from individuals or groups (Sauro, 2015). Data usually consists of non-numerical written expression extracted from written documents or interview transcripts which is analyzed in some ways often into themes. This data generally approximates and characterizes the opinion and thoughts of the respondent(s) on a particular issue under a specific context. While reporting the data, without simply cherry-picking the most eye-catching statement, the theme and some of the flavor of the actual words are conveyed to bring representativeness of the thought process. O'Brien et al. (2014) contend that the reported and quoted data represents the average intensity and direction of the response distilling the most extreme form of reproach or approval about a subject expressed through individual sentiment and opinion. It is further said that to convey the meaning of a quotation by addressing its representativeness and the salience of the underlying sentiment for a particular actor is the essence of data reporting.

Contrarily, Atkins & Wallace (2012) are of the view that where the divergence in opinion or disagreement over the relative influence of an aspect is clear, some interviews over others may be trusted without generating or reflecting a particular bias for absorbing explicit rationale to draw overall conclusions. Mainly data for the research has been collected through elite interviews and textual reviews. A customary approach has been followed to report data from textual review, whereas data from elite interviews has been generated through a rigorous process.

Keeping in view, each aspect enquired from or alluded to by the respondent, a set of codes as per the questionnaire was prepared. According to the nature and content, the text from each transcript was coded. Each coded text was then transferred to the respective chapter. Textually and thematically, the data was reported as per the context developed during the discussion in each chapter. Besides giving the thematic view of each respondent where required, the quotes from transcribed text are shared as the discussion develops under each subject in respective chapter.

Table 3.1: List of Respondents

	Respondents	***Date***	***Format***	***Recording***
1	Mirza Asif Beg Commissioner Indus Water Commission, Lahore	7-Jul-17	Semi - structured	Concurrent and supplementary notes with audio recording
2	Director Climate Data Processing Centre Karachi	20-Jul-17	Semi - structured	Audio Recording
3	Dr. Ghulam Rasul DG Pakistan Meteorological Department	26-Jul-17	Semi - structured	Audio Recording with supplementary notes
4	Mr. Irfan Tariq DG Environment, Ministry of Climate Change	09-Aug-17	Semi - structured	Audio Recording
5	Mr. Mehr Ali Shah Joint Secretary, Ministry of Water, Islamabad	16-Aug-17	Semi - structured	Audio Recording with supplementary notes
6	Dr. Tariq Banuri Exec. Dir Global Change Impact Study Centre, Islamabad	21-Aug-17	Semi - structured	Audio Recording
7	Dr. Tariq Altaf VP Water Resource Div. NESPAK, Lahore	26-Aug-17	Semi - structured	Audio Recording
8	Engr. Shams ul Mulk Ex Chairman WAPDA	12-Sep-17	Semi - structured	Audio Recording with supplementary notes
9	Dr. Zaigham Habib Ex Member Climate Change Task Force	21-Sep-17	Semi - structured	Concurrent and supplementary notes with audio recording
10	Dr. Muhammad Faisal DG SA MoFA	11-Oct-17	Semi - structured	Audi Recording
11	Dr. Qamar Zaman – EX DG PMD and Ex VP WMO	17-Nov-17	Semi - structured	Audio Recording

12	Shafqat Kaka Khel, Ambassador Retd.	15-Dec-17	Semi - structured	Concurrent and supplementary notes with audio recording
13	Sayed Abu Ahmad Akif, Secretary Ministry of Climate Change	19-Dec-17	Semi - structured	Audio Recording
14	Ahmad Kamal, Chairman Federal Flood Commission	29-Dec-17	Semi - structured	Concurrent and supplementary notes with audio recording
15	Mr. Mushahidullah, Minister for Climate Change	14-Feb-18	Semi - structured	Audio Recording
16	Barrister Ahmar Bilal Soofi	28-Feb-18	Semi - structured	Audio Recording
17	Dr. Chung Kyo Park, Dir Asia Region WMO Geneva	17-Oct-18	Un-structured	Audio Recording
18	Gen Muzammil (Retd) Chairman WAPDA	23-Nov-18	Semi - structured	Concurrent and supplementary notes with audio recording
19	Prof. Dr. Ing Martin Grambow, Germany	06-Dec-18	Semi - structured	Concurrent and supplementary notes with audio recording
20	Justice Jawad Hassan, Lahore High Court	03-Feb-19	Semi - structured	Supplementary notes with audio recording
21	Dr Uttam Sinah, Security and Defence Analsyt New Dehli Inida	12-Mar-19	Structured	Written Response
22	Amb Khalid Mehmood, Chairman ISSI	18-Jun-19	Un-structured	Audio Recording
23	Amb Aizaz Chouhdary, DG ISSI	18-Jun-19	Un-structured	Audio Recording
24	Dr. Muhammad Ashraf, Chairman PCRWR	3-Dec-21	Semi - Structured	Audio Recording

PART-II
INDUS WATER TREATY

CHAPTER: 4
HISTORICAL PERSPECTIVE LEADING TO INDUS WATERS TREATY

This chapter skeletons the process through which the IWT was evolved, seeing through the prism of historical perspective. South Asia is gleaned from its glaciated mountains through major rivers basins to the Indian Ocean and the Arabian Sea while elaborately focusing on the Indus Water Basin. Colonial hydrology and partition of sub-continent have their print on IWT, which have also been briefly explained. The irreconcilability in terrestrial and hydrological divisions during partition pointing out water resource as an incompatible entity with its conflictual extents at the state level have been discussed. An overview of efforts to resolve the Indus River water dispute before it was internationalized has also been put into perspective.

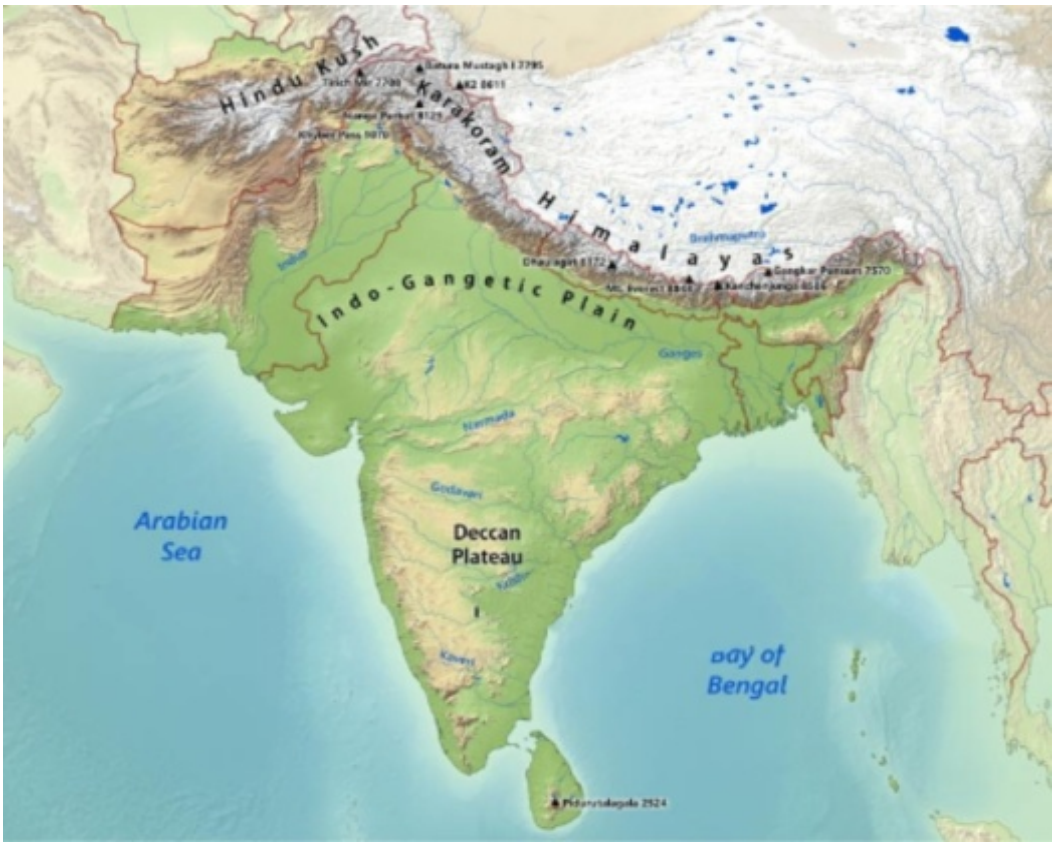
The intervention by the World Bank focusing on the visit by David Lilienthal, former Chairman of Tennessee Valley Authority, the role of Eugene Robert Black, then President of the World Bank, has also been brought to the fore. The proposals for distributing Indus Water as given by Pakistan, India and finally by the World Bank have been laid out for developing background to understand IWT. The aspects relating to the time taken by the parties for deliberation leading to a stalemate situation are also reflected upon. The financial support for the implementation of the final plan which the World Bank garnered to distribute Indus River water is also discussed. This helps develop an understanding of the practicability of the Treaty on the ground. Finally, the chapter closes on signing formalities of IWT.

4.1 South Asia: A Land Dominated by Glaciated Mountain Ranges

Asia is the largest continent on the face of the Earth (NGS, 2006). The southern countries of Asia form South Asia. This region is surrounded by the Indian Ocean in the south and West Asia, Central Asia, East Asia, and Southeast Asia clockwise from the west to east. South Asia comprises eight countries starting from the west, including Afghanistan, Pakistan, India, Nepal, Bhutan, Bangladesh, Sri Lanka, and Maldives (IDS, 2017). The South Asian Association for Regional Cooperation (SAARC), established in 1985, is an economic forum that connects all eight countries of the region into one entity (SAARC, 2013). There are three main mountain ranges, i.e. Hindu Kush, Karakorum, and Himalayan Range, in the north, which are covered

with the glaciers and make the third pole of the world. HKH Ranges is a watershed between South Asia and the remaining parts of Asia in its north (Chapman & Baker, 2002).

Figure 4.1: HKH Ranges and Major Rivers in South Asia



Source: www.freeworldmaps.net

The above Figure 4.1 shows the location of HKH mountain ranges barricading South Asia from the north. Most of this region rests on the Indian Plate and is separated from the rest of Asia by mountain barriers created by HKH. All rivers originating from the northern snow-covered HKH region flow downwards, cutting across the landmass southerly into the Indian Ocean (Indian Subcontinent, 2001; Sinvhal, 2010).

4.2 Major Rivers in South Asia

South Asia comprises glaciated mountain ranges, i.e. the Hindu Kush, Karakorum, and Himalayans as its northern rim. Afghanistan and the nations of the Indian Peninsula are isolated from the rest of Asia by these mountain barriers (Educators, 2012). These mountain ranges are the main source of fresh water. Water flows downwards from the lofty heights in the form of rivers. Indus, Ganges and Brahmaputra are three major rivers in South Asia. Indus is the longest river that originates from the high mountains of Tibet (China), flows northwest through the

Indian Occupied and Azad Kashmir region and then flows generally in the southern direction through Pakistan fall in the Arabian Sea (DAWN, 2009). The second largest river in South Asia is the Ganges. It also originates from the western Tibet region, flows across China, Nepal, Northern India, and enters Bangladesh to join the Brahmaputra before it falls in the Bay of Bengal, the Indian Ocean (Jain et al., 2007).

The third major river is the Brahmaputra which originates from eastern Tibet (China), passes through the Assam region of northeastern India, and finally falls in the Bay of Bengal after passing through Bangladesh (Ahmad & Lodrick, 2019). From the southern side, South Asia is engulfed by the Indian oceans. The Southwestern side of South Asia is the Arabian Sea, where the Indus River falls, whereas the southeastern side of South Asia is the Bay of Bengal, where the Ganges and Brahmaputra fall ultimately. These rivers serve as the cultural and economic backbone of South Asia. Over time, these rivers have contributed to the rise and prosperity of earlier civilizations and today also these are the major source of livelihood for millions of people in the dependent countries across South Asia.

4.2.1 Indus River Basin

HKH Region houses ten major river basins (Educators, 2012). These include the Amu Darya in the northwest, mainly feeding Afghanistan, Tarim, Yellow, Yangtze rivers in north and northeast feeding China, Irrawaddy, Salween and Mekong in southeast specifically providing Myanmar, the Brahmaputra in the center primarily feeding Bhutan, India and Bangladesh and the Ganges in the center mainly serving India and Bangladesh before falling in the Bay of Bengal and lastly, the Indus River Basin cutting across the entire region flowing out from its southwestern part feeds Pakistan before falling into the Arabian Sea. Indus Basin mainly draws water from the glaciers of the western Himalayas. Upper Indus Basin acts as a reservoir, holding the water for a specific period and releasing it to feed the country below (NGS, 2006). Variation in the pattern of water flow of Indus Basin will depend upon the climate change perceivably affecting the glaciers in the Northern Areas of Pakistan, thus resulting in temporal and spatial variation in the magnitude of water (Viviroli et al., 2011).

Varying outflows of melting glaciers combined with the changing rainfall patterns are likely to accentuate vulnerabilities of exposed humans and assets, leading to disastrous consequences. The absence of sufficient water storage capacity in Pakistan further exacerbates the water deficit environment wherein the main outflows, besides causing destruction, will fall in the Arabian Sea (Coenraads & Allaby, 2008). With a total area of 1,138,810 Km^2, Indus Basin cuts across the HKH region (UNEP, 2002). Different countries share basin areas. 52.48 % lies

in Pakistan, 33.51% in India, 6.69% in China, 6.63% in Afghanistan, 0.84% in Chinese control but claimed by India, 0.14% in Indian control claimed by China and a very small part of about 10 Km^2 in Nepal. Basin stretches from Himalayan Ranges in the north to the southern plains of Pakistan before it falls into the Arabian Sea. IRB covers 520,000 square kilometers in Pakistan, making 65% of its territory. Basin comprises two distinct geographical settings, i.e. upper and lower river basins. The upper reaches comprise the high mountain ranges of HKH, whereas its lower reaches comprise the dry alluvial plains of southern Pakistan. River flows of the Indus Basin include glacial melt, snowmelt, rainfall and runoff. The upper Indus River Basin houses the largest glacial accumulation globally, approximately 22,000 square kilometers (Bajracharya et al., 2016).

Figure 4.2: Major River Basins of HKH

Source: International Centre for Integrated Mountain Development (ICIMOD)

Upper Indus Basin comprises ten major sub-basins, including Swat, Chitral, Gilgit, Hunza, Shigar, Shyok, Indus, Shingo, Astore and Jhelum — 5218 glaciers, with a glaciated area of 15040.8 Km^2 and ice reserve of 2738.51 Km^3 (Bolch et al., 2012). IRB comprises six major rivers, the Indus, Jhelum, Chenab, which under IWT are known as western rivers and Ravi, Beas, and Sutlej are known as eastern rivers. Five of these six tributaries of IRB have their point of

origination in Indian held Kashmir. Indus River, the twelfth largest river globally, is the only tributary that cuts across HKH Ranges having its major part in Pakistan (Hussain, 2010). Total water from IRB amounts to 171 million acre-feet (MAF) (Akhter, 2015). 20 % of it amounting to 34 MAF flows in eastern rivers, whereas 80 % amounting to an average of 138 MAF flows in western rivers. Water from snow and glacier melt is the primary driver of the hydrological regime in IRB (Mukhopadhyay & Dutta, 2010). 34% of total streamflow in the area comes from snowmelt and 26% from glacier melt, and the remaining from rainfall (Immerzeel et al., 2010). This is corroborated by Bookhagen and Burbank (2010), who indicates the regimes sensitive to temperature. However, it is contradicted by Winiger and colleagues (2005), who suggest that 70% of runoff entering the plains is derived from seasonal monsoon rains, which appear contrary to the common concept of snow and glacier melt as the main source of the river runoff given by Viviroli and colleagues (2011).

4.3 Colonial Hydrology

Since ancient times, South Asia has been an agro-based economy. Rivers have remained the primary source of water for irrigation (Epstein & Jezeph, 2001). These rivers, mainly comprising glaciers meltwater originating from mountain regions in the north, flow south. After meeting basic agriculture, hydropower generation or domestic needs, the rivers fall into the sea. Right from the beginning, the British, after establishing their rule in the sub-continent, had realized the significance of the development of the irrigation system since agriculture was the main revenue generation source and had started efforts in that direction (Banerjee & Iyer, 2005). After having established their writ in the sub-continent, British Raj focused on increasing the revenue generation and land productivity for the Empire. The most productive area for such gains was nothing else but the field of agriculture. Thousands of years old water irrigation systems in the sub-continent were based on seasonal water availability through inundation canals and lined wells. The traditional water harvesting and irrigation system, which comprised Ahar (Tank) and Pyne (Channel) systems, was considered slow and less productive (Sengupta, 1993).

To maximize productivity, the irrigation system was to be upgraded. So, the British Raj focused on improving this irrigation system by making it perennial. The new concept that could be termed an ‘Imperial Science’ could only be possible if the water was controlled through head works and barrages and transported through the perennial canal system. This concept became the mainstay of ‘Colonial Hydrology’ (D’Souza, 2006). Completing the Upper Bari Doab Canal (UBDC) from Madhopur Head works on Ravi River in 1859 was the first project

to develop an integrated canal irrigation system under British Rule (Syed, 2007). The development of an integrated canal irrigation system continued to expand. Sirhind Canal from Rupar Head Works on Sutlej River was built in 1872, Sidhnai Canal from Sidhnai Barrage on River Ravi in 1886, Lower Chenab Canal from Khanki Headworks on River Chenab in 1892, Lower Jhelum from Rasul on Jhelum in 1901 and so forth. Development of canal irrigation system infrastructure was mainly focused on rivers like Ravi, Beas and Sutlej irrigating the lands of Punjab as it was considered a food basket that had promising dividends from an agriculture perspective (FAO, 2011). In August 1947, when South Asia was divided into two independent countries, the most highly developed irrigation system existed in the world. At that time, 31 out of 37 million acres in Pakistan were being irrigated from Indus Basin Rivers (SOPREST, 2016).

4.4 Partition of Sub-Continent

Although from the mid of 19th century, colonial rule had started receiving physical threats to its survival in the sub-continent, as is visible from the War of Independence in 1857. Yet, no threat to the homogeneity of the sub-continent was felt at that point of time since the political struggle was focused against the British and not on dividing the subcontinent into dominions or states (Kokila, 2013). It was only in the early 20th century; the creation of two different nation-states by the Hindu and Muslim entities of the sub-continent surfaced as a motivating thought (Nayar, 2015). By this time, the development of irrigation systems in the sub-continent, particularly in the province of Punjab, the food basket of the sub-continent, had already attained a natural shape of irrigating arable land with the help of headworks along the flow line of rivers like Ravi, Beas and Sutlej (Jain et al., 2007).

World War II and the struggle for independence in the sub-continent were two parallel events, though their different dynamics were yet exerting pressure on the British government to bring their empire to manageable limits (Rich, 1990). By the end of World War II, the independence struggle in the sub-continent had picked up an unbearable momentum against the British (Hussain, 2014). British had started reconciling with the emerging realities and working on an exit strategy from the sub-continent (Alam, 2002). With mounting pressures on Britain from inland and abroad was minimizing the options of retaining India as part of the Empire. Proposals for drawing boundaries between two states based on their religious majority areas had started receiving deliberations through consultative processes between leading political parties, the Congress and Muslim League (Copley, 1996). Under the pressure of this indigenous political struggle, British rule in the sub-continent weakened to its buckling limit,

and in August 1947, it led to the creation of two independent nation-states, Pakistan and India (Ali, 1967).

4.5 Incompatible Geographical and Hydrological Division

Besides other shared commodities necessitating division between two nation-states, geography and hydrology were two vital assets which needed fair division (Kokila, 2013). After the division of the subcontinent, two issues related to Kashmir and shared water resources remained unresolved (Jain et al., 2007). Before the partition in 1947, the British had developed one of the world's most efficient and largest irrigation systems in the sub-continent. At that time, approximately 37 million acres were being irrigated from the flow of the Indus River Basin. After the partition, a major part of irrigated land formed part of Pakistan. Out of 37 million acres, about 31 million acres made over 84% of irrigated land came to Pakistan's share (D'Souza, 2006). Whereas for controlling the irrigation system, the headworks were constructed upstream of all tributaries flowing through India for downstream lands, making part of Pakistan territory after partition (Basharat et al., 2014). These incompatibilities between geographical and hydrological divisions were germinated to develop into state conflicts in future.

Two major headworks were Madhopur Headwork on River Ravi from where Upper Bar Doab Canal originated and Ferozepur Headwork on River Sutlej from where the Dipalpur Canal originated (Thatte, 2008). Both of these lay on the Indian side, whereas the area to be irrigated by the canal lay in Pakistan after the partition. From these two canals, 80% (64 MAF) of the total volume of water was earmarked for the lands which made part of Pakistan, whereas just 11% (8.5 MAF) was committed for the lands which made part of India. Over 25 Million of the population benefitting from the water of these two canals was in Pakistan, which was left at the mercy of upper riparian India, and about 21 million population living on the Indian side were disconnected from their traditional source of food grain. (Kazi, 2006) That was how; disregard to the hydrology of the area while delineating geographical borders gave birth to the embryo of the Indus water dispute between India and Pakistan (Noorani, 2017). The reasons for disregard to fair division of geographical and hydrological assets notwithstanding, both the issues, i.e. Kashmir and IRB, were perpetual bones of contention between Pakistan and India and would remain so till these are resolved on sustainable foundations.

4.6 Irreconcilable Division: A Source of State Conflict

A political decision led to the divide of British India into two states, Pakistan and India, on 14th and 15th August, respectively (Ahmed et al., 2010). The boundaries were decided based on religious-socio-economic identities. This led to communal riots and killings soon after the partition announcement, resulting in 17-20 million people migrating from one side of the newly established frontier (Ali, 1967). This dreadful saga of human distress was further exacerbated due to the wrongful drawing of the border excluding Kashmir from Pakistan, leading to an armed struggle against an unpopular and unlawful decision (Sinha, 2008). This situation in the backdrop can help understand how the water issue, which any governments had not foreseen, heightened the conflict between two newly born states (Mehta, 1988). Emotionally charged politico-social environment prompted the East Punjab provincial government to apply their positional status of upper riparian (Ali, 1967). They stopped the discharge of water to the canals flowing to Pakistan on 1 April 1948 from the headworks under their control since the 'Standstill Agreement' reached between the Chief Engineers of East Punjab (India) and West Punjab (Pakistan) in December 1947 had expired on 30 March 1948 (Ahmad, 2011).

The discharge of water was resumed by Inter Dominion Accord of 4 May 1948 on payment for administrative costs by Pakistan. According to this accord, India was required to release enough water for Pakistan for annual payments. Although the Accord had met the immediate water requirements of Pakistan, by no means it was a permanent solution. Both sides were fixated on their respective position. The Indian side was more rigid, being upper riparian, and they considered that Pakistan was in no position to force India to divert water for her (Nayyar, 2010). The stoppage of water discharge to Pakistan by India rang the alarm bells into the minds of Pakistan political hierarchy, and a realization emerged for securing the economic independence and foregoing the idea of integrated economic development of Indus River Basin potential (Mehra, 2016). Out of desperation, Pakistan wanted to take the case to the Court of Arbitration, which India declined on the argument that conflict shall be resolved bilaterally (Lawakare, 2015).

4.7 Internal Water Dispute Resolution

Five recorded efforts were carried out before and after the partition to resolve the water disputes between East Punjab and West Punjab before the external players got involved (Ali, 1967; Mehta, 1988; Mehra, 2016; Lone, 2019). Firstly, before the partition, the Indian Government appointed an Indus Commission in 1941 under the chairmanship of Benegal Narsing Rau. This commission laid the foundation for riparian rights of various states and provinces dependent

on the rivers of the Indus system based on the principle of 'equitable apportionment'. This principle protected lower riparian against any disturbance of the existing irrigation system in the Indus Basin (Mehra, 2016; Mirza, 2016). Secondly, the Punjab Partition Committee (PPC) responsible for partition matters had appointed a two-member sub-committee (Committee B) to establish water availability to each canal in East and West Punjab. About two weeks before partition, on 28 July 1947, Committee B recommended that existing water supplies Even though Radcliffe Award had vested the control of headworks with India, Pakistan became complacent on Committee B recommendations and did not go for crafting some instrument that could ensure the water supplies in future (Mirza, 2016).

Since Committee B recommendations were not mutually signed by both the parties, the disagreement was bound to arise concerning the values of the canal system and crown wasteland lying in different parts of Punjab. This situation led to the setting up a tribunal for suggesting a solution to resolve the differences. As a next step, an Arbitral Tribunal was set up on 12 August 1947 under the Chairmanship of Sir Patrick Spens, which came into effect on 14 August 1947. Disputes arising out of partition could be presented to the tribunal, but till 30 November 1947, only five issues related to financial adjustment were presented, and no issue related to water apportionment came to the fore (Gulhati, 1973; Mirza, 1994). Meanwhile, on 20 December 1947, Chief Engineers from East and West Punjab signed a Standstill Agreement**.** **A**ccording to this agreement, the status quo was maintained on canals releasing waters to West Punjab. PPC unanimously approved this on the same day. It enabled submission of the claim of water share by West Punjab on 22 December 1947.

All matters presented to the Tribunal were decided by 17 March 1948. Shortly after completing its assigned mandate, its term expired on midnight of 31 March 1948. This led to the stoppage of water by India to West Punjab, Pakistan, in the early hours of 1 April 1948 (GoP, 1958). The blockage of water was open aggression against Pakistan by India. Chaudhry Muhammad Ali writes that the East Punjab ministers and officials were planning a deadly blow against Pakistan and were lulling the West Punjab government to sleep with sweet words. They were waiting for the day when the life of the Arbitral Tribunal would come to an end on March 31, 1948. On the part of East Punjab, there was Machiavellian duplicity. On the part of West Punjab, there was neglect of duty, complacency, and lack of common prudence — which has disastrous consequences for Pakistan (Ali, 1967). Sir Patrick Spens (1955), the Chairman of Arbitral Tribunal, expressed his disappointment in the same way in the following words:

> I remember very well […]. We were invited by both the Attorney Generals [of India and Pakistan] to come to our decision on the basis that there would be no interference whatsoever with the then-existing flow of water, and the award which my colleagues made, in which I had no part, they made on that basis. Our awards were published at the end of March 1948. I am going to say nothing more about it except that I was very much upset that, almost within a day or two, there was a grave interference with the flow of water-based on which our awards had been made.

This situation disturbed Pakistan immensely. An immediate request to India was made for negotiation. India was adamant not to restore water flow until Pakistan surrendered the rights on waters originating from Indian territories (Ali, 1967). The negotiations process took a month or so before both states agreed to have an interim arrangement on 4 May 1948 in the form of the Inter-Dominion Agreement, commonly known as the Delhi Agreement. According to the Delhi Agreement, the water flow was to be temporarily restored to Pakistan, allowing the Indian Government to gradually reduce the water supplies, thereby allowing Pakistan to find alternate water sources. Indian Government had also demanded seigniorage (canals maintenance) charges which the Pakistan government had principally agreed to, but the dispute over the calculation of these charges remained unresolved. At this point, Pakistan requested to refer the case to the International Court of Justice for arbitration, to which the Indian Government did not agree to lead to an impasse (GoP, 1958).

Pakistan government was under immense pressure due to the water crises which had surfaced due to Indian intransigence. Lord Mountbatten, India's Governor-General and Pandit Jawahar Lal Nehru, the then Prime Minister of India, were involved. Resultantly, a statement was got signed by the Pakistan delegation with no choice of changing a word or a coma as a pre-condition for restoring the flow of water to Pakistan (GoP, 1958). The document did not have any expiry date. Instead, it called for further bilateral discussion to settle the issue. India regarded this statement as an international agreement. India refused Pakistan's claim of it being temporary, invalid, and signed under duress and compulsion (Ali, 1967). The Delhi Agreement created a situation for Pakistan which had long-term strategic implications and consequences (Mirza, 1994). Host of issues propped up from this situation, the solution to none was visible in the offing. Pakistan again offered to refer the disputed issues to ICJ, which India declined (Ali, 1967). For about two years, India and Pakistan remained entangled in finding solutions to their water disputes. They failed to find any headway bilaterally. It was in May 1950; finally, India filed the Delhi Agreement with the UN as Treaty No. 794, which was disclaimed in December 1950 by Pakistan certifying its termination (Ali, 1967). India challenged the

Pakistani claim and registered its disclaimer in November 1951 (Mirza, 2016). This is how the issue became internationalized.

4.8 Intervention by the World Bank

In the late 1940s**,** the World Bank was established under the International Bank for Reconstruction and Development (IBRD) (Marshall, 2008). Both India and Pakistan had approached the bank separately for their respective water development projects (Ali, 1967). Coincidently, this was the time Bank was also looking for an economic venture which could help in its establishment and later become a source of its reputation. To ensure that it could raise capital in the international financial markets, the Bank was set to render technical and financial support to India and Pakistan under such a scenario (Kapur et al., 1997). The series of events that had taken place then brought the World Bank into the dispute, which ultimately led to the solution. The details are given in the succeeding sections.

4.8.1 Visit by David Lilienthal (Former Chairman of Tennessee Valley Authority)

David Lilienthal, former Chairman of Tennessee Valley Authority (TVA) and US Atomic Commission, visited the region on a research mission for writing a series of articles for Collier's magazine (Haines, 2014). Haines writes that Lilienthal's deep interest in the subcontinent was well known at the official level; therefore, he was welcomed by the highest authorities of both India and Pakistan. His arrival in the subcontinent was considered a good sign, so both the states briefed him about the situation and apprised him about their respective perspectives. It was strongly assumed by both the countries that Lilienthal would be able to bridge the gap between newly formed states. In the process, it dawned on Lilienthal that tensions between the states were critical and could not be reduced without a tangible action on the ground. Lilienthal desired that both the countries could benefit from the enormous economic potential of the basin by using modern engineering skills and building water dams with a network of linked canals (Rai & Patnaik, 2012).

Rai writes that Lilienthal had sensed that by developing the economic potential of the Indus system, Pakistan's fear of economic dependence on India would be greatly assuaged, and the Kashmir issue had turned into a bone of contention will be muted. He also realized that those important issues other than Kashmir need to be focused on where cooperation was possible. Meaningful progress in these areas could promote a sense of confidence between the two nations, leading to Kashmir's settlement. Gulhati (1973) expounds that Lilienthal had

envisioned India and Pakistan to evolve a joint program to develop the Indus River Basin System upon which both the nations were dependent for irrigation water and operate it jointly to draw optimum benefits from the arrangement.

Mehta (1988) contends that Lilienthal also had visualized that dams and irrigation canals could enhance the yield of the Indus and its tributaries to increase the food production of both countries. Mehta also highlights that Lilienthal had proposed that such a novel, imaginative plan for developing the Indus Basin should be sponsored and financed by World Bank with the help of a consortium of like-minded countries. Kapur and colleagues (1997) expound that Lilienthal suggested that the World Bank use its good office to bring both the countries to an agreement and then finance its realization on the ground.

4.8.2 Role of Eugene Robert Black

The officials at the World Bank (then International Bank for Reconstruction and Development) and the Indian and Pakistani governments received Lilienthal's proposal in a good vein (Ali, 1967; Gulhati, 1973; Mehta, 1988; Kapur et al., 1997; Mehra, 2016; Mirza, 2016; Lone, 2019). The idea persuaded Eugene Robert Black, the then president of the World Bank, to explore the possibilities of finding an innovative solution that could economically benefit newly born states. Black also found a remedy to Indian objection to third party arbitration that it would restrain itself from adjudicating the conflict; rather, it would work as a conduit for the agreement (Mason & Asher, 1973). In his correspondence with India and Pakistan, Black differentiated between the functional and political aspects of the Indus dispute. He asserted that the Indus waters dispute could be solved if functional aspects of disagreement were focused on political factors. He envisaged a group of specialists who would tackle how the waters of Indus Basin could optimally be utilized, leaving aside its historical distribution (Gulhati, 1973). In 1952, when negotiation on Indus water dispute started in Washington under the auspices of the World Bank, both Pakistan and India gave their respective proposals, which was followed by the submission by the World Bank itself (Michel, 1967).

4.8.3 Indus Waters Division: Proposal by Pakistan

During British rule, Indus Basin was developed as an integrated unit since there was a unity of control for water administration to different parts of agricultural land in Basin command areas (GoP, 1958). During the partition, the geographical division of the sub-continent left the hydrological resource divided without due rationality of its relevance and dependence (Hussain, 2018; Lone, 2019). Before the partition, the agricultural land, whether in East Punjab or West

Punjab, was irrigated through an integrated water distribution system which mainly was developed on three eastern rivers as those were the main arteries taking waters to the food basket of the sub-continent. For an understandable economic strategy followed by British Rule, no worthwhile hydrological infrastructure was developed on western rivers as those were not leading to the lands with promising economic returns (GoP, 1958).

The partition outlined borders between Pakistan and India with disregard to rivers which became the catalyst in giving birth to a serious water conflict wherein Pakistan being a lower riparian, was exposed with its vulnerabilities to upper riparian India, which had control of all hydrological structures in her hand (Hussain, 2018). With this backdrop, Pakistan envisaged its initial proposal to address its water need by maintaining a historical water utilization pattern. After the dispute had reached World Bank, as an initial proposal in 1953, Pakistan did not envisage any Indian right on three western rivers, i.e. Chenab, Jhelum and Indus and proposed only 30% rights on the water of eastern rivers, i.e. Sutlej, Beas and Ravi (GoP, 1958; Michel, 1967; Mirza, 1994). From a Pakistani standpoint, it was clear that it did not visualize any water usage by India from western rivers; however, India could use some from eastern rivers.

4.8.4 Indus Waters Division: Proposal by India

Before going to World Bank through David Lilienthal, there had been efforts by both the states to reach an amicable solution to the water dispute. During those efforts, India had shown its cards and given a proposal in 1950 (Gulhati, 1973). According to that mindset, the Sutlej River, upon which Bhakra Dam was being built, should exclusively rest with India. Secondly, the Beas, Ravi and Chenab be allotted to Pakistan with certain provisions in favor of India; thirdly an arrangement of link canal from Chenab to East to meet water shortfall and finally if the shortfall still exists, a dam on River Chenab be built to meet the water requirement. This proposal by India was under consideration, but within a concise time, the atmosphere completely changed, and the deliberation process could not materialize (Ali, 1967; Mirza, 1994).

After the partition, both the states had fought a war on Kashmir which had a deep impact on the respective positions of India and Pakistan. Their positions in the process had hardened (Ganguly, 2001). In retrospect, the Indian proposal centered on the pre-partition idea of basin unity, water storages and linkages in Indian controlled areas. Broadly, the Indian proposal in October 1953 envisaged Indians 100% rights on waters of three eastern rivers, i.e. Ravi, Beas and Sutlej and 7% from three western rivers, i.e. Indus, Jhelum and Chenab (GoP, 1958; Michel, 1967; Mirza, 1994). Contrarily, from an Indian standpoint, it was clear that it did not visualize

any usage of water by Pakistan from eastern rivers, however from western rivers, India could take little share for maintaining its lien on those rivers irrespective of the necessity.

4.8.5 Indus Waters Division: Proposal by World Bank

From the proposals presented by both the states in Oct 1953, the Bank realized both sides' sensitivities and mindsets. It also acknowledged that technicalities are one part of the plan, whereas to bring comprehensive and completeness in the proposal, other factors like pragmatism and expediency also need to be incorporated (WB, 1954). On 5 February 1954, World Bank proposed the Indus Rivers System division. Based on a general principle that except for local uses in Kashmir, the World Bank proposed that three western rivers would be exclusively reserved for the use and benefit of Pakistan, and the three eastern rivers would be entirely reserved for India (WB, 1954). The allocation of Indus waters proposed by Pakistan, India and the World Bank is tabulated by Fowler as shown in Table 4.1 (Fowler, 1955).

Table 4.1: Indus Basin Water Allocations as proposed by Pakistan, India, and WB in 1953/54

Sr. No.	Details	Pakistan's Proposal	India's Proposal	WB Proposal
1.	***Total Usable Water***			
	Million Acre Feet	118	119	119
	Billion Cubic Meter	145.14	146.37	146.37
2.	***For Pakistan***			
	Million Acre Feet	102.5	90	97
	Billion Cubic Meter	126.07	110.7	119.31
	Percent of Total	87%	76%	81%
3.	***For India***			
	Million Acre Feet	15.5	29	22
	Billion Cubic Meter	19.06	35.67	27
	Percent of Total	13%	24%	19%

Source: F. J. Fowler, "Some Problems of Water Distribution between East and West Punjab," *Geographical Review* 40, no. 4 (1955) 583-599.

Although the proposals by India and Pakistan were divergent, yet, those had commonalities as well, which have been summarized as under:

> Despite differences, interestingly, the plans had a couple of common points too: (i) each party had favoured its own uses above the others; (ii) water availability estimates made by them were nearly similar; (iii) both rejected an integrated approach to share the waters between them; (iv) both appeared to recognize that India's use of the Indus basin could

only come from the eastern rivers; and (v) neither side endorsed each other's allocations for planned uses and future development (Kirmani & Moigne, 1997).

Views by the respondents about the division of water finalized by the World Bank are diverse:

> [A]ctually, IWT was negotiated in a way the circumstances were not favorable to Pakistan because, for instance, the international law was in its infancy. The only international precedence that you had at that time was two; one was American-Mexico Agreement on the Florida River in which the supremacy in a way the rights of the upper riparian were accepted, but the weakness of upper riparian was also kind of responsible for ensuring that there is absolutely no hindrance on flows into the US. The second is the Nile River Agreement. It is again the only agreement in the world where the lower riparian interests are better protected than the upper riparian because all the eight upper riparians happened to be weaker than the lower riparian (S. Kakakhel, personal communication, December 15, 2017).

> The division of water proposed by the World Bank was an unhealthy one. We didn't divide water, rather we divided rivers. Waters of complete rivers cannot be given to one party. This division had implications that we, as lower riparians, shall continue to face under existing conditions (M. A. Baig, personal communication, July 7, 2017).

> Due to this arrangement, we are able to deal with India at Indus Water Forum. If they (India) do anything wrong, we can bring them to the table through this instrument (IWT) which otherwise wouldn't have been possible (M. A. Shah, personal communication, August 16, 2017).

4.9 Time for Deliberations or a Stalemate

By 1954, the deep differences between both the disputants, India and Pakistan, had fully surfaced, and therefore, the idea of integrated IRB management as envisioned by David Lilienthal was finally abandoned by the World Bank. After a period of one month and a half, India consented to the proposal of the World Bank by March 1954 (GoI, 1954; GoP 1958; Mirza, 1994). Pakistan being skeptical, did not respond instantly. Pakistan launched its multi-pronged efforts to establish the efficacy of the proposal by the World Bank. Firstly, Pakistan approached an American Irrigation Consultant Mr. Royce J. Tipton, to propose independent of the Bank's proposal (GoP, 1954). Secondly, Pakistan approached the Bank for discussion, particularly on their objection of need and water flow requirement in light of the proposal (Mirza, 1994). Tipton's report highlighted to the Bank by Pakistan that the waters of western rivers were insufficient to meet the irrigation needs of cultivated land without storage capacity in Pakistan (GoP, 1958).

In January 1955, talks amongst parties for interim arrangements started. A series of ad hoc agreements were signed, which extended till 31 March 1960 (Mirza, 2016). During 1955 and 1956, Pakistan kept reiterating its viewpoint to the World Bank that its proposal of 5 February 1954 did not meet its irrigation needs. After a rigorous discourse of eighteen months, the World Bank accepted Pakistan's argument and conceded by issuing an Aide Memoire on 21 May 1956, wherein the necessity of building Pakistan's storage capacity was acknowledged. Nasrullah expressed that the World Bank had called for an adjustment in its February 1954 Plan to assure timely water supply to Pakistan. This adjustment could be managed in two possible ways: firstly, in the form of water delivery to Pakistan continuously from eastern rivers; secondly, construction of storage facilities on the western rivers with India's contribution. The Bank preferred the later course of adjustment (Mirza, 2016).

In the light of the aide-memoire, Pakistan agreed to work out a plan. The plan was to include the transfer of supplies from the Western rivers to replace, to the extent possible, the supplies historically used by Pakistan from Eastern rivers. It was apparent that available supplies in the Western rivers during July and August were surplus to Pakistan's historical uses, and the requirements of projects in progress were sufficient to meet the entire requirement of Pakistan's existing uses on the Eastern rivers during these months. This fact alone was to determine to a large extent the capacities and the alignment of the necessary link channels, working out the aspect of the problem could, therefore, proceed immediately even before the ultimate apportionment of supplies is finally determined (GoP, 1954). A representative from the Government of Pakistan stated:

> Assuming that India agrees that supplies from the Western rivers should be transferred to meet the full requirements of Pakistan's existing uses on the Eastern rivers during July and August (and to pay the cost of link channels and other works of necessary capacity), the volume of deliveries required from Eastern rivers will be substantially reduced (GoP, 1954).

While deliberating upon the ultimate division of water which was to be done under a comprehensive plan, Pakistan expressed its four major concerns. Firstly, what supplies shall be provided for Pakistan's historic uses and projects in progress on the Western rivers? Secondly, what new engineering works shall be undertaken? Thirdly, what supplies shall be assumed to meet Pakistan's requirements? Finally, what adjustments shall be made if the dependable flow supplies available are insufficient to provide for Pakistan's historic uses and projects in

progress on the Western rivers? To all these concerns, the Bank explained that all aspects would be adequately adjusted, leaving no dispute at the time of the final decision (GoP, 1954).

