
Features of Climatic Zones, Climate Change and Natural Hazards

Jitesh Chandra Saha *

**Assistant Professor, GDC, Kamalpur, Dhalai, Tripura, India.*

*Corresponding Email: *jiteshchandrasaha@gmail.com*

Received: 29 July 2022

Accepted: 13 October 2022

Published: 27 November 2022

Abstract: *There remains a proportionate balance between constituents of an ecosystem and surrounding components of environment. Economic development is a dynamic process which may necessitate alteration in existing proportionate equilibrium and through transition may acquire characteristic of other climatic region over time. As an ecosystem passes through intermediate stage of change in constituents, sustainable economic development process requires the minimization of its unfavourable affects on immediate environment forming climate over long time horizon. From this perspective, this paper makes an effort to prepare a framework for analyzing regional characteristics of climatic zones in India, type of dependence on natural resources and impact of change in carbon-di-oxide (CO₂) emission on associated natural hazards.*

Keywords: *Climate Zone, CO₂ Emission, Natural Hazards.*

1. INTRODUCTION

Living & non-living elements in a space constitute its environment and their continuous interactions form spatial climate. According to time frame, prevailing environment may be thought as short run spatial phenomenon which over long term prepares its climate in a way similar to flow material deposit forming river delta. Consequently change in environment may be found from elements which longevity is shorter varying from five to ten years while those elements influencing climate, last above fifteen-twenty years. Since these provide return in terms of food, fuel & wood, environment and climate are also termed as capital assets – short-term capital and long-term capital respectively.

In production process, basically four factors are employed namely land, labour, capital & entrepreneurship. Out of these four factors, last two in fact are produced by labour utilising natural resources which are part of an environment under particular climatic zone. These retain impact of spatial environment while labour & land attributes over long term embody climate change characteristics in addition. This implies first two inputs may contain details of

evolution process about a regional climate where last two inputs may be having features of different environments. If demise before average life expectancy and land hazards are left aside, first two inputs render attributes of climatic change through alteration from one environment to another in a particular region, changing from one proportionate equilibrium to another over time. Climate change is contextualised from consumption & production side as well. Ali (2016) finds carbon emissions for EU & OECD regions are higher in consumer approach than in producer approach while for BRICS & rest of world, this is exactly the reverse.

Economic Activities and Climate Change

People live in and undertake productive activities at places where the minimum elements remain present for living and these are generated by favourable climate. Lack of care, over-strain and contamination in resources may alter climatic health of a region. Under extreme circumstances, regional climate may become so adverse that human settlement may search a new place to survive without pollution and abrupt rainfall. After Dust Bowl during 1930s, Oklahoma of United States never returned to their pre-drought production levels and led to outmigration (WB, 2016). There is a common parlance that industry led economic development signifies next stage of advancement and mechanisation is a further boost. Proper filter technology is also required to minimize adverse impact on environment in short time and climate in distant version as presence of toxic elements intensify air & water pollution. "Possible solutions lie in air surveillance systems and information campaigns certain technologies can be used like air filters or fuel switching" - (WB, 2016). Without required pollution abatement, such development on one hand affect health of living beings and on other hand, attached polluting elements to environment alter region's climate through bringing change in proportionate equilibrium. Kumar et al, (2015) found that climatic variability from higher temperature had cast negative influence on bovine milk productivity in DPAP & DDP districts of Andhra Pradesh, Karnataka, Maharashtra and Tamilnadu. Variations in atmospheric pressure become abrupt which influences rainfall level, leading to shift in pressure belt, agricultural pursuits and cultivators. Black carbon particulate pollution in Northern Indian Ocean had brought changes in sea surface temperature gradients and this weakened mean vertical wind shear in the region (Chung et al, 2006 & Meehl et al, 2008). Soil quality deterioration from associated water pollution and effluents absorbed through roots & stems result in trees shedding leaves, undergrowth and overall deforestation. Climate of a region can become barren & dry with frequent natural hazards, costing lives and materials. Climatological disasters found by López et al (2015) are associated with temperature change while hydrometeorological disasters are associated with precipitation variation. At present rate of increase in CO₂ emission, number of hydro disasters may double for an average country in about 17 years. Somorin (2010) found rainfall shifting in Africa from west to south, consequent adverse impact on coastal settlements and cropping pattern getting limited to highlands only.

