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Climate Change and Architecture: The Link Overlooked

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Abstract: Every year since the last fifty years, the world is waking up to higher and higher average temperature of the earth. Initially it was thought that this trend is a part of cyclical warming and cooling of the earth and nothing to be much worried about. However, with weather conditions become erratic and unusual over a large swath of the planet more and more frequently and regularly, scientists started to speak of Climate Change and people started to listen. In this paper we briefly discuss the link between global warming, climate change and current policies in the developing world to drive home the urgent need for alternative thinking. We briefly discuss the theoretical link between economic development and greenhouse gas emission and lay the micro foundation of the Environmental Kuznets Curve (EKC) before providing some evidence of global climate change and why this is a matter of concern for social scientists. Then we explore two avenues through which human activities are aggravating the situation especially in developing countries – the role of business architecture and the role of built architecture. We argue that these twin architecture are aggravating global warming by moving away from sustainable development policies.

Keywords: climate change; sustainable development; EKC; global warming; architecture; plastic pollution

1. Introduction

Every year since the last fifty years, the world is waking up to higher and higher average temperature of the earth. Initially it was thought that this trend is a part of cyclical warming and cooling of the earth and nothing to be much worried about. However, with weather conditions become erratic and unusual over a large swath of the planet more and more frequently and regularly, scientists started to speak of Climate Change and people started to listen. To go back in history, Jean-Baptiste Fourier had talked of *greenhouse effect* as early as in 1827, though it lost significance thereafter. The world at that time was going through a phase of unprecedented social and economic progress and the Western European powerhouses were expanding their colonies at a marvellous speed. Wealth creation and appropriation was the sole focus of the ruling class and extraction of natural resource was seen as the prime instrument for doing so. Production had moved from the shoemaker's house to the factories, transport had moved from animal carts and sail ships to automobiles, steamships and coal locomotives. As the scale of such activities multiplied several times so did the use of fossil fuel as source of energy, releasing vast amount of specific gases like CO_2 NO_2, and SO_2 etc. Expansion of cultivation and extensive use of fertilizers also led to rise in methane being released into the atmosphere. Though the mainstream scientists focussed their attention towards newer and newer methods of production and technological breakthrough, a few voiced their concerns. Among these were Svante Arrhenius and P. C. Chamberlain who separately wrote about the effect of building up of CO_2 in the atmosphere on average global temperature and the possibility of a *global warming*. But still the wider society was not concerned and it was another 50 years before Revelle and Sues (1957) commented that we are conducting a *"large-scale geophysical experiment"* on the planet by releasing such high volume of greenhouse gases. Subsequent to this more and more people started to discuss the issues of greenhouse effect, global warming and climate change and the Rio summit

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on environment in 1992 marked a watershed in the global thinking on human actions and its effect on the blue planet (see UN, 1992 for details). Sadly, actions since then have not been able to achieve much and the global template of economic growth has only been scratched at the surface. Our actions are still aggravating rather than solving the problem. In this paper we briefly discuss the link between global warming, climate change and current policies in the developing world to drive home the urgent need for alternative thinking. The paper is divided into six sections. In the next section we briefly discuss the theoretical link between economic development and greenhouse gas emission and lay the micro foundation of the Environmental Kuznets Curve (EKC). In the third section we provide some evidence of global climate change and why this is a matter of concern for social scientists. In the fourth and fifth sections we put forward two avenues through which human activities are aggravating the situation especially in developing countries. The sixth section summarises and concludes.