In the light of the 1956 Aide Memoire, both India and Pakistan readjusted their proposals in 1958. The Indian side was inclined towards transportation water from eastern rivers through diversion tunnels or storage capacity on the Indian side. In contrast, Pakistan insisted on developing storage capacity and transportation of water to the eastern part of the country, developing infrastructure on Pakistan side (Khosla, 1958). Considering all the factors and explanations, Pakistan presented its London Plan to the Bank and India in July 1958. The main features of Pakistan proposal for interjecting in the Bank's proposal are summarized by Nasrullah as under:

> It proposed the construction of dams on the rivers Indus and Jhelum and ten link canals instead of the Upper Indus Link canal, construction of which would have been too expensive. The Tarbela Dam on the Indus River envisaged providing water reservoir for development in Sindh, and replacement in Punjab and Bahawalpur via two trans-Thal link canals transferring water from Kalabagh to Jhelum and Taunsa to Panjnad. In Pakistani-held Kashmir, the Mangla Dam on the Jhelum River planned to supply replacement water to Punjab. On the tributaries of rivers, Indus and Jhelum, three additional subsidiary dams were also proposed to transfer the stored water to the upper parts of Punjab and Bahawalpur via a series of link canals (Mirza, 2016).

To this proposal, Nasrullah alludes to as under:

> Pakistani plan persuaded the Bank to look into its real concerns. Because without some storage facilities, the flow supply of western rivers was inadequate to replace Pakistan's existing uses of the waters from the eastern rivers; and Pakistan, with limited resources, could not construct any dam (Nasrullah, 1991).

Nasrullah writes that Eugene Black had himself later pointed that deliberations by Pakistan made the situation clearer; otherwise, the Banks proposal would have left much of Pakistan's irrigation system without water. It revealed that the proposal by Bank did not include a standard of fairness under International Law as it failed to distribute water equitably (Tipton, 1963). After consistent pursuance by Pakistan, the Bank felt it necessary that an adjustment in February 1954 proposal is essentially required. The Bank considered that water supplies to Pakistan should be ensured by eliminating shortages. This could be possible through two options, i.e. through a continued and timely transfer of water to Pakistan from eastern rivers or ensuring water availability to Pakistan through the construction of storage dams on western

rivers. The Bank preferred the second option and suggested maximum exploitation of Western rivers' flows (Mirza, 2016). Solving this basic issue took four years of deliberation to reach a concrete solution. Then came the problem of financing the implementation of this plan. This took two more years to turn this dream into a reality (Nasrullah, 1991).

4.10 Financial Support for Final Plan

The final outline of the agreement that emerged after four years' deliberation was highly technical and based on an engineering solution. If the eastern rivers, as proposed by the Bank, would go to India on the one hand and Pakistan, on the other hand, would demand an assured water availability arrangement, then the onus of realizing such a plan rests on the Bank. The realization of this plan needed colossal funding. As a condition, once the Bank had asked India to provide assured water to Pakistan through alternate arrangements if eastern rivers go to India, it had refused (Alam, 1998). The Bank resorted to economic diplomacy to meet the requirement of constructing water storage facilities on western rivers and the canals to transfer water from these facilities to the eastern part of Pakistan. In the process, a total of eight donors got managed. The list included six friendly countries like the USA, UK, Canada, Australia, West Germany band New Zealand, besides India and the Bank which contributed finances to sustain the expenditure of constructing such a huge technical feat within a short period of time (WB, 1964).

Repayable grants and loans by Pakistan were extended in 1960, whereas supplemental tranches were released in 1964. The contributions by donors included GB£ 62.06 Million by India, US$ 416.81 Million by the USA, GB£ 34.86 Million by the UK, A£ 11.633 Million by Australia, Can$ 38.911 by Canada, DM 206.4 Million by West Germany, NZ£ 1.504 Million by New Zealand and US$ 148.54 Million by the World Bank (WB, 2018 June 11).

4.11 Signing of the Treaty

After a strenuous effort of about eight years, the World Bank had been able to iron out all legal, technical, and financial details for finalizing the Indus Waters Treaty. The treaty fixing and delimiting the rights and obligations of both India and Pakistan for the use of waters of the Indus Rivers System was all set to be signed by mid-1960 (Nasrullah, 1991). Finally, the document was signed by the President of Pakistan Muhammad Ayub Khan and the Prime Minister of India Pandit Jawahar Lal Nehru on 19 September 1960 in Karachi under the auspices of the World Bank (Khan, 1967). The signing of the Indus Waters Treaty, as shared by Ambassador Shafqat KakaKhel, was the problematic moment for President Ayub khan as the strongest opposition he faced was from technocrats when he was considering whether to accept the draft presented by

World Bank a few months before signing of the treaty (S. Kakakhel, personal communication, December 15, 2017). Mehr Ali Shah, Joint Secretary from Ministry of Water, describes the situation at the time of signing of the treaty in his word as under:

> The signing of the Indus Water Treaty was a political decision. Although the technocrats raised their voice, it was finally muted under political compulsions. That was the decision of leadership at that time. Pakistani top engineers asked president Ayub Khan to clarify the situation to them. President Ayub Khan addressed 40 engineers in Punjab Assembly and took them into confidence. President pointed out that if the treaty was not signed now, there were prevailing chances that the water issues would precipitate war between India and Pakistan. Today, if we see that decision in the bigger picture, it was not bad, although it was not ideal either. It happens to be a good decision; at least we had a decision. The treaty was neither a total win for Pakistan nor India; it was a win-win game for both the states (personal communication, August 16, 2017).

CHAPTER: 5
AN OVERVIEW: INDUS WATER TREATY

This chapter is dedicated to the overview of IWT. The structure and provisions of the treaty for an academic understanding are laid out. The water has been distributed by dividing the rivers through various articles has been highlighted. For the implementation of the treaty, the details about the transition period and replacement works with their implications are drawn. India's financial contributions for replacement work by India are pointed out to establish the context of concessions by each party in the Treaty. Details about data sharing by both parties for sustainability in future through cooperation paradigm is highlighted. The institutional mechanism for making the treaty functionally sustainable by incorporating articles on Permanent Indus Waters Commission, settlement of differences and disputes, emergency management and binding guidelines for the parties are covered for understanding the linkages in IWT.

5.1 Treaty Structure

Indus Waters Treaty is a comprehensive document prepared by the collaborative effort of the politicians, diplomats, strategists, engineering and finance technocrats, bankers and consultants. According to Ahmer Bilal Soofi, IWT is so craftily structured that meddling with it will impinge upon its homogeneity (personal communication, February 28, 2018). This document is considered a success story for all and a win-win game for both the disputants (M. A. Shah, personal communication, August 16, 2017). Although major players in preparation for this treaty were India, Pakistan, and the World Bank, the financial contributions from the USA, UK, Canada, Australia, West Germany, and New Zealand cannot be ignored. The IWT signed on 19 September 1960 to be effective from 1st April 1960 starts with a preamble which outlines the objectives, plenipotentiaries and its subsequent structure as under (WB, 1960):

> The Government of India and the Government of Pakistan, being equally desirous of attaining the most complete and satisfactory utilization of the waters of the Indus system of rivers and recognizing the need, therefore, of fixing and delimiting, in a spirit of goodwill and friendship, the rights and obligations of each in relation to the other concerning the use of these waters and making provision for the settlement, in a cooperative spirit, of all such questions as may hereafter arise in regard to the interpretation or application of the provisions agreed upon herein, have resolved to conclude a Treaty in

furtherance of these objectives, and for this purpose have named as their plenipotentiaries who, having communicated to each other their respective Full Powers and having found them in good and due form, have agreed upon its Articles and Annexures.

The Treaty comprises twelve Articles and eight Annexures. The Treaty outlines principles to share the water of the Indus River Basin between Pakistan and India. It specifies the jurisdictions of both the countries on different sets of rivers in western and eastern halves. Treaty also defines the rights and obligations of both Pakistan and India while sharing the water. Article I spell out important, relevant definitions of all those words, phrases and terminologies used in the Treaty. Articles II to IV lay down provisions regarding Eastern and Western Rivers. Who will use water(s) of which rivers for how much time and in how much quantity has been spelled out in these three Articles (?) These Articles also give specific details of the rights and obligations of both India and Pakistan for the duration of the transitions period during which replacement works by Pakistan will be constructed, and India would continue to supply waters albeit on payment. Article V stipulates financial provisions regarding fixed contributions though in installments by India to Pakistan for construction of replacement works for carrying waters from Western Rivers to the command areas of Eastern Rivers, which had been to India according to Treaty.

Article VI lays down provisions for sharing data concerning the flow in and utilization of the waters of the Rivers by the Parties regularly. Article VII reflects that both parties recognize that they have a common interest in the optimum development of the Rivers, and, to that end, they declare their intention to cooperate by mutual agreement to the fullest possible extent. Article VIII specifies the instrument of cooperation as the Permanent Indus Commission. A high-ranking competent Commissioner was appointed as representative of his government for all matters arising out of the Treaty and served as the regular communication channel on all matters relating to the implementation. Article IX spells out the procedure and methodology for settling differences and disputes through the Commissioners, Neutral Experts and Court of Arbitration. Article X outlines Emergency Provisions with respect to the timeframe for the execution of replacement elements by Pakistan. Article XI gives General Provisions, particularly the parties' agreement not to invoke this Treaty. Article XII provides Final Provisions wherein the Treaty is closed and signed by both the plenipotentiaries (WB, 1960).

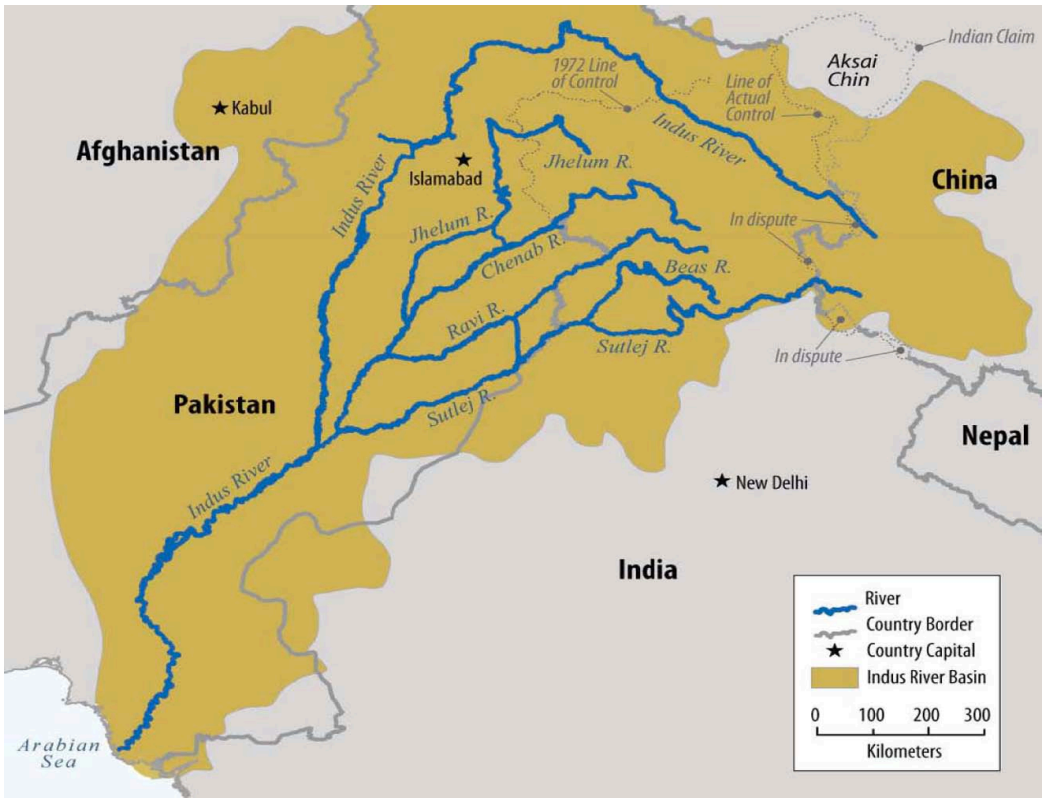
There are eight Annexures in support of the Articles. Appendixes further support the Annexures. Annexure A is about the exchange of notes between the governments of India and

Pakistan, particularly with regards to the New Delhi Agreement of 4 May 1948. In support of Article II (3), Annexure B is about agricultural use by Pakistan from four Tributaries of River Ravi. Annexure C supports Article III(2)(c), which is about agriculture use by India from the Western Rivers. Annexure D supports Article(2)(d) about India's hydroelectric power generation on the Western Rivers. Annexure E, in support of Article III (4), is about the storage of waters by India on Western Rivers. Annexure F in support of Article IX (2) concerns Neutral Expert. Annexure G supports Article IX (5) relates to the Court of Arbitration. Finally, Annexure H supports Article II (5) is about transitional arrangements. This is an exhaustive Annexure that gives details about the utilization of waters by India and Pakistan during the transition period (WB, 1960).

5.2 Division of Waters

Water in Indus Basin is distributed by dividing the rivers. One of the respondents, Mirza Asif Baig, expressed his views that in IWT, the division of Indus Basin Waters is the division of Indus Basin Rivers (personal communication, July 7, 2017). Correctly so, Article II stipulates that all the waters of the Eastern Rivers, i.e. Ravi, Sutlej and Beas, shall be available for the unrestricted use of India with two exceptions. The first exception is that Pakistan shall use waters of the Sutlej Main and Ravi Main in the reaches where these rivers flow in Pakistan for domestic, non-consumptive and agriculture purposes. The second exception was time-bound, which allowed Pakistan to use Eastern Rivers waters as laid down in Annexure H for the transition period from 1st April 1960 till 31 March 1970 extendable to 31st March 1973. During this period, Pakistan was to complete its replacement works, which would ultimately end this use. Details regarding the release of water by India in Eastern Rivers for Pakistan are given in Annexure H (WB, 1960).

Figure 5.1: Indus Water Basin with all its Six Tributaries



Source: http://defence.pk/threads/Indus

Shafqat Kaka Khel, the water expert respondent, being critical of the mentioned division, points out the main problems concerning water (i.e., ecological disorder and fast depletion of the aquifer) which the eastern part of Pakistan is facing. According to the respondent, climate change is accentuating because environmental flows for Eastern Rivers have not been considered in Article II (personal communication, December 15, 2017). Pakistan Indus Water Commissioner Mirza Asif Baig, while highlighting the division of Rivers in IWT, pointed out, as serious implications that coming generations will have to suffer its consequences (personal communication, July 7, 2017). The viewpoint shared by Mehr Ali Shah, Joint Secretary Ministry of Water, about the division of water through Article II is built on the argument that the Eastern Rivers which have been given to India, there was 33 MAF annual water in these rivers and 12 MAF water out of which was under usage of Pakistan at the time of signing of IWT. India was using only 4 MAF water out of a total of 33 MAF water at that time. 12 MAF water was given, which was well established and fixed for Pakistan's usage; the remaining 17 MAF water was also given to India, which any party did not use. In this way, total water was given to India. He further expounds that whenever water is divided under the riparian doctrine, there is a particular method for water division; according to that method, parties have full right of that water which is currently in usage at the time of dialogue

and the rest of the water is subjected to the division which mutual agreement by both parties can do. Against all norms, this basic rule was violated in IWT (personal communication, August 16, 2017).

Article III stipulates that Pakistan shall receive for unrestricted use all waters of the Western Rivers (Indus, Jhelum and Chenab), which India is under obligation to let flow except for restricted use by India on account of domestic, non-consumptive, agriculture and hydroelectric power generation purposes (see Annexures C & D). Additionally, Pakistan shall have the unrestricted use of all waters originating from sources other than the Eastern Rivers which Pakistan delivers into the Ravi or the Sutlej. Annexure D for hydroelectric power generation and Annexure E for the single or multipurpose reservoirs with specified limits allow India to develop storage on Western Rivers. Annexure E (20) enable India to make water releases from conservation storage in any manner it may determine. Mirza Asif Baig has shown his skepticism about Article III in a way that under IWT, Eastern Rivers have been given to India, and in return, Western Rivers have come to Pakistan. In Eastern Rivers, Pakistan has negligible or virtually no rights, while in Western Rivers though Pakistan has almost full rights, India also has an exceptional range of rights (personal communication, July 7, 2017).

Article IV lays down provisions about all those aspects that are common to Eastern and Western Rivers. Article IV (2) outlines that non-consumptive use of waters by either of the parties shall not lead to a material change in the quantity of water in any of the water channels. Similarly, executing any flood control or flood protection scheme should not cause material damage to another party. The vagueness of this clause now under various climate change scenarios warrant specificity regarding the quantity of water, the number of locations, and the time frame of such activities. While commenting on Article IV, Mirza Asif Baig, the leading respondent, showed his discontent on the absence of the mention of the quantity of water in the Treaty. Being critical, he argued that if the whole spectrum of the impacts of climate change is considered, even the water magnitude with its quantity has not been mentioned in the context of flooding and droughts. Some quantities for Eastern Rivers are mentioned, and some are for Western Rivers, but not detailed. If water quantity becomes more or vice versa, leading to floods or drought conditions, the Treaty offers no solution; lower riparian does not have a mechanism to address the issue. He further expounded that when Treaty was signed in 1960, their relevance or salience was not that significant. The knowledge had also not grown to this level what we have today; with reference to quantity, the time frame, the frequency, the duration etc., these dimensions were not taken into account. According to the respondent, the same has started impacting now (personal communication, July 7, 2017).

Article IV (3)(c) & (d), though, vaguely mentions catchment areas, but no provision regarding its protection and sustainability is made, which is a serious concern as the consequence of Anthropocene. Shafqat Kaka Khel being skeptical of Article IV, says that besides other missing aspects, one of the major unattended issues is the protection and suitability of the basin's catchment areas or water sheds. Treaty makes no provision that how the watershed is to be protected. He argued that we have seen, for instance, in Indian Held Kashmir, there has been massive deforestation, which is an adverse factor as for as sustainability of the watershed is concerned. In Kashmir, deforestation is serious, whereas, in the rest of India, they have increased their forest cover, unlike Pakistan, which is losing its forest cover for many reasons, like the timber mafia (personal communication December 15, 2017). Article IV (9) shows the intentions of both the parties to operate its storage dams, barrages and irrigation canals in a manner not to cause damage to the other party, but no methodology to do is explicitly given. Article IV (10) shows the intention of the parties to prevent as far as practicable undue pollution of the water in their respective areas. The article clause also agrees with both the parties to take all reasonable measures to ensure that before any sewage or industrial waste can flow into the rivers, it is treated so as not to cause damage or loss to other party. This area warrants a review to bring specificity into the actions as it is not being done as desired.

Justice Jawad Sheikh points out that water quality is adversely impacted due to vague provisions about pollution in the Treaty. He believes both states shall make their best effort to discharge pollution-free water into the rivers and drains. The word best practices which were written at that time, did not include pollution, so that is the reason now from India all waste is coming in Hudiara Drain (personal communication, February 3, 2019). Kakakhel is of the view since it is vaguely mentioned; therefore, water quality is not being ensured. He dwelled on the discussion and contended that water quality if you ask about the Jhelum entering Pakistan, is already full of filth of effluents, industrial effluents, agricultural effluents, and municipal effluents. Because in this part of the World, watercourses are freely used as dumps for all kinds of wastes, the same is being done by India. In India, PM Modi has taken some initiatives to make the Ganga River pollution-free, religiously essential for them, but only one of the 12 Basins. With Bangladesh as well, India has 40-50 shared rivers, and some rivers start and end within India, so all of them are equally polluted." (personal communication, December 15, 2017).

Dr. Zaigham Habib, an expert on climate change, one of the leading respondents, identifies that in the division of waters, there is no mention of groundwater in the Treaty

(personal communication, September 21, 2017). Kaka Khel argues that groundwater is an essential part of rivers' hydrology and the hydraulic system. Groundwater, contrary to common thinking, is not additional water. It is rather fugitive surface water escaped from existing water resources under the surface. There is massive over-extraction of ground water in both India and Pakistan. If groundwater were less, it would affect hydraulics. He further dwells on that climate change will affect the groundwater; if there are fewer rains, we will have less groundwater (personal communication, December 15, 2017). Mirza Asif Baig also highlights the importance of groundwater and feels it is an essential component of the water equation in a basin. While crafting the Treaty, the omission needs to be appropriately addressed (personal communication, July 7, 2017).

Similarly, an important aspect missing from the Treaty when waters between India and Pakistan were being divided is the environmental or compensatory flows in Eastern Rivers. Almost all the interviewees related to the water sector highlighted this aspect. Kakakhel says in Kishan Ganga Award; actually, the ICJ, Permanent Court of Arbitration, has accepted the concept of the environmental flow, and Pakistan now has a kind of legal stand, which can help Pakistan for getting environmental flows for Eastern Rivers (personal communication, December 15, 2017). Abdul Rasheed, Director Climate Data Processing Centre Karachi, believes that we must make an effort to get the environmental flow for Eastern Rivers. He argues that we should get the compensatory flow in Eastern Rivers even if we give waters from Western Rivers. He contends that our southern part of the country is drying up, the areas in Thal and Thar are falling under desertification, our sub-surface water is going down day by day due to this void, and we should get it addressed (personal communication, July 20, 2017).

When the idea of a water bargain for environmental flows was shared with Mehr Ali Shah, the official responsible for managing the waters in the country, he appreciated it. He opined that demanding compensatory flows in Eastern Rivers from India in return for a Western Rivers water bargain is new. He argues that we need to work on this idea because he thinks we can get a better outcome. He furthered his argument that we can use the relevant international forum to raise our voice and get compensatory flows to safeguard our land in the eastern part of the country. He contends that he is confident that if this voice is forcefully raised at an international level and if we succeed in identifying the difference between the climatic conditions of 1960 and today, we shall be able to get environmental flows in Eastern Rivers with the help of the world community. He further argued that he would instead encourage the researchers to work on this idea. It would be a great contribution (personal communication, August 16, 2017).

5.3 Transitional Period and Replacement Works

As alluded to earlier that for the distribution of waters, rivers were divided in IWT. This arrangement was impregnated with implications for both the countries, surely more for Pakistan. Eastern Rivers had been allocated to India. So, to develop an alternate irrigation arrangement for arable area falling in Pakistan, which was being irrigated by the waters of Eastern Rivers at the time of partition, was an operational compulsion resulting from this division of waters. The Treaty suitably addressed this operational need as replacement works to be executed during the transition period (WB, 1960).

5.3.1 Transition Period

IWT was an instrument to transition both the states from the state of interdependence to independence in the use of Indus Basin waters. During this period, both the states had their rights as well as obligations on each other. The Transition Period was to begin on 01April 1960 and end on 31 March 1970 or, if extended under the provision of Part 8 of Annexure H, on the date up to which it has been extended. Irrespective of the completion of replacement works, the Transition Period would end on 31 March 1973. During the Transition Period, India was obliged to ensure water delivery from Eastern Rivers to Pakistan by limiting its withdrawals for agriculture use and abstraction for storage. After the end of the Transition Period, Pakistan shall have no claim or right to the releases by India of any of the waters of the Eastern Rivers (WB, 1960).

During the interview, Shams ul Mulk, a leading water expert, expressed his views that during this timeframe, Pakistan was urged to complete its replacement work; the World Bank had already arranged necessary financial support for the purpose. He further contributes that the Transition Period was enough, yet the challenge for Pakistan to complete the replacement works was enormous. There were many odds in the availability of finances and execution of highly technical hydraulic works (personal communication, April 23, 2018).

5.3.2 Replacement Works

The infrastructure needed as an alternate arrangement for transferring water from western rivers to the erstwhile command area of Eastern River is called replacement works in IWT. For the construction of these works, funds were arranged by the World Bank from the USA, UK, Canada, Australia, West Germany and New Zealand, besides contributions from the World Bank and India. These works were to be completed during the transition period. During the transition period, the water for irrigation was to be provided from Eastern Rivers by India, and

after the transition period, the supply of water was to stop irrespective of whether the replacement works were completed or not (WB, 1960). Replacement works constructed by Pakistan due to IWT comprised storage reservoirs, barrages and link canals. Three storage reservoirs, Mangla, Tarbela and Chashma, were constructed on Rivers Jhelum and Indus with a gross storage capacity of 5.89, 11.00 and 0.70 MAF, respectively. Tables 5.1 and 5.2 show barrages and link canals (SOPREST, 2016).

Table 5.1: Barrages Constructed as Result of IWT

Sr. No.	Barrage	River	Length (Feet)	Flood Design (Cusec[71])	Flood Record (Cusec)
1.	Chasma	Indus	3,556	950,000	1,176,000
2.	Rasul	Jhelum	3,209	850,000	876,000
3.	Qadir Abad	Chenab	3,373	900,000	912,000
4.	Marala	Chenab	4,472	1,100,000	1,023,000
5.	Sidhnai	Ravi	712	167,000	167,000
6.	Siphon	Sutlej	1,601	429,000	427,000

Source: Society for the Promotion of Engineering Services and Technology, Islamabad

Table 5.2: Link Canals Constructed as Result of IWT

Sr. No.	Link Canal	Length (Miles)	Capacity (Cusecs)
1.	Trimmu-Sidhnai	44	11,000
2.	Sidhnai-Mailsi	62	10,100
3.	Mailsi-Bahawal	10	3,900
4.	Rasul-Qadir Abad	30	19,000
5.	Qadir Abad Balloki	80	18,600
6.	L.C.C. Feeder	20	4,100
7.	Balloki-Sulemanki	39	6,500
8.	Chashma-Jehlum	63	21,700
9.	Taunsa-Panjnad	38	12,000

Source: Society for the Promotion of Engineering Services and Technology, Islamabad

[71] Cusec is the abbreviation for Cubic Feet Per Second. A term used for measuring discharge of water.

5.3.3 Implications of Replacement Works

From Pakistan's perspective, the settlement plan after completing replacement works as envisaged under IWT had a few advantages and disadvantages. The first and the foremost advantage which both countries drew from this intervention was that each had become independent of the other in the operation of water supplies (U. K. Sinha, personal communications, March 12, 2019). Now each country could plan, construct, and administer its own facilities in their respective areas, making the best water use as deemed appropriate. Since the Indus Basin Rivers had been divided and separated, the possibilities of disputes and tensions between the states had considerably reduced. Above all, the storage capability had provided leverage to use water in winter and drought conditions when the water availability from glaciers and rains becomes minimum as the hydrology of rivers is such that 80% of water is produced in 20% of the year in monsoon during summer, whereas, water remains deficient during other parts of the year (S. Kakakhel, personal communication, December 15, 2017).

With storage capacity in place, even the canal heads had increased from 67 MAF to 104.5 MAF (SOPREST, 2016). Contrarily, the settlement plan has a flip side, which has created a few long-term disadvantages that Pakistan would have to live with or address through additional effort. The consequence of the Anthropocene will further aggravate these disadvantages (Mirza Asif Baig, personal communication, July 7, 2017). He further delineates four major disadvantages that the settlement plan has brought for Pakistan. Firstly, with complete control of Eastern Rivers going to India, a considerable land area has been deprived of its traditional SAILAB (Flood) irrigation. Secondly, due to the loss of regular flow in the Eastern Rivers, the depth of channels has reduced due to silting phenomenon. Besides environmental degradation and aquifer depletion, the floods in the channel cause enormous losses in Pakistan. Thirdly, to upkeep and maintain link canals and storage, a huge expenditure is being borne by Pakistan, which is an additional burden on maintaining irrigation. Lastly, storages are a temporary measure that will never be a valid substitute to the perpetual flow due to their limited life.

Mehr Ali Shah contends aloud that after construction of replacement works as a result of IWT, Pakistan might have created a hydraulic wonder, but the enormous cost of maintaining this wonder will keep burdening Pakistan economy for times to come (personal communication, 2017, August 16th). Mirza Asif Baig doesn't mince words either while opining that climate change will further accentuate the voids existing in IWT and shall need a remedy for keeping the efficacy of Treaty intact (personal communication, July 7, 2017).

5.4 Financial Contribution by India for Replacement Works

After signing the Treaty, the most activity was developing a substitute for Eastern Rivers as these were being given to India, and Pakistan's traditional usage of water was to seize. The substitute visualized in the treaty was constructions of storages, barrages and link canals by Pakistan. According to Article IV (1), Pakistan was obliged to complete replacement works during the Transition Period as under (WB, 1960):

> Pakistan shall use its best endeavors to construct and bring into operation, with due regard to expedition and economy, that part of a system of works which will accomplish the replacement, from the Western Rivers and other sources, of water supplies for irrigation canals in Pakistan which, on 15th August 1947, were dependent on water supplies from the Eastern Rivers.

To complete replacement works, India agreed to make a fixed payment to Pakistan amounting to Pounds Sterling 62,060,000 as of the cost of these works. This amount by India was to be paid in ten equal annual installments on the 1st of November of each year. The United States contributed the highest amount for the replacement works. India, the major beneficiary of the settlement plan, was the second-highest financial contributor, yet its share did not cross double figures as it was approximately 9.6%. Mehr Ali Shah believes that India paid too little to get too big a share in the pie (personal communication, 2017, August 16th).

5.5 Data Sharing

Exchange of data for maintaining a record of water flow in the temporal setting is essential for effective management of water by both states. Particularly for lower riparian, it is significant that water data is made available by the upper riparian, which besides correct usage by them according to the Treaty, shall help in timely planning the utilization and disposal of water. According to Article V, the relevant data concerning the flow in and utilization of the waters of the Rivers shall be exchanged regularly between the Parties. The exchange of data shall include daily (or as observed or estimated less frequently) gauge and discharge data relating to the flow of the Rivers at all observation sites, daily extractions for or releases from reservoirs, daily withdrawals at the heads of all canals operated by a government or by a government agency (hereinafter in this Article called canals), including link canals, daily escapades from all canals, including link canals and lastly the daily deliveries from link canals. This data shall be exchanged on a monthly basis but not later than three months after the end of the months to which they relate. Meeting the operational requirement, the provision is also given that should

it be required earlier, it shall be supplied daily or at less frequent intervals, as requested. The cost of data transmission shall be borne by the party requesting the data (WB, 1960).

Mirza Asif Baig, the PIWC for Pakistan, the custodian of data, is too skeptical about sharing data by India. He shares with many discontents that under IWT, India is obliged to share the data of flows and water levels of rivers with Pakistan. If they have to build a hydropower project, they must share technical details with Pakistan. He argues that Indians have developed a typical psyche of denial; they feel taxed and burdened in providing data; they think providing data to Pakistan serves from the lower tier. He builds on his argument that, unfortunately, they have stopped sharing data; this is presently their attitude towards Treaty obligations. He further explains that we usually demand data of those points for which they already have data, but they do not provide; they continuously delay in a way perpetually refusing. He elaborates that even if they come to know that we are collecting data daily from one of their websites, they would stop uploading data on that website (personal communication, July 7, 2017).

Dr. Muhammad Faisal, Director General South Asia, MoFA, Pakistan, talks high of the treaty for its efficacy in the past, but as of now, he is also cynical, contending that the treaty did function even in the height of the crisis in 1965 and 1971, however, now the treaty is not functioning the way it should be. He expounds that when communication between the parties ceases to exist, the exchange of data is stopped, and sharing of information is avoided, the Treaty becomes dysfunctional. He disappointingly contends that India is not responding to our calls now (personal communication, October 11, 2017). During the interview, Mirza Asif Baig, Pakistan PIWC, presented a morbid picture of India and Pakistan's existing state of affairs about data sharing that is hard to believe. He says Indians draw pleasure when they see us dependent on them for data. Indian, while responding to our request, shows they are not obliged to provide data; instead, they are doing it as a humanitarian gesture. Instead of fulfilling the obligation of providing data, they rather use it as a bargaining chip for getting some favor in return. When asked what he meant by favor, he expounded that it refers to relaxation on violations they keep carrying out in the water. He further frowned that whenever Indians share data, they intentionally hold back part of it to show their displeasure about the cases Pakistan has taken up at international forums.

Asif said, after the 1988 floods, we jointly evolved a mechanism to receive flood data from India. It worked well for twelve years and was discontinued by Indians in 2000 when we contested the Kishan Ganga design. They instead pointed out that they would provide data based on Article 4(8), which relates to extraordinary discharges, instead of Article 8 (1) & (2),

which fall under exchange of routine data. Since 2000, Pakistan has been consistently requesting for sharing data which Indians are continuously refusing. He also said that in PIWC March 2017 meeting, we asked for flood releases data under Article 4(8) of Salal and Baglihar Dams, Indians disagreed. They respond selectively. Mirza says Indians do not respond as an institution. Instead, they exchange data as they desire. He said that when we contested the designs of the Ratle Hydropower Project and Kishanganga Hydropower Project and took the case to the Court of Arbitration, India denied us access to the Court of Arbitration through the influence of the World Bank. Asif Baig highlighted another gruesome picture that will directly impact the impacts of climate change. In March 2017, during the PIWC meeting, Pakistan tried to discuss the glacier melting in climate change. Pakistan asked for data exchange to better determine what will happen to glaciers in the future. The objective was to develop prediction models for marking them as a benchmark for the next 15-20 years, but unfortunately, it could not materialize due to poor response from the Indians' side. He concluded that this is the attitude of India towards the implementation of the Treaty (M. A. Baig, personal communication, July 7, 2017).

5.6 Future of the Treaty: Cooperation Paradigm

Ahmer Bilal Soofi, a legal expert respondent, contends that Treaty has successfully sustained the pressures of wars between India and Pakistan. The mechanism of data sharing and dispute resolutions between both countries is in place, and water is being distributed according to the Treaty. It is functional though not entirely but delivering its dividends. At the international level, IWT is considered a successful technical and legal instrument for distributing shared water resources of IRB. World Bank, the broker of IWT, also takes the treaty as an enduring document and boasts for its success and survivability. As upper riparian, India also views the treaty as an effective instrument of distribution of a common water resource as it has completely controlled the waters of eastern rivers without letting a drop flow downstream except the unavoidable escapades and unintended discharges, whereas on western rivers, the specified limits of non-consumptive water utilization are recurrently violated by India (personal communication, February 28, 2018).

The climate change phenomenon impacts the water quantity, water quality and ecological systems, which results in extreme meteorological events like floods and droughts. Frequent violations by India in water utilization on western rivers, lack of information and data sharing by India is creating water stress. Moreover, with weak monitoring and implementation mechanism for the treaty and demand of water for food and energy increasing due to more

population, urbanization, improved quality of life, intensive groundwater extraction and fast aquifer depletion, Pakistan has started feeling the pressure as its water stress is exorbitantly increasing (Z. Habib, personal communication, September 21, 2017).

According to Article VII, both the parties recognize that they have a common interest in the optimum development of the Indus Basin Rivers, and, to that end, they declare their intention to cooperate, by mutual agreement, to the fullest possible extent. According to World Bank, there are four areas particularly mentioned in Article VII, where both parties have shown their deep interest and intent to cooperate. The first of the areas is collecting hydrological data through the installation of additional observation stations. Secondly, each party, to the extent it considers practicable and on agreement by the other party to carry out such new drainage works as may be required in connection with new drainage works of the other party. Thirdly at the request of either party, the two parties may, by mutual agreement, cooperate in undertaking engineering works on the Rivers. And fourthly, if either party shall notify the other party before construction of any engineering work that would cause interference with the waters of any of the Rivers and which, in its opinion, would affect the other party materially (WB, 1960).

Shafqat Kakakhel expounds that cooperation in these areas in some form exists, yet the level is wanting from desired standards. He further highlights that as a consequence of Anthropocene, the missing link in the Treaty is the nonexistence of any clause about preservation and development of catchment areas of different river basins. This is a critical area that shall need attention for future cooperation (personal communication, December 15, 2017). About the future of the Treaty, Dr. Uttam Sinha shares his views that the fact is that the Treaty remains working. PIWC continues to meet reflects cordiality and institutional respect in how the challenges of the basin have to be dealt with. He contends that the overall peace and good bilateral relations between India and Pakistan are dependent on the Indus Basin and other more significant issues as well, often these issues put enormous pressure on the Treaty, but fortunately, the Treaty remains intact. He concludes that the prospect for future cooperation does exist in the Treaty, which needs to be correctly harnessed and capitalized (personal communications, March 12, 2019).

5.7 Institutional Sustainability of Treaty

A permanent instrument was needed to ensure its institutional sustainability for implementation, monitoring, and dispute resolution of IWT. This has been aptly done in the Treaty. There are three Articles which if correctly implemented by the stakeholders, have the latent potential to ensure that Treaty remains alive and parties benefit from it. Different

dimensions of institutional sustainability given in Treaty are discussed in succeeding paragraphs.

5.7.1 Permanent Indus Commission

Article VIII of the Treaty lays down the provisions for the appointment of the Commissioner for the Indus Waters, who should ordinarily be a high-ranking engineer competent in the field of hydrology and water use. Each Commissioner being representative of his government will serve as the regular channel of communication on all matters relating to implementing the Treaty. Both the Commissioners so appointed by the respective governments will make PIWC. The principle purpose of the Commission shall be to establish and maintain cooperative arrangements for the implementation of this Treaty. Besides, the Commission shall promote cooperation for the development of Indus waters and settle promptly any question arising in the implementation of the Treaty in the light of Article IX (1). The Commissioner shall make a general inspection tour every five years or arrange a tour of counterpart as required to ascertain the facts related to various development works on the Rivers. The Commission shall meet regularly at least once a year, alternately in India and Pakistan. The Commission shall meet when requested by either of the Commissioners. The Commission shall submit an annual report on its work to both the Governments before the first of June of every year. The Commission shall determine its procedures for performing its functions to achieve its purpose from time to time.

Asif Baig, the Pakistani Commissioner for PIWC, while sharing his views, opined that PIWC is an effective instrument to keep the Treaty efficacious provided the governments do not intervene in the Commission's functioning by giving different directions or specific instructions. In Pakistan's case, the Indian Commissioner alters routine functioning based on the hydro politics of his government; otherwise, in the past, a regime of cooperation existed in its ensilaged form (personal communication, July 7, 2017). Dr Uttam Sinha also reiterates his viewpoint that in IWT Permanent Indus Waters Commission is an instrument of cooperation, and the fact that PIWC continues to meet reflects cordiality and institutional respect in the way the challenges of the Basin have to be dealt with (personal communications, March 12, 2019).

5.7.2 Settlement of Differences and Disputes

Article IX defines the 'Difference' as a question between the parties concerning the interpretation or application of the Treaty or the existence of any fact that might constitute its breach if established. As a procedure, the difference shall first be examined by the Commission.

All possible efforts will be made by the Commission to resolve the question by agreement. If the Commission is not able to determine the difference, then it shall be taken to the next tier, which is that of Neutral Expert as given in Annexure F. There are 23 sub-clauses of Annexure F (1) which outline various categories of the differences to be dealt with by the Neutral Experts. As a third-tier, a difference turns out to be a dispute if it does not fall under Article IX (2) (a) or the Neutral Expert declares it, in his opinion, to be a dispute. At the request of either Commissioner, the Commission reports the fact to both the governments for resolution. As a fourth step, if either of the governments after receipt of the report forwarded by the Commission or if it concludes that this report is being unduly delayed in the Commission, invite the other government to resolve the dispute by agreement. Finally, a Court of Arbitration is established upon agreement between both the parties or at the request of one party to resolve the dispute in the manner provided by Annexure G of IWT.

When Dr Muhammad Faisal, DG South Asia MoFA was asked about the settlement of disputes in the light of Article IX, he narrated that the Treaty is virtually dysfunctional on this account. He dwells on his argument that, for example, both Commissioners should talk to each other when we disagree on an issue. If the problem is not resolved at their level, then according to the Treaty, the Water Secretary of both the countries should talk to each other. If the issue is still not resolved at the governmental level, then parties reserve the right to go to World Bank under IWT, and it will refer the case to the Court of Arbitration or Neutral experts. He says that we took our case to World Bank in October 2016, but World Bank is not referring our case to the Court of Arbitration. This is a violation of IWT. The IWT itself does not allow the World Bank to pause the case. We have been having a meeting for the last 9-10 months in Washington but have not gotten any effective response from World Bank. If this kind of irresponsible behavior of the World Bank continues, the Indians will build Rattle Power Projects in the next two years. If this is the case, the resolution mechanism is becoming ineffective day by day. He expressed his discontent that he would categorically say that World Bank is not playing its role. The World Bank is not playing neutrally; it is taking sides with India (M. Faisal, personal communication, October 11, 2017). Mirza Asif Baig also had similar feelings about dispute resolution under the mechanism provided by the Treaty. He expressed his views:

> We contested Ratle and Kishanganga Hydropower Projects; we intend to take this case to the Court of Arbitration. India is consistently denying us access to the Court of Arbitration through the influence of the World Bank. He concluded that this is the attitude of India towards the implementation of the Treaty, which is negative (personal communication, July 7, 2017).

5.7.3 Emergency Management

Although Article X titled 'Emergency Provision' is related to the replacement works and transition period, it reflects a component of cooperation between the states that should continue to manifest in the future. According to the Article X, despite best possible efforts, if Pakistan was not in a position to complete its replacement works due to non-acquisition of required material and equipment by 31st March 1973, of that part of the system of works referred to in Article IV(1), under prevalent international environment, the matter shall be brought into the notice of the World Bank and both parties shall sit together and find a way out in a cooperative milieu. In response to this, the Bank shall immediately notify each of the Parties accordingly. The Parties undertake, without prejudice to the provisions of Article XII (3) and (4), that on being so notified, they will forthwith consult together and enlist the good offices of the Bank in their consultation, to reach mutual agreement as to whether or not, in the light of all the circumstances then prevailing, any modifications of the provisions of this Treaty are appropriate and advisable and, if so, the nature and the extent of the modifications (WB, 1960).

In the light of Article X, Ahmer Bilal Soofi, the International Law Expert respondent, believes that Treaty has kept a legal space for both the parties to consider each other's constraints and concerns and accommodate those to continue cooperating in future, which shall give the Treaty a longer and stable life (personal communication, February 28, 2018). Kaka Khel also hints at the cooperation between India and Pakistan in the transition period and, until the end of the 90s, should continue to exist in the future. Both countries should not lose the advantage gained in the form of IWT. Hydro politics should not come in the way to undermine the provision of cooperation inbuilt in the Treaty. The clauses of Article X should be optimally used as precedence by both the states to address the concerns arising from the consequence of the Anthropocene (personal communication, December 15, 2017).

5.7.4 Treaty Binds and Guides the Parties

The last two articles of the Treaty are catalysts in creating a culture of cooperation between the parties through accommodation and adjustment. Article XI binds both the parties to remain part of the Treaty whatsoever the concerns or constraints. According to the article, each of the parties agrees:

> […] that it will not invoke this Treaty, anything contained therein, or anything arising out of the execution thereof, in support of any of its own rights or claims whatsoever or in disputing any of the rights or claims

> whatsoever of the other Party, other than those rights or claims which are expressly recognized or waived in this Treaty (WB, 1960).