Non-Economic Activities and Climate Change

Air cover sustain life not only inside earth but also protect from harmful ultra-violet rays. But ozone layer is already porous and global warming is leading to increased possibilities of heart

stroke & skin cancer. Available statistics shows that during initial sixteen years (1960 - 1976) although CO₂ had been spread at .29 ppm annual compound growth rate (CAGR), average global temperature was diminished at .067⁰ C per annum but during latter sixteen years (1985 - 2001) both CO₂ emission & average temperature rise took place at a higher CAGR (TERI, 2007). Apart from economic development process, this is also caused by deliberate deforestation and lack of cooperative understanding. With rise in population, unplanned areal expansion leads to clearing of greens and this disturbs proportional balance of elements in prevailing ecosystem's environment, affecting region's climate in long run. In Arabian countries building codes are followed using thematic hazard maps and spatial database is prepared for evacuation routes to reduce damage from landslides, particularly flood (UNESCO, 2010). While in Pakistan due to poor implementation and illegal exploitation, forest cover of northern highlands is depleting at more than 1.5% per annum, thereby increasing risk of landslides, floods, soil erosion and casting negative impacts on forests production & related livelihoods (Ali et al, 2014). Similarly during 1990s Gulf war, marine & land ecosystem were devastated by oil pilferage, polluted both ocean & air to such extent that global warming was intensified further. Poonian (2003) found that alongwith decline in Saudi Gulf shrimp stock, sea turtle nesting crumbled, dolphin & finless porpoise became endangered.

Impact of Climate Change

Adverse impact on open skin area as skin cancer are likely to be faster (IPCC, 2007). Human settlement will be further affected by glacier receding, over flooding and alteration in direction of water flow. Sem et al, (2009) finds increasing flooding & irrigation problems in LDCs like Bhutan, Nepal and Bangladesh of Asia from glacier melting in Himalayas while higher water stress possibility in Africa owing to decreased precipitation. This will have affect upon vegetation, forestry and settlement through adaptation. Mangroves of Saudi coast are found to develop aerial roots & pneumatophores for surviving oil pollution (Poonian, 2003). From prolonged droughts, cropping pattern in Sikkim is shifting to seasonal vegetables from cash crops and multiple cropping turning into mono-cropping (Swaroop, 2017). Further erratic rains, flood and drought conditions give rise to new pathogens which require developing new resistant varieties and pest controlling technology. There is potential risk to human health as well. ARI/ILI disease incidences are the highest climate related diseases followed by malaria, influenza, pyrexia and Japanese encephalitis. If climate change continues in this way, there will be more mortality from intense heat waves, cyclones, landslides, floods and fires (GOA, 2015). Over long time horizon these will affect industrial development also. Solar energy based initiatives will become significant while air & water resource based ones will require relocation. Master Plan of Photovoltaic (PV) Rural Electrification was designed in four states of Nigeria to mitigate deforestation and GHG emissions (JICA, 2010). Compared to mechanical industries, climate change will have relatively greater impact on bio-chemical ones, which necessitate overall technology upgradation for enhancing effectiveness (IPCC, 2007). Under global warming as spatial weather turning extreme producing pinching heat and shivering cold, this is likely to increase worldwide importance of air conditioning technology. According to Banholzer et al, (2014) if GHG emissions continue to rise, many regions of Northern Hemisphere are expected to see

20 – 30 % increase in the maximum precipitation and consequent rise in coastal waters during winter. All these incidences of climate change will have simultaneous impact on relocation of human settlement pattern, migration and if this ends up huge, some liveable region will become almost barren while deserts turn into living places. Droughts are likely to be more common in North & Southern Africa while East Africa experiencing regular water stress at present is expected to see an improvement in water resources (WB, 2016).

