IMPACT OF BUILDING MATERIALS ON BIODIVERSITY

[1]ROHIT MUKHERJEE, [2]MADHUMITA ROY

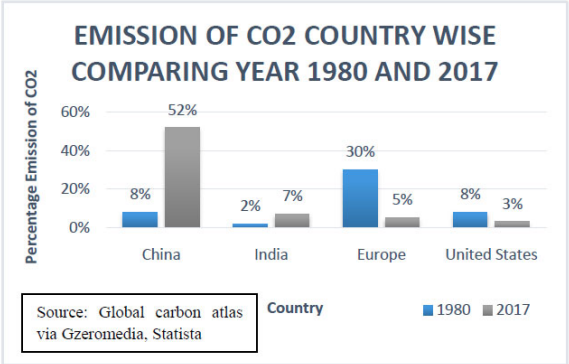
[1]Research Fellow, Energy Efficient Built Environment Lab, Dept. of Architecture, Jadavpur University 188, Raja S C Mullick Road, Kolkata-32, India
[2]Professor, Energy Efficient Built Environment Lab, Dept. of Architecture, Jadavpur University 188, Raja S C Mullick Road, Kolkata-32, India
E-mail: [1]rohit09mukherjee@gmail.com

Abstract -
According to a 2019 *Global Assessment Report on Biodiversity and Ecosystem Services* by IPBES, 25% of plant and animal species are threatened with extinction as the result of human activity. The period since the emergence of humans has displayed an ongoing biodiversity reduction. Biodiversity –the variability among living organisms is an indicator of a healthy ecosystem. Nowadays, the construction of buildings and manufacturing of building materials have grossly affected the overall biodiversity especially in cities. In most of the countries, the building construction activities are largely concrete based and cement being the main binding material in concrete, there is a huge demand in the production of cement in industries. This demand and supply will increase more in coming years. This increase in the production of cement will require a bulk consumption of raw materials which in turn will result in substantial depletion in natural resources involving significant amount of release of harmful gas and large volume of carbon di Oxide and other waste which is harmful not only for our atmosphere but also water bodies where this waste materials are deposited.Glass is another important building material which is being used in abundance nowadays. It also add to the beautification of the building from inside as well as outside which may satisfy humans but erection of glass building is creating huge impact on bird mortality rate which is a very important aspect of our ecosystem that we have to notice for future sustainability. From a recent review, scientists have estimated that not less than 100 million birds die each year in the US colliding with the glass covered skyscraper.The biodiversity impacts of renewable and non-renewable materials in LCA. Hence the extraction of raw materials and the careful selection of building materials must be done in a way that explains sustainability so that we can find a way to replace the conventional energy-intensive materials with much improved raw materials or renewable resources which can help the ecosystem to maintain its balance for the generations to come. In this paper we have used birds as biodiversity indicator and analyzed the effect on birds due to different building materials used in city of Kolkata.

Keywords - Building Materials, production of Cement, Biodiversity, Glass Building, Birds

I. INTRODUCTION

When we define biodiversity, there are three main levels. First is habitats which is composed of wetlands, rainforests and coral reefs. Second one is bird which is most important species that indicates the effect of biodiversity and third one is composed of genetic diversity within the species this is one of the main reason why the genetic modification take place. (Edwards, 2010). India contains over 7 per cent of the world's biodiversity covering over 2.5 per cent of the Earth's surface (Amlesh, n.d.). The regulation of European Union and global narrative of sustainability made a close scrutiny to expose the impact building design and construction on the biodiversity. Some architects and engineers have already are aware of this problem and have started to fillthe gaps between construction and engineering technique and biodiversity by taking principles from around the nature and applying them to building construction technique to make it more environment friendly (Edwards, 2010).With more increase of population there will be more extraction of raw materials and more increase in production of cement as binding material for building construction industries. Though it benefits the people with employment, home, money but It have its own negative effect. Construction sector results in 23% of total air pollution, 40% of drinking water pollution and around 50% of landfill wastes.



According to U.S. Green Building Council (USGBC), the construction industry results in 40% of worldwide energy usage and it is estimated that by 2030 the total emission from commercial buildings will increase by 1.8%. (Snook, 2017)After water, concrete is the most widely used substances on Earth as the most-consumed resource on the planet. Globally cement production has increased more since 1950 and almost four times since 1990. Till 2017 it is seen that China and India produces more cement around 4000 and 2000 millions of tones respectively which is more than entire European Union and US produces.

(Rodgers, 2018). The rapid rise from developing nation to superpower and its extraordinary growth is forcing India to produce mountains of cement, utilize beaches of sand and lakes of water. In this paper we have used birds as an ecological indicator and analyzed its richness and frequency and tried to find its relation to the nature of building materials used in the city of Kolkata. In the above chart we can see the global emission of CO2 due to cement production which is increases by a huge number in china followed by India while the other countries such as in Europe and in US the emission decreased (Statista, 2019).

