IMPACT OF CLIMATE CHANGE ON PAKISTAN IRRIGATION WATER SUPPLY

By

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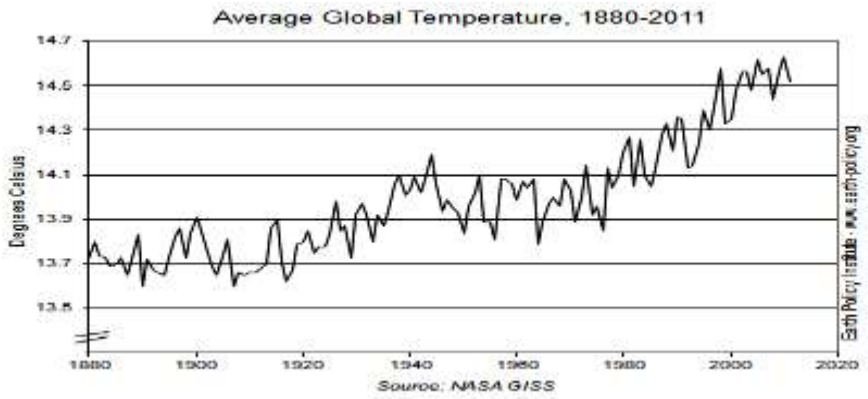
Abstract
Pakistan is GOD gifted with precious water resources. River Indus and its tributaries fulfill the consumptive water use for agriculture in Pakistan. Agriculture is the major industry of Pakistan and often refereed as a back bone of Pakistan economy. A sophisticated and an efficient Irrigation System was developed in Indus basin by the British during late 19th and early 20th century. Nineteen Irrigation Barrages have been constructed on major rivers i.e. Indus, Jahlum, Chanab, Ravi and Sutlej to feed an elaborate canals network. Major source of these rivers are Himalayan glaciers and monsoon rain fall. Both the sources are very sensitive to climate change. Projected recession of Himalayan Glaciers indicates the likelihood of their disappearing or significant reduction in the mid of this century. In mountains global warming triggers more rain than snow and causes flash flooding. Global warming is also a reason of frequent occurrences of extreme events like floods, drought, hurricanes etc. Pakistan is amongst the countries to which the effect of climate changes is expected to be severe. Major water resource of Pakistan i.e. River Indus and its tributaries heavily rely on melting of glaciers and monsoon rain fall. It is anticipated that any noticeable climatic change could adversely affect a century old Irrigation System of Pakistan and cause havoc in the region. As a famous proverb goes "Nature respects those who respect nature".

Key words: *Climate Change, Global Warming, Greenhouse Gases, Ozone Layer Depletion, Water Resources, Pakistan Irrigation system, Indus Basin.*

Introduction

Climate is an average weather condition of a particular area over a longer period of time. Today climate change is considered to be the most imminent global threat. *Global Climate Change is the most difficult and dangerous environmental problem humans have ever created (UNFCCC)*. Climatic parameters including rainfall/precipitation, wind flow, sunshine, humidity and average temperature are interlinked, variation in one parameter disturbs the other parameters of the climate. Increase in average temperature of the world is often referred to "Global Warming". Each of the last three decades has been warmer at the Earth's surface than the preceding decade since 1850(1). It is estimated that during the last three decades i.e. from 1980 to 2010 the increase of global mean temperature is 0.3 ^{o}C per decade (1) and an average rate of global mean sea level rise to about 6cm per decade mainly due to thermal expansion of the oceans and the melting of glaciers from 1961 to 1990 (1). The variation in global average temperature is indicated in Figure-1.

Figure-1 :