2. RELATED WORK

Adhikari (2005): Finds that Nepali household with land & livestock assets make more annual income from common forestry than average poor counterpart and better educated households forest dependence is less.

Banholzer et al. (2014): Assess impact of climate change on natural disasters and finds increasing frequency of the hottest day, heavy precipitation and flood since 1950.

López et al. (2015): According to them, climate change and frequency of intense natural hazards are positively linked. If CO₂ emission continues at present rate of about 0.5 % per annum, then hydrometeorological disasters like floods & storms will become double from 0.775 to 1.55 disasters per country in about seventeen years and particularly, for Indonesia, Philippines & Thailand, this will add one more such disaster in every twenty years.

Menon et al. (2006): Common Property Resource (CPR) collections are the maximum in Eastern Plateau, Western Himalaya, Islands & Southern Plateau while at other ends are Western Dry Region & Ganges. Income from these are the highest in Western Himalayas followed by Eastern Himalayas and relatively higher in Upper Gangetic Plains. Major CPR product collected are fuelwood & fodder. Both fuelwood collection & use are higher in forested areas of Eastern Plateau, Islands, Gujarat Coast, Western Himalayas & Western Plateau whereas it is very low in Gangetic Belt and the lowest in Western Dry Region. In case of fodder, landless labourers mainly depend upon CPRs as livestock possession is 42 per cent and 88 per cent for landless households and landed non-poor respectively.

Mitchell et al. (1992): They are of the view that impact of global warming from greenhouse gas emission will be more in high latitude region to alter thermal gradient, this will shift air & ocean current which will increase occurrence of extreme natural hazard with some change in location.

Nibagwire et al. (2017): They examined correlation between extreme weather events & climate change in respect of Rwanda economy and tested factors that caused natural disasters.

Ozanic (2012): Impact of climate change on temperature & precipitation is studied in Croatia and it is found that in the twentieth century, yearwise number of dry day increase is statistically significant and this was resulted from lower annual precipitation & higher frequency of low intensity rainy days.

Paul et al. (2015): They found significant rise in annual mean temperature of all agro-climatic zones during twentieth century with hotter winter months.

Shaibur et al. (2017): For coastal areas of southwestern parts in Bangladesh, they got positive relationship between climate change and extreme events like Aila, Bijli, Mora, Nargis, Rashmi, Sidr and Viyaru, etc. Climate change was found in terms of higher temperature & greater rainfall and this culminated into rapid sea level rise and more number of floods & cyclones.

3. METHODOLOGY

Empirical part is based upon data available from National Sample Survey Organisation (NSSO) and World Bank (WB). In NSS 54th Round report on Common Property Resources (CPR) of India, this sub-continent is divided into seventeen agro-climatic zones. This report contains data on CPR in relation to total geographical area, forest access, collected material from CPR, annual valuation of these collected materials, used common potable water resources (CPWR) like wells & tubewells and purpose of using other community resources like irrigation, livestock & fishing at household (hh) level with land holding distribution. Only those zones and CPR uses are taken into consideration which count at least ten percent (pct) share of aggregate concern. Second part is based upon WB data on CO₂ emission generated by different types (like solid, liquid & gas) & sources of fuels and National Crime Records Bureau data on accidental deaths by unnatural & natural causes. For CO₂ emission from types & sources, pct shares, annual growth rate and graphical analysis are made. Lastly, to find impact of CO₂ emission, its twenty year lag is taken as independent variable in simple regression analysis and difference between accidental deaths by unnatural & natural causes is treated as dependent variable, natural hazards (NH).