Article XII, besides giving the date of effectiveness of Treaty as 1st April 1960, guides the parties to accommodate each other's concerns and modify the Treaty mutually as required. Article XII (3) outlines the leveraging content as: "The provisions of this Treaty may from time to time be modified by a duly ratified treaty concluded for that purpose between the two Governments". Article XII (4) crystallizes the Treaty further as under: "The provisions of this Treaty or the provisions of this Treaty as modified under the provisions of Annexure XII (3) shall continue in force until terminated by a duly ratified treaty concluded for that purpose between the two Governments" (WB, 1960).

Despite Treaty carrying the instrument of cooperation, binding for sustainability and guidance for effective management as elaborated in preceding paragraphs, Dr. Muhammad Faisal gives his realistic views:

> In the context of IWT, we do not have enough space for dialogue with India. India has never inclined or desired for talks on this particular issue since 1960. The Treaty did function even at the height of the crisis in 1965 and 1971, but now, for the last year, Treaty is not functioning the way it should be. I think India will not agree on negotiation just over climate change aspects. He further contends that they may re-negotiate the whole Treaty based on mutual consensus. He anticipates that when we go for re-negotiation, we should keep in mind that they will also come with some demand. If you see the Treaty, it is not based on best practices; it is based on the geopolitical environment. The best practices may be at variance. In the present scenario, I do not see we can convince India to include climate change-related clauses into the Treaty (personal communication, October 11, 2017).

5.8 Concerns of the Parties with respect to IWT

IWT was crafted in a particular environment. Sub-continent had been partitioned geographically with disregard to hydrological borders. The flawed sub-continent division had surfaced existing differences on distribution and utilization of water for irrigation for food basket in the region of split Punjab in a more serious manner (T. Altaf, personal communication, August 26, 2017; M. Siddique, personal communication, August 26, 2017). Internally both the states had failed to resolve water disputes despite their best efforts. The newly borne states had fought the war on Kashmir in 1948. The environment was extremely tense when external players like David Lilienthal entered the arena bringing in the World Bank for mediation. The process of reaching IWT took more or less one decade. Each proposal by

India, Pakistan and the World Bank was deliberated threadbare to reach consensus and Treaty was signed by major stakeholders, i.e. India and Pakistan, albeit under the compulsion of finding no better solution than that as Uttam Sinha has rightly pointed out: "Good cannot be lost in want of the best that's what IWT is" (personal communications, March 12, 2019; for detailed discussion, see Chapter 4).

Initially, after signing the Treaty, the transition period, which is rightly called the the 'Honeymoon period of IWT' by Mirza Asif Baig, started with effect from 1st April 1960 lasted for over a decade till 31 March 1973, during which both the states cooperated and the settlement works got successfully completed (personal communication, July 7, 2017). There were no major issues. The Treaty had taken off, and the break-in phase had smoothly started. It continued until the end of the nineties, when the more profitable water utilization race under the burgeoning psycho-socio-economic pressures started. These pressures got further accentuated as the consequence of Anthropocene, which crystallized cleavages and fault lines of water concerns of both the countries, particularly Pakistan, more significantly (T. Banuri, personal communication, August 21, 2017). In succeeding paragraphs, the Pakistani and Indian concerns and the common concerns will be discussed separately. In a way, these concerns threaten the sustainability of IWT, which are being highlighted here in detail.

5.8.1 Pakistani Concerns

Stakeholders' water concerns emanating from implementing a transboundary water treaty relate to the interpretation of clauses, the impact of the water division formula adopted in the treaty, and fluctuating water availability of water vis-à-vis its demand (M. Gramboh, personal communication, December 7, 2018). Pakistan's water concerns relating to IWT are numerous, which falls under physical, social, economic, climatic, environmental, military, disaster management, data sharing and technical domains. Pakistan's physical domain water concerns start right from the geographical partition of the sub-continent with disregard to hydrological borders in 1947. According to another respondent, separating the Kashmir issue from the water issue was unfair; these are intrinsically though intricately linked, which have profound implications if separated without resolving the problems (S. Kakakhel, personal communication, December 15, 2017). Treaty specific physical concern relates to unjust division of Indus Basin Waters. This water division philosophy led to the division of Indus Basin Rivers. It deprived Pakistan of the waters of Eastern Rivers. Substitute arrangement for meeting water division philosophy led to economically burdened water transfer, artificial, time-bound, replacement system which is impregnated ultimately to turn eastern part of the country

into the desert if the availability of water from western rivers is compromised due to any reason. Pakistan regards this physical concern as water security, food security, energy security and ultimately, national security issues (M. Muzammal, personal communication, November 23, 2018; A. Kamal, personal communication, December 29, 2017).

Secondly, in the physical domain, Pakistan believes that Indus Basin rivers mainly originate from Kashmir, which is a disputed territory between India and Pakistan. India alone, therefore, cannot have the status of upper riparian in the Treaty. In the social domain, Pakistan's concerns are diverse. First is the sharp reduction in per capita availability of water. Tariq Altaf, the NESPAK expert, says that at the time of partition, per capita water availability was more than 5000 m^3, drastically reducing to triple the figure in 2017. He says with a consistent declining trend of water persisting, increase in population and decrease in water availability, the figure is likely to fall to 700 m3 by 2025 (T. Altaf, personal communication, August 26, 2017). Dr. Zaigham Habib says that over 200 million people of Pakistan are dependent on the Indus River Basin, whereas the Indian population has over a dozen river basins available to draw water from. So, this social differential should have been catered for which is missing. To meet the food and energy requirements of such a massive population under climate change has become a more severe challenge (personal communication, September 21, 2017). Overall, there is a perception in Pakistani mass media that India is undertaking all those long-term measures by design that shall deprive Pakistan of its needed water.

In the economic domain, Dr Muhammad Siddique, another expert from National Engineering Services Pakistan (NESPAK), says that Pakistan's sustainability of irrigated agriculture with a semi-arid climate is a challenge further accentuated under large seasonal and annual water variability. He further states that Pakistan would remain economically burdened while maintaining alternate arrangements of transferring water from west to east through dams, barrages and link canals forever (M. Siddique, personal communication, August 26, 2017). In the climatic domain, Mr. Abu Ahmad Akif, Secretary MoCC, says that water remains the most impacted element of the life cycle, although climate change has impacted every walk of life. With global warming on the increase, the glaciers have started melting faster. Water availability with respect to its magnitude, duration, intensity and frequency has become uncertain. Water quality is being impacted by industrial, agriculture and municipal waste. Water demand has increased, whereas water availability has sharply decreased. Groundwater is being extracted more than it is being recharged. All these factors relate to IWT, which will make it an irrelevant document in the future (personal communication, December 19, 2017).

In the environmental domain, Mr. Irfan Tariq, Director General Environment, MoCC, says that Pakistan has four major concerns. Firstly, with all rights of Eastern Rivers going to India, giving no allowance for even their environmental flows has made the eastern part of Pakistan an environmentally sick region. Secondly, the ecological system in that region has been destroyed. Thirdly over-extraction of groundwater has disturbed hydro balance in adjoining areas. Fourthly, the polluted water falling from drains in riverbeds has made those nullahs, carrying sewerage and sewage. Above all, the country's eastern part has become a hotbed for viral and bacterial diseases (personal communication, August 9, 2017). From a military perspective, Lieutenant General (Retired) Khalid Asghar ex Engineer-in-Chief Pakistan Army, believes that Pakistan and India are two rival states who have fought three major wars in the past. Operational maneuvering of armored columns in cis and trans-frontier areas Indian leverage of storing water allowed under Indus Water Treaty can be used against Pakistan Army by either creating water pondages in operational areas through releasing water in the rivers or denying crossings over the rivers by stopping water thereby impeding operational mobility of Pakistan Army (personal communication, December 26, 2019).

Major General Asghar Nawaz (Retired), Ex-Chairman Earthquake Rehabilitation and Reconstruction Authority (ERRA), shared his thought that climate change is a catalyst in generating hydro-meteorological hazards in the disaster management domain. Three major hazards confronting Pakistan are floods, drought and Glacial Lake Outburst Flood (GLOF). Due to their intensity and magnitude as the consequence of Anthropocene, these have the latent potential to turn into a disaster. He says Indus Water Treaty presently does not have any such clause which shall give a mechanism to prevent and mitigate the effects of disasters emanating from water and glaciers in future. (personal communication, December 26, 2019). Lieutenant General (Retired) Omer Hayat, Ex-Chairman National Disaster Management Authority (NDMA), says that the leading hazard confronting Pakistan is flooding. He believes that Pakistan has suffered considerable losses in Floods (2010). Besides global warming effects resulting in faster glacier melting, unpredictable rain patterns, and shifting monsoon blueprint, the disregard to the maintenance and preservation of the catchment areas of IRB is another major reason behind the fast-flowing velocities of water resulting in extreme flooding conditions. The mountains have been denuded from vegetation cover, which facilitates flowing water, giving it a gushing speed. Unfortunately, there is no mention of such a clause in IWT (personal communication, December 25, 2019).

In the data sharing domain, Mirza Asif Baig, the custodian of PIWC data, has shown his deep concerns about Indians not sharing the data as per dictates of IWT. He says that India

shows reluctance in sharing data, particularly about ongoing and planned hydropower projects, which Pakistan essentially requires to know whether the projects are in line with the treaty (personal communication, July 7, 2017). In technical domains, Pakistan's concerns are numerous, ranging from interpretation of clauses to implementation of the treaty on the ground. Firstly, Faisal says that the Treaty is not based on good transboundary water resource management practices. Instead, this is based on territorial considerations. This concept has given more space to upper riparian to control and manipulate water with serious implications for the lower riparian (M. Faisal, personal communication, October 11, 2017). Secondly, Altaf says the water experts commonly perceive that in the case of Eastern Rivers that pass-through India and Pakistan, the riparian rights are given to India alone. Respondents believed that this discord is against the established international rules

Thirdly, Asif Baig says that allowing non-consumptive use to India on Western Rivers is an endlessly frustrating and ultimately futile task for Pakistan to guard its waters against Indian pouching (personal communication, July 7, 2017). Fourthly, in the technical domain, Ahmer Bilal Soofi argues that interpreting hydropower related clauses in the Treaty for water storages on western rivers is out of place, which has serious implications for Pakistan (personal communication, February 28, 2018). Finally, as highlighted by Mirza Asif Baig, the major concern for Pakistan is about the construction of hydropower projects by India on Western Rivers without due technical consultation with Pakistan which is likely to continue as a dominant factor in undermining the efficacy of IWT (personal communication, July 7, 2017). Akhter says that contrary to the parameters laid down in the treaty, India crosses the limits without taking Pakistan into confidence by sharing the information on design specifications or environmental impact assessment, leading to a legal battle involving international players between India and Pakistan (Akhter, 2015).

5.8.2 Indians Concerns

Concerns by India are different in tone and tenor. As a lower riparian, Pakistan mainly has concerns related to its survivability. The Indus River Basin is its lifeline and the only basin to draw water from, whereas India has over a dozen basins to get water (S. Kakakhel, personal communication, December 15, 2017). India is seen as solely dependent on the Indus River Basin. The concerns discussed in preceding paragraphs from Pakistan's perspective, same more or less are viewed but from another side of the binocular by India so the perspective radically changes. India has few generic water concerns, but specifically, its concerns relate to the Treaty

itself, climate change and Pakistan specific, whereas remaining are the rebuttals to Pakistani concerns over Indus waters which shall be briefly discussed in succeeding paragraphs.

While commenting on 50 years of the Indus Waters Treaty, Uttam Kumar Sinha opines that reaching 50 years is a milestone. Landmarks are also often accompanied by reality checks and introspection. He argues that the success of the treaty is not merely symbolic; instead, it is real as there have been no wars over it, nor has the treaty been abrogated because of the wars fought. He, however, points out that the surfacing of concerns after a treaty gets into mode of implementation is a natural and common phenomenon (Sinha, 2010). Khalid says the Indian location is such that it shares waters of Indus, Brahmaputra and Ganges with other countries as upper riparian, so it inherits the concerns and disputes by default. If the riparian states' demographic, economic, and environmental challenges increase, present tensions may lead to a crisis-like situation. Wars between India and its neighboring countries would likely become imminent, threatening regional stability (Khalid, 2010). Waslekar and colleagues (2005) that water demand is persistently outstripping the supply in India. The water availability over 5000 m3 in 1950 has reduced to 1800 m3 in 2005 which is likely to reach the 1000 m^3 by 2025. He says the concern of water scarcity is gradually rising.

Iyer (2010) argues that the growth of population in India, pace of urbanization, and economic development will accentuate the pressure on increasing demand of a finite resource, leading to water concerns turning into disputes with water-sharing neighboring countries. The primary driver for hydropower generation is growing electricity needs in India. Khan (2015) says that meeting 9% plus of growth rate demand in India is a challenge that forces India to harness untapped hydropower potential, for which the Himalayan region is the most sought out zone for exploration resulting in direct stress on Indus Rivers Basin. The dominant perception in India is that 80% of water to Pakistan and 20% to India was an unfair settlement foolishly accepted by Indian negotiators when crafting the treaty (Iyer, 2010; Waqar-un-Nisa, 2017). Indians believe that water in the rivers and aquifer of the Indus Basin is reducing due to the impact of climate change as the glaciers have started melting more rapidly. Furthermore, the rain pattern has become erratic and more water extraction of groundwater is being done to meet irrigation needs by the farmers; there is no violation of the Treaty being done by Indians leading to such change (Bolch et al., 2012; Dikshit, 2010).

India blames Pakistan on three accounts. Firstly, Pakistan is suffering from a lower riparian anxiety complex, raising frequent concerns and objections by Pakistan due to this syndrome (Bakshi & Trivedi, 2011). Secondly, Pakistan cannot manage its own water well due to fewer storage facilities. Resultantly, a considerable amount of water is wasted in the Arabian

Sea, and the blame is unnecessarily put on India (Das, 2016). Thirdly, India believes that to divert attention from internal dissatisfaction over water distribution of the provinces, Pakistan blames India (Dikshit, 2010 March 13th). The concerns aired by India as a rebuttal to Pakistan's concerns are diverse. Uttam Sinha says that India has been tied up by the IWT, broadly defining its responsibilities as an upper riparian; there is no way for India to violate it (Sinha, 2008). He says India does not have storage from where water can be controlled. Sinha denies the possibility of using water as a weapon in war. According to him, for any aggressive action, India would need to build storage facilities on three western rivers, which is a time consuming and easily detectable activity involving heavy expenditure. He further argues that any effort to flood Pakistan would mean flooding areas on the Indian side first, which has disastrous consequences India cannot afford to do under normal circumstances. Indians give three reasons for not venturing into violating IWT.

Developing water storage or water diversion facility has a long construction time during which another party can raise the issue at international. Why should India waste its time and resources on such s futile effort? Secondly, even if India manages to construct water storage or diversion facility, non-state actors from Pakistan can subject it to the act of terrorism, which is again a 'no-go' area for India. Thirdly it is extremely difficult to garner any external financial support particularly the World Bank, for the construction of such a facility in the disputed area of Kashmir. India will not be keen to undertake the storage facility building that contravenes the treaty and suffer international condemnation and loss of aid (Das, 2016; Sinha, 2008; Swain, 2004). Uttam says climate change is an emerging concern that equally impacts glaciers, water flows, freshwaters, underground water, and rain patterns, from which the IWT is no exception. He is of the view; the phenomenon of climate change is cross-cutting across all sectors, which need to be amicably addressed to save from future disasters (personal communications, March 12, 2019).

5.8.3 Common Concerns

Out of all the concerns, explicitly or otherwise expressed by the stakeholders in both the countries discussed vigorously in preceding paragraphs, the genuine concern about climate change and its impacts on the glaciers and other water resources is predominant. Other problems or concerns are directly or indirectly related to climate change. The dwindling limited water resources in the upstream part of the basin is also related to the fast melting of the glacier, again a climate change impact indeed. Next are the increasing water needs of the growing population downstream, a phenomenon which both countries are confronted with. Both

countries' shrinking per capita water availability is linked with an ever-increasing population and dwindling water availability.

Excessive pumping of groundwater resources to meet mounting irrigation water for food security needs has lowered the water table. Both countries are still doing inefficient water usage. New scientific water usage techniques are yet to be followed to economize water utility. To meet ever-increasing energy security needs, the cumulative effects of the cascade of hydropower projects in the Upper Indus Basin have started disturbing the equation. The increasing frequency of flooding and related concerns are the major common problems shared by a wide cross-section of people in both countries. These common concerns of both the countries are at center stage, which calls for a time-bound robust solution for sustainability to the Treaty.

5.9 Major Controversies

According to Article III of IWT, waters of three western rivers are available to Pakistan with a proviso that allows India non-consumptive use such as hydropower generation or agricultural use to a specified limit (WB, 1960). India has recurrently applied this provision to her advantage without due regard to its impact on lower riparian in terms of water quantity, water quality, damage to the downstream ecological system, environmental degradation, or groundwater depletion (M. A. Baig, personal communication, July 7, 2017). Annexure C of IWT allows India to use about 1.3 MAF of waters from western rivers for agriculture, whereas Annexures D and E illustrate the conditions for non-consumptive use. Subclauses (a), (c), (e) and (f) of paragraph 8 of Annexure D of the Treaty explicitly define the design of the hydropower plants and maximum reservoir capacity for India on western rivers (WB, 1960). Contrary to the parameters laid down in the treaty, India crosses the limits without taking Pakistan into confidence by sharing the information on design specifications or environmental impact assessment, leading to a legal battle involving international players between India and Pakistan (Akhter, 2015).

The first controversial case between India and Pakistan which echoed international corridors was regarding the 450 MW Baglihar Hydro Power Project (HPP) (S. Kakakhel, personal communication, December 15, 2017). It is a run of the river power project conceived by India in 1992. When its construction commenced in 1999, Pakistan claimed that some of its design parameters were too lavish than required for the purpose. Pakistan feared that these lax design parameters would enable India to manipulate water flow by accelerating, decelerating or blocking the water volumes downstream which could provide strategic leverage to India

during political tension or war against Pakistan. These allegations were continuously denied by India (Dar, 2012). After having failed to resolve the dispute through the internal dispute resolution mechanism of IWT, Pakistan approached World Bank in April 2005, a broker and signatory to the treaty, to appoint a neutral expert to peacefully resolve the differences under Article IX (2) of the IWT. World Bank constituted a technical and legal team headed by an expert Raymond Lafitte on 12 May 2005, which delivered its final judgment on 12 February 2007 (Wani & Moorthy, 2014).

While framing his judgment, Raymond Lafitte referred to the latest bulletin of ICOLD rules of science and state of the art practices and applied the Vienna Convention on treaties' laws. Raymond has also highlighted the significance of the latest scientific knowledge in interpreting various treaties clauses. Emerging knowledge of hydraulic, latest research on dams, climate change, and environmental sciences was also applied before giving a verdict to resolve the Baglihar dispute. According to the judgment, the original HPP design as planned by India was upheld; however, minor changes were incorporated to adjust the design. Although the outcome of the process was not as expected by Pakistan, it set precedence to be followed for third-party dispute resolution in case a conflict arises between India and Pakistan in implementing IWT (Wani & Moorthy, 2014). On western rivers, India has made a mega hydro development plan which has serious implications for Pakistan. The hydropower generation being developed on western rivers is much more than the requirement of that area of Indian held Kashmir (IHK). The power so generated from common waters is being exported to the Indian national grid, which is in contravention to the spirit of IWT (Burra, 2013). The second controversial project is the Wullar Barrage or Tulbul Navigation Project, located on the Jhelum River about 30 kilometers north of Sri Nagar and remains unresolved. In this project, India intends to build a barrage on the mouth of Wullar Lake where it meets River Jhelum with a storage capacity of 0.3 MAF, surpassing the limit as specified in Annexure D of the IWT (Khalid et al., 2014).

Another project that has developed deep differences between Pakistan and India is a 330 MW Kishanganga Hydro Electric Power Project (KHEP), a river hydropower scheme designed to divert water to a power plant in the Jhelum River Basin from Kishanganga River — known as Neelum River in Pakistan. The construction started in 2007 without the consent of Pakistan. Bypassing 213 kilometers of Neelum River, water is planned to be diverted to Wullar Lake through a 24-kilometre-long tunnel, ultimately running through Jhelum River to Muzaffarabad in Azad Jammu and Kashmir (AJ&K). This project will increase the catchment area of River Jhelum and deprive long stretch of River Neelum of water, causing damage and

harm to water quantity, water quality and ecological system downstream which is a serious violation of Article IV (3)(c) and especially paragraph-5 and Article VII(1)(b) of the IWT. Pakistan raised the issue of interpretation of KHEP to the Hague Court. The Hague Court, in the final order, asked India to increase the environmental water flow downstream from the dam at all times to 9 Cubic meters per second (Cumsec) as against the Indian government proposal of 4.25 Cumsec (an increase of 112%). The Court also rejected the Indian plea for reconsideration or re-interpretation of the Permanent Court of Arbitration order of February 2013 that the under-construction 330 MW KHEP and all other subsequent projects cannot draw down the water level in projects below the dead storage level (Gopal, 2013).

The recent project which has become controversial is the 850 MW Rattle Hydro Electric Power Project (HEP) on Chenab River which has a faulty design and has been objected to by Pakistan (M. A. Baig, personal communication, July 7, 2017). Suppose India constructed the Rattle Hydropower Project on Chenab River under its objectionable lax design. In that case, it will adversely affect the water flow of the Chenab River at Head Marala, which has a detrimental economic and social impact on Pakistan (T. Altaf, personal communication, 2017, August 26). India has already built 330 MW Dulhasti HEP and 450 MW Baglihar HEP on Chenab and Ratle HEP with its existing faulty design will be third of its kind and biggest of all. Ratle HEP will be three times bigger than the Baglihar HEP and correspondingly will have negative political, economic and social impacts for Pakistan. Through its Indus Water Commission, Pakistan has struggled for a long time that India consents joint nomination for a neutral expert within the stipulated period for resolving the Kishanganga and Ratle HEP issues. However, there has been no response from the Indian side (M. A. Baig, personal communication, July 7, 2017; M. Siddique, personal communication, August 26, 2017).

Finally, Pakistan decided in December 2015 to step up the level and approach the World Bank for the nomination of a neutral expert to resolve the lingering IWT issues between both the courtiers (M. Faisal, personal communication, October 11, 2017). Besides these few examples cited here for contextualizing the issue at hand, there are numerous storage and hydropower generation projects on western rivers that India is constructing in violation of the IWT. Their details have intentionally not been shared with Pakistan. According to Article IV of IWT, either of the parties is obliged to exchange information and data related to the projects being developed in IRB, which is not being done by India (WB, 1960). According to ICOLD, Pakistan and India are signatories; exchanging information and data for developing new projects on shared waters is an unavoidable obligation that India had repeatedly been evading as an upper riparian. And usurping the rights of lower riparian illegally leads it to perpetual

frustration, which is bound to deepen the conflict if this state of affairs continues unabated (Das, 2016).

5.10 A Retrospective View

The efficacy of IWT can be seen through two lenses: (i) set out purpose in its existential perspective, and (ii) its functionality perspective. Appropriateness and correctness notwithstanding, the Treaty efficiently meets its water apportionment purpose. The division of waters has been implemented, replacement works completed, and the implementation mechanism is weak, yet the communication between the parties exists. The second lens is of the functionality of the Treaty (S. Kakakhel, personal communication, December 15, 2017; U. K. Sinha, personal communications, March 12, 2019).

The Treaty is functional. The cooperation level between the parties can be divided into three periods. First is the Transition period, which was amicably completed with the cooperation of the stakeholders. The second period starts between two parties, i.e. India and Pakistan, after the Transition period where data sharing was the major activity. It also went well till the end of the last century. A good cooperative environment existed between the parties, and the functionality level remained high. The third period started when Indians started hydropower projects on western rivers, and Pakistan raised concerns and objections. This is the period starting from the year 2000 onwards that functionality of the Treaty has gone down, particularly the data sharing is not being done. There are diverse opinions about the Treaty. Justice Jawad Hassan Sheikh, Judge Lahore High Court, says the treaty has survived all the wars between India and Pakistan. Notwithstanding the disputes over certain projects on the rivers, the treaty has been instrumental in abstaining both the countries from going to war over water (personal communication, February 3, 2019).

Sinha argues that there is nothing wrong with the Treaty; it is the way it is being interpreted. He further states that overall peace and good bilateral relations between India and Pakistan are dependent not only on the Indus Basin but also on larger issues of cross-border terrorism and violence. Often these issues put enormous pressure on the Treaty but fortunately, it remains intact (personal communications, March 12, 2019). Ahmad Abu Akif says that it is an uneasy peace. It is peace under the nuclear umbrella or whatever it may be called. In fact, it is neither peace nor war (personal communication, December 19, 2017). Faisal says that in the context of IWT today, we do not have sufficient space for dialogue with India, and India has never inclined towards talking about issues related to the Treaty. Under the Treaty, Commission is in place to resolve the issues, mechanisms at the government level exists, and

we can take our cases to international bodies like World Bank etc., but the fact of the matter today is that the system is not functioning as desired or required.

While dilating upon retrospective view about IWT, Mr. Akif has different views. Yet, it sums up the existing situation between Pakistan and India by expressing that the standard institutional approaches for mutual cooperation are classically not applicable to Pakistan and the Indian context; both countries have locked horns on geographical issues where geopolitics tops the list. He further argues that their co-existence and sustainability focus essentially on geo-politics and not necessarily hydro-politics. He contends that Indus Water Treaty sometimes comes into focus, but mainly geo-politics revolve around Kashmir. He ushers his thought that India wants to dialogue on issues other than Kashmir, whereas Pakistan stresses Kashmir to be included as the top agenda, so both countries never come on one page. He fears that they will shift their focus until both countries realize that there is some more significant threat to their existence than the existing one. He says that until the Kashmir issue is resolved, there seems no possibility of moving forward on any other issue. During the last two decades, a lot of discussion over the content and efficacy of IWT is being done on both sides of the border. The latest umbrella issue, likely to go a long way in coming generations, is climate change, which has started exerting pressure on the dimension of the parties' concern about IWT.

5.11 A Prospective View

Dr. Zaigham Habib, during her interview, responded to a question: what would have happened had the IWT been not in place? She said we should visualize if IWT did not work, particularly under a nuclear overhang, what kind of conflicts could emerge between Pakistan and India? She argued that the prospective view of IWT should be a reflection of our future. No progress can be visualized without a cooperative, collaborative and integrative approach between neighboring countries for utilization of their transboundary resource. IWT managing the water resource is no exception to this philosophy. Climate change has further exacerbated the stresses over shared water resource (personal communication, September 21, 2017).

Dr. Qamar-uz-Zaman, one of the architects of Pakistan Climate Change Policy, says that the future of the IWT should be seen through the lens of climate change as the main impact of climate change will be on the water. Climate change will affect irrigation and power generation sectors the most. The availability of water is likely to be decreased. He says that around 70% to 80% water of the Indus River is coming from the glacier melt. In the next few decades, we may not feel it, but ultimately, when the volume of the glaciers decreases, this will be a major concern. Food and energy insecurities are the looming threats that Pakistan needs

to address by managing its water. He says he has discussed IWT on different occasions with Indian policymakers, intellectuals and researchers. He has found them positively responding to filling up those voids that Treaty has left on account of water quality, environmental flows in eastern rivers, underground water, and water quantities due to Anthropocene. He believes that all those clauses related to the transboundary waters as the consequence of Anthropocene should be incorporated in the treaty for making it sustainable for future generations. In a nutshell, the IWT should be transformed to align with future technological dictates (personal communication, November 17, 2017).

Engr Shams ul Mulk, ex-Chairman Water & Power Development Authority (WAPDA), says that all watersheds feeding water to IRB need to be scientifically seen for climate change impacts and relevant conclusions need to be drawn and incorporated into the Treaty only then one will be in a position to make up existing gap scientifically (personal communication, September 12, 2017). Furthermore, several respondents believed that besides updating IWT, we should make a similar arrangement for Kabul River with Afghanistan as well; only then we shall be able to cope with the future dictates of climate change.

PART-III
FRAMEWORK FOR CLIMATE-PROOFING

CHAPTER: 6
CLIMATE CHANGE IMPACTS IN PAKISTAN

This chapter outlines climate change impacts in Pakistan. The co-relationship of climate change with Pakistan in a geographic, physiographic, climatological, demographic and regional context is delineated first. Then the vulnerabilities posing climate risk in the spatial domain are identified with a special focus on the declining water availability. An overview of Pakistan GHG emission profile with its past and future climate trends in annual mean temperature, precipitation and sea-level rise for the Arabian Sea is also highlighted. Climate change impacts on water, agriculture, livestock, forestry, coastal areas and environment are significate which is discussed threadbare for drawing relevant findings and conclusions. The expected consequences flowing from the climate change impacts in the domains of water security, food security, energy security, hydro-meteorological disasters, health challenges, and ecological disorder are also demarcated to establish the context for climate-proofing. Finally, in this chapter, an interplay between national climate change and water policies is highlighted for drawing inferences to devise a sustainable way forward in the form of climate-proofing IWT.

6.1 Climate Change and Correlation with Pakistan[72]

Pakistan has a diverse climate, weather, ecosystems, and biodiversity. Its vulnerability to climate change impacts is well-documented and acknowledged (MoCC, 2012). The past decade has witnessed recurrent spells of extreme weather events. Floods in 2010 and 2011, 2012 2014 (Ali, 2013), droughts in Sindh and Baluchistan from 2016-2019 (WHO, 2019), glacial lake outburst floods in Gyari 2012 (AFP, 2012), cyclones Phet 2010 (NASA, 2010) and Kyarr 2019 (TNI, 2019) and heatwaves in Karachi 2015 (Chaudhry et al., 2015) have taken a heavy toll on both life and property besides adversely affecting the economic growth of the country. In super floods 2010 alone, Pakistan suffered fatal casualties of 1600 people, an inundation of 38,500 km^2 of area and damages worth around the US $ 10 Billion (Ali, 2013). Similarly, due to heatwaves in June 2015 in Karachi, Pakistan suffered a death toll of more than 1200 people (Chaudhry et al., 2015).

[72] Pakistan is much lower as climate change contributor but very high in vulnerability.

6.1.1 Geographic and Physiographic Features

Pakistan occupies 796,096 km^2 is located within latitudes 24-37^0 N to longitudes 61-76^0 E with a great diversity in temperature and precipitation (Maps of World, 2018 June 21st). It borders China in the north and northeast, India in the east and southeast, the Arabian Sea in the south, Afghanistan in the west and northwest and Iran in the west (AIPS, 2019 December 11th). Physically Pakistan is a vast valley of mighty Indus and its major (Jhelum, Chenab, Ravi and Sutlej/Beas Rivers) and minor (Shyoke, Shigar, Hunza, Gilgit, Swat and Kabul Rivers) tributaries, running across the country like bloodlines. The western and southern segments of the country represent the Indus River basin plain and Baluchistan Plateau. The Indus basin covers 520,000 km^2 or 65% of the country's total area, and it receives an average rainfall of around 230 mm annually (Sawe, 2019). The Indus Basin Irrigation System is the world's most extensive contiguous irrigation system, accounting for 95% of the country's total irrigation system (FAO, 2011).

Figure 6.1: Geographic and Physiographic Orientation of Pakistan

Source: Survey of Pakistan, Ministry of Defense, Pakistan

Besides small to medium-sized mountain ranges in the country, northern Pakistan occupies the world's highest land in the form of three great mountain ranges of the Himalayas, Karakorum and Hindukush (Karamat, 2019). The northern region also includes some of the world's highest mountain peaks, such as K-2 (8,611 meters high), and the largest glaciers,

including Siachen (70 km long) and Biafo (63 km) that feed the Indus River and some of its tributaries. During winter, the temperatures in this region drop to as low as –50°C and stay around 15°C in the warmest months of May to September (WCD, 2000). The country's central and southeastern parts are arable, being plain, whereas in the south and southwestern parts are the deserts that act as transition zones between precipitation producing mechanisms (PC, 2019). The geographic and physiographic orientation of Pakistan can be seen in figure 6.1.

6.1.2 Climatological Features

Pakistan lies in the sub-tropic and partly in the temperate regions (Chaudhry, 2017). According to the Aridity Index Map of Pakistan based on C.W. Thornthwaite Concept for the period from 1951-2000 AD, a large part of the country is arid to semi-arid, whereas the lower part of the country is hyper-arid (FAO, 2011). The coastal climate is confined to a narrow strip along the coast in the south and southeast, whereas a humid belt exists along the sub-montane region of the Himalayas (SDPI, 2013). Ghulam Rasul Director General PMD, while giving a detailed account of precipitation pattern in the country, shared that southwesterly summer monsoon showers the eastern areas of the southern half from June to September while the northern and western regions in the southern half get rains mainly from western weather disturbances commonly known as westerlies from December to March (personal communication, July 26, 2017). He further explained that the summer monsoon accounts for around 55-60% of annual precipitation. He shared that the climate varies from arid to semi-arid, where three-fourth of the country receives rainfall less than 250 mm annually, except in the southern slopes of Himalaya and the sub mountain region in the northern segment of the country, where annual precipitation ranges from 760 to 2,000 mm[73].

The temperature difference is quite noticeable between the upper and lower basin plains. The mean winter temperature in the lower plain is 14^0C-20^0C, whereas in the upper plain, it varies between 2^0C-23^0C. During summer, in the lower plain, the mean monthly temperature varies from 42^0C-44^0C, and in the upper plain, it ranges from 23^0C-49^0C. Global Change Impact Studies Centre (GCISC)[74] research report gives an insight into the prevalent seasons in the country. These climatic seasons are 'Pre-Monsoon' from April to May, 'Monsoon' from June to September, 'Post-Monsoon' from October to November and 'Winter' from December to March. The report also outlines climatic zones based on geographic regions where PMD stations collect the meteorological data, as shown in Table 6.1 (Sheikh et al.,

[73] Worlds second highest peak K2 also falls in this region.
[74] Global Change Impact Studies Centre is a dedicated research institute for climate change studies in Pakistan.

2009). PMD maintains climatic data in the country. Based on the criteria laid down by WMO, PMD has published three climatic 'Normals' for 30 years' period, i.e. 1931-60, 1961-1990 and 1971-2000[75]. The last one is the updated version of the previous one (G. Rasul, personal communication, July 26, 2017).

Table 6.1: Climatic Zones of Pakistan

Sr. No.	Zone	Region
1.	Zone 1A	Greater Himalayas (Winter dominated)
2.	Zone1B	Sub Montane (Monsoon dominated)
3.	Zone 2	Western Highlands
4.	Zone 3	Punjab Plains Central & Southern Punjab
5.	Zone 4	Lower Indus Plains
6.	Zone 5A	Baluchistan Plateau, Northern (Sulaiman & Kirthar Ranges)
7.	Zone 5B	Baluchistan Plateau, Western
8.	Zone 6	Coastal Belt

6.1.3 Regional Climate Change Context

Climate change is a global phenomenon. Its impact on a basin is similar in neighboring countries in a particular region (M. Gramboh, personal communication, December 7, 2018). India and Pakistan both are water-stressed countries. Melting glaciers in the HKH region are equally impacting India and Pakistan because the rise in temperature in both countries is almost similar. Precipitation patterns, particularly in the western part of India and Pakistan directly related to IRB, are similar because of the common source of HKH glacier melting and monsoon rains emanating from the Bay of Bengal and Arabian Sea (Kalair et al., 2019). Both countries are extracting groundwater to meet their freshwater deficiency for intensive crop cultivation to boost food production for their growing population (WBG, 2016). Due to exponential population growth in India and Pakistan, the water resource of IRB has come under intense stress and relentless pressure (Alam & Humayun, 2014).

Due to the absence of modern irrigation techniques in India and Pakistan, about 90% of fresh water is being utilized by the agriculture sector, and a huge part of it is wasted due to mismanagement. Water scarcity is impacting both countries, may be slightly different due to allied reasons like the availability of multiple freshwater sources to India compared to Pakistan (Kalair et al., 2019). Before partition, the annual per capita availability of water in India and

[75] PMD mainly draws inspirations from WMO.

Pakistan was over 5000 cum, which reduced to 1170 cum in India in 2010 and less than 1000 cum in Pakistan in 2012 (Chaudhry, 2017). Interestingly, the condition of water utilization in India and Pakistan may be the same, but the impact of climate change; water scarcity and variability for both India and Pakistan are quite different as India has over a dozen basins to feed its land, whereas Pakistan has only IRB on which its population, economy and environment are dependent. Secondly, being an upper riparian country, the flexibilities and leverages which India can exercise are much more than Pakistan; therefore, stakes of Pakistan in IRB are much higher and deeper than India, particularly under climate change environment when water availability has become uncertain on spatial and temporal scales (SDPI, 2013).

6.1.4 Demographic Contours

According to Pakistan Economic Survey 2018–2019, Pakistan, with a population of approximately 212.82 million, is ranked the fifth most populous country in the world. The current population growth rate is 2.4%. The density of population is 231 persons per km^2. 37% of the population reside in urban areas, whereas 63% living in the rural areas are associated with agriculture in one form the other. The current total fertility rate of 3.6% is one of the highest in the Asia Pacific region, though it has dropped from 3.8%, the figure of the previous survey of 2012-2013 (NIPS, 2019). The Economic Survey 2019 gives Pakistan literacy rates for adults as 57 %. The female literacy rate is 65.5%, whereas the male is 79.8%. According to United Nations Development Programme (UNDP) Human Development Report 2018, Pakistan is ranked 150th out of 189 countries with the Human Development Index (HDI) value of 0.562 (with 1 being the maximum value). According to the educational indicators, only Afghanistan lags behind Pakistan in the context of regional comparison (HDI, 2019). Agriculture contributes 18.5% to the country's GDP and provides 38.5% employment to the national labor force, but it remains a backward economy sector. Climate change poses a serious challenge to Pakistan's agriculture and threatens the country's water availability and food security (MoF, 2019). Economic Survey identifies water scarcity as the major reason behind the decline of agriculture performance as under:

> The performance of Agriculture during 2018-19 remained subdued. On the aggregate, the sector grew by 0.85%, much lower than the target of 3.8% set at the beginning of the year. This underperformance of the agriculture sector was mainly due to insufficient availability of water, which led to a drop in cultivated area and a drop-in fertilizer off taking. The crops sector experienced negative growth (-4.43% against the target of 3.6%) on the back of decline in growth of important crops by -6.55%.

According to the Ministry of Energy, during July-March in 2019, the installed electricity capacity reached 34,282 MW, 2.5% more than the corresponding period of the previous year. The generation increased by 2.1%, getting 84,680 Gigawatt hours (GWh). Besides growth in renewable (1%) and nuclear energy (0.5%), the hydropower generation during the same period saw an increase of 1.4%, showing the resolve of the government to harness water resource for future power generation (MoF, 2019). According to MoCC, the erratic weather patterns and climate change have emerged as the most significant environmental challenges affecting almost all the sectors of the economy, particularly water resources, energy, health, and bio-diversity, with a major impact on agricultural productivity (MoF, 2019).

6.2 Vulnerabilities Posing Climate Risk

According to UNISDR, vulnerability is a set of characteristics and circumstances of a community, system, asset, or country that make it susceptible to the damaging effect (UNISDR, 2009). Vulnerability to climate change will fall in the domain of physical, social, economic and environmental spheres. Vita-Salute San Raffaele University defines risk as to the combination of the probability of an event and its negative consequences (UNISDR, 2009). Risk manifests in two ways. Firstly, it refers to a chance of an incident happening, and secondly, it refers to the potential losses visualized from that event. According to national climate change policy 2012, Pakistan's major vulnerabilities to climate change include rise in temperature, glacial fluctuation, the uncertainty of water availability, increase in frequency and intensity of extreme weather events like floods and droughts, decrease in already scanty forest cover, increased intrusion of saline water in the Indus Delta, rise in sea level, increased health risks, climate change-induced migrations and finally increased stress between upper and lower riparian in sharing of water resource. The climate change-related threats indeed lead to major survival concerns for Pakistan, particularly in water, food, and energy securities (MoCC, 2012).

6.2.1 Spatial Vulnerabilities

South Asia, due to its generally warm climate, is more vulnerable to climate change than other courtiers as it lies in a geographical setting where the expected increase in temperature is likely to be higher than the global average (Chaudhry, 2017). About 60% of Pakistan's land area is arid, which receives less than 250 mm rainfall, 24% is semi-arid, which receives rainfall between 250-500 mm, whereas the remaining area, generally mountainous, receives more than 500 mm rainfall annually (G. Rasul, personal communication, July 26, 2017). The main source

of its freshwater is rivers of IRS that are predominately fed by HKH glaciers which are reportedly retreating due to global warming. Pakistan's economy is largely agrarian, drawing water from rivers, rainfall, and groundwater, which are highly sensitive to climate change (Z. Habib, personal communication, September 21, 2017; A. A. Akif, personal communication, December 19, 2017).

Due to the increasingly large risk of variability in monsoon, Pakistan is exposed to protracted drought and voluminous floods. Due to rising sea levels, saline seawater intrusion, coastal erosion, and increased cyclone activities, Pakistan coastal areas are equally vulnerable to climate change. Due to its peculiar geographical and climatic location, Pakistan is expected to experience an increase of 4^0 C by the turn of the 21st century against the global anticipated average increase of 2^0 C (Q. Z. Chaudhry, personal communication, November 17, 2017; A. Rasheed, personal communication, July 20, 2017).

6.2.2 Declining Water Availability

At the time of partition, Pakistan had over 5000 cum per capita water availability, but now, by 2019, with a changed demand profile, the water availability has decreased to less than 1000 cum per capita, rendering it a highly water-stressed country (MoF, 2019). With a gradual rise in average global temperature, Pakistan's precipitation and thermal regimes have also experienced sharp changes in the last two decades (G. Rasul, personal communication, July 26, 2017). Pakistan has a diverse landmass that ranges from ice-capped HKH Mountains in the north, descending through arable plains, desert and semi-desert in the centre and south, and the coastal belt of Arabian Sea in the south (M. A. Baig, personal communication, July 7, 2017). IRB is the only source of freshwater for Pakistan. It draws 80% of its water from glacial melting, complemented by rains from monsoon or westerly weather systems to meet its agriculture, power generation, industry and domestic needs (M. A. Shah, personal communication, August 16, 2017).