2. A Micro Foundation

It is said that '*matter can neither be created nor destroyed*'. So the process of development of mankind has always been dependent on nature. While in the early days of the hunter gatherer society we used the natural resources directly for consumption, as the society changed over time, we came to use more and more processed commodities. They may appear to be *man-made* but look deeper and there is hardly any commodity that does not eat up some natural resource. Hence the process of development can be seen as a process of transforming natural resource to consumable commodities. The relation between natural resources and commodities can thus be represented by a downward sloping concave to origin Production Possibility Curve (PPC) signalling that some amount of resource has to be sacrificed to get additional amount of commodities (Figure 1A). This includes not only exhaustion of non-renewable resources for direct production or consumption process, but also the negative impacts caused on nature/environment during the production and consumption processes, different types of water land and air pollution, for example. The process of development as we know it therefore proceeds along the PPC from A to B to C and so on. This has been the story for most part of the last 200 years. However this journey cannot continue for long. Our blue planet needs to retain some quantum of natural resource just to sustain life in it and that minimum amount may be termed as the carrying capacity of the earth. If on our journey towards more commodities we move below that line (point Z for example), our existence will become uncertain. Does that mean that our march towards affluence has to be halted? Not necessarily so. Technological change can lead to a leap in the potential and more commodities can thus be produced with less depletion of nature as technology improves. This can be represented by an outward shift of the PPC and moving from C to D′ to E′ etc., thereby postponing the doomsday referred to earlier (Figure 1B). We have been doing this for the major part of the last 50 years or so. But this is applicable neither globally not *ad infinitum* because of two factors – the nature of technical progress over time, and, the disparity in the preference pattern across societies, regions and countries.

Figure 1. Production Possibility Curve & Technological Progress.

Societies face choice between nature and commodities, deriving utility from both and their preference pattern can be represented by Social Indifference Curves (SIC) (Figure 2A). The SIC map signals that societies must sacrifice some amount of nature (or commodities) to have more amount of commodities (or nature) while maintaining its total utility (movement from X to Y). Similarly more of at least one natural resource or commodity is needed to improve the utility level, that is, to attain better living (movement from X to Z, for example). Countries and societies that are at lower levels of development with lower command over commodities have relatively steeper SICs as they are ready to sacrifice more of nature to get additional amount of commodities. Countries that are at higher levels of development with more commodities at their disposal have relatively flatter SICs as they are ready to sacrifice less nature to get more commodities (Figure 2B).

Figure 2. Social Indifference Maps.

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The shifting of the PPC over time has also not been unbiased. With greater focus on maximizing output of commodities the PPCs have shifted more towards the commodity axis rather than blowing up parallelly outward. Also, the quantum of technological advancement is different across different types of countries leading to different time paths. Less Developed countries, with very little technological advancement and preference for commodities (relatively steeper SIC), move along the path PQRST (Figure 3A). Thus typically poor countries have nature depleting economic policies. Developed countries are already at higher levels of income, enjoy more command over commodities and hence value nature relatively more (thereby having flatter SICs) and achieve greater technological advancement. As a result, they are likely to move along the path MNOPQR (Figure 3B). Consequently, they are more likely to have a nature conserving economic policies and may even be able to replenish the historical loss to natural resource to some extent when their time path bends upward. Thus the production/consumption path of countries over time would resemble ABCDEFG, sloping downward initially, reaching a trough, and then rising upward once more at higher levels of income and affluence (Figure 4). This gives rise to the celebrated Environmental Kuznets Curve which signals that low income countries have low environmental degradation; middle income countries have relatively higher levels of degradation; while high income countries again have low degradation levels (Figure 5).

Figure 3. Production-Consumption Path of Different Countries.

Figure 4. Production-Consumption Path of Countries over phases of Development.

Figure 5. Emergence of the EKC.

