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CLIMATE CHANGE SCENARIO: FROM WHERE TO START?

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Abstract

The present paper briefly reviews various natural reasons responsible for climatic change in geological time. It also describes anthropogenic factors resulting in global warming since last two centuries. Evidences of recent climatic changes indicate some challenges which may be encountered by people of Pakistan. Many papers suggested that Dendrochronology (Tree-ring science) could be a solution. It may not only describe the climatic variation of recent past (500 to 1000 years) but future trends of climate may also be predicted using this applied, rapidly growing and multidisciplinary science. It is also suggested that reconstruction of past climatic history should be the first step to prepare ourselves in a climatic change scenario. Successful application of tree-ring to solve hydrological problems in Pakistan has also been mentioned.

Keywords: Dendrochronology, Climatic change, Past climatic variations, Proxy record, Prediction of future climatic state.

Introduction

Weather changes throughout the day but average pattern of change of weather, called climate, stays pretty much the same for centuries. Our daily life depends upon climate. Today, mankind is facing the greatest threat of climate change. The prominent responsible factor is increasing temperature or global warming.

Climatic change is not a new phenomenon for our world. It has being changed for unknown times since the origin of this globe. However, naturally, it changes gradually by hundreds of years but sudden change has always been a disaster for different life forms on this planet. 65 million years ago, mighty dinosaurs were eliminated due to the sudden cooling of some part of the world. Recent ice age and elimination of Indus valley civilisations are a few examples to help to understand the consequences of sudden or rapid change of climate.

Brief review

There may be several reasons why climate changes naturally. One such factor is attributed to the pattern of the earth's orbit around the sun, including changes in the shape of the orbit every 100,000 years (Imbrie and Imbrie, 1980), changes of rotation axis every 400,000 years (Berger, 1979) and the disproportion that spins on the axis after 260,000 years (Smith, 1981). The movement of the tectonic plates bringing about changes in the geography of the earth is another factor (Barron, 1985). Also, due to the orbit change after a million years, an expansion of glaciers world-wide takes place (Haye et al., 1976; CLIMAP, 1976, 1981). Changes in atmospheric gases in ice (Eddy et al., 1982) and release of green house gases in and above sea is iterated by the sudden shifts in ocean current, warming the earth. On the other hand, the sudden disruption of oceans causes cool climate (Smith, 1981). Sudden eruption of magma from volcanoes, releasing sulfur hexafluoride in volcanic ash, is another contributor to the green house effect, albeit it shares a benign 4% contribution. Southern oscillations (Fritts, 1976; Cook, 1983; Thompson et al, 1984) and ENSO effects, those of El Nino (warm water) and La Nina (cold water), are other factors which have been identified.

Effect of man on climate

Humans have also been responsible in creating a situation which has led to climatic changes. One such major cause is attributed to the economic negative externality viz. air pollution: since the last 200 years, the temperature of the

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earth has risen from an average of 1.1 to 2 ºF whereas CO_2 emission has increased by 30% with the explosion in consumption in fossil fuels and urbanisation (Wright, 1983; Kellogg, 1987). 64% of CO_2 comes from burning forests, grassland and fuel in automobile and factories, adding 30 billion tonnes of the gas (Anne et al 2006). Such activities and those usually observed in cities have also released other green house gases including methane, nitrous oxide, ozone and water vapours. The organic green house gas has been observed to absorb 20 to 30% more infrared radiation and is usually released by rice fields, coal mines, landfill sites, pipeline leaks and animals, contributing 19% of the green house gases to the atmosphere. Apart from methane, the now-banned coolant, chlorofluorocarbon, is also a powerful absorber of infrared radiation. Nitrous oxide is released by burning organic liquids and by nitrifying bacteria through the process of denitrification, contributing 6% to the green house effect.

Based on computer modelling, Arms (1996) suggested that average world temperature would be 2.3ºC warmer by the year 2050. Besides some scientists related to the commercial world, there is no second opinion that the world climate is changing rapidly.

Evidence of climatic change

The changes in the climate can be noted because of the high amount of rainfall on higher altitudes and the low amount of rainfall in tropical areas. Frequent evaporation, storms, floods, landslides, hurricanes, tornadoes and typhoons is another indicator. The reduction number of animals in the Arctic region and alpine glaciers also stand as supporting evidence. Droughts have become far frequent because of which 1.7 billion people suffer. Sea level has risen by 6 to 8 inches on average, which could be attributed to the melting ice caps. The disappearance of coral reefs, amphibians in Costa Rica, 57 types of butterflies in Europe and Northern America and many ecosystems stands as another alarming testimony (Burroughs et al., 2007). Main causes of climate change are as under:

1. More rainfall on higher altitude areas.
2. Tropical areas receive less rainfall.
3. Warm temperature, more evaporation, storms, floods, landslides, hurricanes, tornadoes and typhoons occurring more frequently.
4. Arctic-number of animals reduced.
5. Lesser number alpine glaciers.
6. 1.7 Billion people live in less water supply areas.
7. Sea level rise 6-8”.
8. 57 types of Butterflies died in Europe and northern America.
9. At Costa Rica, disappearing Amphibian population.
10. Coral reefs disappearing.
11. Many ecosystems are disappearing rapidly.