Due to climate change impacts, visible variations in the hydrological cycle of Pakistan have been observed. These variations include changed thermal regimes and fluctuating precipitation patterns resulting in rapid glacial retreat, frequent and intense floods (since Floods-2010, there has been no break), protracted droughts, variable water quantities in terms of timings, duration and magnitude, deteriorating water quality, disturbed cropping patterns with increased crop water requirement, frequent and intense heat waves, rise in sea level, saline water intrusion, coastal erosion, frequent cyclones and above all, groundwater depletion as a result of intense extractions (T. Altaf, personal communication, 2017, August 26). In the given

climate change scenario, in future as well, in Pakistan, the temperature is expected to rise as anticipated, and precipitation patterns will also remain disturbed as the adaptation and mitigation measures to arrest deteriorating trends causing climate change have not come in place and are not expected to be in place in near future as well (M. Siddique, personal communication, August 26, 2017).

6.3 Pakistan's GHG Emission Profile

To correctly understand the climate change context regarding Pakistan, it is prudent to identify Pakistan's GHG emission profile. IPCC AR5 reports that GHG emissions have accelerated unprecedentedly over the years despite global efforts. Climate model projections of AR5 indicate that during the 21st century, using stringent mitigation measures, at the lowest emission scenario, the global surface temperature is likely to rise by 0.3^0 to 1.7^0C; whereas for business as usual carbon-intense emissions, the temperature rise is expected to range between 2.6^0 to 4.8^0C (IPCC, 2014).

According to the Global Carbon Project (GCP), in 2017, global CO^2 emissions were 36.2 Billion tons of CO^2 ($BtCO^2$). Asia contributed 19 $BtCO^2$ (53%, China leading with 27% followed by India with 6.8%), North America 6.5 $BtCO^2$ (18%, US leading with 15%), Europe 6.1 $BtCO^2$ (17%), Africa 1.3 $BtCO^2$ (3.7%), South America 1.1 $BtCO^2$ (3.2%) and Oceana 0.5 $BtCO^2$ (1.3%). Pakistan, with 199 Million tons of CO^2 ($MtCO^2$) (0.55%), ranks at 135th for per capita and 31st for national production-based emission in 2017 (Ritchie, 2019). In the coming decades, the situation regarding the emission of CO^2 is likely to worsen. In equivalence of CO_2 emissions, Pakistan produced 182 Million tons of CO^2 emissions ($MtCO^2e$) in 1994, 309 $MtCO^2e$ in 2008, 369 $MtCO^2e$ in 2012, 650 $MtCO^2e$ in 2020 and the increase will reach 4200 $MtCO^2e$, which is around 14 times by 2050. The major contribution for GHG emission in Pakistan is from the energy sector (45.9%), followed by agriculture (44.8%), industrial processes (3.9%), waste (2.8%) and Land Use Change for Forestry (LUCF) is 2.6% (Chaudhry, 2017).

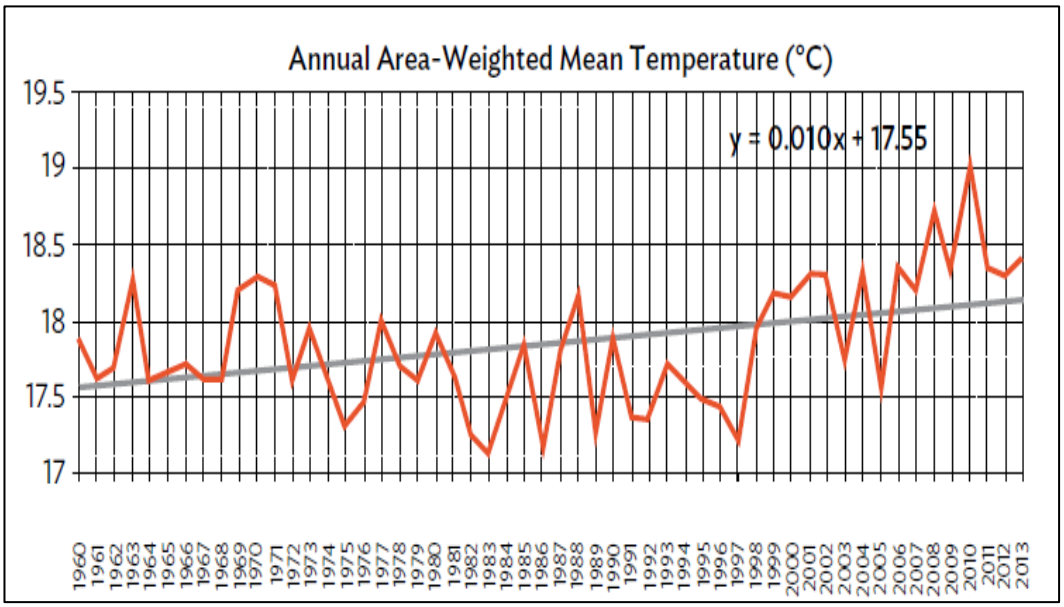
6.4 Past Climate trends

To understand the climate change impacts regarding Pakistan correctly, it is prudent to first know about climate change past and future trends, which shall set a stage to discuss its impacts and consequences on different sectors of Pakistan's economy and development. Based on PMD station data from 1951-2000, past annual mean surface temperature and precipitation (annually) trends are discussed in succeeding paragraphs (Chaudhry, 2017).

6.4.1 Annual Mean Temperature

During the last century, Pakistan's average annual temperature increased by 0.57°C as against 0.75°C for South Asia (Figure 6.2). An increase in winter temperature is the reason behind warming. From 1980 to 2007, heatwave days increased by 31 days. Cold wave days increased in western and northwestern parts and decreased in the eastern and southern parts of the country. During 1960–2007, it was observed that the mean temperature over the hyper-arid plains, arid coastal areas, and mountains regions has increased, ranging from 0.6°C to 1.0°C.

Figure 6.2: Annual Area Weighted Mean Temperature of Pakistan



Source: Pakistan Meteorological Department (PMD) Technical Report no 25. Redline–Area weighted mean temperature and Black line-Linear trend Rate of change is 0.01^{0}C.

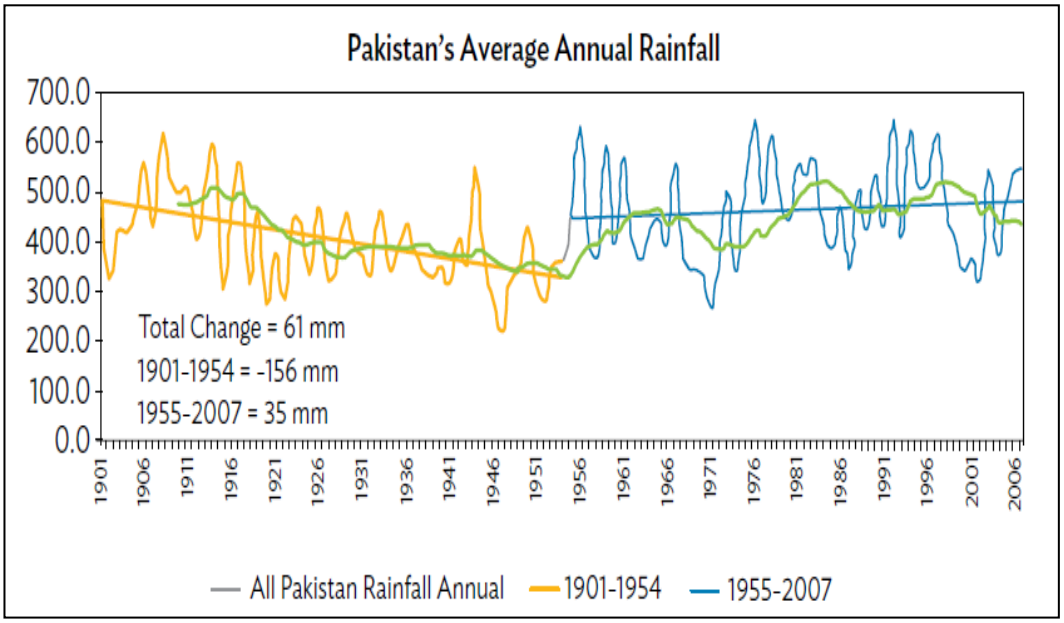
It was also observed that the minimum temperature in summer over central parts of the country had shown a pronounced warming trend while the extreme northern and southern parts of the country have shown a slight cooling trend in some climatic zones. Cloud cover over central parts of Pakistan has decreased by 3-5%, resulting in an increase in temperature by 0.9°C. While the coastal belt in general and the Indus delta, in particular, have not shown any significant warming or cooling trends (Mahmood et al., 2012).

6.4.2 Annual Precipitation

Pakistan's average annual precipitation has increased by 25% (Figure 6.3). During 1960–2007, it has been observed that 10-15% rainfall in winter and summer has decreased in the arid plains and coastal areas. 18-32% rainfall in the summer over the core monsoon region has increased.

Relative humidity over Baluchistan province has decreased by 5%. Solar radiation over the southern half of the country has increased by 0.5-0.7%. During seven strong El Niño events in the last 100 years, a decrease of 17% to 64% in rainfall has been observed. Outside the monsoon region, the country's northern parts have suffered from expanding aridity (Chaudhry et al., 2009).

Figure 6.3: Pakistan's Average Annual Rainfall

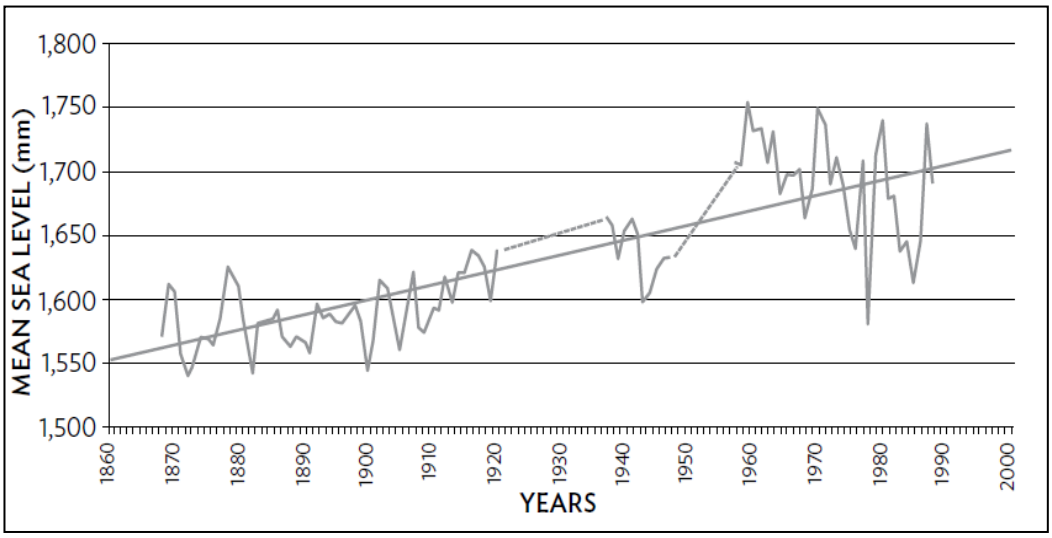


Source: Pakistan Meteorological Department (PMD) Technical Report no 22.

6.4.3 Sea Level Rise (SLR)

The mean SLR record along Karachi Coast from 1860 to 2000 is shown in Figure 6.4. Bahria University in 2008 at Karachi held its 2nd International Maritime Conference; the key finding was that a rise by 1.1 a millimeter per year in sea level past century had been observed (Rabbani et al., 2008).

Figure 6.4: Pakistan's Mean Sea Level Rise



Source: 2nd International Maritime Conference, Bahria University (2008).

6.5 Projected Future Climate Trends

Ghulam Rasul, Director General PMD, the custodian of Pakistan climate data, says climate change is a reality. The results coming from 67000 climate stations of WMO recording temperature and parameters from across the globe cannot be denied (personal communication, July 26, 2017). IPCC AR5 has defined a set of GHG emission scenarios for the 21st century. Based on these scenarios, GCISC and PMD using General Circulation Model for future climate change projection have conducted the studies. In succeeding paragraphs, critical findings of mean temperature, rainfall, and sea-level rise for the 21st century are given.

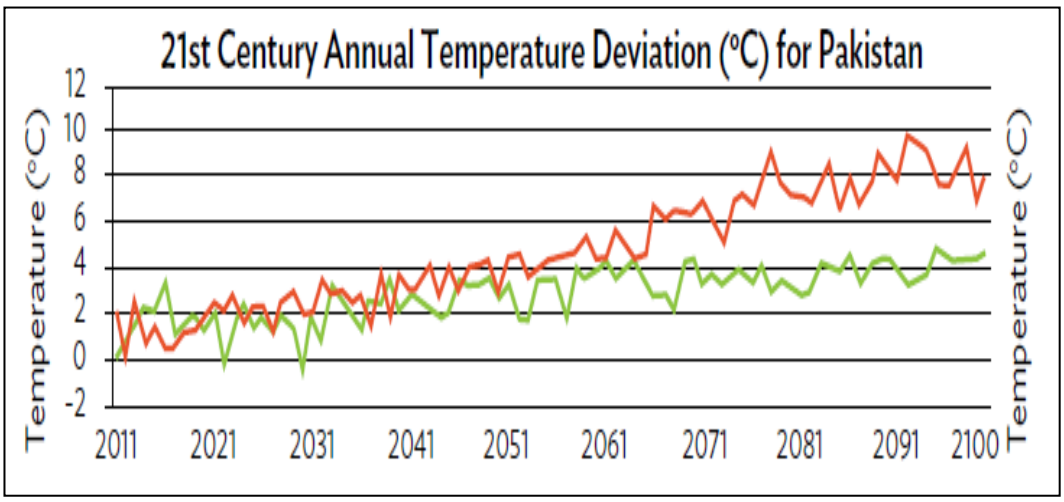
6.5.1 Temperature

In 2007, GCISC modeled annual temperature change for 2020, 2050 and 2080 under two emission scenarios, i.e. A2 Business as usual and A1B as a balanced scenario. According to the model, by 2080, the temperature rise in Pakistan will be as high as 4.38^0 C. The study further observed that temperature increase in both summer and winter would be higher in northern and southern parts of the country. The study further observed that temperature increase in both regions in winter than summer (GCISC, 2007).

In 2015, PMD released a daily gridded downscaled temperature time series from 2010 to 2099 climate change scenarios. The study results show a rise of 3.5^0 to 5^0 C in mean temperature under the Representative Concentration Pathway Scenario. Another scenario shows an increase of 40^0C to 60^0C by the end of the century, with a sharp rise after 2050 (PMD, 2015). Under both the studies, snow-covered areas in the north showed a more considerable

increase in mean temperature than central and southern parts of the country (Chaudhry, 2017). Sinha says that unprecedented spells of hot weather are expected in a temperature rise scenario from 2^0C to 4^0C, covering a larger area. A high-temperature climate regime will emerge with a significant impact on agriculture (personal communications, March 12, 2019). Figure 6.5 shows Pakistan's mean annual temperature deviation projections during the 21st century using two different emission scenarios.

Figure 6.5: 21st Century Annual Temperature Deviation



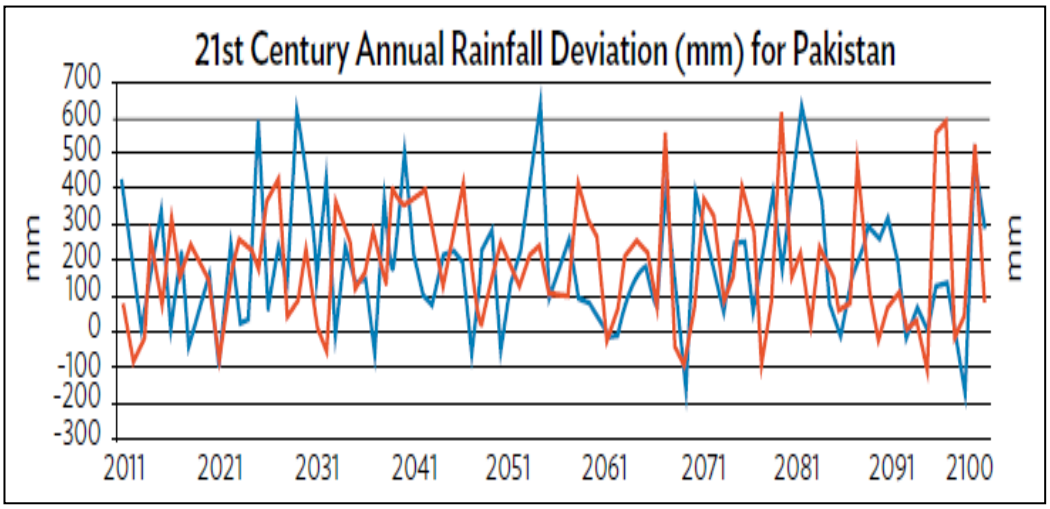
Source: Pakistan Meteorological Department (PMD) 2015.

6.5.2 Precipitation

In 2007, GCISC also modeled annual precipitation change for future years 2020, 2050 and 2080 under two emission scenarios, i.e. A2 Business as usual and A1B as a balanced scenario. According to the model, for the percentage of precipitation change, no significant change has been observed (GCISC, 2007). However, according to research by Iqbal, there is some precipitation increase in summer and a decrease in winter in the southern part of the country (Iqbal & Zahid, 2014).

In 2015, PMD released a daily gridded downscaled precipitation time series from 2010 to 2099 climate change scenarios. The study results showed mixed trends for future precipitation over different country regions. The rainfall results are highly variable in both spatial and temporal domains. Area average rainfall shows large inter-annual variability. Sharp rising peaks indicate extreme precipitation events, while negative peaks indicate drought (PMD, 2015). Figure 6.6 shows Pakistan's mean annual precipitation deviation projections during the 21st century using two different emission scenarios.

Figure 6.6: 21st Century Annual Rainfall Deviation

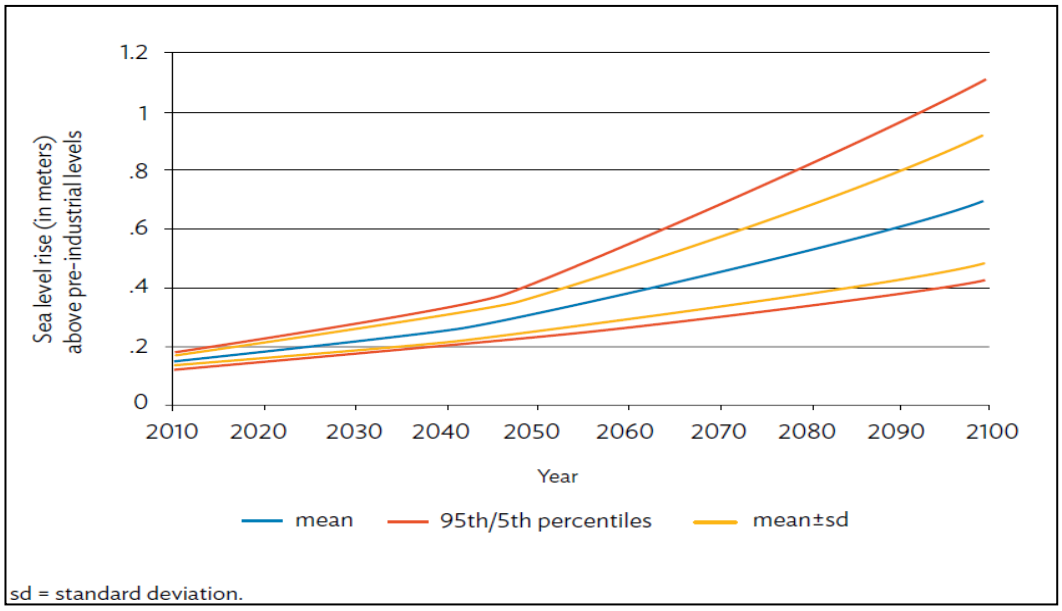


Source: Pakistan Meteorological Department (PMD) 2015.

6.5.3 Sea Level Rise

In the last century, Pakistan's mean sea level rise is recorded as 1.1 mm per year (Rabbani et al., 2008). Due to a lack of sufficient data, no worthwhile projection has been made by concerned agencies about SLR. The projections made at a global and regional level can be equally applicable to Pakistan as its coastal line forms part of a bigger whole (Chaudhry, 2017).

Figure 6.7: Projected Mean Sea Level Rise by 2100 in South Asian Region



Source: Pakistan Meteorological Department (PMD) 2014.

According to IPCC AR5, the world is likely to experience a 0.2 to 0.6 meters rise in sea level by the end of the 21st century (IPCC, 2014). Regionally for south Asia, sea-level rise is

anticipated to be 0.7 meters (between 0.42 and 1.12 meters with a 90% confidence level). Figure 6.7 shows the projected mean sea level rise by 2100 in the south Asia Region (Ahmad & Suphachalasai, 2014). On average, SLR is a projection for 2100 is made relative to the pre-industrial level. The low-lying coastal areas south of Karachi towards Keti Bandar and Indus River Delta are likely to be affected by sea-level rise (Chaudhry, 2017).

6.6 Climate Change Impacts

In his address to the UNGA in 2018, Secretary-General Antonio Guterres, while quoting WMO data, expressed that climate change is a reality. He highlighted that the last two decades had witnessed eighteen of the twenty warmest years since record-keeping began in 1850. He said, "Climate change is moving faster than we are." He further added, "We must listen to the Earth's best scientists" (IPCC, 2019). Senator Mushahidullah, the minister of climate change, in his interview on 14 February 2018, said that the phenomenon of climate change has impacted every walk of life in Pakistan.

While sharing his views about impacts, he explained that climate change has direct effects which lead to consequences. He elaborated his viewpoint through an example that climate change occurs due to rising temperature, melting glaciers faster. Resultantly, it is impacting water which is either being increased or decreased. Consequently, the impact is affecting agriculture, power generation, sea, air and ecology etc., leading to food, energy and health insecurities. He said it is an extremely complex phenomenon that needs to be correctly understood (Mushahidullah, personal communication, February 14, 2018). Sinha says that evidence and computer simulation climate change risks are now far better understood. These tools have helped scientists in India to arrive at the likely impacts of climate change on water resource, agriculture, cities, coastal areas and eco-systems etc., in a better way (personal communications, March 12, 2019). The impacts of climate change on water, agriculture, livestock, forestry, coastal areas and the environment will be discussed in succeeding paragraphs for drawing relevant conclusions.

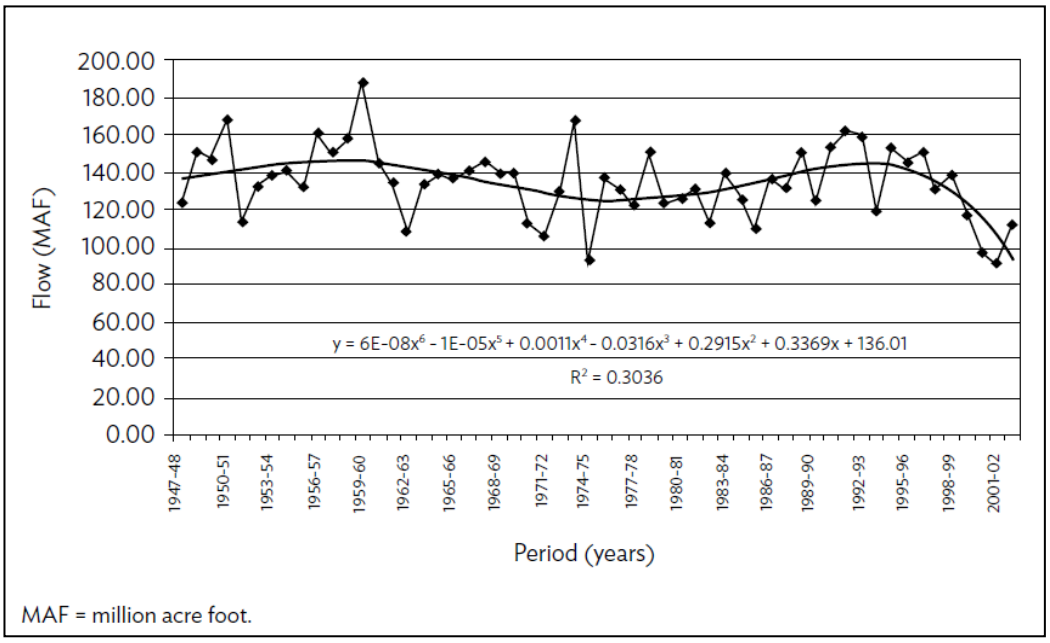
6.6.1 Water

The water experts of NESPAK, Tariq Altaf and Muhammad Siddique, state that due to increasing in the variability of monsoon and winter rains resulting in increased river flows, uncertainty about glacial melting shrouding the future river flows with doubts, increased irrigation demand due to higher evaporation at elevated temperatures with conventional irrigation system, burgeoning population, reduction in water storage capacities due to increased

sedimentation (0.2 MAF per year), depleting groundwater and lack of appropriate transboundary river inflows and glacier monitoring system, it can be said with a high level of certainty that water sector as the consequence of Anthropocene will come under immense stress in future in Pakistan (T. Altaf, personal communication, 2017, August 26; M. Siddique, personal communication, August 26, 2017).

Ghulam Rasul says there are four sources of freshwater in the Indus Basin for Pakistan, namely glaciers, snow, rainfall and aquifer; all these are being impacted by the global warming triggered phenomenon of climate change (G. Rasul, personal communication, July 26, 2017). Asian Development Bank (ADB) report on the climate change profile of Pakistan (Chaudhry, 2017) reports that water is the most affected sector by climate change. Pakistan receives 142 MAF as river inflows from glaciers and snow, 50 MAF from rainfall and approximately 48% (48 MAF) of surface water from the aquifer. 92% of available water is used in agriculture, 3% for industries and 5% for domestic use and infrastructure.

Figure 6.8: Annual River Flows of Indus River System in Pakistan



Source: Pakistan Agriculture Research Council 2009.

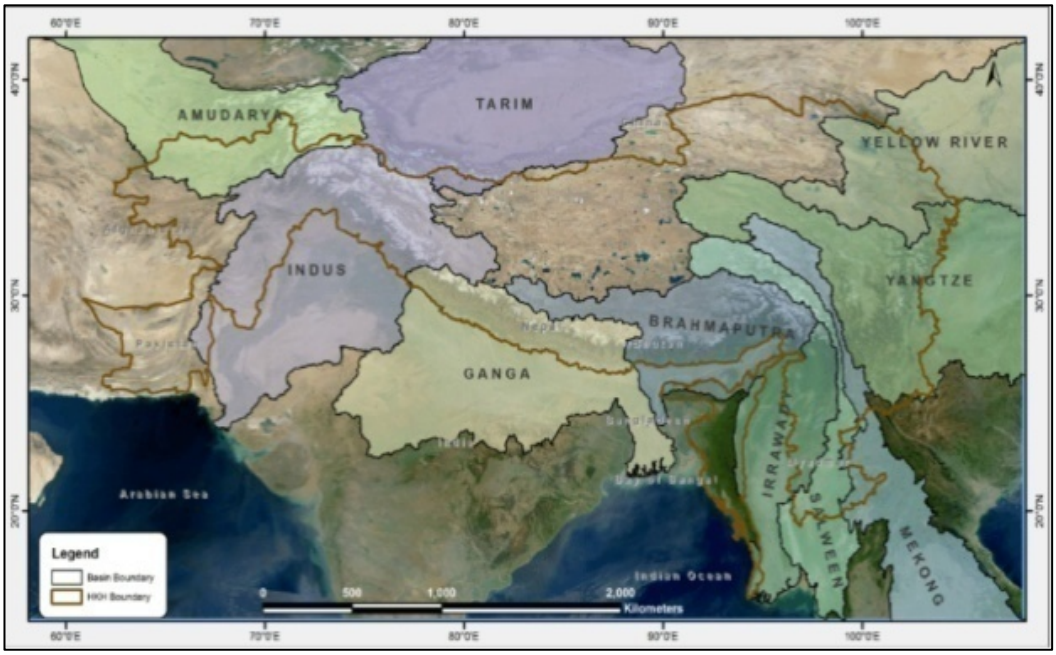
Due to socio-economic development and the increase in population, the water demand is likely to increase, exerting pressure on declining water availability (Chaudhry, 2017). Based on analyses of river flows from 1947 to 2002, it has been observed there is a decreasing trend in annual flows particularly a rapid decline is observed from 1998 which resulted in a long six-year drought in the country. Figure 6.8 shows the Annual River Flows of the Indus River

System in Pakistan (Ahmad et al., 2010). Four sources of water will be discussed separately in the succeeding paragraphs.

6.6.1(a) Glaciers

Glacier is a large, perennial accumulation of ice, snow, rock, sediment and liquid water with origination on land and moving downslope under the influence of its own weight and force of gravity. Glaciers are dynamic rivers of ice that are classified by their size, location and thermal regime. Glacier streams transport the accumulated liquid water on (supraglacial), in (englacial) or under (subglacial), moving under the influence of gravity to main water channels adding up to its flow (IPCC, 2014). As part of the HKH region, other polar regions, Pakistan has the largest number of glaciers on the face of the earth. HKH, considered the third pole of the world, has major glaciated areas, forming the upper basins for major rivers in the region. Pakistan has a glacial area of approximately 15061.74 km^2, out of which it has an estimated ice reserve of 2174 Km^3 comprising a total number of 11413 glaciers. The largest glacier area covers about 925.93 Km^3 (Bajracharya & Shrestha, 2011). HKH region, due to the largest areas covered outside the north-south poles, is commonly called as 'third pole of the world', the roof of the world' or 'world water towers' (Bajracharya et al., 2016). Map 6.9 shows ten major river basins fed by HKH.

Figure 6.9: Ten Major Basin Boundaries in HKH



Source: International Centre for Integrated Mountain Development (ICIMOD) 2016.

According to Bajracharya et al. (2016), 9.04% of the Himalayas is covered by glaciers, with 30-40% additional area covered by snow that feeds major river basins like Indus, Ganges, Brahmaputra and Magna etc., supporting the livelihood of over 1.3 billion people. Qamar-uz-Zaman says that global warming is likely to change cryosphere dynamics, hydrological cycles and atmospheric flows of the region. Except for the Karakorum, about which uncertainty prevails, the HKH glaciers are receding (Q. Z. Chaudhry, personal communication, November 17, 2017). Immerzeel and his team have applied modeling approach across HKH and concluded that glacial meltwater is extremely important for the Indus basin, reasonably important for the Brahmaputra, but only plays a modest role for the Ganges, Yangtze and Yellow Rivers (Immerzeel et al., 2010). The preliminary results by Immerzeel revealed that snow and glacial melt contribution, compared to total runoff generated below 2000 meters is 15% for Indus, 27% for the Brahmaputra, 10% for the Ganges, 8% for the Yangtze and 8% for Yellow River basins.

Ghulam Rasul says that IRB is the most vulnerable Basin. He dwelled on saying that UIB is a glaciated basin that is suffering from not only solid precipitation fluctuation but also from liquid precipitation. Furthermore, Monsoon is intensified by increasing temperature, which takes it to higher elevations. He explains the phenomenon that the Monsoon water is showered on glaciated ice, making glaciers melt faster because the Monsoon water is at 15^0C to 16^0C temperature whereas ice is at about -4^0 to -5^0C. This difference of 20^0-25^0C accelerates the melting process. He says that meltwater is accumulated either under the glacier in the form of pondages or front of the glaciers near the vicinity, making glacier lakes. When filled beyond capacity, the glacier lake suffers an outburst resulting in GLOF events. The water from glacial melt ultimately adds up to river inflows (G. Rasul, personal communication, July 26, 2017). Another PMD expert, Rasheed, says that for the next 30 to 40 years, the amount of water flowing in the rivers will be more, but then it will reduce, resulting in extreme water shortage (personal communication, July 20, 2017). Sinha believes it is not easy to determine but erroneous to claim that glaciers are melting and disappearing. In the northwestern Himalayas and the Karakoram Ranges, the glacial mass has remained stable and advanced, but glaciers are retreating in the Himalayan Range as one move eastward, possibly because of the erratic monsoon (personal communications, March 12, 2019).

6.6.1(b) Snowfall

For centuries, the snow accumulation or addition to the glaciers has happened through precipitation, snow solidification and wind transportation. The ablation or reduction in glacial

mass occurs when ice and snow are lost through melting, runoff, sublimation, calving, evaporation, and wind transportation. This keeps changing the mass of the glaciers to positive or negative side depending upon the climate conditions prevalent in the region (Bendle, 2019). In Pakistan, most of the glaciers lie in the valleys. Some of which are also temperate in nature, where liquid water coexists with frozen water resulting in glacial lakes (Jilani et al., 2007). The glacier mass balance is also known as the mass budget, is gained or lost by snow and ice over a hydrological cycle. Annual air temperature determines the hydrological cycle where the accumulation dominates in winter and snow in summer. The prevailing climate will affect the quantum of accumulation and ablation and the span of mass balance season. The thinning or retreating of the glaciers or their thickening or advancing is determined by the snowfall and the climatic conditions which determine its melting or solidifying (Cheema et al., 2016).

Ghulam Rasul says that the shift of pattern has been observed in snowfall (G. Rasul, personal communication, July 26, 2017). He explains that snowfall used to peak in Dec and Jan, but now the peak is occurring in Feb and Mar. When this is shifted towards spring, immediately after winters, the temperature is increased, and fresh snow washes away. This increases the spring inflows in the rivers and streams of IRB. He further deliberated upon the process and said that the fresh snow made up the deficiency of ablation or depletion of the ice due to melting in the previous summer season on the glaciers. The fresh snow used to stay for a more extended period on the glaciers, and through a metamorphic process of thawing (melting and freezing and again melting and freezing), the fresh snow used to become ice, and that ice would become part of the glacier, so in this way, the depletion of glaciers was made up in next winter season. He said under the climate change impact; it is not happening now. He said rather, the late winter snow is immediately washed away during spring. The following summer, the glaciers melt, causing negative mass balance and increasing river inflows.

6.6.1(c) Rainfall

Ghulam Rasul says that Pakistan is geographically located in a heat surface zone. So, it is invaded by Mid Latitude Weather System, known as western disturbances or westerly waves, and also from Tropical Weather System, the Monsoon. He says Pakistan is a playground for the interaction of both systems. Both the weather systems have been affected by climate change. He dwelled that the two easterly and westerly weather systems produce precipitation in solid and liquid forms. They are suffering from different types of shifts and different types of changes in their pattern. Monsoon also suffers from different changes because high pressure over the Tibet plateau is important in bringing Monsoon to this region. Pakistan is making

western borders of summer Monsoon, and if firm high pressure is built up at Tibet Plateau, then we receive perfect Monsoon because easterly current gets much strength along the foothills of Himalayas lot of moisture is driven from the Bay of Bengal to Pakistan. In mountainous and sub mountainous areas of Pakistan, that monsoon is good. Pakistan receives good rainfall, but not if the Tibet Plateau pressure is low.

According to Choudhry and colleagues (2009), during 1960–2007, there is decreased rainfall in winter and summer by 10-15% in the arid plains and coastal areas besides a decrease of 17% to 64% in rainfall during seven strong El Niño events in the last 100 years. Sinha says there is a decline in monsoon rainfall, and the frequency of heavy rainfall events has increased. It is expected that dry months are going to be drier and wet months wetter (U. K. Sinha, personal communications, March 12, 2019).

6.6.1(d) Aquifer

Kaka Khel says that groundwater is a natural reservoir readily available for consumption on the consumer's doorstep. It is charged through perpetual percolation from surface water. It has been adversely affected due to over-extraction due to higher demand as a consequence of Anthropocene. The water table persistently decreases, entailing exorbitant extraction effort and cost. This has disturbed the overall water availability equation in the IRB (S. Kakakhel, personal communication, December 15, 2017). Ghulam Rasul says that aquifers are directly related to the variability of climate and the changes in climate. Under increased population, developmental and economic needs as the consequence of Anthropocene, the water demand has increased. Contrarily, our surface water stocks are also limited. All users have started drawing water from the aquifer. Resultantly it has gone down. If you look at Baluchistan, its Karez System has dried up. The water table has gone more than 1000 feet down. Aquifer in Pakistan and India both needs extensive study. Based on research conclusions, it should be made part of the IWT (personal communication, July 26, 2017).

Ahmad Kamal, Chairman Federal Flood Commission, says that due to his professional dictates representing Federal Flood Commission, he has been part of three studies conducted in different political regimes. As a response to one of the queries that why the water table in Pakistan Punjab and Potohar Region is going down very fast, it was found in Indian Punjab the groundwater extraction is too high, and the underground water profile is sloping towards India. So, whatever water resource in underground water exists is being shifted to the Indian side, whereas their own resources remain intact (personal communication, December 29, 2017). Qamar-u-Zaman Choudhary, in his interview, says that when the surface water availability is

reduced or becomes uncertain, the subsurface water is extracted. Subsurface water is a more serious challenge than surface water as in some areas (particularly dry areas like Baluchistan), the underground water is being exploited to the extent of criminality. One of the major reasons behind aquifer depletion in the eastern part of the country is the absence of environmental flows in Eastern Rivers. The link canals partially recharge the aquifer, but it is being exploited equally by Indians and Pakistanis alike. If the research conclusion is correct that the slope of the aquifer is towards the Indian side, then it is a matter of concern. This needs to be studied and appropriately addressed (personal communication, November 17, 2017).

Zaigham Habib says that the groundwater is not mentioned in IWT. She says that Indians claim that the river-related sources were also divided when rivers were divided. In IWT, the uses restricted of Eastern Rivers have been restricted, whereas Pakistan is extracting more water than its share. Zaigham referred to a NASA report on groundwater extraction in both Indian and Pakistani Punjab, according to which the groundwater level in Pakistan is higher than the Indian side, which is more beneficial to Pakistan. It shall be adequately studied, and recommendations can be made (personal communication, September 21, 2017). Uttam Kumar Sinha, in his interview, shared that 60% of India's agriculture is dependent on rain making groundwater a crucial source. Even without climate change, India's groundwater is being increasingly stressed. Climate change has aggravated the situation of declining water availability, and sub-surface water is no exception. Water resource management and efficient water use are needed across the sectors and borders (personal communications, March 12, 2019).

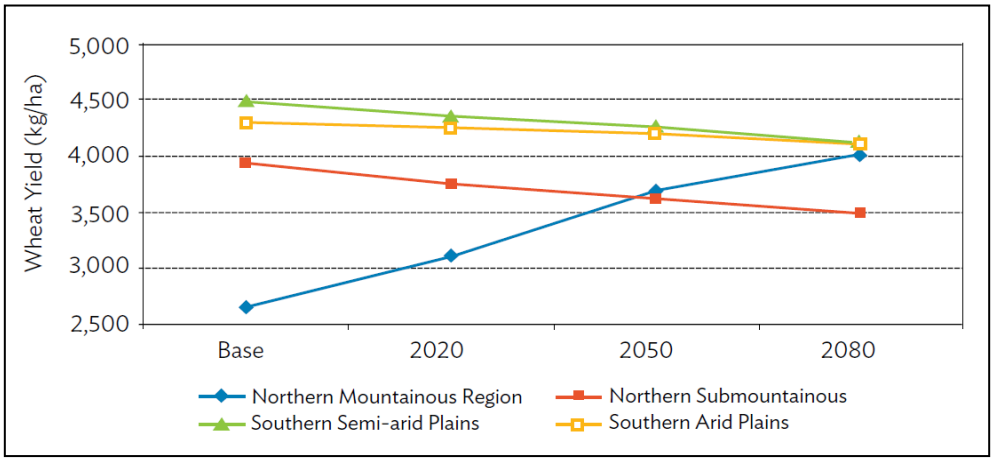
6.6.2 Agriculture

Climate change is equally impacting the agriculture sector. There are two cropping seasons in Pakistan. One is Rabi season (winter season) when crops are sown in autumn (October–November) and harvested in spring (March-April). Wheat is a major Rabi crop. The second is Kharif season which is a more extended season. Its major crops like sugarcane start in February, cotton in March-May, rice in June-July and maize in July-August. There usually are two crops sown in a year with a combination of varying patterns. Pattern may vary from Rice-Wheat, Cotton-Wheat, Maize-Wheat, Sugarcane-Wheat and some coarse Grain-Wheat combination. Wheat is Pakistan's leading staple food, grown in all patterns, even in farming areas. The second staple food is rice which is also essentially grown in water irrigation areas. (Khan & Tahir, 2018).

Agriculture is one of the vital economic sectors contributing 18.5% of GDP. 38.5% of the country's workforce is employed in this sector. The sector contributes 60% of the export (MoPD&R, 2019). Pakistan, excluding northern areas, has a total geographical area of 79.61 million hectares (Mha), of which only 72% is reported for land use, and 28% is not yet surveyed for land use classification. The total cropped area is 23.4 Mha, representing 29% of the reported area. 18.63 Mha out of the cropped area is irrigated, whereas the remaining 4.77 Mha is under spate farming. Of this irrigated crop area, 77% is in Punjab, 14% in Sindh, 5% in KPK, and 4% in Baluchistan (BoS, 2011). According to WWF 2015 report, with the rise of temperature from 0.5^0 to 2^0C, agriculture productivity will decrease 8% to 10% by 2040 (Dehlavi et al., 2014).

Using crop–growth simulation models, Iqbal estimates that there will be a decrease in the yield of major crops, specifically wheat and rice and the length of the growing season in four agro-climatic zones of the country. The model predicts a decrease of 14 days for a 1^0C rise in temperature by 2080 in the growing season length of wheat in northern areas compared to the country's southern regions (Iqbal et al., 2009). According to the modeling, Iqbal finds that under A2 Scenario (Business as usual) and B2 Scenario (relatively more control on population and GHG as compared to A2), there is an increase of 40 to 50 % of wheat production by 2080 in northern mountainous regions (2% share in national production). Other than this exception, there is a decrease in all different agro-climatic zones. Wheat production is reduced in the northern sub-mountainous region (9% share of national output) by 11%, in southern semi-arid plains (42% share in national production) by 8% and southern arid plains (47% share of national output) by 5-6 %.