This also lays the foundation of the global econo-political conflict among developed and developing countries regarding the pathway to be followed by the latter countries. While the developed countries (which, as we have shown, are more concerned about conservation of nature and environment) want the developing countries to cut down on their anthropogenic environmental degradation, the developing countries with an eye on catching up with the developed world, are less concerned about the environment than about their economic performance. While this conflict ebbs and flows, certain global understanding has been reached regarding emission and conservation. Countries are trying to adjust to norms and standards, balancing between economic targets of eradicating poverty and inequality and social targets of reducing global warming. However, practices in developing countries are sometimes out of sync with the professed pathway. Blinded by the dazzle of the developed *North*, global *South* are adopting policies that are not in tune with the situation of these countries. This is aggravated by the functioning of global capital which is more concerned about the returns to investment than the future of the planet. We will discuss two such processes that are common around the world but are more rampant in developing countries. Before we discuss these maladies, let us take a brief look at the symptoms which are too obvious to be ignored

3. Signals of Climate Change & Its Cost

Climate change refers to significant departure in weather parameters from their long-run averages. Such changes are themselves more permanent in nature than transitory. Thus climate change manifests itself as rise in average temperature of the earth, changes in pattern of precipitation, and increased frequency of extreme events like heat waves, cold snaps, cyclones, droughts, and floods. Most of the evidences suggest that these are actually happening. Average surface temperature has been rising for the last hundred years (Figure 6). This has resulted in lower arctic snow cover each year for the last four decades (Figure 7). Higher temperature has resulted in expansion of seawater and accompanied by more volume of water due to melting ice cover Mean Sea Level has shown rising trend (Figure 8). Frequency of extreme events like tropical cyclones and the proportion of severe cyclones have shown a gradual increasing trend in spite of the irregularities (Figure 9).

Figure 6. Global Land and Sea Surface Temperature Change.

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Figure 7. Northern Hemisphere Winter and Summer Snow Cover.

Figure 8. Global Mean Sea Level Change.

Figure 9. Frequency and Intensity of Tropical Cyclones in Northern Hemisphere.

All of these have serious economic impact as well. It is argued that climate change and related extreme weather events shall have significant impact on production, transportation and storage of commodities, and cause severe damage to infrastructure installations, asset & wealth, and health. Though global warming may not decrease global agricultural output in aggregate, the pattern and regional spread of agro production is expected to undergo a sea-change, causing differential impact on countries around the globe. While tropical countries are expected to suffer more, temperate and higher altitude countries may benefit from slight warming. However, major damages to global economy is likely to be caused by extreme weather events like cyclones, drought and urban flooding, whose intensity and frequency are both likely to increase due to global warming and climate change. As these events multiply, assets will be damaged, economic activities will be suspended, and personal wealth will have to be rebuilt. It is estimated that in the United States alone there were about 300 such disastrous events in last 40 years that exceeded 1 billion USD in losses each, and got paid out by the insurance sector (NCEI, 2021). In other countries, the losses may appear to be less because of low valuation of properties & assets and low insurance penetration, but nevertheless they cause substantial reduction in the size of the economy. It is estimated that annual loss to global GDP due to such climate and weather related events is about 1.5-2 per cent of GDP (IPCC, 2019; Harris et al., 2017). Compared to no change in global climate, countries are estimated to lose around 10 per cent of their GDP by 2050 because of global warming and associated events, ranging from around 6 per cent in Canada to close to 20 per cent for countries like Malaysia, Philippines and Thailand (Swiss Re, 2021). It is also being pointed out that the economic damage will be disproportionately higher in low income countries in Asia and Africa, which ironically contribute relatively little to the climate change problem (Burke et al., 2015). These estimates do not include non-economic costs like damages to ecosystem, loss of freshwater resources, and depletion of aquifers; neither do they bring out damages to specific social and ethnic groups that are more dependent on natural resources than others or live in vulnerable regions. It is therefore obvious that the costs of climate change are substantial and will cause significant damage to global wealth especially in developing countries. In the following sections we bring up two processes that are furthering the damage to environment and precipitating extreme events in developing countries – processes that are avoidable and manageable with proper understanding and administration.