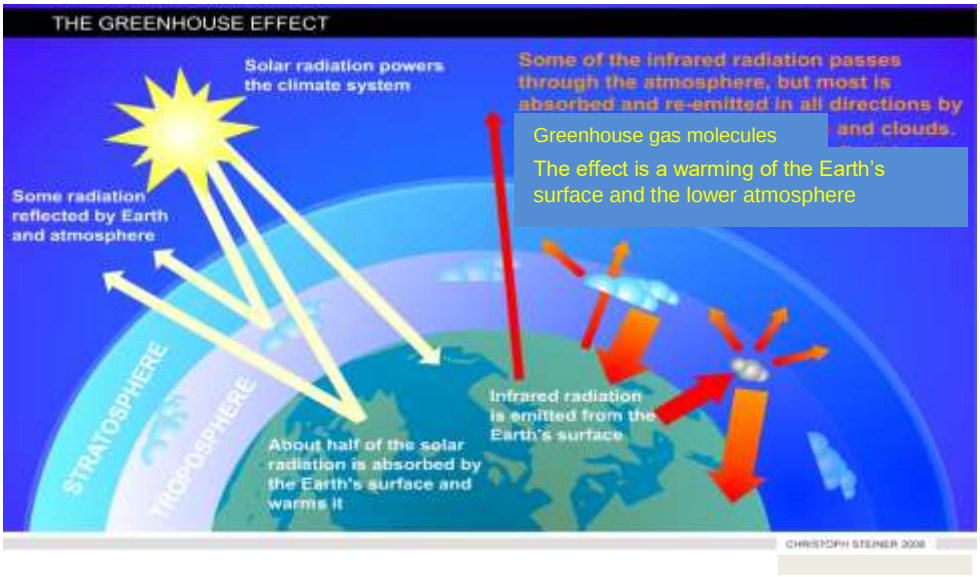
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Sunlight and emission of Greenhouse Gases (GHGs) at the Earth's troposphere are the two main reasons of Global warming. Sun emits all sort of lights including Ultraviolet rays, visible light and infrared rays. Ozone layer in the stratosphere atmosphere protects earth from Ultraviolet or UV rays emitted from sun. UV light has more energy than radio, infrared or visible light. The UV spectrum is broken down into three regions of wave length, called UV-A, UV-B and UV-C. UV-A covers from 400 to 320 nanometers; UV-B works down to 280 nanometers; UV-C contains the remainder from 280 to 100 nanometers. It is estimated that ozone layer in the stratosphere of earth stopped 99% of UV-C (the most harmful UV rays), 90% of UV-B (the remaining 10% escape is big factor in inducing sunburns and triggering skin cancer) and 50% of UV-A (2). Man made chlorine's products, primarily Chlorofluorocarbons (CFCs), contribute to the thinning of ozone layer in the stratosphere and allow larger quantities of harmful and high energy ultraviolet rays to reach the earth.

GHG in the troposphere of earth absorbs and emits radiation within the thermal infrared range. The major GHGs include water vapors, Carbon dioxide (CO_2), Methane (CH_4), Nitrous Oxide (NO_x) and ozone. Greenhouse gases trap heat in the atmosphere and consequently raise the temperature of the Earth. The whole action is demonstrated in Figure-2.

Figure-2:



Impacts of Global Warming on Water Resources

The possible impacts of Global warming include adverse effects on agriculture, sea level rise, water resources, troposphere ozone air pollution, hurricane damages, impact on human health and loss of life, forest loss, species loss and increased electricity requirement. Global warming deteriorating water resources in a number of ways including impacts on water cycle and water demand, water supply and its quality and impacts of changes in water resources in other sectors. Warmer temperatures increase the rate of evaporation of water into the atmosphere, in effect increasing the atmosphere's capacity to hold water. Increased evaporation may dry out some areas and fall as excess precipitation on other areas. Less snowpack in the mountains and earlier snowmelt mean that less water will likely be available during the summer months when demand is the highest. Heavy rainfall put extra burden on sewer system and water treatment plants. Also heavy downpour raise the runoff into the rivers and lakes, washing sediment, nutrients, pollutants, trash, animal waste and other material into the water supply. Similarly sea level rise may contaminate the fresh groundwater source along the coast. Because saltwater has a higher mineral content than freshwater, it is denser and has higher water pressure. As a result, saltwater push inland beneath the freshwater sources and deteriorate the freshwater resources along the coast. In this respect the unfavorable climatic conditions could be devastating for the low-lying coastal countries also known as Small Island Developing States (SIDS).

Impacts on SIDS

SIDS are located among the most vulnerable regions in the world in relation to the intensity and frequency of natural and environmental disasters. Of the 25 countries that suffered the greatest number of natural disasters during the 1970s and 1980s, 13 were small island developing states (3). Forty one SIDS are currently parties to the United Nations Framework Convention on Climate Change (UNFCCC). An estimated fifty million people live in SIDS (4). These states share similar sustainable development, challenges, including small but growing population, limited resources, remoteness, susceptibility to the natural disasters and fragile environment. Sea level rise and increased ocean temperatures will have a substantial impact on the major nurseries of the fishing industry, such as mangroves and sea grass beds. Antigua and Barbuda is currently losing its mangroves forest at an annual average rate of about 1.5 to 2 percent with a sea level rise 3 to 4 millimeters a year (4). The long-term effects of sea level rising may threaten the very existence of some small island developing states (5). Change in precipitation is likely to changes in altitudinal zonation, species type, vegetation type and location. This could be devastating to the banana industry and to the agriculture sector as a whole in SIDS.