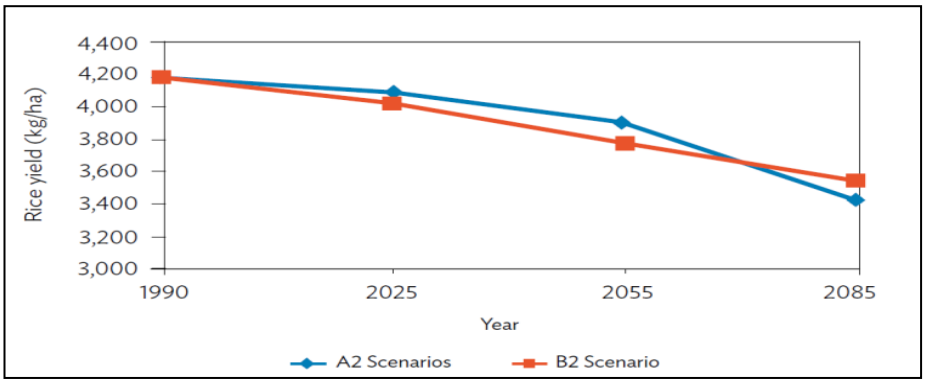
Figure 6.10: Wheat yield in different agro-climatic zones of Pakistan by 2080 under IPCC A2 Scenario



Source: Iqbal et al., 2009

Figure 6.10 shows wheat yield in different agro-climatic zones of Pakistan by 2080 under IPCC A2 Scenario. According to the same study by Iqbal, a decrease of 15 to 18 % in rice yield is estimated. It is also found that rice yield decreases less under the B2 scenario where climate change adaptation and mitigation efforts are in place compared to the A2 scenario where business as usual is being run. Figure 6.11 shows rice yield by 2085 under IPCC A2 and B2 Scenario. According to International Institute for Applied Systems Analysis (IIASA) Austria, by 2080, the yield will decrease for all major crops and cereals, and the wheat would have the highest reduction in the output. The results show a decrease of 27% in wheat, 1.9% in Rice and 4.3% in Maize.

Figure 6.11: Rice Yield by 2085 under IPCC A2 and B2 Scenarios



Source: Iqbal et al., 2009

6.6.3 Livestock

According to Economic Survey 2018-19, livestock contributes 60.5% to the overall agricultural and 11.2% to the GDP. It contributes around 3.1% to the total exports. It is a source of 35-40% of income for over 8 million rural families and provides them food security by supplementing high valve protein of animal origin (MoF, 2019). The GHG emission of the livestock sector makes up a large part of the total emission of the country's agriculture sector. The enteric fermentation and manure management of livestock makes around 90% of the GHG emissions of agriculture which produces 40% of Pakistan's total GHG emissions (Mir & Ijaz, 2016). It is estimated that 60% of the land supports around 93 million livestock in northern Pakistan, Baluchistan and arid and semi-arid areas of Sindh and Punjab (Ahmad, Islam et al. 2012).

It is assumed that degradation of grazing pastures and lands will take place due to drought, floods and rise in temperature, which will result in loss of land productivity, decrease in fodder quantity and quality and increase in disease epidemics which will affect the decrease in livestock productivity (Thornton et al., 2015). According to Thornton, more research is

required to find specific results related to climate change impacts on livestock, as IPCC AR5 does not contain much data about this sector. ADP reports highlight that it is found through studies in Sub-Sahara African regions that there are limitations and high costs attached to the various adaptation options explored for the enhanced resilience of household and food security for livestock management (Chaudhry, 2017). Due to perpetual drought-like conditions prevailing in Sindh and Baluchistan, the growth of grass in rangelands has been affected by the water shortage and increase in temperature, and people have been forced to downscale their livestock holdings or migrate to some other areas for survival (Mukhtar, 2019).

6.6.4 Forestry

On the one hand, deforestation is the cause of climate change, and on the other hand, climate change is becoming a cause of reduction in forest cover (Ali et al., 2014). Ali says that deforestation is taking place in Pakistan at the rate of 1.5% annually, which has increased the risk of landslides, slope destabilization, flood, increased surface runoff, and soil erosion. In his research, he opines that forests are carbon sinks; if the forest cover is reduced, the GHG will aggravate the phenomenon of global warming resulting in climate change. In Pakistan, the forest area is 4.19 Mha which is 5% of the total land area. Coastal mangrove forests cover an area of about 132000 ha, which is 3% of the country's forest area. Forests provide a rural livelihood to millions of people.

The Indus delta alone supports 97% of mangrove forests, home to over a million people (WWF, 2005). ADB report on climate change profile of Pakistan predicts that the anticipated impacts of climate change like sea-level rise, changes in temperature and precipitation and increasing frequency and intensity of extreme events will severely affect the forests, resultantly threatening the biodiversity and soil quality in the country (Chaudhry, 2017).

Both parts northern and southern areas of the country exhibit different responses to climate change. A study for a period from 2020 to 2080 was conducted on the impact of climate change on the forest eco-system of nine dominant plant types of northern Pakistan in 1999. The study showed a decrease in forest cover of three of the plants (alpine tundra, grassland or arid shrubland and deserts) and migration of some species to another forest biome; whereas for five other types of plants (cold conifer or mixed woodland, temperate conifer or mixed forest, warm conifer or mixed forest and steppe or arid shrubland) an increase in forest cover was observed (Siddiqui et al., 1999). Figure 6.12 shows changes in forest areas of different types of plants in northern Pakistan under changed climate vs 1961-1990 average in percentage change.

Figure 6.12: Changes in Forest Areas of Different Types of Plants in Northern Pakistan under Changed Climate

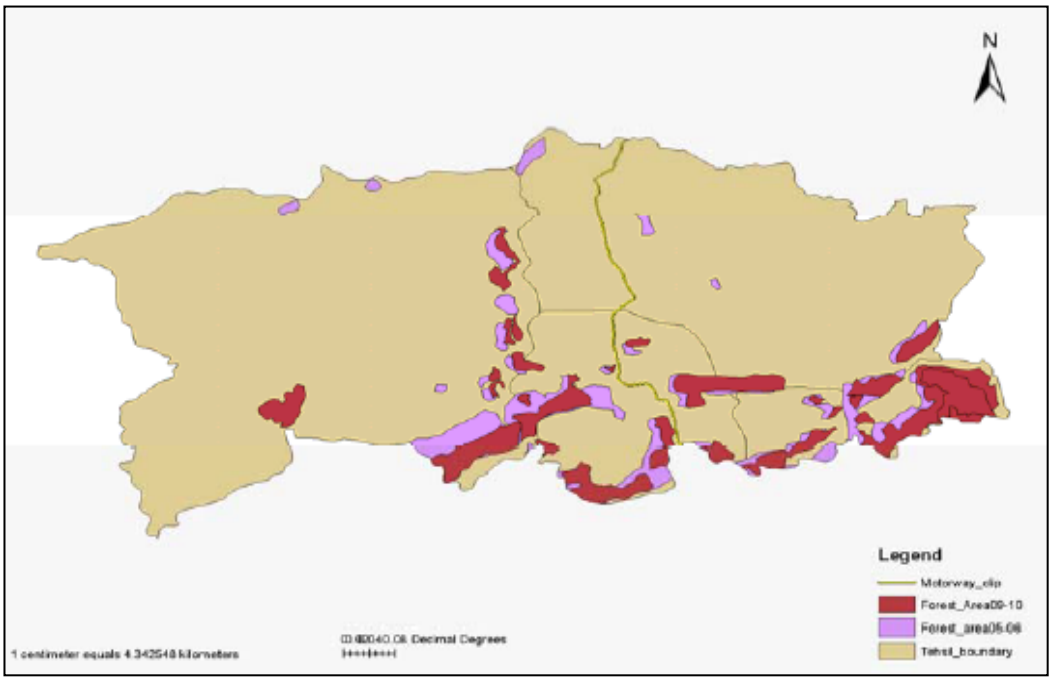
Biome Type	2020			2050			2080		
	-P	0P	+P	-P	0P	+P	-P	0P	+P
Alpine tundra	-16.7	-16.7	-16.7	-31.5	-31.5	-31.5	-38.9	-38.9	-38.9
Cold conifer/Mixed woodland	22.2	22.2	11.1	5.6	44.4	22.2	44.4	33.3	11.1
Cold conifer/Mixed forest	10.3	10.3	13.8	13.8	20.7	24.1	6.9	10.3	13.8
Temperature conifer/Mixed forest	5.6	5.6	5.6	2.8	5.6	5.6	16.7	19.4	19.4
Warm conifer/Mixed forest	22.0	22.0	34.1	43.9	56.1	63.4	51.2	68.3	85.4
Xerophytic wood/Scrub	0.0	0.0	0.0	-1.8	-3.6	-1.8	0.0	0.0	0.0
Grassland/Arid shrubland	-42.9	-28.6	-28.6	-57.1	-57.1	-57.1	-57.1	-57.1	-28.6
Steppe/Arid shrubland	5.2	8.1	10.7	9.1	13.0	17.6	10.1	16.9	20.5
Desert	-7.6	-7.6	-16.3	-12.9	-19.3	-26.1	-14.4	-25.4	-33.0

Note: The assumptions of the study are: Precipitation change (P) of 0, +3, and -3% with 0.9^{0}C increase in temperature, and carbon dioxide concentrations of 425 parts per million (ppm) in 2020; 0, +3, -3 P, 500 ppm of carbon dioxide, and 1.80^{0}C increase in temperature for 2050; and 0, +9,-9 for P, 575 ppm of carbon dioxide, 2.7^{0}C increase in temperature for 2080

Source: Siddiqui et al., 1999.

Applying GIS and Remote Sensing (RS) technology, a study was conducted in Chakwal, a district in the Potohar region of Pakistan. Prime forest areas in district Chakwal were identified by integrating the areas of land cover change derived for the change in climate in the years 2005-06 and 2009-10 by using GIS mapping. Results show that the minimum temperature of the district increased from 9.4^{0}C to 9.9^{0}C during the period of 2005-06 to 2009-10, and the maximum temperature increased from 33.8^0 to 35^{0}C. The humidity changed from 69.1% to 73.3%, followed by the rainfall decrease from 872 mm to 557 mm. These distinguished changes in the climate caused the decline in the forest area of the region. The total forest area was around 698 km^2 in 2005-06, which declined to 625 km^2 in 2009-10. Figure 6.13 shows the forest cover decline in District Chakwal of Pakistan during 2005-06 to 2009-10 (Ahmad et al., 2010).

Figure 6.13: Forest Cover Decline in District Chakwal of Pakistan during 2005 to 2009



Source: Saeed Ahmad 2010.

6.6.5 Coastal Areas

Pakistan has a 1046 km long coastline that stretches along the Arabian Sea to the south of the country. The coastline falls under Sindh and Baluchistan provinces (Chaudhry, 2017). The coastline of Sindh is relatively more vulnerable to climate change than the Baluchistan coastline due to its flat tidal topography, higher population concentration, industrial infrastructure, and coastal areas (A. Rasheed, personal communication, July 20, 2017). The impacts of climate change on coastal areas have already become evident in the form of inundation of the low-lying regions, degradation of mangrove forests, declining drinking water quality, and decreased fish and shrimp productivity (GFDRR, 2011). According to research, a 2-meter SLR is expected to submerge 7500 km^2 in the Indus Delta (Khan & Rabbani, 2000). The report further identifies that low-lying areas of Baluchistan coastal areas like Pasni may also be impacted by SLR since its mean sea level is about 1.4 m. Under the climate change scenario, the SLR is expected to increase further the rate of erosion which is already happening in active erosion hotspots like Hajamaro, Ghoro, Kaanhir and Kahhar areas. Presently the erosion ranges from 31 m to 176 m per year. With the highest erosion frequency of 176 m per year, a retreat rate of 425m from 2006 to 2009 has already been observed (Pakistan, 2012).

The Indus Delta region is shrinking and sinking due to a lack of sedimentation and subsidence. Compared to the early 20th century, a reduction of 80% in river sediment due to extensive damming of the Indus River has been observed. The current level of sediment

aggradations of 1 mm per year does not exceed the relative projected SLR, which is considered the main reason for the SLR in nearly 70% of the world deltas, and Indus Delta is no exception. Due to the risk it faces, the Indus Delta is ranked third among the global deltas in the greater risk scale (Syvtiksi et al., 2009). To assess potential vulnerability to sea level incursion into deltas, Ericson conducted a seminal study in 2006 wherein he extrapolated the baseline effective sea level rise condition from 2000 to 2050. He found that 0.79% of the Indus Delta population is at risk, with 2.73% of the Delta area potentially lost by 2050 (Ericson et al., 2006). During an interview with Sinha, it was confirmed the impact of climate change on coastline across the border that India has a coastline of about 7500 km and numerous islands. Being situated close to the equator, a large part of India's coastline will see a rise in sea level (personal communications, March 12, 2019).

6.6.6 Environment

According to the World Bank report 2013, Pakistan's leading environmental issues include air pollution, inadequate supply of uncontaminated drinking water, noise pollution and the health deterioration of urban and rural populations due to pollution (WB, 2013). The report highlights that environmental issues besides causing harm to living beings also pose a serious threat to the country's economy and development. The report also stated that the increased industrialization, urbanization, motorization and climate change would further inevitably worsen this problem. Irfan Tariq, Director General Environment, MoCC, says that rising temperature, water scarcity and pollution all out of climate change are impacting the environment of Pakistan adversely (personal communication, August 9, 2017). He says the ecology of the country is in the process of transition as the consequence of the Anthropocene. He says IWT did not consider the water requirement of the ecological system. The terrain and communities that once used a quantity of water were denied their fundamental intrinsic right. The denial of these three rivers in the first place and then denial of environmental flows subsequently has caused considerable damage to the eastern part of the country in terms of ecology and environment, and now climate change is the threat multiplier; since there was no water in the eastern rivers, so their ecological system has virtually collapsed.

Water provides essential support services to humans and ecology, biodiversity, and the livability of that area that has been sacrificed. There is a need to address this issue. That quantity of water required to keep the ecological system functional is very important for the area. As far as water scarcity is concerned, he referred to a news item that appeared a week back and carried pictures of dried-up Hanna Lake in Quetta. Pakistan is already a water-stressed country, and

our lakes are drying. He said natural lakes in Sargodha Division which provided a route to the migratory Siberian birds, have all dried up. Hanna Lake or Sargodha Division lakes were not in the eastern part of the country; it can be well imagined the state of water that is affecting the environment in the country as a whole.

According to Baig water pollution is a real threat to the environment. He says lower flows in the rivers are due to IWT and diversion to canals that have diluted the water flows. This is a reason behind water pollution besides the growing economy and population. He says there is complete lack of water treatment, the overuse of chemical fertilizers and pesticides, the dumping of industrial effluent into lakes and rivers, untreated sewage being dumped into rivers and the ocean, and contaminated pipelines being used to transport water are the major reasons which are aggravated due to climate change (Baig, personal communication, July 7, 2017). According to the World Bank report 2013, "Karachi's urban air pollution is among the most severe in the world, and it engenders significant damages to human health and the economy." This can be considered as the consequence of Anthropocene, the challenges like an inefficient use of energy, an increase in the number of vehicles used daily, an increase in unregulated industrial emissions and the burning of garbage and plastic have contributed the most to air pollution in urban areas and have been further aggravated the problem.

Irfan Tariq says industrial activity is one of the most significant contributors to air pollution (personal communication, August 9, 2017). He says that inadequate air emission treatments and a lack of regulatory control over industrial activities have contributed to the deterioration of ambient air quality in major cities of Pakistan. He contends that the common practice of burning massive amounts of solid waste, including plastic and rubber, has accentuated the environment deterioration processes due to Anthropocene. Irfan finally concluded that the accumulative impact of climate change on the environment is a catalyst for health challenges faced by the people in Pakistan.

6.7 Expected Consequences Flowing from the Climate Change Impacts

As discussed in the preceding paragraphs, the impacts of climate change in Pakistan are numerous. Temperatures in both summer and winter are rising. Glaciers are melting and retreating. Monsoon has become erratic with its variable timings, duration, and intensity[76]. Precipitation in the form of snow, as well as rainfall, have become variable. Water quantity is changing in magnitude, volume, and duration. Water quality of surface and sub-surface

[76] The duration, intensity, magnitude, frequency, and spatial and temporal variations have made Monsoon uncertain thereby leading to its present erratic state.

groundwater is deteriorating. Water availability day by day is declining. The agriculture sector is sensitive to climate change has been affected. The yield of major crops is estimated to reduce in future. Water demand due to multifarious climatic and non-climatic reasons is swelling. Forest cover has been reduced. The environment is deteriorating with air and water pollution. These climate change impacts will translate into dire consequences in Pakistan's physical, social, economic, and environmental domains, which need to be taken cognizance of. In succeeding paragraphs, the consequences of climate change's impact on different domains like water, food, energy, disasters, ecology, and health will be discussed. The picture about consequences will facilitate contextualizing adaptation and mitigation measures besides helping in evolving recommendations and a way forward for climate-proofing of IWT.

6.7.1 Water Security

With a population of 212.82 million, Pakistan is ranked the fifth most populous country globally (NIPS, 2019). With the current population growth rate of 2.4%, in 2050, the population will be 366 million. Growing population and increasing development will place mounting pressure on IRB supplies. Contrarily, climate change has negatively affected all water sources such as glaciers, snow, rainfall, and aquifer. With HKH glaciers receding, the region's cryosphere dynamics, hydrological cycles, and atmospheric flows are already changing (Q. Z. Chaudhry, personal communication, November 17, 2017). According to Immerzeel et al. (2010), the snow and glacial melt contribution for Indus are the highest. IRB, the most vulnerable Basin, is suffering from solid and liquid precipitation fluctuation. The shift of pattern has been observed in snowfall. The fresh snow is not staying enough to become ice, causing a negative snow mass balance and increasing river inflows (G. Rasul, personal communication, July 26, 2017).

For the next 30 to 40 years amount of river inflows will be more but subsequently will lead to extreme water shortage (A. Rasheed, personal communication, July 20, 2017). According to Chaudhry et al. (2009), there is a decrease in rainfall by 10-15% during 1960-2007, and in future as well the decline in rainfall is expected in the arid plains and coastal areas. There is a decline estimated in monsoon rainfall. Due to increased population, developmental and economic needs, the water demand has increased due to Anthropocene. Due to the water shortage in channel inflows and rainfall, irrigation relies on groundwater extraction. The water table persistently decreases exorbitant extraction effort and cost (S. Kakakhel, personal communication, December 15, 2017). Furthermore, climate change has aggravated the situation of declining water availability. Water availability per capita has already reduced from

5200 m^3 at partition to below 1000m^3 by 2020. By 2050, the figure is estimated to reach 550 m^3 (SDPI, 2013). The picture emerging from the discussion above reflects that Pakistan is entering into a water security situation due to Anthropocene.

6.7.2 Food Security

After the partition, Pakistan Punjab continues to be home to 77% of cropped area of the country (SDPI, 2013). There are two basic elements of food. One is grains, and the second is meat. Wheat and rice are the staple food of Pakistan (Khan & Tahir, 2018). Both of the crops are estimated to reduce yield in major parts of the country in the future (Iqbal et al., 2009). With temperature rise from 0.5^0 to 2^0 C, agriculture productivity will decrease 8% to 10% by 2040 (Dehlavi et al., 2014). Through modeling, a reduction of 14 days for a 1^0 C rise in temperature by 2080 in the growing season length of wheat in northern areas compared to southern areas of the country is predicted. A 15% to 18% decrease in rice yield is also estimated (Iqbal et al., 2009). It is assumed that degradation of grazing pastures and lands will take place due to drought, floods and rise in temperature, which will result in loss of land productivity, decrease in fodder quantity and quality and increase in disease epidemics which will affect a decrease in livestock productivity leading to scarcity of meat (Thornton et al., 2015). High cost will be attached to various adaptation options explored to enhance household and food security resilience for livestock management (Chaudhry, 2017).

Due to perpetual droughts like conditions prevailing in Sindh and Baluchistan, the growth of grass in rangelands has been affected by the water shortage and increase in temperature. People have been forced to downscale their livestock holdings or migrate to some other areas for survival, affecting the availability of meat (Mukhtar, 2019). A decrease in fish and shrimp productivity, a major source of white meat, has also been reported (GFDRR, 2011). The vulnerability to sea level incursion into deltas is assessed to lose 2.73% of the Delta area by 2050 (Ericson et al., 2006). Extreme events like floods, drought, cyclones, heatwaves and GLOFs are climate risks that can threaten food security in the region of their occurrence (O. Hayat, personal communication, December 25, 2019). With these indicators, it is safely assumed that Pakistan will face food insecurity in future if appropriate adaptation and mitigation measures against climate change are not timely taken.

6.7.3 Energy Security

Where the energy sector is the leading contributor to climate change through its high GHG emissions, at the same time, it is sensitive to its impacts as well (Chaudhry, 2017). Different

sources of electricity generation in Pakistan are mainly four. As of July-March FY 2019, the leading one is thermal (62.1%), which comprises oil, coal and gas, followed by hydroelectric (25.8%), nuclear (8.2%) and renewable (3.9%). For the same period, the electricity consumption is for household (48%), Industry (27%), agriculture (9%) and commercial (8%). The share of hydroelectricity generation has decreased from 70% in 1989 to the present level due to multiple reasons, but the non-availability of required water is one of the major reasons for reduced generation from hydel power plants (MoF, 2019). Due to rising population, economic growth, and changing consumption patterns, energy demand will increase in the future (M. Muzammal, personal communication, November 23, 2018). The most likely impact of global warming is the recession of Himalayan glaciers, which is the largest source of freshwater supply in the country.

Reduction in water availability will likely affect the country's power generation systems. Extreme hydro-meteorological events like floods and storm surges can potentially damage oil, gas, and power infrastructure. Climate change-induced higher temperature will cause faster evaporation, increasing electricity to pump more water for irrigation. Warmer air and water temperatures will lower the efficiency of nuclear and thermal power plants. An increase in water temperatures used to cool nuclear and thermal power plants will reduce the power plants' efficiency. The energy crisis will adversely affect the GDP (A. Nawaz, personal communication, December 26, 2019; M. A. Baig, personal communication, July 7, 2017).

6.7.4 Hydro-Meteorological Disasters

According to the Long-Term Global Climate Risk Index (CRI) developed by German Watch, out of 10 countries most affected by climate change from 1999 to 2018 (annual averages), Pakistan is ranked the fifth most vulnerable country globally. People all over the world are facing the reality of climate change. In areas like Pakistan, extreme weather events' increased volatility (Eckstein et al., 2020). Pakistan is confronted with geophysical (Earthquake, landslides, tsunami) and hydro-meteorological (Floods, drought, GLOF, avalanches, landslides, heat waves, storm) surges, cyclones, sea intrusion and SMOG) hazards. However, the leading impact is flooding, primarily a climate change-induced phenomenon (O. Hayat, personal communication, December 25, 2019). The past two decades or so have witnessed recurrent spells of hydro-meteorological disasters. The first one was a four-year drought that lasted from 1998 to 2002. After a bit of a more extended period, in 2010 country experienced the mega-disaster of super floods. This catastrophic event was followed by a series of flood

events almost every year. In 2011, 2012 and 2014, there were floods in different parts of the country.

During 2012, the country also experienced GLOF in Gyari (AFP, 2012 April 19th). The second spell of drought, within two decades, was again experienced from 2016-2019 in Sindh and Baluchistan (WHO, 2019). Similarly, on the coastal front, the country experienced climate extreme events like cyclone Phet 2010 (NASA, 2010), heatwaves in Karachi 2015 (Chaudhry et al., 2015) and cyclone Kyarr 2019 (TNI, 2019 October 28th). In super floods 2010 alone. Pakistan suffered fatal casualties of 1600 people, inundation of 38,500 km^2 of area and damages worth around the US $ 10 Billion (Ali, 2013). Similarly, due to heatwaves in June 2105 in Karachi, Pakistan suffered a death toll of more than 1200 people (Chaudhry et al., 2015). In a country like Pakistan that does not have sufficient capacity to prepare for, respond to, and recover from disasters, these hydro-meteorological events take a heavy toll on both life and property besides adversely affecting the economic growth of the country (A. A. Akif, personal communication, December 19, 2017). Ghulam Rasul argues that GLOF events are associated with a vast amount of water coming downstream, bringing the water melt, boulders, and debris downstream and sometimes blocking the river streams. These are the challenges we will be facing in the future to a more considerable extent in terms of the increase in intensity and frequency of extreme events (personal communication, July 26, 2017).

6.7.5 Health Challenges

Both environmental and social determinants of health are affected by the consequences of the Anthropocene. Availability of safe drinking water, clean air, sufficient food and secure shelter is compromised during hydro-meteorological events such as flood, drought, heatwaves, variable rainfall patterns, which lead to health challenges (Chaudhry, 2017). Extreme weather events leading to hydro-meteorological disasters are likely to increase in frequency, duration and intensity (A. A. Akif, personal communication, December 19, 2017). During the heatwave in June 2015 in Karachi, a maximum temperature of 44.8^0C was recorded, the second-highest temperature after 1979. During this extreme event, 1200 people lost their life in Karachi alone, and 200 fatal casualties were suffered in the province of Sindh (Chaudhry et al., 2015). In the plains of Pakistan, the heatwave is a common phenomenon during May and June (G. Rasul, personal communication, July 26, 2017).

The rise in temperature and variation in rainfall has a deep relationship with the spread of different infectious diseases (Malik, 2011). According to a study by United Nations International Children's Emergency Fund (UNICEF), during the floods 2010, the proportion

of population below the minimum level of dietary energy consumption got increased by 3%, which added a burden of 5 million to the population of undernourished people (UNICEF, 2010). The extreme events also have a deep relationship with the mental health of the population. Mental diseases like depression, distress and aggression are caused by extreme events (STC, 2011). The rising temperature has the risk of water-borne and vector-borne diseases. An increasing number of dengue and malaria cases in the country is due to change in temperature and heavy rainfall. Mosquitoes find a conducive breeding environment under higher temperatures and more water expected during the flooding season (Khalid & Ghaffar, 2013).

6.7.6 Ecological Disorder

Pakistan has a host of eco-system like glacial-eco-system, desert eco-system, grassland eco-system, aquatic eco-system, marine eco-system, forest eco-system, agro-eco-system, human eco-system and urban eco-system. The ecosystems comprise plants, animals, soil organisms and climatic conditions (Harris, 2018). There are two primary components of an eco-system: biotic or living component, which comprises producers, consumers and decomposers and abiotic or nonliving components, which comprise air, water, light, soil, rocks, minerals, and nutrients. These components interact to support different food chains and food webs for regulating essential ecological processes to sustain lives. The recycling of nutrients between biotic and abiotic components is done through eco-systems. The eco-systems maintain the proper flow of energy in the Water Cycle, Carbon Cycle, Oxygen Cycle, Nitrogen Cycle, and Energy Cycle (Adams, 2017).

Irfan Tariq says that the rise in temperature and variability in rainfall has disturbed the ecological order in all ecosystems (personal communication, August 9, 2017). Ghulam Rasul says that as the consequence of Anthropocene, the forest covering is reducing, water is being polluted through industrial and municipal wastes, the air is being polluted through undesired gases, subsurface water is polluted through sewage induction and above all, absence of environmental flows in eastern rivers have created an ecological disorder which is an overwhelming challenge for Pakistan (personal communication, July 26, 2017).

6.8 Interplay between National Climate Change and Water Policies

Pakistan National Climate Change Policy (NCCP) was approved in September 2012. The policy's goal is spelled out "To ensure that climate change is mainstreamed in the economically and socially vulnerable sectors of the economy and to steer Pakistan towards climate-resilient

development" (MoCC, 2012). Abu Ahmad Akif, Secretary of MoCC, says that out of the main objectives laid down by the NCCP, four leading objectives act as cornerstones for building the structural framework to meet dictates of future climatic risks. Firstly, the Policy stresses pursuing sustained economic growth by appropriately addressing the challenges of climate change. Secondly, NCCP proposes integrating climate change policy with other inter-related policies. Thirdly, to ensure water security, food security, and energy security in the country, face the challenges posed by climate change. Finally, NCCP aims to minimize the risks arising from the expected increase in frequency and intensity of extreme weather events such as floods, droughts and tropical storms (A. A. Akif, personal communication, December 19, 2017).

National Water Policy (NWP) was approved in April 2018. NWP outlines the conceptual framework of the policy as a national imperative: "To ensure water security for the people of Pakistan laying down the outlines of an integrated water management strategy that can optimize the economic, social and environmental returns on water resources, ensure equitable allocation among its competing demands as well as its judicious use by consumers and safe disposal of post-use effluents" (NWP, 2018).

Dr. Muhammad Ashraf, while dwelling on Pakistan's key water issues in the National Institute of Population Studies (NIPS) Round Table Conference on IWT, explained leading policy objectives around which the structure of NWP is built as five. First and foremost is to promote sustainable consumption and production patterns throughout the water sector from exploitation to utilization. The second is to augment available national water resources through judicious and equitable utilization via reservoirs, conservation and efficient use. The third is to improve the availability, reliability and quality of freshwater resources to meet critical municipal, agricultural, energy, security and environmental needs. Fourth is to provide food security and expand water availability to help adapt to climate change, population and other large-scale stresses. Finally, to improve watershed management through extensive soil conservation, catchment area treatment, preservation of forests and increasing forest cover (Asharf, 2019). While talking on important aspects of IWT, Engineer Suleman Najib Khan highlighted an intrinsic relationship between NCCP and NWP and said both the policies need to be integrated. He said this would only be possible if IWT is seen through the lens of climate change and all transboundary related climate change provisions and clauses are appropriately incorporated into the existing IWT document (Najib, 2019).

CHAPTER: 7
CONTOURS OF CLIMATE-PROOFING INDUS WATER TREATY

This chapter frames the contours, the outline, and the salient features of climate-proofing IWT. As alluded to in earlier chapters, climate-proofing is a concept and a process of incorporating climate change-related clauses and provisions applicable to transboundary waters in the treaty. Understanding the co-relationship between IWT and climate change is therefore important. Consequently, this understanding will facilitate picking up the voids existing in the treaty, particularly regarding climate change. Water allocation strategies, response strategies, monitoring, evaluation and review processes and joint implementation concepts are discussed before outlining the contours of climate-proofing IWT. In climate-proofing IWT, its salient features like collaborative and integrative approach, what issues will the application of the concept address? What is its necessity? What are its benefits? What applicability environment is required, particularly in terms of acceptability? What incentives will both countries have as a result of climate-proofing? And what risks they would have to face otherwise? Finally, the challenges vs. opportunities quandary of climate-proofing IWT is outlined to complete the logic matrix.

7.1 Correlation between Climate Change and IWT

During the partition in 1947, the hydrological border between Pakistan and India was ignored while deciding the lines of geographical borders. Inadvertently it created a permanent space for a complex interaction of their geo and hydro-politics. Across the globe, there are over 300 agreements between the states which delineate boundaries of shared rivers, lakes and aquifers, laying down rules for equitable distribution and utilization of transboundary waters. He further dilates that IWT is one of the successful instruments which has survived almost six decades between nuclear rival states. The correlation between IWT and climate change is straightforward, i.e. the most impacted commodity on earth by climate change is water, and IWT is the one that deals with water only. So directly, the IWT, a transboundary shared rivers water agreement, is affected by climate change. IWT was signed in the 1960s, when the world was not much familiar with the phenomenon of climate change.

In the last half of the 20th century, there have been immense technological and educational advancements in hydrology, water resource management, transboundary watercourse management, conflict resolution, environment monitoring, data acquisition, storage, sharing, and archiving techniques as the consequence of Anthropocene. Water quantity, as well as quality, has immensely changed over the years. Pressures such as population growth, urbanization, economic development and extreme climatic events like drought and floods, decreased levels of sub-surface water and aquifers etc., have substantially altered the water demand and supply equation in Pakistan. Consequently, water has become a source of tension between the two countries and has the latent potential to turn into a conflict if the existing knowledge and practice gaps in IWT are not timely managed. One of the solutions to the problem lies in climate-proofing IWT by incorporating current knowledge, particularly of climate change and its alignment with the current set of international rules and water laws. The absence of these aspects from IWT has a negative impact which can only be addressed if voids related to climate change existing in IWT are addressed by incorporating all climate change-related transboundary waters clauses and provisions into the treaty. Over 50% of global freshwater flows across trans-borders (Thomas, 2017). Thomas says that to facilitate the application of structural and non-structural climate change adaptation and mitigation measures and prevent or reduce the negative impacts of unilateral interventions by the riparian states at the basin level, the cooperation framework in the management of transboundary waters is essentially required.

7.2 Voids in IWT

Ahmar Bilal Soofi, the Law expert respondent, opines that although IWT is a comprehensive document covering almost all functional aspects of an agreement, it inherits a few voids that make it vulnerable to external pressures (personal communication February 28, 2018). It is needless to mention that for climate-proofing IWT, only those voids are identified here that relate to climate change and will stand addressed in the process. The main structure and content of the treaty are not intended to be disturbed, rather, supplementary content relating to climate change shall be incorporated for providing sustainability to the treaty.

The first and foremost void in IWT as the consequence of Anthropocene relates to the division of rivers for the distribution of waters. Treaty has allowed complete control of Eastern Rivers to India, which dried up three Eastern Rivers. There is no flow allowed in the treaty to retain the ecological systems in the command areas of these rivers. The country's eastern part has become a hotbed for viral and bacterial diseases. There is a need for environmental flows

to sustain these rivers as a consequence of the Anthropocene. The second void relates to declining water availability. At the partition, water was more than 5200 m^3 per capita, drastically reducing to less than 1000 m^3 in 2017. With a consistent declining trend of water persisting, increase in population and decrease in water availability, the figure is likely to fall to 700m^3 by 2025 (e.g., T. Altaf, personal communication, 2017, August 26).

Thirdly, Pakistan's sustainability of irrigated agriculture with a semi-arid climate is a challenge that has been further accentuated under large seasonal and annual water variability. This has developed an economic burden for Pakistan to maintain the alternate arrangement of transferring water from west to east through dams, barrages and link canals forever (M. Siddique, personal communication, August 26, 2017). The infrastructure developed half a century back is aging, needing repair, replacement, and reconstruction. The Treaty had given one-time relief to Pakistan without mentioning what would happen to it in the future as the need for water would continue to exist. Fourthly, with global warming increasing, glaciers have started melting faster. Water availability concerning its magnitude, duration, intensity, and frequency has become uncertain and increased for the initial years, which will decrease when the glaciers perish. There is no provision in the treaty to accommodate such a change. Fifthly, the water quality is being impacted by industrial, agriculture and municipal waste. Polluted water falling from drains in riverbeds has made those nullahs carry sewerage and sewage—no provision in the treaty address this climatic risk.

Sixthly, with water demand increasing and water availability declining, the pressure on groundwater has increased. The extraction from the aquifer has increased, whereas the recharging is not taking place correspondingly. Over extraction of groundwater has disturbed hydro balance in adjoining areas (A. A. Akif, personal communication, December 19, 2017). There is no clause in the Treaty to address this anomaly. Seventhly, climate change is a catalyst in generating hydro-meteorological hazards. These extreme events have the latent potential to turn into a disaster. He says Indus Water Treaty presently does not have any such clause which shall give a mechanism to prevent and mitigate the effects of disasters emanating from water and glaciers in future. (A. Nawaz, personal communication, December 26, 2019). Eighthly, the maintenance and preservation of the Indus River Basin's catchment areas and water sheds is another factor not covered in IWT. The mountains have been denuded from vegetation cover, which increases the speed of water flowing down from the mountains. There is no mention of such a clause in the Indus Water Treaty (O. Hayat, personal communication, December 25, 2019). Ninthly, timely data sharing for future hydropower projects essentially required by

Pakistan to know whether projects are in line with the treaty or not is yet another void (M. A. Baig, personal communication, July 7, 2017).

Tenthly, interpreting hydropower related clauses in the Treaty for water storage on western rivers is out of place on the one hand, and on the other, not fixing the limit of such projects for India is yet another lacuna that has serious implications for Pakistan (A. B. Soofi, personal communication, February 28, 2018). Finally, it has been realized in the research process that there is no joint body overseeing the interpretation, implementation and execution of treaty for monitoring, evaluating and review for subsequent correction to increase its life for sustainability. Research also leads to a few common concerns by India and Pakistan that need to be necessarily addressed in the Treaty. All these concerns are directly or indirectly related to climate change. These concerns are about glacial melting, the uncertainty of water availability, declining per capita water availability, maintenance and preservation of catchment areas, water pollution, groundwater depletion and increasing extreme events. There is no way that these serious issues can be overlooked. The inadequacies rampant in water resource management have also started revealing more strongly than before due to Anthropocene (Shah, 2018). He says that besides other solutions at the users' end for efficient water resource management, the basic solution lies in reviewing IWT to incorporate current knowledge, particularly climate change which is missing from the document. He says that this missing link is a major source of rendering IWT incompatible with the latest knowledge. He believes that the absence of climate change knowledge from IWT places it at serious risk of creating tension between India and Pakistan, which is naturally impregnated with the latent potential of turning into a conflict of grave character between two nuclear states.

Uttam Sinha, an Indian Security and defense Analyst respondent, optimistically expresses without pointing out the voids that good should not be lost in the want of the best that's what IWT is (personal communications, March 12, 2019). Martin Gramboh, a European Water expert interviewee, responds that usually, the voids existing in a transboundary water treaty relate to the interpretation of clauses, the impact of water division formula adopted in the treaty and the flexibility required in the face of fluctuating availability of water vis-à-vis its demand which can be addressed through a mechanism provided by a framework (personal communication, December 7, 2018).

7.3 Water Allocation Strategies

Across the globe, there are several international water agreements where water from shared rivers, lakes or aquifers is allocated to two or more parties. The water-sharing concept is

replicated locally by the states to manage their internal water allocations. There are two main categories of water allocation strategies; fixed or volumetric allocation and flexible water allocation (Speed et al., 2013). Different approaches and principles are applied for water allocation within both strategies. Akif argues that at the time of signing of IWT, the variability of water based on the climate variability, a natural recurring cyclic phenomenon existed but had not been considered in the Treaty. What to talk of uncertainty about the availability of water caused by the climate change, and anthropogenic outcome, which did not exist then, could have been considered in the Treaty at that time (personal communication, December 19, 2017).

Irfan says that IWT explicitly should have left space for future options (personal communication, August 9, 2017). The treaty should have allowed responses to unforeseen events, including those outside the historical record. He further stresses that Treaty should have established a mechanism or monitoring system to observe changes and propose applying the correction. He suggested that the waters of IRB be re-assessed as the consequence of the Anthropocene. Mechanisms are incorporated in the Treaty to address water variability and uncertainty. He further alluded that contingency based on circumstances be developed, and finally, he said that environmental flows be protected under a range of scenarios. Altaf says that as of now, the IRB water is stressed. Its allocations should be linked to broader social, environmental, economic development, climate variability and climate change. Therefore, IWT needs to ensure equitable and reasonable allocation of IRB waters. The treaty further needs to incorporate flexibility in recognizing uncertainty over the medium to long-term regarding changing climate, economic and social circumstances.

Ahmad Kamal, one of the architects of NWP, says that future effective water allocation needs to focus on developing water management strategies, institutional capacities and policy frameworks (personal communication, December 29, 2017). He says water allocations should address basic human needs and critical social issues. He further states that eco-system integrity and economic development should be a factor that should not be ignored while allocating water. As a whole, the sense developed from the elite interview is; the environmental flows in eastern rivers should have been allowed by the Treaty (I. Tariq, personal communication, August 9, 2017). The issues related to subsurface water should have been addressed. India's number of hydropower plants and storage arrangements on western rivers should have been specified in the Treaty (A. B. Soofi, personal communication, February 28, 2018; Z. Habib, personal communication, September 21, 2017).).

Mushahidullah says that it is high time that climate change-related clauses and provisions should be made part of IWT (personal communication, February 14, 2018). Cooley

and Gleick (2011) contended that transboundary agreements should have inbuilt flexibility to deal with adaptability to varying excess or less water conditions, effective operation rules, regular communication and data sharing. He points out that the impact of climate change needs to be assessed, put in modeling and analysis, and findings of water quantity, quality, and extreme events should be made part of the treaty; this will make the treaty flexible. A flexible transboundary waters cooperation framework can enable the integrated development of intervention as a cost-effective solution (Subramanian et al., 2014). Ashok, in his work, further alludes that an integrative approach can help synergize the hydrological effects of interventions applied by riparian states in their respective areas. He further expounds that the cooperation framework can lead to shared costs and benefits of adaptations economically. He believes that an integrative approach will broaden the knowledge base, enlarge the range of adaptation measures and reduce social inequalities leading to sustainable development. The voids threaten the survivability and sustainability of IWT, which have been sufficiently highlighted for correctly understanding the climate-proofing perspective.

7.4 Response Strategies

Many transboundary agreements include exceptional circumstances though specificity varies (Cooley & Gleick, 2011). Cooley and Gleick cite the example of Nile Basin where the Permanent Joint Technical Commission can proffer its recommendations for new water allocations in response to an extraordinary drought. In the Convention between USA and Mexico over the Rio Grande River, Mexico can supply less than the minimum amount of water to the USA during an extraordinary drought for five years. During this period, Mexico incurs water debt which they must repay in the next five years cycle (Sandoval-Solic & McKinney, 2011). Colorado River agreement between seven riparian states is an inspiring example of flexible water allocation to address extraordinary extreme events like drought. The water is being saved by planning to manage the River amid a 19-year drought, voluntarily cutting their water use to prevent imposing a mandatory squeeze on the supply. The agreement provides apace for 'Intentionally Created Water Surplus', allowing lower basin riparian to invest in extraordinary conservation efforts and store the water saved or generated by such efforts for delivery in future years (Schwartz, 2019).