4. Business Architecture and the Demon Called Plastic

Economics has been concerned with purchasing power from its birth and the most basic foundation speaks of demand as *desire backed by purchasing power.* Thus demand is created by those who have purchasing power and global business had traditionally targeted the better off sections of the society for its profit. However, by early 1980s, global wealth pyramid had reached levels of disproportionate inequality with more than two-thirds of global population being at the base of the pyramid. Though global wealth was concentrated at the top of the pyramid, there were too few consumers up there. The mass, though lacking wealth, was at the bottom. It was evident that existing business models were unable to tap this vast market which had certain typical characteristics. These people mostly buy their products locally in small quantities and on a daily basis. Though they lack purchasing power in traditional sense, they do not lack in aspirations and desire to *keep up with the Joneses*. Global capital suddenly woke up to realise that what this people lacked in terms of quantum of individual purchase was more than compensated by the sheer numbers and potential customer base. *Fortune at the Bottom of the Pyramid* (Prahalad and Hart, 2002) was the new mantra and the new business architecture evolved to target this market. This gave birth to what we call the Sachet Revolution – sale of branded products in very small quantities for single use in plastic sachets or disposable packs. Starting with products like shampoo, toothpaste, and tobacco, it soon extended to

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almost everything under the sun from tea to alcohol, coffee & milk powder to spices & cooking oil, and to motor lubricants and others. This business architecture allowed the global poor to buy these products at least sporadically, but with 4 billion people at the bottom of the pyramid even infrequent buying translated into high volume of sales. In addition, rates per unit are higher for sachet sales compared to bulk packs that are sold to high end consumers, and at the end total profit is higher at this segment of the market. But what is the link between this business architecture and climate change? The link is through the demon called *Plastic* or its soft version called Polyethylene. Invented by accident in 1933, *Polyethylene*, the most common form of soft plastic, has spread its shadow over almost all human activities now, generating a humongous amount of plastic waste. Around 300 million tonnes of global plastic waste is generated every day, about half of which is single use soft plastic like sachets, packets and wrappers – by-product of the business at the bottom of the pyramid. These single use plastic are the main reasons behind more than half of global plastic production being discarded indiscriminately (Table 1).

Table 1. Global Production and Destination of Plastic – 1950-2015.

	Million Metric Tonnes	% of Total
Primary production	8300	-
In-use stocks	2500	30.1
Recycled	500	6.0
Incinerated	700	8.4
Discarded	4600	55.4

Source: Author's calculations based on Geyer et al. (2017). *Note:* Does not consider secondary production through recycling.

These sachets are made of a thin film of plastic and aluminium in a sandwich laminated form. The recycling cost of such single use plastic is very high and their value is low, making them unworthy of recycling. As a result about one-fourth pof plastic wsate is not managed and are dumped all around (Table 2). Improperly dumped plastic wrappers and sachets are completely ignored by the informal recycling sector in developing countries and most of them end up in sewers and drains. It is thus no surprise that developing countries have higher proportion of plastic waste being *unmanaged*. This leads to clogging of the sewerage system and causes urban flooding even with moderate rainfall. While in developed countries dispensers and carry your own containers schemes are more popular and sometimes legally enforced, in developing countries such schemes are either absent or present only on paper. Scientists have developed biodegradable packaging alternatives but these are not cost effective at the bottom of the pyramid as their high cost affect the low entry price offered by the new business architecture. The packaging sector is thus responsible for close to half of plastic waste generated globally (Table 3). With virtually non-existent garbage collection, separation, and disposal system in the populous developing countries, most of these single use plastic, apart from wrecking havoc with urban drainage system, ultimately end up in the ocean leading to destruction of marine life and the delicate biodiversity of the ecosystem (Petruzzello, 2020; Vaughan, 2020).

Table 2. Global Giants in Plastic Waste Generation - 2010.