4. RESULT & DISCUSSION

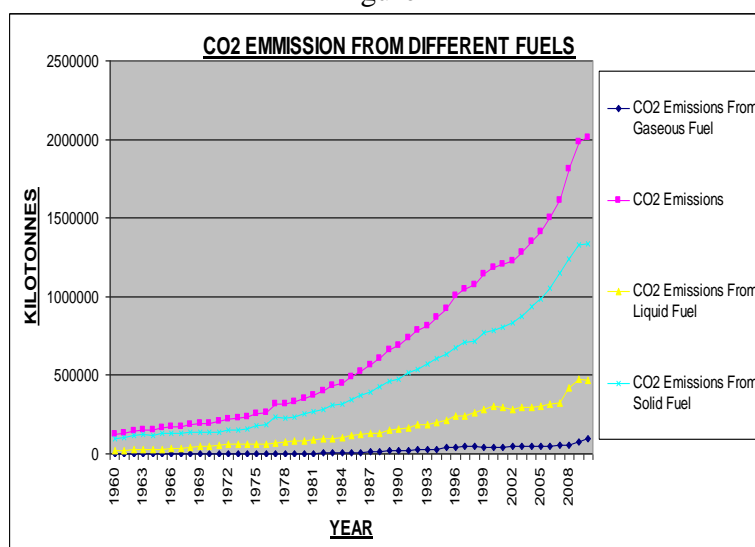
Above .30 pct CPR in relation to total geographical area are in western Himalaya (WHm) & western dry region (TD), in Gujarat coastal region (GC) this stands at .27 pct while for west coast (WC), western plateau (WHg), eastern plateau (EHg) & central plateau (CHg) areas, CPR ratio varies between .10 - .20 pct and rest climatic zones are having below .10 pct. At per hh level, the maximum CPR is possessed by TD zone followed by that of GC, CHg, WHm and EHg. Regarding forest access, above ninety pct hh in Islands (Isl) & WHm are having nearby forests, this varies between forty to seventy pct in CHg, EHm, Southern plateau (DP) and WHg followed by other climatic zones. Above fifty pct hh in WHm & Isl can access forest within village, this stands over twenty five pct hh in CHg, EHg, WHg, EHm, DP & GC while over one fourth such hh found only in EHm & Isl go outside village for forestry. Available statistics regarding collection of material from CPR shows that principal products on which above ten pct hh depend are fuelwood, fodder, thatching material, fish, bamboo & fruits. For fuelwood & fodder, hh are found to be involved more in collection of these materials than their selling. Among these climatic zones, higher level of hh participation in material collection is found for WHm, EHm, EHg, CHg & Isl. Annual

valuation of these collected materials are more for rural labour than that for hh possessing lands. Itemwise particular material for which collection exceeds ten pct of aggregate valuation are leaves, weeds, grass, bamboo & fish. Such collection takes place for fruit, roots, tubers only in UG, EHg, CHg, EG, WC, GC & Isl and for medicinal herbs only in WHm & UG. Except WHm, hh living in villages depend mainly upon common potable water resources (CPWR) like wells, tubewells and others. Tubewells are predominant sources in EHm, LG, MG, TG, CHg, WHg, DP, EG & GC followed by wells while only for WHm and Isl, other CPWR occupies water source of primary & secondary importance respectively.

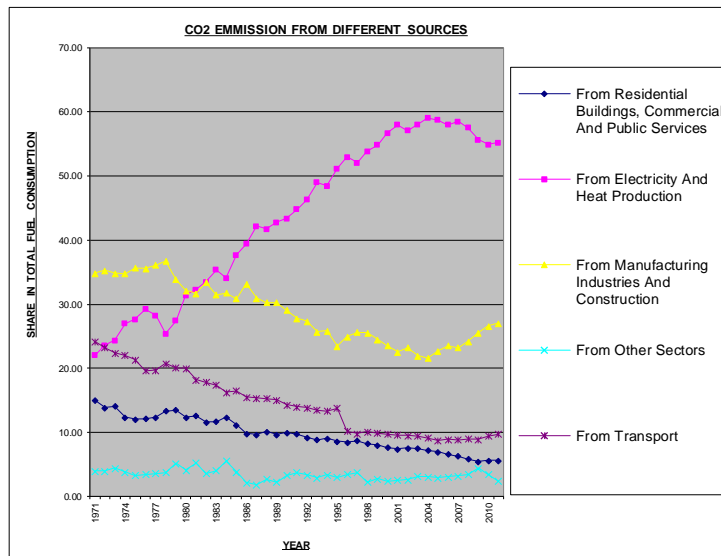
Use of other community resources is limited to mainly irrigation and livestock with fishing share hovering about twenty five pct only in EHm. According to Menon et al, (2006), rural poor than rural non-poor depend significantly more on CPRs and this is more in hilly tracts than in UG plain areas. Only for LG, MG & TG, irrigation is main purpose for which CPWR is used while for other thirteen climatic zones, its place is next to that of livestock rearing. Greater number of hh having land than rural labour force possess livestock.