Drought is normally addressed in transboundary agreements, but floods are not managed (Cooley & Gleick, 2011). Due to the Anthropocene, the critical water impacts on water quantity like magnitude, intensity, duration and frequency, etc., result in extreme flooding events that need to be included in the shared water agreements. Asghar Nawaz believes that floods in Indus

River Basin have phenomenally increased in the last decade (personal communication, December 26, 2019). He says Pakistan has suffered approximately US$ 16 Billion losses in Floods in 2010, which is the highest in Pakistan for any disaster. Omar Hayat says that institutional capacity and a clear understanding of water management in shared rivers can reduce the floods risk and mitigate social, economic, environmental and physical effects (O. Hayat, personal communication, December 25, 2019). Columbia River Basin Treaty stipulates that Canada will adjust its hydroelectric dams to mitigate flooding impacts in the USA (CRS, 2019). In the cooperation agreement for sustainable development of the Mekong River Basin, upstream dam operations are adjusted to meet maximum river flow rates (MRC, 2019). Similarly, SMOG[77] has come up as a threatening hydro-meteorological extreme weather event in Indian and Pakistan Punjab as the consequence of Anthropocene, which needs proper studying, analysis and integration with IWT suitably.

Mirza Asif Baig shares that proper data sharing between both India and Pakistan through their respective PIWC can reduce the risk of extreme events and improve response strategies for better water management of shared rivers of Indus Basin (personal communication, July 7, 2017). Basin-wide floods remediation and management activities are critical. Integrating flood management protocol into IWT can prove a risk reduction instrument. According to Shah (2018) says that climate change has impacted every facet of human life, which needs to be accurately measured for precise and timely response. He illuminated that water mapping, data acquisition and monitoring through GIS and Remote Sensing for accurate water analysis and response is an essential component of response strategy that needs to be incorporated in IWT for effective management by both countries. He further alludes that for complex transboundary water management where bilateral monitoring and implementation mechanisms are not very effective, for making the process more transparent and responsive, there is a need to constitute a mutually consented external body for monitoring, data acquisition, and subsequently, and subsequent information and data sharing to all stakeholders. The response strategy is more efficient, particularly for extreme events like floods and droughts.

7.5 Monitoring, Evaluation and Review Process

Transboundary water agreements are the instruments of cooperation that are subject to changes due to natural changes in the water demand and supply equation (GWP, 2019). The change in demand relates to social, economic and environmental domains, whereas the change in supply

[77] A mixture of smoke and fog

relates to hydrological and climatological cycles besides political or structural interventions by the riparian states. This may be a typical scenario where both demand and supply are considered, but there may be scenarios in transboundary waters, where equitable and reasonable supply is to be ensured as defined in the agreement at the time of water allocations (Speed et al., 2013). Besides the demand and supply equation, the water quality and ecological integration are two more rudimentary aspects that will call for consistent research to upgrade an agreement according to the dictates of changing requirements (Grafton et al., 2019).

A monitoring, evaluation and review system in a transboundary agreement is needed for adapting to changing hydrological, social and climatic conditions. Shah (2018) believes that it becomes outdated and stagnant without monitoring, evaluation, and review process in a transboundary agreement. He further argues that by making a treaty living documents between the states, a joint institution should monitor, evaluate, and proffer recommendations for review of the agreement to adapt suitably to future changes. Shah also considers that monitoring and evaluation are progressive measures that shall be basin-wide and conducted through a comprehensive mechanism, preferably by the combination of integral and impartial monitors. He suggests monitoring and evaluation should lead to a change; it should not be fixated with the status quo.

Cooley and Gleick (2011) states that in Colorado River Basin, as a result of monitoring and evaluation by a joint body, the recommendations are discussed in joint meetings. The minutes of meetings become the instrument for reviewing the agreement to incorporate changes. He points out that since 1922, 317 such amendments have been made in the agreement. Kaka Khel explains that monitoring and research are intimately linked. Technologies based on research and monitoring are the essence of acquiring correct information and Knowledge. These elements go together for the transboundary river basin. He says that in the case of IWT, glacial fluctuation, weather systems like the monsoon, river inflows, aquifer fluctuation, ecological systems and water quality should be researched and monitored based on which treaty can be reviewed for amendments and modifications (personal communication, December 15, 2017).

7.6 Joint Implementation

The strength of an agreement lies in its implementation. There may be golden rules and regulations written in the agreement; it carries no weight if those are not implemented in true letter and spirit. Pakistan's PIWC points out an Article in IWT for data sharing between India and Pakistan, but it does not happen. According the respondents Indians would not respond despite repeated requests as there is no joint body or mechanism to oversee the implementation

(e.g., M. A. Baig, personal communication, July 7, 2017). With regards, joint institutions play an important role in implementing a transboundary agreement, particularly under changing conditions. And, an effective joint implementation institution has members from all riparian states and management and enforcement authorities (Cooley & Gleick, 2011).

Shah (2018) argues that joint implementation shall essentially comprise policy and intervention level functions. According to him, the policy functions should include inter-party dialogue, effective communication, application of policy frameworks and capacity building at all levels. Whereas intervention level functions should consist of a collection of information about climate impacts, the assessment of vulnerability to climate change and the need for adaptation for capacity building, adaptation measures and the mechanism for their implementation, implementation of adaptation interventions, and monitoring and evaluation to suggest further adjustments. Under the implementation regime, at basin and sub-basin levels, the opportunities and synergies need to be identified for formulating climate change adaptation strategies (Habib, personal communication, September 21, 2017). She says that for effective implementation, climate, environmental and socio-economic models and scenarios should be integrated and harmonized to involve all stakeholders in the implementation process. She further suggests that the implementation measures should also include basin-wide monitoring and observatory system, which shall be an important component to be subsequently used for evolution purposes.

The climate change adaptation concept is nascent and similar in its application to transboundary water resources (Ali & Zia, 2017). Zia says that for evolving conceptual framework for policies and interventions for many climate change adaptation practices, the foundational knowledge of existing Integrated Water Resource Management (IWRM) is being followed. He says that climate change adaptation and IWRM due to their conceptual similarities complement each other. European Union Water Framework Directive (EU WFD, 2000) is a case where IWRM knowledge has been essentially used to draw climate change adaptation responses, particularly for extreme events like floods and droughts (White & Howe, 2003). Van Beek says it is more practical to outline a contextual framework for climate-proofing within the context of IWRM. For applying climate change adaptation strategies and practices in a transboundary context (Van Beek & Arriens, 2016). For this purpose, the United Nations Economic Commission for Europe and the International Network of Basin Organizations have jointly done an exhaustive work and documented it in the form of lessons learned and good practices for water and climate change adaptation in transboundary basins in March 2015 which

can help customize climate-proofing strategies and its projected application context for joint implementation (UN, 2015).

7.7 Climate-proofing IWT: A Collaborative and Integrative Approach

Climate-proofing indeed is a concept as well as a tool. Climate-proofing a transboundary treaty at the concept level will incorporate climate change-related dimensions. Climate-proofing as a concept of mainstreaming adaptation means considering climate change across all legal, political, economic, technical, and psycho-social fields of the treaty instead of designing it for adaptation measures alone. It outlines the contours for the practical manifestation of adaptation as a practice when it acts as a tool. A climate-proof treaty is designed to support the integration of climate change impacts and awareness of the challenges and opportunities for managing a shared water resource (Cooley & Gleick, 2011). Consequently, the climate-proofing concept aims at making a treaty more inclusive and responsive (see also Kabat et al., 2005).

Three essential elements in climate-proofing transboundary waters promising sustainability and credibility. Firstly, the up-gradation of a transboundary waters' treaty will have to be done to meet the dictates of impending risks of climate change. It is a time-consuming process. It needs strong leadership for implementation. It has to be indigenous. Borrowed or imposed decisions will not work. Secondly, climate-proofing has to be flexible, particularly as a tool. It has to be adapted concerning the context and the existing institutional framework. Thirdly, the apt integration of ground knowledge with scientific expertise and technological development is necessary. The process of climate-proofing a transboundary waters treaty is an exhaustive exercise. The process will start with gathering current and future climate trends to create a database. In the course of data collection, dominant trends will automatically emerge. After setting a baseline of possible impacts, an analysis is conducted to assess the biophysical and socio-economic effects on exposed elements of society at risk. The relevance of these effects is then evaluated by the probability of occurrence, the impact and the ability of institutions and affected people to adapt to the changes. This will lead to options for action in the form of a practice to be incorporated in a treaty. Finally, the agreed-upon actions are integrated to form an adaptation practice under a monitoring and evaluation umbrella. It is essentially required that a complete process be seen to establish how the existing treaty shall be upgraded and with what additional technologies, budgeting, and implementation methodologies. The application of climate-proofing is then visualized under the auspices of a credible third party who shall ensure the implementation of this instrument of cooperation based on merit.

Like oil, hydro-politics also has a long history of conflicts worldwide. Inking over 300 mutual water agreements across the globe is testimony to the fact that it is necessary to keep peace and stability in the region and ensure that future supply and demand matrix between the riparian states is timely managed (Burra, 2013). An insight of transboundary agreements amongst riparian states for different rivers like Nile, Rhine, Mekong, Jordon, Danube, Tigris, Euphrates, Brahmaputra and Colorado Rivers etc., show that effective cooperation, collaboration, integration and coordination are a catalyst to creating a conducive environment of working together (Wolf, 2011; Daoudy, 2010). Both Wolf and Daoudy reveal that the conflicting situations between the riparian states have been amicably avoided with the help of transboundary agreements acting as institutional mechanisms. Water, the basis of human life, is a finite and shared resource that has been first allocated by nature and then by the people according to its availability, which holds good for India and Pakistan. Any threat to its availability is considered challenging for both countries (Haftendom, 2000; Khalid & Begum, 2013).

The climate-proofing of a particular transboundary water treaty will be done by integrating all those climate change adaptation practices which are applied by different countries on transboundary rivers, lakes or aquifers basins. Climate-proofing contextual framework shall include feasibility, applicability, monitoring and sustainability (Shah, 2018). For feasibility, principles of basin adaptation, legal and institutional frameworks and institutionalized approach for climate-proofing strategy development shall be considered. He dwells on each component one by one. He says the basin principles shall include a basin-wide approach to climate change adaptation. Uncertainty needs to be reconciled and flexibility in the implementation of interventions retained. Linkages shall be established between various levels and sectors, and climate change shall be used as an added pressure for formulating strategies. He also expounds that legal and institutional frameworks should be adaptive to existing transboundary protocols with implementation flexibility. The process shall be systematically organized through collaborative, integrative, transparent and participative measures. He points out that the capacity for climate-proofing should be developed through deliberate planning, data and knowledge sharing, a collaboration between technical specialists and decision-makers and clear communication amongst all stakeholders.

One of the key elements of IWRM is to integrate water management decisions across sectors which can be instrumental in identifying the potential climate change vulnerabilities and synergies. Approach for hydrological analysis to establish the patterns of extreme events for their frequency and severity followed in IWRM can also help identify transboundary manifested

or potential patterns of climate change. Although IWRM is a generally accepted framework for natural resources of water, there is the possibility that different countries shall interpret, define, and implement the concept under the climate change umbrella to build desired cooperation amongst the riparian states (van Beek & Arriens, 2016).

7.8 Climate-proofing IWT: What will it address?

The correlation between IWT and climate change has been relatively well established in the preceding paragraphs. Voids in IWT have been thoroughly identified. Salient contours of climate-proofing concepts like water allocation strategies, response strategies for extreme weather events, monitoring, evaluation and review process, joint implementation concept through joint bodies and institutions and its collaborative and integrative approach have also been discussed at length. Now the stage is set to ascertain what issues climate-proofing IWT shall address. This will outline the relevant clauses and provisions relating to climate change for transboundary waters to supplement the existing document(s). This was made a key question for respondents. The discourse thereof shall be shared here. Ms. Wendy Gilmour, Canadian High Commissioner to Pakistan, while sharing her views on managing Columbia River between Canada and the USA in a national conference on the subject of 'Water Beyond Boundaries' at Serena Islamabad on 23 January 2020, said that the success of a transboundary agreement lies in its flexibility to adapt to changing situation. She said that since climate change is an evolving subject, our shared document should also be living in the present (Gilmour, 2020).

In the same conference, Ms. Anne Marchal, Minister and Deputy Head of Mission projected her stance with deep concern that transboundary agreements need to be upgraded; otherwise, these lose their purpose. Professor Gramboh, argues that the most important aspect which a transboundary agreement should inherit is the trust within stakeholders. He said that is only possible through effective communication, sharing of data and joint institutions for enforcement, monitoring, evaluation and review (personal communication, December 7, 2018). During the interviews it was argued that the missing provisions relating to water quantity with its dimensions like timings, intensity, frequency and duration etc., water quality, environmental flows for Eastern Rivers and sub-surface water should be added to IWT. Similarly, IWT should be a flexible Treaty, its review should be pre- audited, it should not be rigid that what has been signed today will not be changed tomorrow; instead, it should be periodically reviewed. Moreover, the basin's aquifer, ecology, water shed, and cryosphere should also be included in the Treaty.

Moreover, several respondents underscore that the water quantity, water quality, sub-surface water and environmental clauses should be incorporated in the Treaty. In particular, integrated water resources management, water efficiency, and local practices are important and should be incorporated in IWT. With regards, one of the respondents mentioned that the inspiration of Pakistan's NCCP-2012 and NWP-2018 should be included in IWT. It was stressed that the voids existing in IWT like extreme events, aquifer, catchment areas, environmental flows and water pollution should be well covered in IWT (Dr Muhammad Ashraf, personal communication, December 03, 2021).

Mehr Ali Shah, Joint Secretary, Water Division, points out that in Annexure C of IWT, the quantity of water for agriculture use is mentioned, but the crop type is not mentioned. He highlights that earlier Indians used to grow maize; now, they grow sugar cane, a water-intensive crop, may appear a minor thing, but it affects the quantity of water. He further underscores that the water reduction in a certain period can be calculated through authentic scientific proof of climate change. The clause is added to allow increased acreage based on water reduction (personal communication, 2017, August 16th). Ahmer Bilal Soofi, while delivering a talk on 'The Indus Water Treaty 1960: Salient Legal Aspects' at ISSI on 29 August 2017, identifies that the number of dams that India wish to construct on the Western Rivers is an issue outside the scope of the treaty. He further adds that the treaty is a regulatory framework giving technical specifications. It is confined to these technicalities and does not address the substantive decision of the number of dams that the Indian government may construct. All these aspects relating to water quantity, water quality, aquifer rechanging, watershed management, glacial fluctuation, environmental flows and uncertainty about the availability of water leading to extreme events, which the research and the respondents have highlighted will stand addressed if IWT is climate-proofed.

7.9 The Necessity of Climate-proofing IWT

Climate-proofing transboundary water agreement or treaty is a comprehensive concept (Shah, 2018). Climate change-induced risks and impacts can be reduced to the minimum possible level by following this concept. Climate-proofing concept is not an end in itself rather, it is a means to bring flexibility in the treaties and agreements. It is inferred that the climate-proofing concept shall keep away from a conflicting situation between the riparian states and lead to conflict resolution institutionally if a difference in interpretation or implementation of the concept arises (Shah, 2018). The concept has the latent potential to absorb the negative impacts of climate change with the help of technological, institutional, social and legal innovations. States shall

not wait for the existing treaties to succumb under burgeoning future pressures. Besides addressing the water quantity and quality aspects, the concept shall have the ability to address low probability but high magnitude climate events like floods and droughts. It shall provide a long-term sustainable solution against political, economic, and social pressures triggered by climate change (Kabat et al., 2005).

From experience shared by Termeer et al. (2017) for climate-proofing the Netherlands, an understanding develops that the climate-proofing concept shall integrate isolated or fragmented climate change adaptation practices applied by different countries in their respective transboundary water agreement. It shall multiply dividends and create synergy in efforts and results. With due feasibility and practicability prospects, the concept is applied in a customized manner. A comprehensive monitoring mechanism provides the concept necessary for endurance and sustainability to meet intended future needs and dictates of climate change. The whole concept leads to the synergy of effort and outcome (Solecki et al., 2011). Conceptually, strengthening existing institutional mechanisms like IWT by its climate-proofing and its subsequent implementation promises to build peace between two nuclear states (Shah, 2018).

From a political perspective, Senator Mushahidullah, Pakistan's Minister for Climate Change, said that the clauses and provisions related to climate change should be applied to IWT. Indeed, India will not readily come to the negotiating table for obvious reasons. Nevertheless, Pakistan should initiate the process. MoCC and MoW shall prepare the case, process it through their own Foreign Office with Indian counterpart and diplomatically handle it (personal communication, February 14, 2018).

From a technical perspective, a host of respondents supported the idea. According to the respondents, IWT needs to be climate-proofed because under changing climate conditions, Pakistan is suffering a lot, there is no release of water in Rivers Ravi, Sutlej and Bias and environmental flows are also almost nonexistent. They argued that the Treaty as a whole is seen through, and rivers of the basin should also be climate-proofed. One of the respondents shared that he has met the Indian Permanent Indus Water Commissioner a few times in some of the meetings; they realize the need to incorporate these provisions into Treaty; how can we approach them for this purpose is a different story? He informed that informally in the discussions, he had found them agreeing to this because everyone with a rational mind thinks that at the time of signing IWT, the climate change phenomenon was not factored in, but now it is high time that it should be taken care of if both the countries agree (Q. Z. Chaudhry, personal communication, November 17, 2017).

Although Tariq Banuri, Executive Director GCISC, criticized the climate-proofing concept, it was affirmative about doing it. He retorted that first, we need to respect and understand the existing Treaty; he said he is not for re-crafting it. He did not endorse climate-proofing for rationalizing the distribution of water. Instead, he supported climate-proofing IWT to ensure that the core objective of the agreement, peace, remains protected under new conditions. He suggested that future research regarding IWT should include three pillars, i.e. Equity, Treaty and Climate Change and not only climate change (personal communication, August 21, 2017).

Dr. Zaigham Habib, a technocrat respondent, responds that in her views, instead of bringing something new, we should capitalize existing space for introducing climate change proofing in the Treaty. She identifies that variability in flow, protection of catchment, and environmental flows can be discussed if the space provided by the future collaboration clause is incorporated in the Treaty. She suggests offering India joint research under that clause and talking about joint monitoring (personal communication, September 21, 2017). Dr. Chung Kyo Park, Director Asia Region, during a meeting in WMO Head Office at Geneva in his remarks on a question about climate-proofing IWT, contended that historically India and Pakistan had been cooperating that's why the Treaty has survived until now, both countries should sit together now and find scientific evidence to reach a solution. Climate-proofing IWT is not a political issue. Rather, it is a technical issue that should be scientifically managed. He further highlighted that data sharing is the basic foundation of climate-proofing for which mechanism already exists in the Treaty, so that mechanism should be used to find scientific evidence about climate change, which should help climate-proof the treaty (C. K. Park, personal communication, October 17, 2018).

Gen Muzammil, Chairman WAPDA, explained that technically, it should be done, but politically, it may not be possible. He pointed out that the existing Treaty should not be fiddled with. Treaty does not have a clause of 'Stay Order', which is always in favor of India. He retorted that India initiates a violation and puts us in a long resolution process while completing the project. He dismayingly underscored that Pakistan could not get it stopped; there is no such provision. He said that be mindful that even World Bank does not come on your side and see how you would be able to do it (personal communication, November 23, 2018).

On the legal front, Advocate Ahmer Bilal Soofi, an international law expert, opines climate-proofing by expounding that IWT is a bilateral document prepared and signed under the auspices of the World Bank. He points out that there are three stakeholders in a way in IWT. He suggests that at least both countries should make a joint study group which should see all the

pros and cons and then give their recommendations based on which further decision can be taken (personal communication, February 28, 2018). In his interview, Justice Jawad Hassan Sheikh, Judge Lahore High Court, contended that IWT should be upgraded by incorporating climate change and environmental knowledge. He suggested that experts of both countries should sit down and find out how best the climate-proofing of IWT be done. He, however, retorted that the Treaty should not be changed instead, amendments may be added as a protocol or addendum. Consequently, he wished that climate-proofing IWT should bring stability to the region (J. H. Sheikh, personal communication, February 3, 2019).

On the one hand, Mr. Tariq Altaf, Vice President Water Resource Division NESPAK, appreciates the concept of climate-proofing IWT but is not inclined to do it as of now. He retorts that the clauses of IWT are so watertight that you cannot expect anything from the existing water distribution framework to adjust as India has already developed so much infrastructure on Eastern Rivers that they would not agree to release any water, may our requirement be so genuine. He proffers that without re-negotiating IWT, our problem is not likely to be solved and re-negotiating strategically is not in our favor. He contends that it is a paradoxical position for us. He points out that climate change knowledge has to be introduced into IWT, but the Treaty doesn't have space. He further suggests that research should come up with some innovative thought only then it may be possible; for the time being, he found it a challenging proposition. He again reiterates that researchers need to think of some incentive for India, which should convince them for accepting the proposal of climate-proofing (personal communication, 2017, August 26). Dr. Muhammad Ashraf, Chairman of PCRWR, confirms the necessity of climate-proofing but opines that both countries would have to build capacities for undertaking such a significant intervention (personal communication, December 03, 2021).

7.10 Climate-proofing IWT: Key Benefits

This was an interesting discussion that ensued when the question about the visualized benefits of climate-proofing IWT for Pakistan and India was asked from the respondents. The response varied from political, environmental, ecological and social to economic benefits for both the countries. Dr. Ghulam Rasul contends that climate-proofing IWT will lead to regional stability, and we will be known as climate-friendly nations. He further opines that both India and Pakistan can take the credit for this; it will resolve long-standing issues between the two countries as transboundary issues are now the burning issues in the world. He also expounds that it will resolve long-standing water issues. He concludes that it will benefit both the countries as it has the latent potential to bring peace to the region. (personal communication, July 26, 2017).

Professor Dr. Martin Gramboh also aligns with other respondents and opines that both countries will live together in peace. He philosophizes that you can only live in peace when your neighbor lives in peace. He further shares an insight that it would benefit two neighbours and the whole world as the best way to fix the problems is through the treaty, not wars. Grambow pleasantly shares their own experiences and explains the happiness from what they did in Rhine and Danube River Treaties, due to which they are living in peace. He also pointed out that now they have common plans to deal with flood protection, pollution and chemical industries. He highlighted that Pakistan might draw more benefits as a lower riparian than India, but India is lower riparian to China, so India will use the same precedence to get benefits from China on the Brahmaputra (personal communication, December 7, 2018).

Dr. Muhammad Faisal, DG South MoFA, while sharing his view, contends that there shall be a lot of benefits in climate-proofing IWT like we will become part of the Paris Climate Agreement, the environment will get better, we will be able to sustain our sub-surface water in the agriculture sector, we will be able to use maximum water and the same benefits India will be able get (personal communication, October 11, 2017). Dr. Qamar-uz-Zaman Ch, ex DG PMD contends that water is important for both countries, particularly for food security. When water management is used on a scientific basis, this will help both the countries to sustain (Q. Z. Chaudhry, personal communication, November 17, 2017). Dr. Shams ul Mulk, ex-Chairman WAPDA opines that both the nations will benefit equally as it would help them meet their basic water needs in a better way (Shams-ul-Mulk, personal communication, September 12, 2017).

Dr. Uttam Kumar Sinha shares that modifying the IWT to accommodate the challenges of climate change on the basin or setting up a new institutional arrangement to account for climate-proofing would require mutual agreement based on evidence and facts and not on politics of gains, losses and misinformation. He pointed out that Article VII of the IWT describes future cooperation that can become the starting point of discussion on climate-proofing. He further shares that to put the onus on the IWT for all the problems and ills of sharing water is rather missing the point. He highlights that IWT was agreed upon to divide the rivers and share the volume with restrictions and permissions on either side; now, the climate factor needs to be incorporated in the national water policies of each country. Moreover, he suggests that internal water practices can help strengthen the IWT (personal communications, March 12, 2019). General Omar Hayat, Chairman NDMA, while expressing his views, contends that climate-proofing IWT will lead to better management of extreme events. He says presently, disaster management plans in Pakistan are in isolation, stand-alone without due input from upper riparian; if the Treaty is climate-proofed, we will get data that will help Pakistan take

safeguards in real-time. He further adds that we will be able to recharge our aquifer, our ecological system will come in order, our environment will get better, and so forth (personal communication, December 25, 2019).

Mr. Ahmad Kamal, Chairman FFC, while sharing his views, expounds that climate-proofing will help humanity, future generations, communities and water requirements of both countries; it will act as an achievement for both the countries at the global level for claiming climate change credits leading to financial benefits from the global community. He further ushered new thoughts to open new avenues for India to climate-proofing the Brahmaputra River. He adds that Pakistan will be able to make such arrangements with Afghanistan as well (personal communication, December 29, 2017). Mr. Irfan Tariq, DG Environment MoCC, says that climate-proofing IWT can bring both countries closer on so many transboundary issues. He identifies that nowadays SMOG is a common phenomenon which is being attributed from across the border paddy fields burning activity. If understanding between both the countries would exist, they will be able to resolve their host of transboundary disputes. Climate-proofing will become a source of peace building between both countries. He points out that both the countries cannot build dams in disputed territory, say for Dassu Dam, we are not getting funding from World Bank because it is in Gilgit-Baltistan a disputed territory. Similarly, India has built numerous dams in Occupied Kashmir through own resources. He rather gave a tiding that climate-proofing IWT will open international financing for building water storage capacity of both Pakistan and India (personal communication, August 9, 2017).

Mr. Mehr Ali Shah, Joint Secretary Water Division, has a different viewpoint than others. He opines that climate-proofing IWT is tricky in the Indo-Pak scenario. The benefits to both will only accrue if it is a win-win game. If India perceives that it is at giving end of being upper riparian, it may get stalled. If the concept is applied through an integrative water management approach bringing equal benefits to India and Pakistan, it may get through. He visualizes that no worthwhile benefits are visualized for India under normal circumstances, which is worrisome for the application of the concept (personal communication, August 16, 2017).

7.11 Applicability Environment

Water and national security are inextricably linked (Wani & Moorthy, 2014). This relationship is perhaps the most significant nexus that can be threatened due to climate change, particularly in the context of transboundary water resource. Within the inextricability of the ‘water and security paradigm’, transboundary water resources have always remained a potential source of

conflict (Boute, 2016). Controlling the shared transboundary water resources and their consequent impacts on fair distribution and management creates competition and escalate the conflict between riparian states. Usually, disputes over transboundary water resources are managed through cooperation rather than conflict (Cooley & Gleick, 2011). Various institutions like WB and ICJ etc. have played an instrumental role in building peace between the states. Traditionally, Pakistan and India are embroiled in a host of disputes. Besides Siachen Glacier and Sir Creek issues, the Kashmir dispute dominates the conflict matrix. The Nuclearization of both states has given a unique dimension to the conflict matrix. Between India and Pakistan, some major hydraulic controversies like Baglihar HPP, Wullar Barrage and Ratle HPP show proneness to contradiction and uneasy peace, yet IWT has survived three major wars and continued border tensions (Ali & Zia, 2017).

Hydro controversies and political rhetoric can usher an era of non-traditional conflict matrix which can exacerbate existing stresses. Recent Indian intransigence to revoke IWT is a peace-threatening gesture, yet the treaty is a successful instrument for regulating shared waters (Singh, 2016). However, various scholars have considered these discords as sophistic because of the strong and mature institutional mechanism of IWT. Sequel to this argument, Petersen et al. (2017) call to explore opportunities that can be capitalized to make IWT a stronger cooperation and dependence source. Through its climate-proofing, i.e. formation of one of the principles 'turn' within the studies of natural resource management, disaster risk management and conflict resolution, it can help establish the required framework (Petersen-Pearlman et al., 2017).

7.11.1 Acceptability of the Concept and Its Necessity

One of the key questions was whether India and Pakistan would accept the climate-proofing concept and its necessity for application on IWT. The response was though varying yet consistent. First of all, political perspective was taken from Senator Mushahidullah, Minister MoCC. He being well cognizant of Indo-Pak geo-hydro politics, responded that Indians will not readily come for obvious reasons to negotiating table (personal communication, February 14, 2018).

When Abu Ahmad Akif, Secretary MoCC, believed that Modi Government will not show any keenness of negotiating with Pakistan. No multilateral negotiating effort between the countries seems imminent. He pointed out that one thing is clear; India has managed water better than us; we have not been able to reach a political consensus to build Kala Bagh Dam even, we did not have Kala Bagh, but Nowshehra still drowned in 2010. Mr. Akif was posing realistic

questions while responding, saying that as a result of the climate-proofing IWT analytical exercise by the experts, if it is established that Pakistan shall get more water, will India agree to this? and contrarily if it is established that Pakistan would surrender water to India, will Pakistan do it under the present environment of antagonism, so he said it is difficult to predict at this stage. He disappointingly pointed out that India has rejected all multilateral peace efforts; how will India agree to this arrangement now? Until and unless, if both countries don't settle on their political issues, he did not foresee India agreeing to climate-proofing IWT (personal communication, December 19, 2017).

Mr. Irfan Tariq, DG Environment MoCC, responded that both Pakistan and India are not in a position to negotiate climate-proofing IWT. He pointed out two important aspects essentially required for such intervention: the first is the political aspect, and the second is the technical aspect. He argues that the technical aspect is subservient to political factors. He underlines that presently political momentum doesn't exist, which could mobilize both countries towards negotiating IWT on the pretext of climate change or any other pretext. He retorts that example of the SMOG issue, which is very simple and small. Both countries do not have the political will to handle even this one, what to talk of climate-proofing IWT (I. Tariq, personal communication, August 9, 2017).

Dr. Sinha, Security and Defense Analyst, India, gave insight into the Indian perspective by saying that it will be a far-reaching achievement if that were to happen. Sooner than later, climate change will influence the political thought process between India and Pakistan and the IWT in some ways will be modified to accommodate the climate challenges on the water. He further argued that climate-proofing could become an important part of the discussion under the PIWC. While continuing to share his thought process of whether both the countries would accept the concept or not, he retorted that this could come only when the politics are right, while upper riparian responsibility is important; lower riparian reciprocity is equally important for healthy relations. He pointed out that water and politics cannot be separated; a good water relation can help build good politics, and India thought very much on this line to have bilateral water treaties with its neighboring countries, but it takes two to make good politics and hence it can be said that in the given environment, politics will dictate the water landscape. He summed up his thought-process that it was not intended but has become so (personal communications, March 12, 2019).

Dr. Muhammad Faisal, DG South MoFA being the official spokesman, gave Pakistan's version that India will not agree on negotiation just over climate change aspects; maybe, they will re-negotiate the whole treaty based on mutual agreement consensus (personal

communication, October 11, 2017). Ambassador Shafqat Kakakhel, who had served in India for four years, gave an insight into the Indian perspective by saying that they always try to find their interest while accepting or rejecting any intervention (personal communication, December 15, 2017).

7.11.2 Application Strategy

Another critical question is 'what strategy should be followed to apply the climate-proofing concept to IWT. Selected respondents responded to this highly technical question. Professor Dr Martin Gramboh shared an understanding of applying the concept as they have done it for rivers in European countries. He alluded to that there are two ways to do this. One is to renew or re-negotiate the existing treaty, which he says may not be possible due to political reasons in the case of IRB. He then points out that some alternative ways need to be searched. He shared that they did this lately in Lake Constance Treaty between Germany, Austria and Switzerland. He highlighted that although all these states are very friendly, we had to go a long way to make agreements with each other. He explained that the Treaty was not practical or working anymore for some core issues. What they did was they didn't change the whole treaty; instead changed the environment of the Treaty to make it effective. A new panel of experts was introduced and created a new framework of the joint body. He suggested that amendments to IWT need to be made to make it workable and effective. He retorted that making changes in the treaty indeed is a big challenge, so the existing treaty should not be touched rather should come up with additional arrangements to address the issues (M. Gramboh, personal communication, December 7, 2018).

Dr. Ghulam Rasul argues that the climate-proofing strategy by Pakistan has to be a two-pronged approach; its first part is internal, i.e. putting its own house in order, and the second part is eternal, i.e. negotiating with India. He further argues that as the first part, Pakistan should manage its water resources first, which can be easily done in own geographic limits. According to him, Pakistan should revive the ecology of Eastern Rivers, delineate boundaries, stop intrusion into riverbeds and flood plains, remove human settlements, encroachments, land cultivation and ensure continued perennial flows. Whereas for Western Rivers, the river ecology needs to be preserved. Similarly, the riverbeds, flood plains, and ecology should also be well maintained in lower Indus plains. He continues his argument and proffers that the process of climate-proofing should be uninitiated; as a second part, we should follow an approach that ensures a win-win situation both for India and Pakistan (personal communication, July 26, 2017).

Jawad Hassan Sheikh suggests that the mechanism for resolving the disputes and future cooperation in the Treaty should be followed. He further argues that it should be rather technically handled. The Ministry of Climate Change should approach UN Environment Program (UNEP) from the climate change perspective, which should pave the way for climate-proofing Indus Water Treaty. He also said that it is a diplomatic issue as well, so different organs of the UN and other international players should be mobilized for this purpose. Pakistan is now leading the world in climate change, the present government in general and the climate change ministry, in particular, is very active at the global level, full advantage of this position should be taken, and the initiative should start. He furthers his point of view that we need to mobilize the world on climate change so that pressure is built on India to come to negotiating table for climate-proofing IWT. He underscores that international law experts, water resource experts, climatologists, strategists and for that matter, all the stakeholders need to sit down and prepare a response which should be leveraged on global players through diplomacy; this would generate the required pressure to bring India to negotiating table (J. H. Sheikh, personal communication, February 3, 2019).

7.12 Risks in Not Climate-proofing IWT

Shafqat Kaka Khel articulates his views as he hails from a diplomatic cadre that climate-proofing IWT should be a routine neighborly affair under a political environment. However, unfortunately, in Indo–Pak scenario, politics has intruded into hydrology. (personal communication, December 15, 2017). Akif further argued that if the process of climate-proofing IWT is not carried forward, all the adverse impacts that can be visualized as the consequence of Anthropocene would have to be faced by Pakistan (personal communication, December 19, 2017).

Dr. Muhammad Faisal, DG South MoFA, expresses his views that due to climate change, we are already facing flash floods, changed weather patterns and decreasing levels of sub-surface water; the devastating impacts are showing up in the areas of Ravi, Sutlej and Beas rivers. The agriculture sector in Sindh is being impacted due to a shortage of water, and our water, food and energy securities are likely to be impacted if IWT is not timely climate-proofed (M. Faisal, personal communication, October 11, 2017). Dr. Qamar-uz-Zaman Ch discourses that right now, without climate-proofed IWT, we have already started a political fight on these issues as the Indian Prime Minister got involved. Even without climate change clauses, we are already in a difficult situation, especially for Pakistan. Without incorporating climate change, things will worsen because of political shortsightedness and narrow vision. Both the political

leaderships need to rise above trivial issues because water is about life in both countries. He argues that we need to realize how climate change will affect the water resources in the region and how can we adapt to such conditions. He wishes to see how realistic distribution of water resources can be possible due to Anthropocene (personal communication, November 17, 2017).

7.13 Climate-proofing IWT: Key Incentives[78]

What will be the incentive for the partners, particularly India, after IWT is climate-proofed? This query was presented to almost all the respondents. The response has been varying though inconspicuous yet promising. Dr. Ghulam Rasul DG PMD proffers that from climate-proofing IWT, indeed Pakistan will be the beneficiary in tangible terms, but in a broader sense, if we look at the whole eco-system when this treaty is climate-proofed, it will be a win-win situation for both the countries. He is also of the view that environmental conditions in both countries will improve, positively contributing to South Asia's environment. More so, he says it will contribute to the water sector and uplift other socio-economic sectors in both countries. He visualizes that, take the example of the water shed environment of IRB, if it is preserved as the consequence of Anthropocene, the major beneficiary from it will be India. That will benefit India (personal communication, July 26, 2017).

Mr. Ahmad Kamal, Chairman FFC, says that IRSA at the national level employs a concept of minimum and maximum rule curve for dam filling, which first addresses the interest of upper riparian and then automatically addresses the interest of lower riparian. He says based on this concept, climate-proofing IWT should be mobilized. He proposes that a customized definition of minimum and maximum rule curve shall be applied to solve the problem of water distribution between India and Pakistan. The scenarios should be linked with UNFCCC clauses and IPCC research. He concludes that the concept will become an incentive for India (personal communication, December 29, 2017). Dr. Muhammad Faisal, DG South MoFA, envisions that in climate-proofing IWT, both countries will benefit because both are getting the same impacts of climate change. He argues that we can offer them a joint ownership initiative to use maximum water in both countries, but they are not ready for this so far. He thinks that if both countries go for the joint initiative, there are possibilities of giving and taking (personal communication, October 11, 2017).

There is a possibility though remote, that India might be willing to slightly more intrusively handle transboundary rivers due to the Brahmaputra, one of the rivers that emanate

[78] Basic difference between incentives and benefits lies in intent. The benefits will naturally flow but incentive will be intend to be provided or accrued.

from Tibet and is also utilized there, unlike the Indus that starts from China but is not helpful for China. Chinese have a variety of plans and strategies on the Brahmaputra, though not yet finalized but are well known to Indians, and they would like to capitalize on this proposal for their interest. If India is able to establish a framework with the Chinese for monitoring the utilization of Brahmaputra waters, they can discover an incentive in climate-proofing IWT (S. Kakakhel, personal communication, December 15, 2017).

Dr. Tariq Banuri, Executive Director GCISC, gives a varying thought process on climate-proofing IWT. He foresees that it is easy to bring two countries to negotiating table through a positive-sum game. A positive-sum game means that we will cooperate for mutual benefits, while in a zero-sum game, you go just for your benefits. We maintain stability through threat or external violence; see how you suggest a positive-sum solution. He argues that when IWT was crafted, it was positive-sum. At that time, both India and Pakistan were interested in developing hydropower projects, so conflict was avoided. He gives an example that there is huge hydropower potential on the boundary line between Tajikistan and Uzbekistan, but they cannot develop any hydropower project because there is conflict, the land mines are everywhere, they are killing each other, and even World Bank and Asian Development Bank cannot come and help them. While relating the situation to Indo-Pak scenarios, he opines that presently, we are not in a positive-sum game anymore, so in my view, there is no deal we can get today which is better than we signed in 1960 (personal communication, August 21, 2017).

Dr. Zaigham Habib also seems at variance with a traditional trajectory of thought process. She thinks that, in her opinion, we cannot give any incentive to India; we can pressurize them. We have already lost the Kishan Ganga and Baglihar cases, and climate change is also not likely to benefit us. Indians have worked very effectively on their water security. We did not bother to do so. They have covered water for a 7 Million Acre area under the IWT clause, which grants them water to develop their irrigation land, even though it is still not there. For the time being, she feels that the situation seems precarious for this preposition (personal communication, September 21, 2017).

Abu Ahmad Akif, Secretary MoCC, feels that both Pakistan and India, after having climate-proofed IWT, will draw benefits under the umbrella of the Paris Climate Agreement – 2015. He further opines that for Pakistan, it will be in line with the national road map of economic growth, social inclusion and sustainable development as given in Pakistan's Vision – 2025 and more significantly, it will reflect Pakistan's resolve to implement its INDC in compliance with the decision taken at the 21st session of COP at UNFCCC. Akif says that similarly, India can correlate incentives from the concept of climate-proofing IWT for herself

very easily (personal communication, December 19, 2017). Omar Hayat, Chairman NDMA, points out that if climate-proofing of IWT is done, both countries will have better adaptation, mitigation and response capacities against extreme events as the extreme events do not follow political boundaries, both countries are equally exposed (O. Hayat, personal communication, December 25, 2019).

7.14 Climate-proofing IWT: Challenge and Opportunities

For India and Pakistan, climate-proofing IWT is a double paradox situation. Technically, both countries feel that climate-proofing of IWT needs to be done, whereas politically, both cannot do it. Strategically, if they do it due to any factors whatsoever, they will not sustain it due to their inherent conflicts, particularly the Kashmir dispute. This is the predicament and dilemma for both countries. They have challenges in it; they have opportunities for cooperation, stability, and peace, which political leadership of both countries need to explore and capitalize on.

Shah (2018) proffers that the antagonistic dynamics existing between India and Pakistan though preclude the possibility of coming closer today. If the need is identified, the idea floated to the stakeholders; it will find ways and means to get it through tomorrow. He further opines that it is understandably difficult but not impossible. He further dwells on the idea that it would never get realized tomorrow if something is not visualized. He visualizes that political and administrative options only come into play if the concept exists academically and technically.

Zaigham expounds that the research shows that it is the necessity of time, it's a technical dictate, it is an academic desire, so the political will needs to be mobilized through diplomatic and scientific pressures to get over this challenge vs. opportunity predicament. She further builds on her argument that building multi-level governance capacity can be an instrumental outcome of climate-proofing, providing coordination and cooperation at inter-institutional and inter-sectoral levels normally referred to as horizontal and vertical integrations. This, she says, will be done by establishing linkages and empowering multi-level actors for evolving strategies and finding solutions to climate change problems. She sums up that the framework for developing the climate change adaptation strategy for IRB would automatically evolve (personal communication, September 21, 2017).

Under the inspiration from IPCC Special Report, this framework shall comprise the universal components like data or information collection, impact, vulnerability and capacity assessment, development of legal and institutional frameworks, adaptation measures, implementation, monitoring and financial support mechanisms, instituting mechanisms and implementation of measures and evaluation of implemented measures and mechanisms for

adjustment in strategy which will give strength to both countries in future collaboration (IPCC, 2019). This strategy development shall define the realized and expected climate change impacts, anticipated vulnerabilities, and general principles for adaptation at the Indus River Basin level. Consequently, it shall be minimizing the possibility of unilateral adaptation measures while maximizing adaptation interventions beneficial for the transboundary perspective. In conclusion, the concept will empower the countries in five fields of cooperation, which shall include the water (quantity and quality), the ecology (eco-systems and species), the data acquisition and sharing (thematic, spatial and temporal), impartial monitoring and evaluation system and finally the sustainability of interventions through shared financial responsibilities. IWT is a unique protocol where rivers instead of water are divided. Therefore, incorporating climate change into the treaty without addressing the basic voids would remain a wanting document (M. Ashraf, personal communication, December 03, 2021).