Impact on Water Resources of Pakistan

The understanding of substantial adverse impact on Pakistan's environment due to climate change has been raised a number of times in international and national gatherings on climate change issue. Pakistan is amongst the countries which will be affected most by climate change even though it contributes only a fraction to global warming; this was revealed in the Regional Conference on Climate Change Challenges and Opportunities for South Asia held in Islamabad on 13th January 2009. Similarly on 8th October, 2013, in the seminar on Climate Change Repercussions fifth IPCC Assessment Report organized by Sustainable Development Policy Institute (SDPI), Experts were unanimous that Pakistan is one of the most effected countries as far as the climate change is concerned.

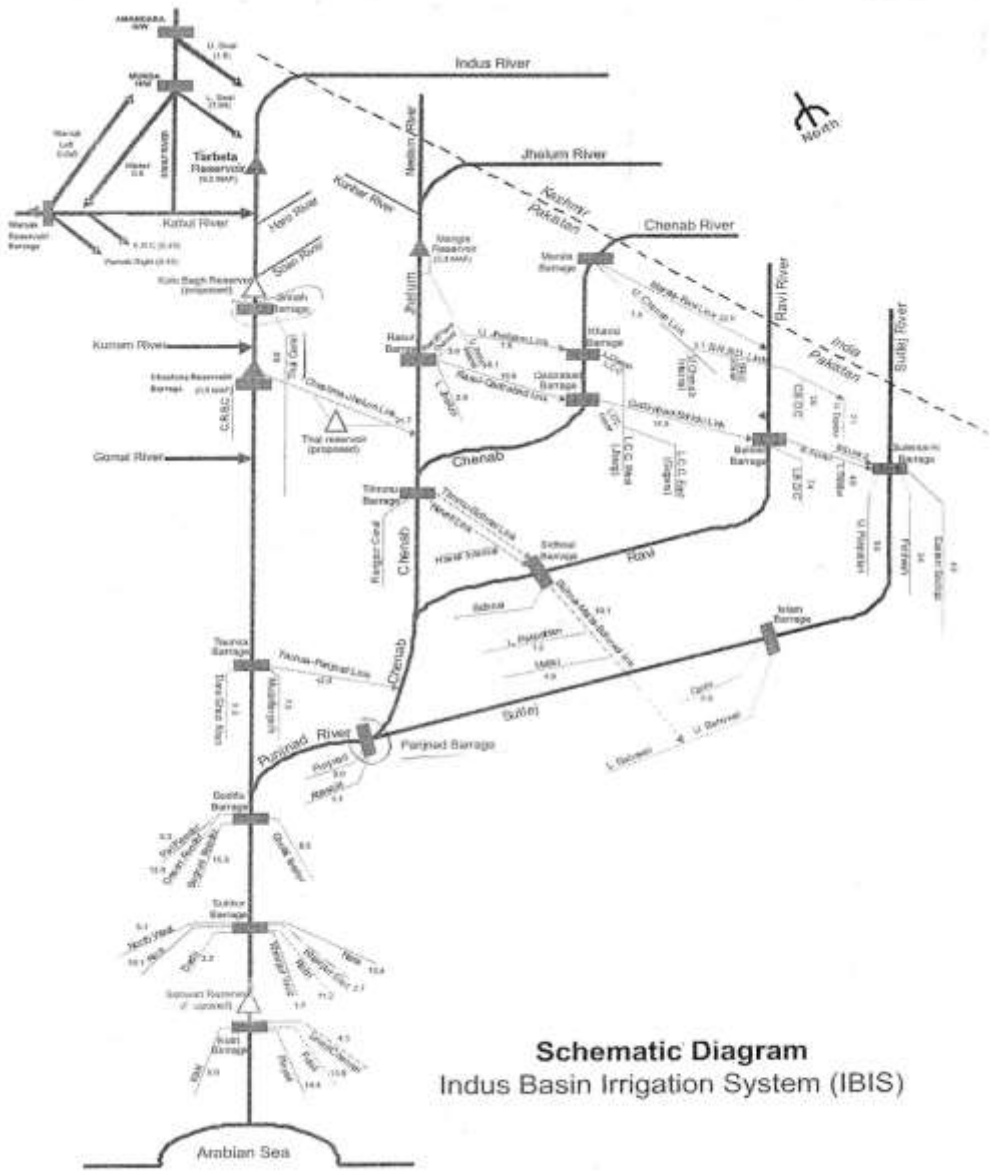
Global warming is expected to increase both evaporation and precipitation in most areas of Pakistan. Pakistan's irrigation system mostly depends upon snowmelt of Himalayan glaciers and monsoon rain fall on the catchment area. It is estimated that Himalayan glaciers contributing over 80 per cent water to river Indus during summer (6). Himalayan glaciers are receding at dangerously high rate if the present rate continues, there is likelihood of their disappearing by the mid of 21st century (7). This means increased frequency of floods in the foreseeable future but serious shortage of water in the rivers after some time threatening the livelihood of people dependent on them. Less availability of river or surface water for irrigation will force people to pump more groundwater and erode centuries old aquifer. It also raised the risk of pumping brackish groundwater which will adversely affect the agriculture production.