	Million Metric Tonnes (MMT)	% of Total Global Plastic Waste	Unmanaged Waste as % of Total Waste	Total Unmanaged Plastic Waste (MMT)
China	59.1	21.6	74.0	43.7
United States	37.8	13.8	0.0	0.0
Germany	14.5	5.3	0.0	0.0
Brazil	11.9	4.3	9.0	1.1
Japan	8.0	2.9	0.0	0.0
Pakistan	6.4	2.3	86.0	5.5

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Nigeria	6.0	2.2	81.0	4.8
Russia	5.8	2.1	16.0	0.9
Turkey	5.6	2.0	16.0	0.9
Egypt	5.5	2.0	67.0	3.7
Indonesia	5.0	1.8	81.0	4.1
United Kingdom	4.9	1.8	0.0	0.0
Spain	4.7	1.7	0.0	0.0
France	4.6	1.7	0.0	0.0
India	4.5	1.6	85.0	3.8

Source: Author's calculations based on Ritchie & Roser (2018), OWID (2021).

In addition, the journey of plastic from cradle to grave is GHG intensive at each step. Petrochemicals account for more than a third of global oil demand and nearly half of oil-demand growth by 2050 will be driven by Petrochemicals, most of which goes into making of plastic (IEA, 2018). It is estimated that emissions from plastics production and incineration would release 56 Gigatons of carbon between 2020 and 2050. Even recycling plastic produces greenhouse gas emissions, as fossil fuels are combusted to run the machines that shred plastic waste and heat it up to make other products. Thus any economic model that increases use of single use plastic is detrimental to the health of the planet and the precipitates climate change. In this regard, business architecture in the developing countries and the quest for profit at the bottom of the pyramid by global capital accompanied by lax ground level environmental protection mechanism is leading to global climate change, and accompanied by increased frequency of extreme events are increasing the impact of such events and economic damages in these countries.

5. Built Up Architecture and Climate Change

The second issue which we put forward is a bit more unconventional than the one discussed above. According to us, built up architecture in developing countries is also contributing to global warming.

In ancient times sociocultural traditions were in harmony with nature and determined by geography and climate. Dresses, customs, rituals, agricultural practices, and architecture were all in sync with the surroundings. Locally available raw materials, mostly natural, like wood, stone, mud, brick, bamboo etc. were used for building purposes. Population pressure on land was low and habitations were spread horizontally. However starting from the second half of the 20th century, fast urbanization, increased pressure on land, and rising aspirations changed the pattern of architecture in developing countries as well. This trend gained momentum since late 1980s when the sweeping winds of globalisation led to cultural convergence across the globe, at least in terms of how cities looked and how buildings were built. Earlier, at least in tropical developing countries in the global south, houses were built along the lay of the land without levelling it too much. Good natural ventilation and natural light, so abundant in these countries, were beautifully utilised by the local artisans and planners. Natural blinds, wind shafts, water tanks in a central courtyard, orientation of the rooms and open spaces were all appropriate for the local climate and wind pattern. Thus building plans were not only different across societies, it suited the local climate also (Figure 10).

Figure 10. Traditional Building Plans adapted to Local climate.

Over the last fifty years however, in the name of development and modernization, the western concept and template was imitated lock stock and barrel in the tropical developing countries, forgetting that the developed countries mostly had a temperate climate. Building sites changed from detached individual houses to compact community living and horizontal spread gave way to vertical rise. While this change was somewhat inevitable, it could have been slowed down by spreading infrastructure and amenities to the hinterland and dissuading people from flocking to the handful of cities. Building plans simultaneously changed from being *spacious* to *space saving* and utility driven