PART-IV
CARVING SUSTAINABLE WATER FUTURE IN SOUTH ASIA

CHAPTER: 8
DISCUSSION: CONNECTING THE DOTS

All dimensions relating to research assumptions, objectives, questions, and queries pertaining to climate change as a phenomenon, its impacts on various sectors, consequences thereof are deliberated here for drawing relevant findings, conclusions and recommendations. IWT, with its present efficacy, existing voids, inbuilt flexibility and diminishing myths of its success, are reflected upon to draw requisite inferences. Climate-proofing as a concept with its versatility for application on transboundary water agreement, acceptability by the stakeholders, and applicability under varying environments are seen to establish desired linkages. Transboundary water management as a source of peace and stability is also discoursed, particularly in India and Pakistan, where politics seems to take over policy and technology. A need for political reorientation is also brought into the debate for reaching a workable solution. Finally, an insightful argument on international water laws is discussed to draw inspiration for a sustainable way forward in climate-proofing IWT.

In this chapter, I have interpreted and described the significance of research findings in light of what was known about the impact of climate change on transboundary waters and to explain new understanding that emerged as a result of research about climate-proofing IWT. The reader shall frequently find discussion connecting with the concepts discoursed in earlier chapters by way of the research questions or assumptions posed and the literature reviewed.

8.1 Climate Change as a Phenomenon

The progressively increased production of CO^2 over the last few centuries has been alarmingly unabated, leading to global warming. From the last half of the 20^{th} century, the phenomenon of global warming, mainly due to the concentration of GHG emissions, has started with deeper intensity and impacts. With every passing year, the outcome of global warming is being intensified and manifested. The research finds that vastly evidenced fact, intensively reported by IPCC (IPCC, 2007; IPCC, 2014; IPCC, 2015; IPCC, 2019) about the rise in global surface temperature over the last century has significantly disturbed the global climatic conditions. The increase in temperature generally attributed to a host of factors (Brown et al., 2007; Rasul et al., 2008; Arguez and Vose, 2011; Smit et al., 2014; IPCC, 2019; Chegwidden, 2020) has altered the composition of the global atmosphere and disturbed the weather systems. Human-

induced activities resulting in global warming have led to the phenomenon of climate change. Climate change is an undeniable phenomenon to be reckoned with and acknowledged as a global reality. The findings by the climatologists pointing towards emissions of an estimated aggregate of GHG crossing the limits of least cost 2^0 C scenarios (Jafroudi, 2018; IPCC 2019) is a matter of concern for policymakers and planners alike. Consequently, the climate change phenomenon will become more intensified and impacted.

The direction from the COP 21 for holding the increase in the global average temperature to below 2^0 C above pre-industrial levels or 1.5^0 C above pre-industrial level (Jayaraman, 2015) is an important call for increasing the efforts for the reduction in GHG emissions vs what has been indicated in the INDCs by different nations. The course of research revealed that climate change is real, yet its impacts and consequences are still evolving. Over time, these will reveal more intensively. It is considered with high confidence that the risks of climate change with evidence and computer simulation are now far better understood than before. As discussed in chapters 2 and 6, Pakistan is a country of diverse climates, weather systems, eco-systems, and bio-diversities (NASA, 2010; AFP, 2012; MoCC, 2012; Ali, 2013; Chaudhry et al., 2015; WHO, 2019; TNI, 2019) is extremely vulnerable to climate change whereas its contribution to GHG emissions is relatively on a much lower scale. The survival insecurities developed by the climate change phenomenon in Pakistan, particularly in the domain of water, food and energy (MoCC, 2012; Abubakar, 2020), have made it obligatory for policymakers and planners to think of adaptation measures that can guarantee a precursor for sustainable development in the country.

The extreme events in the last decade in the form of cyclones, floods, GLOFs, heat waves, droughts, etc. (NASA, 2010; AFP, 2012 April; TNI, 2019; WHO, 2019) are glaring evidence of the manifestation of climate change in Pakistan. Since climate change is a global phenomenon, its manifestation sees no borders and frontiers. A country like Pakistan which may be very low on GHG emissions will become highly vulnerable if it lies within reach of the impacts of climate change. Climate change as a phenomenon will pose a high risk where vulnerabilities are high and capacities are low. In the case of IRB, all its water sources across the borders in India and Pakistan will be equally affected by the phenomenon of climate change except where adaptation measures will be appropriately and timely instituted. Correct understanding of climate change in the regional context is of paramount importance if its impacts are translated into IWT; otherwise, IRB water resource, a shared entity, shall become a potential conflict between Pakistan and India in the future.

As with recurring references, it has been well established that climate change is the primary reason behind environmental impact, particularly since the industrial revolution. This Anthropogenic relationship needs to be correctly factored in our responses in each facet being deliberated for finding transboundary water solutions. The impacts of the Anthropocene contribute to the pressures on ecosystems in almost all domains and can reduce the positive effects of the ongoing and completed measures that are being implemented to attain the set environmental objectives. There is also no reason to assume that the underlying system governing climate change-related processes will be fundamentally different in the decades to come. Coping with the negative impacts of the Anthropocene pre-supposes that water solutions will evolve towards genuine sustainability. This development is imperative for meeting our basic water needs.

8.2 Understanding Climate Change Impacts for Translation into IWT

To understand the impacts of climate change which this research presents for translation into the IWT, the first thread on the web is the understanding about the rise in temperature, which is causing glaciers to melt faster. As a result, the water is either being increased or decreased at different points in time. This change in water availability consequently impacts agriculture, livestock, forestry, power generation, coastal areas, environment and ecology etc., leading to survival insecurities like food, energy and health. India and Pakistan both are water-stressed countries. Melting glaciers in the HKH region will equally impact both states as the rise in temperature in both countries is almost similar. Precipitation patterns, particularly in northern and part of India and Pakistan, directly related to IRB, are similar because of the common source of HKH glacier melting. The rise in temperature leads to glacial fluctuation, which has created uncertainty about water availability from rains, rivers, and aquifers, thereby threatening food and energy security.

The increase in frequency and intensity of extreme weather events like floods and droughts creating disasters lead to physical, economic and environmental losses. The decrease in already scanty forest cover has reduced carbon sinks and adversely affected IRB catchment areas besides causing erosion and landslides. The increased intrusion of saline water in the Indus Delta due to the rise in sea level and the non-availability of freshwater on estuary has led to the loss of mangroves and their habitats. The increased environmental degradation has led to air pollution and health risks. Climate change-induced migration has disturbed the demography of the areas. Increased stress between upper and lower riparian in sharing water resource has increased bilateral hydro-tension between India and Pakistan. These impacts

reflect on Pakistan's vulnerability to climate change impacts and testify to the German Watch's findings of placing as the 5th most vulnerable country in the Global Climate Risk Index in the world (Abubakar, 2020). In succeeding sections, the impacts of climate change (on water, agriculture, livestock, forestry, coastal areas, environment and ecology) will be discussed.

8.2.1 Uncertainty about Water Availability

The research focuses on water and climate change, as climate-proofing IWT will surround these elements. Climate or weather conditions prevailing in an area has three main elements, i.e. temperature, rains and humidity. All of these are changing. The most affected element of the climate by climate change is water, i.e. glaciers melting, and rainfall patterns have been disturbed by rising temperatures with varying degrees. Freshwater in Pakistan is received from glacial and snowmelt, rainfall and the aquifer (Chaudhry, 2017), all of which have been affected by climate change in one form or the other, particularly water's availability has become uncertain. Empirically, since a major portion of freshwater (92%) is used for agriculture, its uncertainty in availability will hit food security the most.

On the other hand, due to socio-economic development and the increase in population, the water demand has phenomenally increased. On the one hand, the pressure on declining water availability has increased manifold, whereas, on the other hand, all fresh water sources are being impacted by climate change. The first source of freshwater is glacial melt; the main source for IRB is the HKH region. Except for the Karakorum about which the uncertainty prevails (Immerzeel et al., 2010), other glaciers recession is a worrisome fact that can immensely disturb Pakistan's water availability demand-supply equation.

IRB being the most vulnerable Basin (Rasul et al., 2008), substantiates the fear of uncertainty about water availability. Rising temperature is causing fluctuation in the solid and liquid precipitation in UIB, thereby increasing the flow of water into the rivers turning into frequent flooding conditions causing huge economic losses. Intensified monsoon under increased temperature scenarios now reaches higher elevations of the HKH region. Since monsoon water has a higher temperature when showered on glaciated regions with an obvious thermal difference makes the glaciers melt faster. These fast-melting glaciers produce excess water, turning into floods, GLOFs and avalanches, resulting in river inflows. The change in the quantum of accumulation and ablation and the span of mass balance season (Cheema et al., 2016) is now making snowfall peak in February and March instead of December and January, which is why water variability. Moreover, the shift of snowing towards spring makes it wash away due to higher temperature, thereby increasing the spring inflows in the rivers and streams

of IRB. Now the fresh snowfall is not making up the deficiency of ablation or depletion of the ice due to melting in the previous summer season on the glaciers resulting in negative glacial mass balance rather it adding to the inflows.

The research finds rainfall as a freshwater source in both the weather systems, i.e. Mid Latitude Weather System or westerlies, and the Tropical Weather System or Monsoon has also been affected by climate change. Both the weather systems are suffering from different shifts, and changes in their pattern, particularly the monsoon, have become erratic as the air pressure over the Tibet plateau fluctuates abnormally, thereby retarding Monsoon mobility to this region. Due to weaker pressure on Tibet Plateau, the Monsoon weather system becomes more vulnerable, and UIB starts getting affected adversely due to this variation. Decreased rainfall in winter and summer in the arid plains and coastal areas, besides a decrease in rainfall during seven strong El Niño events in the last 100 years as elucidated by Chaudhry et al. (2009), substantiates the debate about rainfall disturbances in the region. The claim by Sinha that there is a decline in monsoon rainfall and an increase in the frequency of heavy rainfall events, so the dry months are getting drier and the wet months wetter (U. K. Sinha, personal communication, March 12, 2019) is a contributory factor in making the monsoon unpredictable and indifferent from the past trends.

The aquifer as a source of freshwater is charged through percolation from surface water. It has been adversely affected due to over-extraction due to higher demand due to Anthropocene. The water table persistently decreases, entailing exorbitant extraction effort and cost. This has disturbed the overall water availability equation in the IRB. The assertion by Ahmad Kamal (A. Kamal, personal communication, December 29, 2017) that the water table in Pakistan Punjab and Potohar Region is going down very fast due to over-extraction of groundwater by Indian Punjab.

In contrast, their own resources remaining intact is a worrisome proposition. This needs due attention by the authorities as it will lower the ground water table on the Pakistan side much faster than anticipated. Qamar-uz-Zaman Choudhary pointed out that one of the major reasons behind aquifer depletion in the eastern part of Pakistan is the absence of environmental flows in Eastern Rivers (Q. Z. Chaudhry, personal communication, November 17, 2017) is a relevant aspect in relation to climate-proofing IWT. This would have to be considered for making IWT a sustainable document. Resultantly, the water quantity and quality have immensely changed over the years in IRB.

Declining annual per capita availability of water and still resorting to age-old water utilization techniques for agriculture in India and Pakistan is a case in point to create an alarm

for both countries. The impact of climate change on the water concerning technological and educational advancements in hydrology, water resource management, transboundary watercourse management, conflict resolution, environment monitoring, data acquisition, storage, sharing, archiving techniques need to be viewed for suitably incorporating into IWT. Of course, the pressures like population growth, urbanization, economic development and extreme climatic events like drought and floods, decreased levels of sub-surface water and aquifers etc., have attained added significance as the consequence of Anthropocene and need to be aptly factored in the Treaty. The research finds that water is the most impacted element by climate change which has a direct bearing and relationship with the IWT. The uncertainty about water availability is real, evolving and impacting and is bound to have serious consequences for national and human securities.

8.2.2 Marring Productivity of Agriculture and Livestock

The consequence of the Anthropocene seriously impacts water-related and dependent sectors. In Pakistan, as the leading consumer of water, the agriculture sector is the next area bearing the revealing brunt of the climate change phenomenon. Water and temperature are two major elements that affect agriculture. Both Rabi and Kharif cropping seasons in winter and summer (respectively) need water for cultivation, which has become uncertain. To make up for the deficiency of water, over-extraction from groundwater is done, which depletes the aquifer. Crops grown in both Rabi and Kharif seasons are water and temperature-sensitive. The rising temperature resulting from climate change will impact agriculture, which consequently shall impinge upon national food security. With the rise of temperature from 0.5^0 to 2^0 C, the agriculture productivity by 2040 will decrease by 8% to 10% (IPCC, 2007; Iqbal et al., 2009; WWF, 2014; Dehlavi et al., 2014) is an implication which shall affect the economy and impinge upon food security.

The importance of agriculture as a key economic sector is significant as it absorbs about 38.5% of the national workforce, contributes 18.5% to GDP, and makes 60% of the export (Dehlavi et al., 2014), so marring its productivity will have telling effects on the economy of the country. Since agriculture and livestock are two interdependent sectors, the impact of the Anthropocene on one will correspondingly translate to the other. The livestock sector contributed 60.5% (MoPD&R, 2019) to the overall agricultural and 11.2% to the GDP with 3.1% contribution in the exports and 35-40% source of income for over 8 million rural families (Thornton et al., 2015; MoF, 2019) attains added significance for the economy of the country as a result of Anthropocenic consequences. The degradation of grazing pastures and lands will

occur due to drought, floods, and temperature rise. This shall result in loss of land productivity, decrease in fodder quantity and quality and increase in disease epidemics resulting in a decrease in livestock productivity. This impact of climate change on the agriculture and livestock sectors can seriously affect the economy and food security of the country.

8.2.3 Squeezing Forestry

Forests being the best carbon sink, can reduce the amount of GHG emission, thereby acting as one of the best climate change mitigation sources. Paradoxically, on the one hand, deforestation is causing climate change, and on the other hand, climate change is causing the reduction in forest cover as reduced forest cover can aggravate the phenomenon of global warming resulting in climate change. The deforestation rate of 1.5% annually in Pakistan is a very high figure that can be a major source of carbon sinks reduction. Deforestation has increased the risk of land sliding, slope destabilization, flooding, increased surface runoff and soil erosion. Over the years, due to arid and semi-arid climatic conditions in most parts of the country, the forest cover in Pakistan has reduced to a forest area of 4.19 Mha, which is 5% of the total land area only.

Coastal mangrove forests also cover small, making only 3% of the country's forest area. Besides reducing the carbon sink, a small forest cover with a high deforestation rate brings millions of people living in rural areas under pressure. The shrinking mangrove forest in the Indus delta has also developed economic pressure on around 97% of the people of the area. Despite poor forest cover, Pakistan is highly rich in eco-system and species biodiversity where the host of eco-systems thrive. Pakistan has great variation in physiographic and climatic conditions. It is home to nine distinct eco-regions. Wide-ranging eco-regions sustain diverse biodiversity. Unsustainable forest management practices and a high dependency of local communities on forests for meeting a wide variety of needs - including timber, firewood, fodder for livestock, agricultural land, and non-timber forest products, including wild fruits and medicinal plants — often result in deforestation and degradation of forest cover and eco-systems. Consequently, forest degradation in the country has negatively impacted communities, ecosystems, and biodiversity.

With shrinking forested areas, the attendant resources are also disappearing. The anticipated impact of climate change on forests is likely to threaten the country's biodiversity and soil quality, which has serious implications for the environment and health sectors. The realization to increase forest cover in Pakistan as a climate change mitigation measure has been manifested by present political leadership for the last few years. From 2013 to 2018, the PTI

government in the province of Khyber Pakhtunkhwa (KPK) planted one billion trees and now set a target of planting ten billion trees in the country (Gul, 2018) inherits concrete promise to improve the GHG emission condition in future). Recently USA joined the Pakistan government to sustain a ten billion tsunami initiative by providing physical support in the form of sustainable plant species (APP, 2019) will post the process. The initiative by the Pakistan government can be instrumental in reversing environmental degradation and managing climate change through the tree plantation campaign, but the damage already done to forestry would be undone through a sustained effort. As of now, the consequence of Anthropocene on forestry has denuded the IRB watershed from the tree cover, which needs to be factored in IWT for preservation as the consequence of Anthropocene.

8.2.4 Distressing Coastal Areas

Two southern provinces of Pakistan, namely Sindh and Baluchistan, have a 1046 km long coastline stretching along the Arabian Sea. Tidal flat topography, higher population concentration and industrial infrastructure along the coastal line of Sindh province make it more vulnerable to climate change. The unprecedented climatological events are continuously affecting the coastal areas of Pakistan. Due to climate change, the reduction inflow of river Indus has virtually converted the Indus delta into tidal creeks with high salinity value and pollution load. Seawater has intruded miles and miles into the land. The landward movement of seawater is also contaminating the groundwater aquifers. The scarcity of water has changed the cropping pattern in coastal areas. The declining availability of agricultural land is forcing the local community to shift from their traditional agriculture profession to fishing, which has decreased the fish catch. Due to insignificant flow in River Indus, the declining mangroves have perished the traditional eco-systems and biodiversity. The local population along the coastal line is equally vulnerable to climate change as most people live below the poverty line. The coastal areas are also typically vulnerable to tropical cyclones. Although the frequency of cyclones has not increased significantly yet the intensity has increased at an alarming rate which causes colossal economic losses. Other climate change impacts on coastal areas visible in the form of inundation of the low-lying regions, degradation of mangrove forests, declining drinking water quality and decrease in fish and shrimp productivity are the disturbing economic, social and environmental profile of coastal areas.

The expected sea-level rise of 2m to submerge 7500 km^2 in the Indus Delta, as researched by Khan (Khan & Rabbani, 2000), is alarming. This will increase the erosion rate, ranging from 31 m to 176 m per year. Rising sea levels will also exacerbate saltwater intrusion

into the rivers and aquifers that furnish freshwater to coastal settlements. The shrinking and sinking phenomenon in the Indus Delta due to lack of sedimentation and subsidence (Syvtiksi et al., 2009) is worrisome as they shall have serious economic, environmental, and ecological implications in the future. Besides the physiographic outline, the geological characteristics of the Pakistan coastal area make it more distinct. Pakistan's coastal and offshore geology tectonically exhibits both active and passive margin features. The hazards resulting from progressive climate change are expected to manifest all along the coast in the future. The projected climate change impacts on coastal areas include soaring sea surface temperature and surface water acidification. The repercussions of these changes on the coastal ecosystem and communities could threaten health and livelihood, destroy infrastructure, and displace millions of people.

8.2.5 Degrading Environment and Ecology

Global warming and climate change can alter biological systems. Changes in near the surface air temperature can influence ecosystem functioning, thereby affecting the biodiversity of plants, animals, and other forms of life. The current geographic ranges of plant and animal species are established by adapting to long-term seasonal climate patterns. Since these patterns are likely to be altered by global warming on timescales considerably shorter than those that arose in the past from natural climate variability, relatively sudden climatic changes will potentially challenge the natural adaptive capacity of many species. These plant and animal species will be at an increased risk of extinction if global average surface temperature rises by 1.5°C to 2°C by the year 2100 as anticipated by IPCC.

Similarly, surface warming in temperate regions is likely to lead to changes in various seasonal processes. Earlier leaf production by trees, earlier vegetation greening, altered timing of egg-laying and hatching, and shifts in the seasonal migration patterns of birds, fishes, and other migratory animals are a few examples that can be visualized under this milieu. On land, rising temperatures and changes in precipitation patterns and drought frequencies are also likely to alter disturbance patterns by fires and pests.

Climate risk due to rising temperature to bio-diversity in coral reefs, ocean acidification, marine pollution, runoff from agricultural fertilizer, migratory animals, air pollution, inadequate supply of uncontaminated drinking water, noise pollution and the health deterioration of urban and rural population due to pollution has the potential to spread infectious diseases having serious implications for the environment and ecology of the region. Environmental and ecological degradation as the consequence of Anthropocene, besides

causing harm to living beings, also pose a serious threat to the country's economy and development. Increased industrialization, urbanization, and motorization under a looming climate change threat can worsen the consequences.

The ecology is also in transition under the emerging consequence of Anthropocene, particularly ecological systems in the eastern part of Pakistan; certain species have become extinct or have evolved into a new set of habitats as no water has been catered for environmental flows for eastern rivers in IWT. Denial of water for the environment and ecology of the country in IWT has rendered the eastern part of Pakistan deprived of its intrinsic right of water, which should have been given in the light of its past water utilization pattern, but that was not done, so the environmental and ecological equation has got adversely disturbed. Now climate change is acting as a threat multiplier, and all across the country, water bodies are being impacted in one way or the other. Lowering water table, higher evaporation and transpiration due to rising temperature and uncertain availability of water have dried up many lakes in different parts of the country; Hanna Lake is a case in point that reflects environmental dilemma likely to impact the country at different vulnerable spots in future as well. The ecological disorder is the likely outcome of a disturbed environment.

Water pollution is another real threat to the environment. The river flows are reduced. There is no treatment to mitigate water pollution and inflow from chemical fertilizers and pesticides. The dumping of industrial effluent into lakes and rivers and untreated sewage into rivers and seas degrades the environment and ecology. Air pollution is yet another growing environmental problem in major cities, becoming a major reason behind deteriorating health issues. Inefficient use of energy, increased number of vehicles, increased unregulated industrial emissions and the burning of garbage and plastic have become significant sources of air pollution in urban areas. Inadequate air emission treatment, lack of regulatory control over industrial activities and absence of mitigation measures have deteriorated the ambient air quality in major cities. Accumulatively, climate change has adversely impacted the country's environment and ecology, leading to serious health issues.

8.3 Climate Change Consequences

The substantial impact of climate change shall lead to a host of consequences, including geopolitical, socio-economic, environmental, health and hydro-meteorological extreme event disasters. A substantial rise in temperature over the 21st century, which may range from 1.5^{0}C to 2^0 C and beyond, would produce economic losses across the globe. The socio-economic benefits would tend to decline, and the costs would increase. Sizeable disturbances are expected

specifically in agriculture, food and forest products, water and energy supply, and human health. Climate Change impacts are real and beyond control, but the consequences can be managed by undertaking adaptation and mitigation measures. Major consequences are likely to reveal in the domains of national security, water security, food security, energy security, extreme events, health and ecological system. If water availability is uncertain, all food, energy, and health securities get disturbed. Mostly, the HKH glaciers are receding (Immerzeel et al., 2010), causing more river inflows, resulting in excessive water availability, leading to either extreme events or waste of water into the seas.

The snowfall patterns shift, resulting in the fresh snow melting before turning into ice, causing a negative snow mass balance and increasing river inflows. The increased rivers inflow will persist till the snow-mass decreases to a minimal natural level. Now that increased water inflows are causing floods, decreased water inflows will cause water shortage or droughts. The decreased rainfall by 10-15% during 1960-2007, declining monsoon rainfall and over-extraction of groundwater are possible impacts of decreased and uncertain water availability. The research endorses the findings by the researchers (Bates et al., 2008; Rasul et al., 2008; Immerzeel et al., 2010; IPCC, 2014) that freshwater resource is vulnerable to climate change with numerous wide-ranging consequences on societal and ecological structures. The impacts and consequences both will remain variable and evolving in magnitude and severity. The water demand and availability matrix will determine the impact and consequence equation.

8.3.1 National Security Milieu

Growing water demand for enhanced population growth, agriculture production, economic development, power generation, and human health will create food, energy, and health insecurities. It can ultimately lead to national security as a water resource in Pakistan is shared and already under geopolitical stress. Transboundary water and conflict are synonymous in nature and effect with which peace also remains threatened. Water and national security are intimately linked because water is a catalyst in ensuring food, energy and health security for the dependent population. The research discovers what Boute (2016) had expounded that transboundary water and peace have an intimate relationship which can be threatened if external factors impact it like climate change, and it can turn into a conflict, same is true for IWT as well.

Since shared water is unequally divided and distributed, the water quantity is always finite. Excessive demand creates competition in riparian states to achieve incompatible goals in its utilization. This results in a conflict leading to geopolitical tension usually managed

through an instrument of cooperation in some mutually agreed protocol. That is why the UN always stresses promoting water-resource management as a tool to foster cooperation and prevent conflicts. Population growth and climate change together are likely to make the problem worse. Incompatible and uncertain water demand and availability equation will undermine a nation's ability to ensure social and economic development, resulting in compromised living standards, as the water, food and energy security would have disturbed the social fabric and structure of society. This state of an affair will generate a race to acquire water resources that can potentially initiate confrontation and competition for survival between the states. This can turn into a conflict (Blaabjerg et al., 2016); its severity would depend upon the strength and capabilities of the involved riparian in handling its settlement. The intensity of such conflict in India and Pakistan's nuclear-armed rivals will become extremely severe if shared water between both states is not managed with rationality and equity.

8.3.2 Looming Food Insecurity

Agriculture is dependent on the regularity and reliability of freshwater. Water availability can threaten agriculture production as both Kharif and Rabi crops are temperature, time and water sensitive. The hydrological imbalance will affect the ability of farmers to produce a sustainable level of food and fiber to meet national dietary needs. Crop growing and reaping cycles and seasons will lead to uncertain productivity when disturbed by climate change. NIPS assertions (NIPS, 2019) that with a current population growth rate of 2.4%, in 2050, the population will be 366 million, whereas a claim by news item (TNI, 2019) indicating population growth by 2050 is estimated to be over 403 million in Pakistan is a worrisome proposition particularly when scientists and researchers have warned that water availability will considerably decline by mid of this century. Which so ever figure is taken, the growing population and increasing development will mount an absolute pressure on IRB supplies, and the freshwater resource will further shrink, which is already constrained by climate change, leading to food insecurity.

Food comprises two basic elements, i.e., grain and meat. The grain need of the country is met by wheat and rice being the staple food. With the rise in temperature from 1.5^0 to 2^0 C, the yield of both wheat and rice is expected to reduce in major parts of the country in the future, thereby reducing productivity by 8% to 10% by 2040. The degradation of grazing pastures will occur due to a rise in temperature, floods and drought. This will result in a loss of land productivity, leading to a decrease in fodder quantity and quality. If the quantity and quality of fodder are affected, animal epidemic diseases will increase, becoming a major impediment in livestock productivity. Besides leading to scarcity of meat, milk products will also be affected.

The cost and effort to maintain livestock will increase manifold. Due to climate change impacts on coastal areas, the productivity of fish and shrimp is likely to be affected, which will also reduce the availability of white meat. Extreme events like floods, drought, cyclones, heatwaves, and GLOFs can threaten food security. Appropriate adaptation and mitigation measures against climate change will be required to ensure that the country does not slip into the food insecurity scenario.

8.3.3 Constraining Energy Security

The impacts of climate change on water resources will affect energy production. The country's ever-expanding thermal power production is sensitive to temperature increases and is highly dependent on water for steam production and cooling. The installation of hydro-power plants is likely to face greater competition for water resources to meet its growing needs as the climate change phenomenon gets deeper. Run of the river hydroelectric power installations are also likely to be affected by the vulnerability of Pakistan's water sector to the impacts of climate change. On the other hand, the energy sector, being a leading contributor to climate change through its high GHG emissions, will also remain sensitive to the impacts of climate change. All four sources of electricity generation in Pakistan, which include thermal (62.1%) based on oil, coal and gas, hydroelectric (25.8%), nuclear (8.2%) and renewable (3.9%), will either be impacted by climate change or will contribute to climate change. In both cases, the impacts and consequences of climate change would have to be managed.

Extreme hydro-meteorological events like floods and storm surges, etc., will potentially damage oil, gas, and power infrastructure. Faster evaporation and transpiration will happen under climate change-induced higher temperatures due to which electricity needs will increase, entailing higher costs and effort to pump more water for irrigation. The efficiency of nuclear and thermal power plants is also likely to be lowered due to warmer air and water temperatures, affecting the cooling of nuclear and thermal power plants. Over the years, the decrease in hydroelectricity generation in the country in the 1980s from 70% to the present level, i.e. 25.8%, is due to multiple reasons, yet non-availability of required water is one of the major reasons. Rising population, economic growth, and changing consumption patterns will increase the energy demand in the future on the one hand; on the other, the energy generation will be constrained as the consequence of Anthropocene, thereby leading to an energy security situation.

8.3.4 Burgeoning Extreme Hydro-meteorological Events

Findings of uncertainties of climate change are overwhelmingly consistent. Temperatures, precipitation rates, and consistent precipitation events will bring more climatic variability and change, leading to extreme hydrological events (Bocchiola et al., 2011) like floods, droughts, cycles, SMOG, etc. render human, economic and environmental losses. In the light of vulnerability to climate change, they are sliding down of Pakistan in Global Climate CRI as prepared by German Watch from 7th to 5th ranking in the world in a matter of few years. It reflects serious concerns and radiates multiple implications with respect to hydro-meteorological events. People all over the world are facing the reality of climate change. Hydro-meteorological hazards like floods, drought, GLOF, avalanches, landslides, heat waves, storm surges, cyclone, sea intrusion and SMOG are increasing. Although all hydro-meteorological hazards impact, flooding and droughts are the leading ones, they are more worrisome.

In the past two decades, current spells of hydro-meteorological disasters testify that Pakistan has been adversely impacted by climate change-induced hazards. The manifestation of this vulnerability started in 1998 with drought in the southern part of the country and lasted for four years, and then came the flooding spell beginning in the central and southern plains of the country from 2010 onwards and lasting for the next five years or so. The second spell of drought, which started in 2016 in Sindh and Baluchistan, reflects the slipping of Pakistan into recurrent hydro-meteorological cycles. Similarly, on the coastal front, experiencing extreme climate events like cyclones and heatwaves reflects that the only sea belt that country inherits has been impacted by climate change. The higher altitude northern region of the country has suffered from GLOF and landslides, which reflects that no geographical and climatological region is safe from the impacts of climate change and the consequences thereof. The results of extreme hydro-meteorological events will impact water, food, energy and health securities with wide-ranging social, economic, political and environmental implications. Besides, Sendai Framework for Disaster Risk Reduction (SFDRR) is a global instrument developed from the UN platform to address disaster risk for sustainable development to build resilience in states, institutions or communities. SFDRR advocates the application of Science and Technology to facilities achievement of its goal and acts as a monitor for reviewing the progress of its projects. Making climate-proofing of IWT part of this arrangement will bring global dividends for both countries.

8.3.5 Ecological Disorder

In an abiotic environment, the eco-systems are dynamic complexes of micro-organisms, fungi, plants and animal communities. The human-induced impacts on the terrestrial and aquatic ecosystems affect their biodiversity. The human population is dependent on the ecosystem as the service providers. These services include products such as food, fuel, and fiber. Water provides services like supporting, regulating, or provisioning systems for human life. All freshwater sources like glaciers, snow, rainfall, and ground water support different ecosystems. So, any change in these processes due to climate change will ultimately affect human beings. Biodiversity is also threatened by habitat destruction, which is done through changes in land use and over-exploitation of resources, pollution, invasion by non-native species, biological consequences of increased carbon dioxide levels in the atmosphere, and climate change.

The climate change impact on the ecology and environment is usually slow and difficult to measure but more often irreversible. Besides water, the temperature plays a major role in determining where individual plants and animals can live, grow and reproduce. The effects of climate change on species and ecosystems can be both direct and indirect. One of the examples is the sex of developing the embryo of turtle and alligator, which depends on environmental temperature. There are several direct impacts of climate change on species and ecosystems. Changes in the forest cover due to climate change are expected to occur. The vegetation zones or biomes are likely to shift in ranges of species and their composition. Climate change will affect the physiology, phenology, and interaction between species, resulting in changes in the geographic distributions. The impact of climate change is also likely to change the functioning of the eco-system as the physiology of species is affected by changes in temperature and availability of water.

There are a host of eco-systems in Pakistan, including glacial-eco-system, desert eco-system, grassland eco-system, aquatic eco-system, marine eco-system, forest eco-system, agro-eco-system, human, and urban eco-system. The plants, animals, soil organisms and climatic conditions are likely to be affected by climate change. The interaction of both these components to support different food chains and food webs for regulating essential ecological processes to support lives will also be affected by climate change. The recycling of nutrients between biotic and abiotic essentially happening though eco-systems will also be affected. The flow of energy in the water, carbon, oxygen, nitrogen and energy cycles is likely to be disturbed by climate change, creating an ecological disorder, thereby, affecting human beings.

8.3.6 Menacing Health Security

Understanding the impacts of climate change on the health sector is a complex phenomenon. Knowledge is absent regarding how the health sector will be affected by climate change, whether through future changes in water quality or by the presence of water-borne diseases. The increase in hydro-metrological extreme events will disturb the temperature and water equation, posing a greater risk of adverse health outcomes. Poor water quality is likely to persist as the frequency, duration, and intensity of climate change-related extreme events will increase. Climate change will affect both environmental and social determinants of health. Hydro-meteorological events such as floods, drought, heatwaves, and variable rainfall patterns affect the availability of safe drinking water, clean air, sufficient food, and secure shelter, leading to health challenges. The rise in temperature and variation in rainfall has a deep relationship with the spread of different infectious diseases.

Similarly, extreme events also have a deep relationship with the population's mental health Variable hydrological cycles resulting from climate change in less developed countries like Pakistan can become major reasons for water-borne and vector-borne diseases. Extreme flooding and drought conditions are disturbing the hydrological cycle. Since the ecological systems and habitats are vulnerable to climate change, either by elimination or migration, the micro-organisms are disturbed, which become the source of different diseases leading to individual and collective societal health challenges. The research concludes that climate change impacts will threaten health security in the country.

8.4 Understanding IWT as a Protocol

The core of research objectives lies around IWT. Whether it is its analysis to make it climate-proof, its climate-proofing to prevent or mitigate water conflicts or envisioning its climate-proofing for making it sustainable, the discussion would have to revolve around the Treaty. Since IWT is to be climate-proofed, it remains mandatory for the research to delineate all strands and contours of the Treaty elaborately to develop a correct framework for incorporating climate change-related clauses and provisions. In fact, IWT is the foundational document that outlines water-sharing principles in IRB between India and Pakistan. A deep collaborative effort by the politicians, diplomats, strategists, engineering and finance technocrats, bankers and consultants has led to this craftily structured instrument of cooperation.

The jurisdictions of both the countries defining their rights and obligations on both the sets of western and eastern rivers have been specified in this document. This research endorses the findings from the literature review and the respondents that IWT is a credible confidence-

building instrument between India and Pakistan. Although both the countries initially had reservations after signing the IWT in 1960, the treaty survived over the years, with tense political relations and three wars between nuclear rivals. Despite the feelings of transgressions and objections by upper and lower riparian, the treaty is generally considered a source of cooperation and not conflict. In succeeding paragraphs, I wish to highlight the basic elements of IWT as to what is its efficacy as of now, what are the voids that are creating problems for riparian states, what role flexibility can play for sustainability inbuilt in the Treaty and finally, how the myth about its success is gradually revealing and diminishing.

8.4.1 Efficacy of Treaty: An Inspiration

IWT being the oldest and the strongest confidence-building measure, enjoys a positive rapport at the international level wherein the Treaty is considered a successful instrument of cooperation between India and Pakistan. At the international level, IWT is considered a successful technical and legal instrument for distributing shared water resource of IRB, for which the World Bank, the broker of IWT, rightly takes pride in its success and survivability. Although both the countries had reached an incongruent consensus on the division of IRB waters and signed IWT with reservations, it has endured tense politico-military relations and three wars between nuclear rivals. The existential purpose and functional state of a treaty reflect on its efficacy. The sole purpose set out for IWT is the apportionment of IRB waters between India and Pakistan which is being met efficaciously. The replacement works were timely completed.

The Treaty became functional from the beginning and remains functional albeit with stagnancy, particularly on sharing data and information about inflows and hydropower projects. Despite dormant activities by PIWC on both sides and politico-military pressures, the Treaty has survived all the wars in the past and has abstained both the countries from going to war over water as well. The mechanism of data sharing and dispute resolutions between both the countries is in place, and water is being apportioned as set out in the Treaty, so it is functional, though not entirely, but delivering its dividends. May that be an uneasy peace, but it is prevailing. This is also true that India has never inclined towards talking about issues related to the Treaty but still, it would be known as a functional Treaty. Despite the feelings of transgressions and objections by upper and lower riparian, the treaty has generally remained a source of cooperation and not conflict. In the Indo-Pak scenario, hydro-politics will not be divorced from geopolitics; water will never become depoliticized. The standard institutional approaches for cooperation here will classically not be applicable.

Due to geographical disputes like the Kashmir issue, the focus will essentially remain on geo-politics and not necessarily the hydro-politics, and it would remain so till both the countries would start realizing that there is some more significant threat to their existence than the existing one. Without resolving the Kashmir issue, there seems no possibility of moving forward on any other issue, may that be IWT, though it is a dangerous scenario under anthropogenic consequences. The consequences of Anthropocene and climate change, in particular, is the only common concern on which both countries can build a new edifice of cooperation by addressing the issues related to IWT without resolution of other conflicts. This approach will be in line with Article VII of the Treaty, which calls for cooperation based on a common interest of parties, i.e., collection of hydrological data, construction of new drainage works, undertaking engineering works on the rivers with mutual agreement and notification before construction of any engineering work which would cause interference with the waters by affecting the other party materially. Treaty already has an inbuilt institutional mechanism for its sustainability like Article VIII for PWIC, Article XII for settlement of differences and disputes, Article X, which provides legal space for both the parties to consider each other's constraints and concerns and accommodate those to continue cooperating in future which shall give the Treaty a longer and stable life. Finally, Article XI binds both parties to remain part of the Treaty, whatever concerns or constraints emerge.

Besides the consequence of Anthropocene, while strategically analyzing more specific conclusions need to be drawn based on the witness statements collected in the interviews how best to tackle the limitations caused by the IWT provisions that artificially divide the water resources in the natural river basin (IRB) into 'Eastern' and 'Western' rivers. The possibilities of using existing or planned dams for better flood and drought management, ensuring minimum ecological flows, or improving sediment management. Similarly, a process needs to be initiated for groundwater management and protection, including demand management, forest protection, and protection of the river basin in the holistic sense, including internal management, at the national level. The need for, and the enormous potential of, implementing permanent transboundary working groups for specific issues at the technical level and the opportunities for synergies and innovative solutions that this can provide, especially in the long term, need to be considered for making IWT more efficacious.

8.4.2 Voids in the Treaty

The completeness of the Treaty notwithstanding, there are certain voids existing that have now started radiating real threat to the efficacy of the treaty and need to be addressed. The

fundamental void in IWT remains a reality: it divides the rivers and not the waters. Impact of water division formula adopted in the treaty, absence of the flexibility required in the face of fluctuating availability of water vis-à-vis its demand and indifferent interpretation of clauses have made the voids deeper. Although the concerns of Pakistan and India exist about the treaty and there are common concerns as well which have been discussed at length in Chapter 5, here discussion shall be focused on the interpretation, explanation in my language, the meanings as I have picked up during the course of research and the implications thereof of those voids in IWT which are likely to be accentuated due to climate change and are essentially needed to be addressed in climate-proofing of the treaty.

Without disturbing the main structure and content of the treaty, the voids need to be addressed to provide the treaty's sustainability. The division of rivers for distribution of waters allowing complete control with no exception of environmental flows of Eastern Rivers to India resulting in their drying up is the first and the foremost issue which has disturbed the social, economic, environmental, and ecological façade of the eastern part of Pakistan. With no provision of flexibility in the treaty, the declining water availability has started impinging upon its efficacy. The real state of declining water availability has already been deliberated in preceding chapters and paragraphs that per capita availability of water in Pakistan has declined from 5200 m^3 at the time of partition to three figures digit now and is likely to continue with its sliding trend threatening to make Pakistan a water-scarce country within the next decade or so. Pakistan's irrigation system developed as a result of IWT is one of the largest systems in the world. Maintaining such a huge system as an alternate arrangement to compensate for the water shortage in the eastern part has an economic cost to bear.

Limited age of replacement work is a dimension with economic implications for Pakistan. Two major expenditures are anticipated on replacement works of IWT. One is its repair and maintenance, and the second major expenditure will be done when it will complete its useful age. The Treaty makes no mention of sharing such responsibility. Global warming is on the increase. The glaciers are melting faster. The magnitude, duration, intensity, and frequency of water availability have become uncertain. The amount of water available now is more, decreasing when glacier mass reduces. IWT is rigid; it does not have provisions to accommodate these changes. The quality of water is deteriorating by industrial, agriculture and municipal waste falling from drains in riverbeds. No provision in the treaty addresses this climatic risk. Increased water demand vs. declining water availability has increased pressure on aquifer water extraction, which is not being recharged. The water table is going down. IWT does not cater for this anomaly. Due to the Anthropocene, hydro-meteorological hazards have

started revealing more vigorously, turning into disasters due to the country's limited capacity for disaster risk reduction and management. Treaty does not reflect on hydro-meteorological extreme events.

The catchment areas and watersheds of IRB are under threat. There is no provision in the treaty for their maintenance and preservation. A complete article for data sharing between India and Pakistan under the PIWC arrangement is not mainly for future hydropower projects. Interpretations related to hydropower clauses in the Treaty, particularly for water storage and their numbers on western rivers, are being done through an understanding developed by India alone, which poses serious implications for Pakistan. Lastly and most importantly, no joint body oversees the treaty's interpretation, implementation, and execution for monitoring, evaluating, and review for subsequent correction to increase its life for sustainability, which adversely affects the treaty's efficacy. The existence of voids in the Treaty and the absence of a mechanism to address the same have serious implications for the sustainability of the Treaty and peace and stability in the region. All these concerns, which relate to climate change, when get addressed, will lead to effective climate-proofing of the Treaty.