Some challenges

Are climatic changes and their consequences thoroughly understood? Special consideration must be paid to impact on agriculture, hydrology, forestry, energy, glaciers, water supply and tourism, in order to be able to prepare these sectors against attacks of the climate.

To start with, the climate of next 50 to 100 years needs to be known. To predict the climate for 50 years ahead would be an enormously important achievement, which would have great impact in almost all aspect of Pakistan’s economy. However, exact prediction seems unattainable. It is stated that by the end of this century the temperate increase would be 6.4ºC, Task Force (Ahmed and Shams-ul-Malik, 2010) but such measures will not suffice. What we must aim for are reliable statements about trends and about the probabilities of particular types of climatic events occurring in the future. Reliable estimates of such probabilities would be of great value in planning for expansion in tourism, expending forming, hydrology, energy, predicting flood losses, etc. In addition, if this is successfully completed, provided data on the climatic states will be available over a much longer time span than present. A thorough understanding of climate changes is particularly important in a small country dependent for much of its income from agriculture, farms, orchards and fisheries.

Global Change Impact Studies Centre (Sheikh et al., 2009a) and Pakistan Meteorological Department (Chaudhry et al., 2009) have presented some trends based on short meteorological data but predictions of future

climate need huge past climatic data. Even the most developed countries do not have more than 100 years of meteorological data due to the lack of instruments in that period. Besides, experts and also present authors have some concerns on available meteorological records, including those of standard meteorological instruments, location of stations where such instruments are available and lack of climatic station at higher elevation. Climate stations are also not isolated from the effects of cities and their expansion. Another major concern which is frequently cited relates to the non-professional attitude of data collecting workers. These and other factors give unreliable, short or missing data. Whatever data that are present are also frequently threatened by corruption via viruses.

Therefore, it is not reliable to model past climatic variations or trends using this record, thus giving rise to the need for proxy data. According to Guiot et al. (2005), historical data may provide short term climatic variation. Paleoclimatic information over short or long terms can be obtained from the records of ice cores (Thompson et al., 1985, Baumgartner *et al.*, 1989, Lough and Barnes, 1990) but the techniques are extremely expensive.

Relatively inexpensive solution: The best available proxy data and tool are annual growth rings of some huge and old tree species. Often they live up to nine thousand five hundred years (*Abies abies* at Sweden). The science of tree-ring dating is called Dendrochronology and is a rapidly emerging multidisciplinary and applied subject. According to Speer (2010), Dendrochronology examines events through time that are recorded in the structure of annual rings that can be dated accurately, making Past is the key to the future (Fritts, 1976). These past proxy data give reliable and detailed data to model possible past and future climatic variations. This technique, tool or science is being successfully applied in developed and developing countries (USA, Germany, China, Russia, Britain, India and Pakistan) to investigate problems related to hydrology (Cook *et al*, 2009), climatology (Fritts, 1991), glaciology (Catchpole, 1985), plant ecology (Fritts and Swetnam, 1989), seismology (Jacoby, 1997), archeology, pollution *etc*. In Pakistan, it has been successfully used (Ahmed et al., 2011) to explore hydrological potential of River Indus.

WAPDA has only 50 years of instrumental records of Indus River flow. Pakistan's whole water planning is based on this data whilst this sort of record is not reliable for any planning. It is perhaps not surprising that Pakistan always has water dispute amongst provinces. With collaboration of Earth Conservatory, Columbia University of New York, USA and Gondwana Tree-Ring Laboratory of New Zealand under Pak/US research project, we have established data of 500 years of Indus flow (Cook et al., 2013). If WAPDA uses this data for their planning, benefits will be yielded not only for this institution but also for Pakistan's economy. This technique is also been used in USA, China, India and other developed countries to solve their water problems.

The first step is thus to find climatic history of the past. We are also working on past climatic variation on northern areas of Pakistan. This past (500 years) climatic variation would help to predict or model possible future climatic trends. This would be the only way to cope or prepare for, in climatic change or a global warming scenario. At a later stage, once the variation and trends of the future (50 to 100 years) climate can be approximated, Pakistan will be able to adjust agriculture, orchards, farming, tourism and games programme.

In the current climatic change situation present sowing, irrigation and harvesting time which is based on hundreds of years experience would be changed. Therefore, investigation and preparation must be done to use new time table. In addition, the climatic change would induce changes in weed crop relation from an increased temperature situation. Moreover, insect pest populations would increase. A research in New Zealand showed enhanced growth of three weeds with increasing temperature (Ahmed and Wardle, 1991). Extensive research will be required in order to determine how weeds in Pakistan would react so as to take precautionary measures for Pakistan's crops.

Scientists in various fields should start investigation to explore relations between various biological organisms and increasing temperature and with its related factors. Task force (Ahmed and Shams-ul-Mulk, 2010) gave several

examples. During this time, it would be a big challenge for dendroclimatoligists; not only should they present the climatic variations and trends of recent past (last 500 to 1000 years) but also the possible future climatic trends with special reference to Pakistan.

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