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(Figure 11). But the major, and perhaps avoidable, change came in the building materials – shifting from natural materials like stone, brick, and mortar to concrete, glass. and steel (Figure 12). The construction sector, with its focus on cement and steel (two of the most energy intensive manufactured products), have been the greatest driver of energy consumption, fossil fuel use and carbon emission in the last fifty years. In addition to this role in increasing stock of greenhouse gases in the atmosphere, these *modern* buildings in developing countries continue to degrade the environment throughout their lifetime. The traditional buildings with their building plans and materials become hot during the mid day but start to cool down rapidly from the afternoon and become comfortable at night. The modern buildings, on other hand, do not get as much hot during day time but retain their heat even after evening. As a result, it has been estimated that modern buildings in tropical countries exceed the comfort limit for 60 percent of the time in an average hot day while the traditional buildings do so for just 35 per cent of the duration of an average hot day (Figure 13). This results in increased use of space cooling devices like coolers and air conditioners not only during day time but at night also, pushing up energy consumption further. It is thus no wonder that energy consumption in the cities of global south is fast approaching that of the developed north. However, there is no understanding, nor even recognition of the fact that building architecture in tropical developing countries, in a bid to become as 'grand looking' and as 'modern' as those in Western Europe or North America, are in fact driving up global GHG stock and global temperature. At the same time, they are losing out on the comfort index as well, making the habitants dependent on device controlled artificial climate for comfort.

Figure 11. Modern Building Plans.

6. Concluding Comments

We have thus outlined three major issues in this paper. First was how micro-economic behaviour leads to the emergence of the EKC and the conflict between countries at different levels of development trajectory regarding environmental conservation vis-a-vis economic growth. The second issue flagged is the role played by business architecture in degrading the environment and multiplying the damages caused by extreme events. Specifically we have spelt out the link between urban flooding and '*fortune at the bottom of the pyramid*' business models. The third issue is the long run impact of cultural convergence and associated global model of development on built up architecture of developing countries. The blind imitation of everything occidental is leading to disjoint between nature and society in the large, populous, tropical developing countries.

What is the way out from this conundrum? Foremost, we have to accept the fact that every single action of ours, however minute that may seem to be, has some impact on the environment. Second, we have to understand that perhaps in all our economic activities as producer or consumer there are some external diseconomies. Unless we look at the bigger picture and internalise all these external negative impacts on the environment, our market based economic structure will not help us to reach social optimum. On a broader scale, it brings to question the neoclassical fetishism with laissez faire and '*market as god*' principle. Without government intervention and taxes on environmental bad to reflect their social costs, global capital cannot be expected to protect the future sustainability of the planet. Competitive capitalism by governments at global, continental and even intra-country level is leading to a network and hierarchy of pollution havens whereby environmental degradation is not removed but only relocated from the line of vision to the obscure corner. The problem is pushed under the proverbial carpet, but alas, the genie called GHG emission and pollution has ingenious ways of coming out and engulfing us and like the proverbial genie cannot be pushed back into the kettle. At the same time, the chariot of economic progress shall go on and can neither be stopped nor slowed down, nor is it desirable to do so. The only way then is to reconsider global cooperation on a newer frame where the rich (countries) has to help the poor (countries) in their own long run interest. Technology transfer, rehabilitation of vulnerable population, discouraging polluting business models even at the cost of short run frugality have to be the cornerstone of the new policy regime. But more than all that, the concept of development itself has to be reconsidered. Much of our 'ancient past' holds valuable lessons for us in the form of traditional knowledge and nature friendly practices. In

most countries the tribals and indigenous populace are the repository of such knowledge. Instead of trying to modernise them, we have to seek solutions from them to cure us from the curse of '*development*' and '*modernisation*', as being manifested in the developed North and blindly aped by the global South. For true development is not simply a linear path, neither is it

'the process of change towards those types of social, economic, and political systems that have developed in Western Europe and North America'

(Eisenstadt, 1966).

Rather development is unfolding of the true potential of a region and its people while preserving difference in culture, developmental styles, and options of diverse regions, the autonomy of indigenous groups, and defending the specificity of local action (Leff, 2009). It is more like blooming of a seed into a giant tree while still being rooted in its local climate and soil, providing refuge, food and other needs to a large range of living beings – a great example of mutual coexistence. Only then can we prevent this blue plant from turning prematurely grey and bald. The choice is ours.

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