8.4.3 Flexibility: A Norm of Sustainability

IWT is designed on a fixed water allocation strategy (Biswas, 1992) wherein the six rivers have been divided once for all, and a certain amount on a volumetric basis from western rivers essentially allocated to Pakistan has been allowed to India. The IWT maintains a reasonable space for monitoring its implementation by both the PIWCs. The Treaty provides that wherever implementation of the Treaty is found, wanting the recommendations to be evolved for amendment and incorporation into the Treaty and problem be addressed. Of late, this flexibility has been lost due to tense bilateral relations between the states. Geopolitics has taken over the hydro-politics, and this integral instrument for internal amendment and modification to Treaty, mutually by the parties, has got deeply buried under the huge mass of politico-military tension between the countries. The internal mechanism of upgrading the Treaty has been lost over the years in the antagonistic culture between India and Pakistan. Now there is no remote possibility for incorporating those factors into the Treaty that had not been visualized at the time of signing it. This is the leading reason for making the Treaty stagnant today.

The remedy lies in creating flexibility in the treaty, which shall address all factors related to climate change or any other aspect needed for up-gradation to ensure its sustainability. The approaches like mean annual or monthly diversion, minimum guaranteed flow, cross-boundary flow requirements, percentage of available flow and sharing of rivers etc., provide flexibility to

a treaty which is essentially required for its longer life. Understandably, the fluctuation in water quantities based on the climate variability[79] being a natural recurring cyclic phenomenon as it existed at the time of signing of Treaty and was factored in, I have a reason to argue here that how come an unforeseen phenomenon like climate change which causing uncertainty about the availability of water now, not known at the time of signing the Treaty, could have been incorporated.

The climate change phenomenon is revealing, so it must be incorporated to make it efficacious and sustainable. Like climate change, its impacts are also abnormal and uncertain. Similarly, its consequences are exceptional and extreme, like floods, drought, SMOG, aquifer depletion, GLOF and saline water intrusions into deltas etc. If these factors are not covered in transboundary agreements like IWT, there is no way to ward off disastrous socio-economic and environmental effects. Basic human needs and key social issues related to ecosystem integrity and economic development keep evolving, which can only be sustainably addressed if uncertainty about the availability of water is removed. The Indo-Pak scenario would only be possible if all related factors are aptly incorporated through climate-proofing IWT. The process will give due flexibility to the Treaty besides restoring its integral one, which are essentially required for its sustainability.

8.4.4 Diminishing Myth of IWT Success

About sixty years had passed when the IWT was signed. It was considered an achievement by all stakeholders. It rolled on the path of implementation well. The financing for replacement works started. The replacement works got a timely completed. The water apportionment got implemented. The data sharing started as laid out in the Treaty. India started constructing hydropower projects on western rivers, yet their volatile nature made those controversial. Resultantly the popularity and success of IWT began to slip into its waning mode. Over the period, based on existing voids and concerns by the stakeholders, the aspersions have started getting cast whether IWT will survive (Sinha et al., 2012) or is IWT being deviated (Mustafa, 2019) or has IWT become stagnant (Vishwanath, 2019). To stop the diminishing spree of the rapport of IWT as a success story, I argue that a question should be asked that what would have happened had the IWT been not in place? In answer to this question that both India and Pakistan would have been fighting over their shared water, lays the truth that IWT is binding both the countries not to fight over their waters.

[79] Climate variability is the change in climatic conditions due to the natural phenomenon as against the human induced changes cause climate change.

There is a need to visualize that if IWT did not work as it is now, particularly under the nuclear overhang, what kind of conflicts could emerge between Pakistan and India? IWT needs to be viewed while reflecting on the future. If correct visualization does not exist, then the success story of IWT will turn into mythology. The myth of success would start diminishing, which needs to be effectively checked. To that end, a cooperative, collaborative, and integrative approach would have resorted between both countries for utilizing IRB waters. Climate change is likely to further exacerbate the stresses over IRB water resource. Food and energy security need to be protected by protecting water security, which shall happen when IWT is climate-proofed so that its voids are amicably addressed. All those clauses related to the transboundary waters under the overhang of climate change need to be incorporated in the treaty for making it sustainable for future generations. The process will automatically align it with future technological dictates as well.

8.5 Climate-proofing IWT: Sustainability and Peace Building

Water is the basis of human life. It is finite and usually a shared resource. This precious gift is unevenly distributed by nature, yet it is even for sustainability and peace, and equitable allocation for utilization by the people is necessary. Inequitable distribution by people leads to conflict over its utilization. Transboundary water agreement acting as the institutional mechanism can amicably avoid conflicting situations between the riparian states if even equitable allocation for utilization by the people is aptly catered for. For making IWT sustainable, the well-established concept of Environmental Impact Assessment (EIA) needs to be incorporated as a basis for negotiations in the climate-proofing context, particularly concerning plans for new or modified infrastructure. The research objectives and main questions and queries thereof seek to explore the possibilities and propensities of visualizing climate change, its impacts and consequences and find spaces in IWT to incorporate related clauses and provisions applicable to transboundary waters for making it sustainable, thereby building peace in the region

8.5.1 Integration Leading to Synergy

The climate-proofing IWT will be done by integrating all relevant climate change adaptation practices applied by different countries on transboundary rivers, lakes, or aquifers basins. The main components of the contextual framework of climate-proofing shall include the feasibility of the concept, its applicability, the monitoring of its implementation and its sustainability. The feasibility encompassing the principles of basin adaptation with legal and institutional

frameworks having institutionalized approach shall be worked out for developing climate-proofing strategy. After having developed the feasibility, the concept's applicability shall be the next tier that would need shaping of the environment for implementation of the concept. In the process, the uncertainty will be reconciled, and the flexibility in the performance of interventions will become possible through monitoring and evaluation processes. The complete process shall be systematically dovetailed through collaborative, integrative, transparent, and participative interventions.

Climate-proofing of IWT would only be possible if both countries had the required capacity for deliberate planning, data and knowledge sharing, a collaboration between technical specialists and decision-makers, and clear communication amongst all stakeholders. The climate-proofing IWT is visualized to incorporate relevant clauses and provisions related to climate change for transboundary waters as an additional supplement to the existing document. IWT, after being climate-proofed, will grow internal flexibility to adapt to changing situations, particularly climate change since it is an evolving subject. IWT shall become a living document that shall grow with time. It will keep upgrading to remain aligned with its purpose. The process will develop trust amongst all stakeholders as effective communication, and data sharing will be done with institutions in place for enforcement, monitoring, evaluation and review of the Treaty. Since missing provisions related to water quantity with its dimensions like timings, intensity, frequency, duration, etc., water quality, environmental flows for Eastern Rivers and sub-surface water will be added to the Treaty, the voids and concerns will get automatically addressed. The aquifer, the ecology, the watershed and the cryosphere of the basin will be well covered with their wholesome management details. All scenarios shall be considered, wherein the water disputes can turn into conflicts to avert the possibility of war between India and Pakistan.

The climate change-induced risks and impacts will be reduced to the minimum possible level with climate-proofing. It will lead to conflict resolution institutionally if a difference in interpretation or implementation of the concept arises. It shall provide long-term sustainable solutions against climate change's political, economic, and social pressures. The climate-proofing concept shall integrate isolated or fragmented climate change adaptation practices applied by different countries in their respective transboundary water agreements, multiplying dividends and creating synergy in efforts and results. Impacts of climate change have been revealed vigorously, yet the scientific assessment and estimation with specificity are still at a level. Customized research about varying temperature and weather conditions needs to be conducted to establish their impact on water in IRB. These shall subsequently be translated into

water quantities when specific impacts are assessed. This level of customized research will only start when the concept of climate-proofing IWT is initiated and accepted principally. With all facets of IWT integrated through its climate-proofing, both countries' synergy of effort and resources will be a natural outcome.

8.5.2 Notional Acceptability by the Riparian States

It has been revealed through the course of research from literature review and the responses by around two dozen elite respondents that theoretically, the concept of climate-proofing IWT shall be acceptable to both countries. However, practically it seems that it will be difficult for both countries to mobilize towards climate-proofing IWT because climate-proofing, as found during the research, shall mean addressing all the voids existing in the Treaty readjustments in positions and allocations. Almost all the voids existing in the Treaty now relate to climate change, which means that it will be a complete review of the treaty under the umbrella of climate change, and modifications evolved thereof shall be added to the Treaty as an addendum or a supplement. If the acceptability is further judged at the riparian level, Pakistan being a lower riparian under more water-stressed conditions may be relatively easily ready to accept the concept and initiate the process.

Contrarily, India being upper riparian and at a comparatively better position with respect to water availability, will not be readily inclined to review the IWT even as the consequence of Anthropocene. In this situation, the onus of initiating the climate-proofing IWT will rest with Pakistan. Based on available research and evidence, which being generic in nature may not be satisfactory to reach conclusions yet is sufficient to enter customized objective-based sectoral research for climate-proofing IWT. For that purpose, Pakistan preparing the case, processing it through its own Foreign Office with its Indian counterpart and diplomatically taking it forward involving international players seems a plausible course of action. The issue floated as an agenda, and then keeping it there as a moot point for discussion has the possibility of realizing it in future. Without really fixing the outcome, the process needs to be initiated, which shall then be steered at all levels for the correct direction to the destination. The antagonism and intransigence prevailing between India and Pakistan need to be transformed into an opportunity by suitably projecting the necessity of climate-proofing IWT. Both the riparian states will accrue the benefits and incentives that are capitalizing on this opportunity will offer.

Efforts would have to be made to apply climate change-related knowledge to the IWT based on customized research pragmatically through a joint body comprising members from both the states and experts from the international community. This shall create an environment

for the acceptability by both the riparian states, which shall automatically get both the states mobilized. Climate-proofing may seem, on the face of it, an idealistic phrase, but when it enters the practical domain, its benefits will start revealing more vigorously when both the countries accept the concept for implementation in IRB. The sole purpose of climate-proofing is not re-crafting IWT to rationalize water distribution. Rather, the core objective of the effort would be to protect peace under new hydro-meteorological conditions. The central concept of delivering water with equity to riparian states under climate change should remain in focus at all times while undertaking the process of climate-proofing IWT; only then the prospect of acceptability has a better propensity to prevail.

From another perspective, climate-proofing IWT can create new opportunities for riparian states. The 'Transition Phase Model' of the 1960s could arguably even be replicated regarding the new dams being planned or constructed by India: Now, whilst they are being planned/built, joint commissions could work together to analyze how this could have positive effects, i.e. regulating the flows could mitigate floods and droughts on both sides of the border in the future. The existence of dams upstream could help compensate for the shrinking glaciers' function – as reservoirs or "buffers" for hydrological extremes. From a technical point of view, such solutions are most probably possible. As desired under Sustainable Development Goal (SDG)–15 relating to Climate Action, both countries would stand vindicated for pursuing international protocols in letter and spirit.

8.5.3 Concept Applicability: An Attribute of Cooperation Environment

An intimate relationship between water and national security cannot be denied. Besides food, livelihood, energy, and health, water is the leading component of human security. Likewise, human security is the foundation for national security. Based on the transitivity rule, each component of human security shall form a building block of national security. This shall translate and mean that water security upon which all other components of human security hinge shall be the foundation of national security. The research also confirms the conclusions established by the scientific research that water on earth is the most affected element by climate change so is the national security if shared water resource between the riparian states is not equitably allocated. The effort to control the shared water resource leads to competition and escalate the conflict between riparian states. Traditionally, Pakistan and India are embroiled in a host of disputes, with the Kashmir issue dominating the conflict scene. The Nuclearization of both the states has added severity to the hostile natured relationship between the countries.

Climate-proofing IWT is a challenge. It will need extraordinary efforts, particularly the advocacy and lobbying will be the hallmark of this process. All tentacles, including diplomatic, geopolitical and state organs, would have to be mobilized to convince riparian states for coming to negotiating table. International law experts, water resource experts, climatologists, and strategists, in short, all stakeholders would have to be brought into the loop. World players would have to be mobilized on the pretext of climate change so that pressure is built on both the countries to come for climate-proofing IWT.

The original 'Transition Phase' of the early stages of IWT is described as a comparatively constructive positive period by several witnesses. It was a temporary necessity and an obligation to make joint water management works. This situation with positive and constructive elements could be emulated in this 'New Transition Phase' into the Anthropocene era, arguably a permanent regime of transition.

8.6 Transboundary Water Management and Peace Nexus

Efficient water management of shared water resource is an effective platform to induce cooperation over larger political issues, ultimately settling conflicts. Contrarily inequitable water allocation breeds bilateral and regional conflicts on the one hand, and on the other hand, accentuating the existing conflicts. The underlying premise remains dominant that water can act as a catalyst to build peace and cooperation by thinning the air of conflicts. The negotiation process mainly shaped the perception of IWT being equitable and fair followed to reach its outcome and the political environment of cooperation that existed at the time of signing the Treaty and over three decades. The perception about the efficacy of IWT started drifting into negativity when the antagonistic environment between India and Pakistan started dominating.

The geo-political and hydro-political aspects of shared water resources in the context of bilateral and multilateral conflicts started contributing insights into geopolitics, political landscape, and environmental policies, thereby shaping the overall bilateral and regional environment. This has given birth to hydro-politics, which now seems a major hindrance in climate-proofing. On the other hand, water consumption is continually increasing. Population growth, industrialization, growing overuse and pollution, and the consequences of global warming result in increased pressure on the water resources. Water has become essential for the maintenance and development of the national economy. The overall standard of living has developed a close relationship with the national economic conditions that now dictate water usage and consumption. If access to water is limited due to overuse, pollution, or political factors, the societal standard of living may decline sharply, leading to considerable homegrown,

internal societal tensions. These tensions shall transform into conflicts between the parties, particularly when a solution is not visible insight. The degree of bilateral or regional geo-political and hydro-political tensions, particularly under climatic and hydrological conditions, influences the degree to which such water tensions are prone to conflict.

As a consequence of the Anthropocene, shared river basins will increase controversies in the coming years since both the riparian states often tend to disagree on water allocations. The ensuing water conflicts will involve both riparian states with differing and often vital national interests. Their interests would differ structurally and under territorial, economic, military, demographic and comparable determining factors depending upon their socio-cultural and socio-economic contexts. The efficient management of shared water resources by India and Pakistan will promise an in-built peace and stability as the conflicts would be mutually settled through institutionalized dispute resolution mechanisms. The prevailing transboundary water-sharing agreements between the states will create many opportunities.

Experiences from many parts of the world show which my research also endorses that adaptation to water demand by riparian states fosters cooperation, build trust, mutual confidence amongst states, and supports the processes of political and economic cooperation, sharing the benefits beyond the rivers and regional integration. This promising scenario is urgently required by India and Pakistan, which climate-proofing IWT can instantly afford. The research has demonstrated that nature, in this case, hydrology, cannot be overruled by 'technocratic' decisions: Now, in the 'new era' of the Anthropocene and climate change, rivalling neighboring countries all over the world are being pushed towards the adoption of a coordinated, holistic approach. A positive aspect is that this can be an unexpected catalyst for peace and reconciliation in the long term, as the parties will have no choice but to engage, talk, and find consensus. As a result of climate-proofing IWT, a Joint Thematic Working Group can be set up and given credible mandate continually thematizing different issues raised in the thesis and joint ways forward elaborated at a purely technical, scientific and administrative level free from the burden of political agendas.

8.7 Inspiration from International Water Laws

As thoroughly discussed in Chapter 2, three main organizations at the global level have prepared a set of rules and regulations to regulate international waters, i.e. The IIL, the ILA and ILC. IIL and ILA are scholarly non-governmental organizations, whereas ILC belongs to United Nations. IIL revolves around not causing significant harm to lower riparian while applying the right of water utilization. ILA has framed Helsinki Rules, which establishes the

principle of 'reasonable and equitable utilization as a fundamental principle of international waters law. The factors considered by the Helsinki Rules revolve around the geography and hydrology of the basin. The climate affecting water utilization has been made part of these factors. Moreover, the socio-economic relationship concerning the population has also been well considered in ILA's work. The probability of harm or damage avoidance to other co-basin states while applying the right of water utilization is an important aspect that has been deliberated by Helsinki Rules, same has great relevance to IWT.

The set of rules given by ILC about ensuring the utilization, development, conservation, management, and protection of shared watercourses has an apt relevance to IWT. Like Helsinki Rules, the principle of reasonable and equitable utilization of shared water resources as the leading principle adopted by ILC has also become a popular feature for managing shared waters under the umbrella of cooperation. ILC also considers the rule of determining reasonable and equitable water utilization as has been done in Helsinki Rules. ILC also focuses on the principles of not causing significant harm to other riparian states while utilizing its water and advocates appropriate measures by the watercourse states for preventing damage and harm to co-basin states. There are two basic principles around which the work of these three expert organizations revolve. The first one is the principle of reasonable and equitable utilization of water and the second one is not to cause harm to other riparian states while utilizing its water. Since these organizations got established after signing IWT and the work they have done has not been included in the IWT, as was the climate change solely for the reason of not existing at that point when the Treaty was being crafted. So, there is a requirement that when IWT is climate-proofed, the work by these organizations should also be incorporated into the Treaty.

It is worth mentioning that in Helsinki Rules and UN Watercourse Convention, the basic principle of 'obligation not to cause harm' was placed after the 'reasonable and equitable utilization' principle, but the position changed when Helsinki Rules got upgraded to Berlin Rules, the latest one. The most significant aspect where Berlin Rules differ from Helsinki Rules and UN Watercourse Convention is establishing the relationship of two basic principles of international waters law that relate to 'obligation not to cause harm'. In Berlin Rules, this status has been altered the other way round. The Helsinki Rules and UN Watercourse Convention establish and emphasize equal rights of each riparian state to reasonable and equitable utilization. On the other hand, Berlin Rules emphasize managing the shared water resource on a reasonable and equitable utilization basis. The Berlin Rules address the significant harm aspect while managing the international waters. Berlin Rules refrain from and prevent acts or omissions within their territory that cause significant harm to co-basin states having due regard

for the right of each riparian state to make reasonable and equitable use of the waters. Climate-proofing needs to incorporate these assertions suitably for making IWT comprehensive, sustainable and an instrument of peace building in South Asia.

8.8 Political Re-Orientation

As the global temperature rises, HKH glaciers are melting, with a high degree of uncertainty IRB rivers are either flooding or getting dry, the water is getting scarce, becoming a potential flashpoint and a source of tension between nuclear-armed rival India and Pakistan. Both the countries have concerns about IWT, which are being exacerbated by the phenomenon of climate change. In South Asia, geopolitics dictates hydro-politics. Both cannot divorce each other. In the Indo-Pak scenario, both must learn to live together as a matter of fate. Neither the neighbors would change nor would change the source of water. The only variable which both counties have in managing transboundary waters is politics, i.e. both geo-politics and hydro-politics. This they can and should, in India and Pakistan, it is easier said than done.

Both countries have historical baggage. Just one year after the partition, they fought their first war in 1948, which besides the Kashmir war, it was the water war since the water dispute had surfaced right after the partition. The second war they again fought in 1965 also revolved around the Kashmir issue. The third war they fought in 1971 was linked to erstwhile East Pakistan, yet its spillover embroiled Kashmir again. After having attained the status of nuclear power, the last war they fought on Kargil in 1998 was also linked to Kashmir. My research concludes that the common factor in all Indo–Pak wars is the Kashmir issue. Kashmir is the core issue between Pakistan and India. Till the time the Kashmir issue is resolved, all the other problems, including water issues, will keep simmering without any resolution, rather would get intensified. The politics of realism in the face of climate change would not work but rather be counterproductive. Water is, of course, a traditional source of conflict under the politics of realism, which will drag both the countries to another war, a war between two nuclear-armed states, fighting with each other with third nuclear power China sitting on their borders this the world cannot afford.

Tensions over water will undoubtedly intensify in future. It will put IWT under immense pressure. In the quagmire of realpolitik, the leadership of both the countries would have to show pragmatism and sagacity to introduce the politics of liberalism for managing shared waters. With this political re-orientation towards liberalism, the non-traditional conflict resolution will become the hallmark of hydro-politics, which exists as an instrument of cooperation in the form of IWT, which needs to be further capitalized. If IWT would be climate-proofed, it would further

enhance cooperation by integrating segmented climate change adaptation practices. This will resultantly bring synergy into the efforts of both the states for managing IRB waters. This will make IWT sustainable for coming generations while ensuring peace and stability in South Asia and the world in general. All three objectives of this research shall stand realized if political re-orientation as suggested gets actualized.

CHAPTER: 9
CONCLUSION:
A PRECURSOR TO CLIMATE-PROOFING IWT

In this thesis, I sought to identify that IWT was signed in 1960 when the phenomenon of climate change was not visualized and acknowledged as it is now. The climate change impacts, therefore, could not be factored in IWT. These impacts are revealing now, particularly on transboundary waters. To make IWT sustainable, there is a need for all clauses and provisions related to climate change applicable to transboundary waters to be incorporated for making it a climate-proof protocol. Before I present the key findings, I shall revisit the predicament which motivated this research. During my literature review for proposing the topic of my PhD research, I discovered no treaty or agreement related to transboundary waters that have been climate-proofed yet. This fact inspired me to voyage the world of unknown realities of climate-proofing a treaty, the outcome of which I anticipated with confidence shall contribute new knowledge to the world for nurturing peace and stability in managing the shared waters for coming generations as the consequence of Anthropocene.

I based my research on three underlying assumptions. Firstly, climate change is adversely impacting freshwater resource. Secondly, variability in the transboundary water resource can lead to conflicts. Thirdly, the climate-proofing IWT will prove an instrumental means to ensure equitable and reasonable water utilization, thereby forestalling the conversion of conciliatory mode into a confrontational one between India and Pakistan. To proceed, I framed three research objectives: analyzing IWT, assessing how climate-proofed IWT will prevent or mitigate water conflicts, and envisioning how climate-proof IWT will make it a sustainable protocol. To achieve the research objectives, I constructed three research questions.

Firstly, how is climate change impacting the water resource of IRB? Secondly, what consequences does the impact of climate change have on transboundary waters? Thirdly how will climate-proofing of IWT be done? The research questions translated into research queries helped develop data reservoirs from the literature and the elite interview respondents to achieve the research objectives. I intend to outline key findings in succeeding paragraphs in a manner that, first of all, the image about climate change, its impacts and the consequences is speckled, which shall be followed by the available spaces in IWT for filling up the contours of climate-

proofing before I carve the way forward for further course of action by the researchers and the policymakers.

Climate change, a phenomenon prompted by human-induced global warming activities, is undeniably reckoned with and acknowledged global reality. It is consistently impacting every walk of life in every region at all times. With its geographical setting, Pakistan is highly vulnerable to climate change. During the last century, its average annual temperature has increased, rainfall during strong El Niño events decreased, and the mean SLR per year was experienced. The projected climate trend shows a sharp increase in average temperature, large inter-annual variability in the rainfall and a huge rise in mean SLR. The temperature rise is expected to disturb the weather systems and melt the glaciers faster, precipitation uncertainty will make rainwater availability unpredictable, and the increase in SLR will engulf the usable land into the seas.

The impacts of climate change are wide-ranging. More revealing and alarmingly visible impacts are being experienced on the water, agriculture, livestock, forestry, coastal areas, and environment. Due to the climate change phenomenon, water availability has become uncertain. More water will be available when less is required, and less will be available when more is required. Water demand has increased due to socio-economic development and increased population. Besides exerting pressure on uncertain water availability, this shall also exert a pull-on sustainable development. Since all sources of fresh water, i.e. glaciers, snow, rainfall, and aquifer, are being impacted by climate change, the variability in water quantity will result in compromised quality of life, bringing mental and physical discomfort to the people.

Agriculture is the next sector impacted by climate change. Agriculture depends on water and temperature, both of which have been disturbed due to climate change. Agriculture is the key economic sector contributing almost one-fifth of the GDP, absorbing over one-third of the country's workforce and forming nearly two-thirds of the export when affected by climate change will affect the national economy. Agricultural productivity will decrease with the rise in temperature and uncertainty about water availability. As livestock is also linked with agriculture, climate change will affect it. The livestock contributes around two-thirds of the agriculture, over one-tenth of the GDP, and though a small yet essential part of the export when affected by climate change, will disturb national social, economic, and environmental equations. Economic damages and losses due to persistent flooding and drought-like conditions prevailing due to uncertainty of water availability will accentuate the impacts.

Climate change has adversely impacted forest cover in Pakistan. Deforestation is taking place at an exorbitantly high rate which has increased the risk of landslide, slope

destabilization, flooding, increased surface runoff and soil erosion. Forests are carbon sinks; with reduced forest cover, the GHG will not get sunk but would complement the temperature rise, thereby aggravating climate change. Coastal mangrove forest cover is also reducing. Forests provide a livelihood to millions of people; its reduction will have serious socio-economic implications. Factors like sea-level rise, changes in temperature and precipitation, and increasing frequency and intensity of extreme events will severely affect the forests, threatening the country's biodiversity and soil quality. Coastal areas are yet another field that climate change has impacted. The impacts of climate change on coastal areas are revealed in the form of inundation of low-lying areas, degradation of mangrove forests, declining drinking water quality, and decreased fish and shrimp productivity. Climate change also impacts the environment of Pakistan. Leading environmental issues emanating from climate change impacts like air pollution, inadequate supply of uncontaminated drinking water, noise pollution, and the health deterioration of urban and rural populations will seriously threaten the sustainability of the country's socio-economic conditions. Increased industrialization, urbanization, motorization as the consequence of the Anthropocene will further worsen the environment and eco-system of the country. The ecology of the country is in the process of transition since the water requirement of the ecological system had not been catered for in IWT, which is getting exacerbated. The harms due to climate change are not restricted to humans alone, rather, the ecology, biodiversity and livability have also been disturbed.

There will be a host of socio-economic and environmental consequences flowing from the corresponding impacts of climate change. The implications of the effect of climate change will reveal in the domain of water, food, energy, disasters, ecology, and health, thereby creating insecurities and challenges. Water insecurity will be the immediate and most serious consequence of climate change. Growing demand will apply further compression on declining water availability. The water scarcity on the brink of Pakistan will worsen, and the most serious climate risk posed to Pakistan is climate change. Food security is the following consequence which impact of climate change on water, agriculture, livestock, and forest will yield. The availability of the basic food elements i.e., grain and meat will be compromised under climate change impacts that create food security conditions.

Extreme events like floods, drought, cyclones, heat waves, and GLOFs will also pose a risk for food security, leading to social disorder at the time of occurrence under disaster conditions. Energy Security is yet another consequence Pakistan shall face due to climate change. On one side, the energy sector with high GHG emissions is the leading contributor to climate change, and on the other hand, it is also sensitive to its impacts. The recession of HKH

glaciers being the largest source of freshwater supply threatens regular availability of water which is essentially required for power generation. In the long run, this reduction in water availability will deprive the country of hydropower generation, consequently pushing it to energy security. The energy crisis will adversely affect the GDP in terms of productivity loss.

The following serious consequence that Pakistan has started experiencing is hydro-meteorological disasters. Pakistan suffers from extreme weather events, including floods, drought, GLOF, avalanches, landslides, heat waves, storm surges, cyclone, sea intrusion and SMOG. These hazards are impacting socio-economically and environmentally. Recurrent spells of hydro-meteorological disasters in the past two decades have caused the phenomenal economic loss. The next consequence which the country shall suffer relates to the health challenges. Both environmental and social determinants of health are affected by climate change. Availability of safe drinking water, clean air, sufficient food, and secure shelter is compromised during hydro-meteorological events such as flood, drought, heatwaves, and variable rainfall patterns, leading to health challenges. The ecological disorder is yet another consequence that Pakistan shall face Anthropocene's consequence. All the eco-systems like glacial-eco-system, desert eco-system, grassland eco-system, aquatic eco-system, marine eco-system, forest eco-system, agro-eco-system, human eco-system, and urban ecosystem will be vulnerable to climate change. The ecological disorder will disturb the flow of energy in the water, carbon, oxygen, nitrogen, and energy cycle, leading to the disintegration of existing eco-systems essentially required to support the life cycle of humans, animals, plants, and micro-organisms.

After having given summarized findings of climate change, its impacts and consequences, the main findings of IWT will now be outlined. IWT, a comprehensive document prepared by the collaborative effort, has lived as water-sharing protocol for 60 years over turbulent times and has survived, albeit reaching the present quasi functional stage, particularly on data sharing. The Treaty outlines principles that specify the jurisdictions of both the countries on different sets of rivers in western and eastern halves and defines both the states' rights and obligations while sharing the water. The most powerful message is given in Article VII, which reflects that both the parties recognize that they have a common interest in the optimum development of the Rivers. To that end, they declare their intention to cooperate by mutual agreement to the fullest possible extent, for which Article VIII specifies the instrument of cooperation through the establishment of the Permanent Indus Commission. The missing contents or the voids as felt by Pakistan, as the consequence of Anthropocene, include division of rivers for distribution of waters, absence of environmental flow in eastern rivers, absence of

provisions to adjust declining and uncertain water availability, sustaining irrigated agriculture alternate arrangement of transferring water from west to east posing permanent economic burden, absence of specific provisions regarding water quality which is being impacted with industrial, agriculture and municipal wastes.

Furthermore, the treaty has no provision to address this climatic risk. There is no mention of groundwater which is being over-extracted disturbing hydro balance in adjoining areas. The Treaty does not have any clause that shall give a mechanism to prevent and mitigate the effects of hydro-metrological hazards. There is no provision regarding maintenance and preservation of catchment areas and watersheds of IRB. Provision regarding timely data sharing for future hydropower projects essentially required to know whether projects are in line with the treaty or not is yet another void. Interpreting hydropower related clauses in the Treaty for water storages on western rivers with fixing no limit of such projects for India is yet another lacuna with serious implications for Pakistan. Lastly, no joint body oversees the treaty's interpretation, implementation, and execution for monitoring, evaluating, and reviewing for subsequent correction to increase its life for sustainability. These voids shall be addressed in the process of climate-proofing without disturbing the main structure and content of the Treaty rather than adding it as a supplement or addendum.

IWT continued smooth functioning till the end 1990s, when the race for more profitable water utilization under the burgeoning psycho-socio-economic pressures started. The climate change further exacerbated the cleavages and fault lines, and water concerns of both the countries, particularly Pakistan, more significantly started appearing on the surface. The concerns of the parties primarily relate to the concept followed in IWT for water sharing, interpretation of the clauses, the implementation of Treaty, the impact of water division formula adopted in the treaty and fluctuating availability of water vis-à-vis its demand. Pakistan's concerns relating to IWT fall under physical, social, economic, climatic, environmental, military, disaster management, data sharing and technical domains. Whereas concerns by India are different in tone and tenor as their status as riparian is different from Pakistan. Indian concerns about IWT relate to the division of water by the Treaty, declining water availability, need for hydropower generation, Pakistan attitude towards India and water utilization, depleting aquifer, climate change and rebuttals to accusations by Pakistan. Out of all the concerns regarding IWT, the impact of climate change on the freshwater resource is the dominant common concern of both the countries with which a host of other concerns are further related. When all factors related to climate change are incorporated in IWT in the process of climate-proofing, all the concerns of both countries will stand addressed automatically. The

strong possibilities exist that the concept's incentives will be tempting for both countries to adopt.

With regards to climate-proofing IWT, the findings are charted here. With water coming under intense pressure, the competition between the countries will get intensified for controlling water to their advantage. At this point, IWT will play a leading role in providing direction to both the states to remain within the bounds by following the rules laid down in the Treaty. Now, if the common concerns and voids would not have been addressed, then this instrument of cooperation will turn into an instrument of conflict. It is better for both Pakistan and India that following a proactive approach, the consensus is developed on common concerns and voids, and these shall be addressed by undertaking the process of climate-proofing IWT. For complex transboundary water agreements like IWT where bilateral monitoring and implementation mechanisms are not very effective, a mutually consented external body for monitoring, data acquisition and subsequently information and data sharing to all stakeholders shall be essentially required (and monitoring and research shall be intimately linked). Technologies-based research and monitoring are the essences of acquiring correct information and knowledge for IWT.

The strength of an agreement lies in its implementation. The joint institution plays a vital role in implementing a transboundary agreement, particularly, under fluid conditions. For evolving conceptual framework for policies and interventions for many climate change adaptation practices, the foundational knowledge of existing IWRM shall be followed. The Climate-proofing process shall be systematically organized through collaborative, integrative, transparent, and participative measures. Vital capacity for climate-proofing should be developed through deliberate planning, data and knowledge sharing, the collaboration between technical specialists and decision-makers, and clear communication amongst all stakeholders. The success of IWT would lie in its flexibility to adapt to changing situations. Since climate change is an evolving subject, our shared document should also be living in the present time. The most important aspect of IWT is to inherit the trust within stakeholders, which will be only possible through effective communication, sharing of data, and joining institutions for enforcement, monitoring, evaluation, and review.

In the process of climate-proofing, the missing provisions related to water quantity with its dimensions like timings, intensity, frequency, duration etc., water quality, environmental flows for Eastern Rivers and sub-surface water will be added to the Treaty. Under climate-proofing, the aquifer, the ecology, the watershed, the cryosphere of the basin will also be included in the Treaty. With climate-proofing done, the eventuality of climate change turning

into a threat of war will be obviated. Integrated water resources management, water efficiency and local practices will be the hallmark of IWT. The voids existing in IWT will be well covered. Climate-proofing IWT will not be an end: rather it will be a means to bring flexibility. It shall keep away from a conflicting situation between the riparian states and lead to conflict resolution institutionally. The concept will lead to the synergy of effort and outcome. With evidence of climate change impacting water resources growing stronger and the vulnerability rising in the Indus Basin, a case for climate-proofing the basin vis-a-vis Indus Waters Treaty makes sense hydrologically.

Climate-proofing IWT will lead to regional stability. Both India and Pakistan will become climate-friendly nations for which they can take credit. The long-standing water issues between the two countries will get resolved. Both countries will be the beneficiaries. There will be an interface between policy and technology; both will gain. Both countries will live together in peace. The problem will be fixed through Treaty and not war. For climate-proofing IWT, an applicable environment would have to be created by relegating geopolitics to lower notch and bringing the hydrology with its actual perspective in focus for seeking a solution to water issues lingering between both the states for years. Both Pakistan and India are now not able to negotiate climate-proofing IWT. Both at the political and technical levels are at odds. The technical aspect has gone subservient to politics. Political momentum is essentially required to mobilize both countries towards focusing IWT for climate-proofing. Equitable allocation in shared water resource is a source of cooperation and progression.

On the other hand, unfair and unjust water allocation leads to bilateral and regional instability. Both India and Pakistan have an antagonistic background. The underlying premise is that water can act as a catalyst to build peace and stability between countries and regions. Climate-proof IWT shall become an instrument of peace building in South Asia, and the synergies created thereof, particularly concerning flood risk management and drought prevention, can look after the national interests of both states. Climate-proofing IWT, besides all the advantages it would accrue between India and Pakistan, shall also give a lead for crafting a treaty for Kabul River between Afghanistan and Pakistan duly incorporating all provisions and clauses relating to transboundary waters under Anthropocene environment.

Finally, I intend to propose a few recommendations with political, institutional, diplomatic, technical, legal, and academic dimensions for policymakers and subsequent researchers[80]. Water is a national security issue as its abundance and scarcity can lead to hydro-

[80] It is a way forward recommended for initiating the process of climate-proofing.

meteorological disasters, and its shortage can lead the country to food, energy, and health security challenges. The foremost factor besides initiating the process of climate-proofing IWT, Pakistan would have to ensure that its available water is optimally utilized by fair distribution and effectively conserved by building storage capacity at the national level. In climate-proofing IWT, water and climate change, two major national sectors must be integrated at a conceptual level. The concept of climate-proofing will entail review, modification, or amendment in IWT, so it would have to be dealt with by political leadership. As a way forward, it is recommended that a central body comprising secretaries from MoCC, MoWR, MoL, MoFA, MoST and Academia be formed, which should evolve the climate-proofing framework for IWT. PIWC, as part of MoWR and being the custodian of IWT, shall act as the secretariat for this purpose. MoWR should process the case as lead stakeholder and, after due approval by the prime minister, should be handed over to MoFA for further processing with Indian MoFA. A copy of the case should also be sent to the World Bank and UNSC.

IWT enjoys a global reputation for its philosophy, conception, and efficaciousness. IWT is referred to as a role model for states to emulate. Apparently, climate-proofing IWT is a bilateral issue between India and Pakistan; as a matter of fact, it is not. Instead, it is an international issue. Besides World Bank, the stakeholders are all those countries that financially contributed to replacement works. All those countries which have adapted to climate change and upgraded their agreements on shared waters are also the associate stakeholders who can contribute with rich knowledge resources for climate-proofing IWT. Under MoFA, the diplomatic effort should be launched across like-minded and influential countries to facilitate climate-proofing. There is a host of technical disciplines involved in climate-proofing IWT. These disciplines include hydrology, climatology, glaciology, morphology, ecology, geology, GIS & RS etc. Knowledge of all these technical disciplines must be integrated. To that end, MoCC should formulate a committee that should bring experts from all nooks and corners under one roof through seminars and workshops for evolving responses for climate-proofing IWT at conceptual, processing and crafting levels.

Moreover, IWT is a legal document that international law experts can only deal with. Each word and phrase of the Treaty has a meaning. Each Clause, Act and Annexure have a context. To understand present contents correctly and propose new contents for climate-proofing would require a colossal effort by international experts to work out and evolve the document. Parallel to the technical committee, a legal committee under MoL in collaboration with MoWR should also be formed to evolve required responses. Subsequently, the knowledge created by both technical and legal committees should be integrated to form part of the national

response. Lastly, this research had limitations in terms of scope and objectives. This research revolved around conceptual framework only. This needs to be further expanded vertically and horizontally. To that end, HEC and PCRWR should assign the responsibility to related universities to research different themes, sectors, and geographical settings to evolve recommendations for the climate-proofing IWT process. The future research by using GIS & RS techniques and knowledge should include areas relating to 'Law for legal options', 'Climate Change Impacts and Consequences with particular focus on water, food, energy and health securities', ' Water resource with its hydrology', 'Glacial fluctuation and melting', 'Environmental flows', 'Subsurface water and aquifer', 'Watershed preservation', 'Water pollution', 'Dam Construction', 'SMOF', and 'Agriculture related to water consumption by efficient farming techniques'.

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Annexure A

Consistency and Reliability Index					
No.	**Respondents**	**Key Questions**			
		Is Climate Change Real?	**Is Water impacted by Climate Change?**	**Should IWT be climate-proofed?**	**Will India agree to climate-proofing IWT?**
1	Mirza Asif Beg Commissioner Indus Water Commission, Lahore	Still a generalized phenomenon	Not clear yet	Would have to be seen from both sides	Depends what benefits India will draw from this intervention
2	Mr. Abdul Rasheed, Director Climate Data Processing Centre Karachi	Yes	Yes	Yes	India will only agree if they will draw benefits from it
3	Dr. Ghulam Rasul DG Pakistan Meteorological Department (PMD)	Yes	Yes	Yes	India should agree for benefits of own people
4	Mr. Irfan Tariq DG Environment, Ministry of Climate Change	Yes	Yes	Yes	Political environment between both Pakistan and India doesn't support such intervention
5	Mr. Mehr Ali Shah Joint Secretary, Ministry of Water, Islamabad	Yes	I don't see any visible impact	Yes	Since India is likely to draw any benefits from this process so they will not agree
6	Dr. Tariq Banuri Exec Dir Global Change Impact Study Centre, Islamabad	Yes	Yes	Yes	Not outrightly. Yes, if there are peace dividends, then this concept may be accepted by India, otherwise no.

7	Dr. Tariq Altaf VP Water Resource Division NESPAK, Lahore	Yes	Yes	Yes. Not as a result of re-negotiation rather by adding an additional protocol	It will be very difficult to convince Indians to re-negotiate IWT
8	Engr. Shams ul Mulk Ex Chairman WAPDA	Yes	Yes	Yes	India should agree if the sense prevails
9	Dr. Zaigham Habib Ex Member Climate Change Task Force	Yes	Yes	Yes, when impacts of climate change on IWT are scientifically clear	It will be very difficult to bring India on negotiating table
10	Dr. Muhammad Faisal DG South Asia Ministry of Foreign Affairs	Yes	Yes	Yes	India may not agree to re-negotiating IWT for climate change alone
11	Dr. Qamar Zaman – EX DG PMD and Ex VP WMO	Yes	Yes	Yes	It is difficult to predict their behaviour, their professionals know its significance
12	Shafqat Kaka Khel, Ambassador Retd.	Yes	Yes	Yes, though it is an idealistic concept	India will not re-negotiate IWT
13	Sayed Abu Ahmad Akif, Secretary Ministry of Climate Change	Yes	Yes	Yes	India will not accept it instantly. Lot of effort would have to be done for that purpose.
14	Ahmad Kamal, Chairman Federal Flood Commission	Yes	Yes	Yes	No. Not as of now. In Future, may be possible
15	Mr. Mushahidullah, Minister for Climate Change	Yes	Yes	Yes	We should initiate the process, then see what happens

16	Barrister Ahmar Bilal Soofi	Yes	Yes	Yes, through an additional protocol	It is difficult but not impossible
17	Dr. Chung Kyo Park, Dir Asia Region WMO Geneva	Yes	Yes	Yes	No comments
18	Gen Muzammil (Retd.) Chairman WAPDA	Yes	Yes	Yes, without fiddling with the treaty	Difficult, but Pakistan should prepare for it
19	Prof. Dr. Ing Martin Grambow, Germany	Yes	Yes	Yes, with out touching original treaty, innovative and alternate options be explored	I don't know exactly when India would agree. I would rather ask, will Pakistan agree.
20	Justice Jawad Hassan, Lahore High Court	Yes	Yes	Yes, without changing the treaty, required content be separately added.	No, not an easy job
21	Dr Uttam Sinah, Security and Defence Analyst New Delhi India	Yes	Yes	Yes	It is far reaching achievement if it was to happen.
22	Amb Khalid Mehmood, Chairman ISSI	Yes	Yes	Yes	Not really possible to predict
23	Amb Aizaz Chouhdary, DG ISSI	Yes	Yes	Yes	Seems difficult
24	Dr. Muhammad Ashraf, Chairman PCRWR	Yes	Yes	Yes	Not in present environment
	Yes	96%	92%	96%	0%
	No	0%	0%	0%	8%

	Other Opinion (Doesn't seem likely)	4%	8%	4%	92%