One principal factor behind climate change is CO₂ emission. CO₂ is generated by combustion of solid, liquid & gaseous fuels. Since 1960, solid fuel consumption is principal generator followed by that of liquid fuel and relatively very low volume emitted from gaseous sources. In absolute kilotonnes, CO₂ emission increased rapidly from 1980s and componentwise at a greater rate from solid fuels than from liquid ones [Fig.-I(a)]. Sourcewise electricity production, manufacturing and construction sector remained major emitting agent followed by that of transport sector, residential building & other sectors. Although 1970s statistics depict balanced emission from different sources, from mid-1980s CO₂ emission from electricity production, manufacturing industries and construction sector were rapid [Fig.-I(b)].

Figure- I



(a)



(b)

Source: World Bank

In terms of share in total fuel combustion upto 1980, CO₂ emission from manufacturing industries and construction sector was the maximum followed by that from electricity but later periods show steep rise in share of electricity & heat production while all other sources of CO₂ emission are found to register declining share over the period of 1971-2011 [Fig.-I (b)]. CO₂ emission from manufacturing industries and construction sector reduced from 3.71 thousand metric tonnes in 1971 - 1991 to 2.54 in 1991 - 2011 for one \$ value added in manufacturing sector.

Regression framework was attempted to construct for measuring impact of CO₂ emission on NH occurrences over the period of 1980-2007. Difference between accidental deaths by unnatural and natural causes was regressed upon twenty year lag in CO₂ emission. [Eqn (1)] estimates negative relation and this implies with increase in CO₂ emission, accidental deaths by natural causes are increasing. From short period interval of 1980-1991(Table-I) to long period interval of 1980 - 2007, intensity of the relationship is found to increase from .61 to .95. This implies greater frequency of accidental deaths by natural causes in tandem with increasing CO₂ emission.

$$NH = -0.95 * CO_2 - 9.35e-007 \text{ ----- (1)}$$

Table-I

1980 1991				
Dependent Variable: NH				
Method: Least Squares				
Included observations: 12				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CO220	-0.611967	0.030340	-20.17046	0.0000

C	0.334910	0.034828	9.616100	0.0000
R-squared	0.976010	Mean dependent var		0.955081
Adjusted R-squared	0.973611	S.D. dependent var		0.348869
S.E. of regression	0.056672	Akaike info criterion		-2.752053
Sum squared resid	0.032117	Schwarz criterion		-2.671235
Log likelihood	18.51232	F-statistic		406.8475
Durbin-Watson stat	1.310908	Prob(F-statistic)		0.000000

5. CONCLUSION

Climate of a zone is determined by both constituents, internal to it as well as external aero, hydro and tectonic spill-over flowing from other climatic zone. Without soothing regeneration of natural resources through afforestation, recycling efforts like waste management, renewable resources based technological advancement and intensification of solar energy use alongwith hydro & aero dynamics, normal rate of population expansion, progress through economic development placing internal constituents to a new balance and circumventing adverse external climatic spill-overs, activities initiated deliberately in a climatic region for well-being of living beings may energize occurrence of natural calamities.

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