Adverse effects on Pakistan's irrigation system means damaging the agriculture industry of Pakistan which is often referred to as a back bone of Pakistan's economy. Agriculture and industry contribute 21.4% of GDP and employs 45% of the country's labour force (8). On the basis of these facts the world's renowned global risk analytics company GERMANWATCH ranks Pakistan on 8th on the climate change vulnerability Index 2011 (9) even though Pakistan is a low emitter of greenhouse gases and its contribution towards the total global GHGs emission is only 0.8% (10).

Impact on Pakistan Irrigation System

The present Irrigation System in Pakistan's region was first developed by the British during mid of 19th century when controlled year round irrigation began in 1859 with the completion of the Upper Bari Doab Canal (UBDC) from Madhopur Headworks (now in India) on River Ravi. Completion of UBDC was very successful and led to development of a sophisticated and highly efficient irrigation system in the region. Major part of the Irrigation System was constructed during end of 19th and first half of the 20th century. For example Khanki Barrage completed in 1892, Sukkur Barrage on Indus River constructed in 1932, Sutlej Valley Project (comprising four barrages) completed in 1932, Jinnah Barrage in 1946 etc. The schematic diagram of Indus Basin Irrigation System is shown in Figure-3.

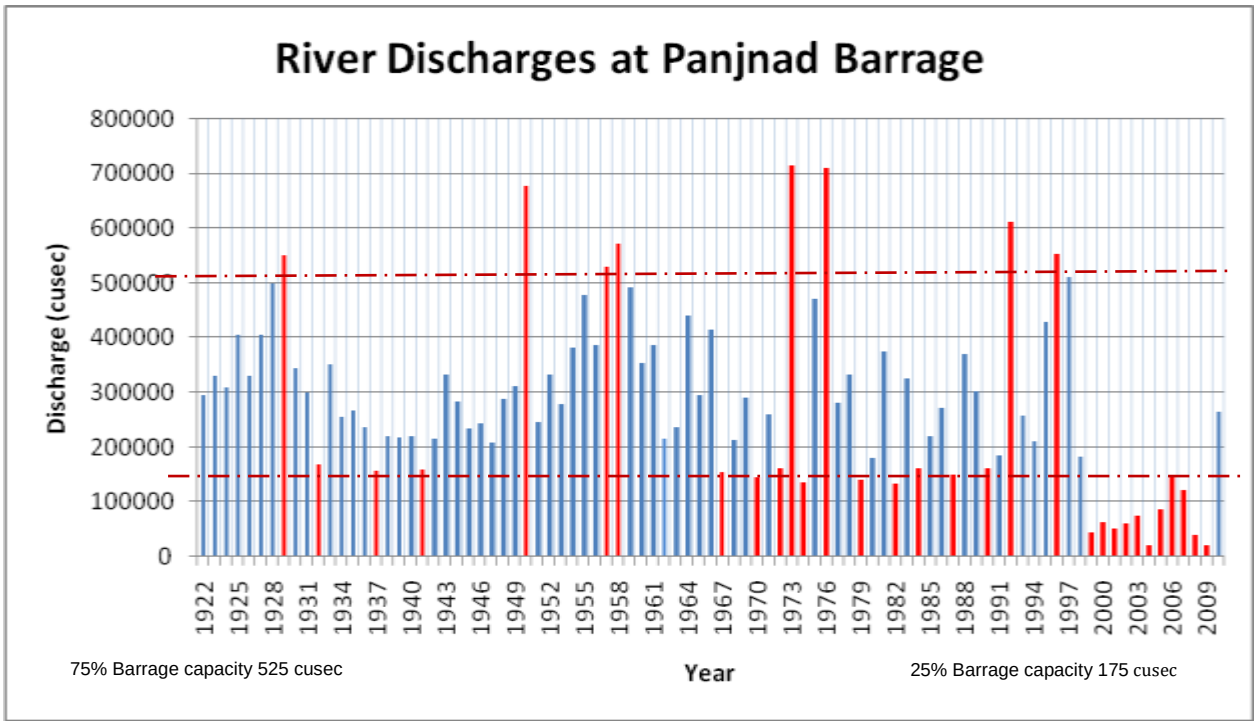
Figure 3:



Water discharges in Indus and its tributaries have been changed a lot during last 100 years and, therefore the upgrading of the Irrigation System is required on urgent basis. Under Punjab Irrigated, Agriculture Investment Program (PIAIP) consultants analyzed the historical river discharges and found that the barrage capacity of Panjnand and Trimmu Barrage are significantly less than their 100 years return discharge (11). There are number of reasons of change in river water flow including. Indus Water Treaty-1960, man made development (dams, reservoirs etc) and global warming. Global warming causes unexpected weather conditions and it is now widely recognized that one of the impact of global warming is likely to experience extreme events e.g. flooding, drought etc more frequent than before (12). To check this phenomena river discharge data from 1922 to 2010 at Panjnad barrage is analyzed and graphically presented below. Panjnad barrage is located just below the confluence of River Chenab and River Sutlej. The barrage design discharge capacity is 700,000 cusecs and is working since 1932. Discharge values above 75% or below 25% of the barrage capacity is highlighted in red on bar chart (Figure-4). Considering, above 75% or below 25% flow is the extreme event, there are only eight extreme events from 1922 to 1969 (48 years) and twenty three extreme events from 1970 to 2010 (49 years). Therefore, it can be concluded that the

global warming is disturbing the river flows in Pakistan and extreme events occur more frequently now than before.

Figure-4:



Another recent example of extreme event is heavy monsoon rainfall during July – August of 2010 in Khyber Pakhtunkhwa, Sindh, Balochistan and lower Punjab region of Pakistan that brought the worst flooding in Pakistan history (13). Heavy rainfall in the short period of three to four days over the Indus River catchment area is the major cause of this devastating flood. It was estimated that one fifth of the total land of Pakistan was under water, approximately 62,000 square miles and more than 20 million people were affected (14). IPCC scientist warns that "the floods of the kind that hit Pakistan may become more frequent and more intense in the future in the same region and other parts of the World".

Conclusion

Global warming is considered to be the most imminent threat to our environment. The global temperature is increasing regularly because of the continuous increase in the concentration of Greenhouse gases due to burning of more and more fossil fuels and ozone layer depletion which occurs due to cholorofluorocarbons (CFCs) compounds present in the refrigerants / coolants. The projected levels of global warming have serious consequences on Pakistan's water resources. These include continued melting of ice cap and glaciers, major alteration in rainfall patterns and frequent occurrence of extreme events like flooding, drought etc. It is envisaged that, the Himalayan glaciers releasing fresh water during summer in Indus Basin could be grossly reduced by the mid of this century. That causes more floods and drought in the region. This is also confirmed by UN body IPCC's scientist that Pakistan water resources are diminishing at an alarming rate due to the global warming. Global warming is already impacting on the river discharges in Pakistan and as Pakistan's Irrigation System almost completely rely on River Indus and its tributaries, the whole system may become nonfunctional due to disturbance in river discharges. There are two ways of responding to climate change; through adoption and through mitigation measures. Mitigation mainly involves reduction in emission of GHG. Pakistan is already a low emitter of GHGs, therefore, it is not much to do in mitigation. The best way to tackle the climate change is through the improvement in the adoption capacity by managing the water resources more efficiently, besides minimizing the water losses. New reservoirs and storage dams should be constructed without losing any time for survival of the country and welfare of its people.

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