1.1. Effect of Concrete on Environment:

Concrete is used as a key building material for most foundation and footing of any kind of superstructures. It is also used to construct building, car parking spaces and basement, bridges and dams and almost anything that human can construct. Cement being the key ingredient in concrete is responsible for its strength due to the presence of carbon di sulfide(C2S)and carbon tri sulfide(C3S). Cement is made in industries using limestone and clay as main raw materials which are quarried and crushed, mixed with iron ore and ash and heated at temperature around 1450 degree Celsius. The process of calcination takes place to form clinker is the main reason behind the emission of carbon di oxide in the atmosphere.(Rodgers, 2018). If Cement industries if considered as a nation, it would be the third largest carbon dioxide emitter in the world with up to 2.8bn tones, which is only surpassed by China and the US. Each year, more than 4 billion ton of cement are produced which results in around 8% of the world's carbon dioxide (CO2) emissions, a potent greenhouse gas. 50% is emission is caused due to chemical process and 40% is caused as a result of burning fuel. The remaining is due to transportation and electricity uses. It is estimated that around 5000 million metric ton of carbon dioxide is projected to get emitted from the global cement industries by the year of 2050 (Lorenzo H. Zambrano, 2002). Other Volatile organic compounds that are released such as NOx and Sox are responsible for local pollution causing respiratory problems. Concrete used underwater also has its effect there too as it proves to be poor for marine and aquatic life due to its high alkalinity having pH value of 13 which is higher than pH value of sea water (Samiyra Abdus-Samad, 2013). It nearly consumes at least 10^{th} of the world's industrial water use which results in restricting the supplies for drinking water and for irrigation affecting the livelihood of the people and other animals on this region.

1.2. Effect of Glass as Building Materials:

Nowadays in concepts of architectural design glass are largely considered in modern constructions and high rise building to avoid concrete uses. In the last 25 years the use of glass as main building material has considerable increased (Achintha, 2016) due to a large number of aspects such as beautification modernization that includes transparency, illumination which progressively increased the usefulness and interest for such innovative constructional material in building (Bedon, 2017). Being transparent the glass gives a sense of open space and letting in more natural lights while it keeps out rain and insects away (Singh D. , 2015). However, when compared to other traditional building materials, standard glass although is having high compressive strength but it is typically brittle in nature and with limited tensile resistance which is a major setback in the safe design point of view (Bedon, 2017). There is another major setback to glass material that is glass traps heat. It is the principle of glass that is inclined to greenhouse effect. Building which have high proportion of glass sometimes gets overheated when there is not sufficient internal cooling system. Another major issues related to the glass building is birds. The glass building is the reason for death of many number of bird every year. It may be due to the reflection or vegetation on this glass and the view of vegetation on the other side of the see through glass may confuse the bird which collides with it and die. (Fischer, 2013). So several research must be done which takes into account the multiple aspects of glass as a material in use as building construction, such as mechanical properties and its high sensitivity to temperature, effect on thermal properties on glass due to fire, (Bedon, 2017)effect on compressive and tensile strength of bird due to seismic pressure and sudden load, its effect of brittleness and also introduction of graphically designed glass or colored glass that may reduce bird mortality rate.

1.3. Effect in India:

Eyeing the growth market in India who have become a huge production hub for construction related business, the research and development of cement industries is a key in this regions. India is a developing nation and to match its development with the western countries and China it need more and more industries and construction project which although boost the economy of the nation but it also results in increasing vulnerability to other climatic impacts directly and indirectly. On the basis of this context of growing public concern and a challenging period for financial performance are forcing the major cement hub to re-examine and move into more innovative business models for future. India can reduce can speed up their decarbonization process from cement industry by accelerating up the process of using flyash and more use of blast furnace slag cement. The brick which are used as building material made with clay earlier can also be made with flyash which will not only increase the strength but also is available with reduced cost. Reduction of high-blended cements can also be a remedy with

slowly moving out of use of coal and finding the use of an alternative to clinker such as calcined clays (Johanna Lehne, 2018). The sustainability rank of Eco-Friendly building materials are 67% where the sustainability of conventional system is 56%. (Nishad, 2018). Construction of green building is slowly increasing in India with total construction from 6,000 sq. m of green space in 2003 to 304,800 sq. m by the end of 2008, as per the Indian Green Building Council, which is promoting the movement of green building in India. The first green building which is constructed in India was the CII-Sohrabji Godrej Green Business Centre in city of Hyderabad. In city of Kolkata the Technopolis is said to be first green building for information technology in India. There are also other benefits and advantage for the construction of green building as real estate developers can charge a higher rate for such buildings. The green building is said to be cost between 4% and 10% more than the normal conventional buildings. (Hussain, 2007).

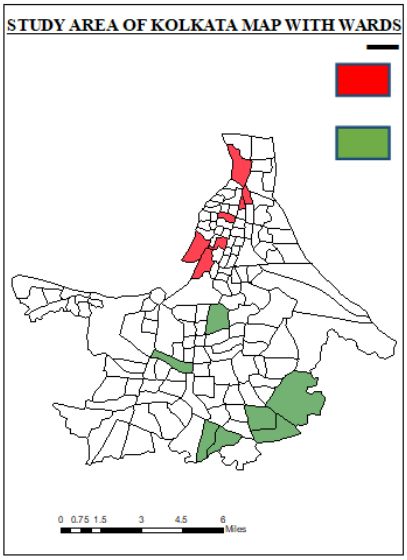
1.4 Birds as a Biodiversity and Ecological Indicator:

We humans derive great pleasure, fulfilment and inspiration from watching birds and listening to them and consider them as a part of our social life from chirpings in the morning till evening but birds are also an important component of ecosystems (Hill, n.d.). Birds play an important role in the effective functioning of ecological systems transforming pollutants into nutrients also providing insects and rodents control. Birds eat up to 98% of worms and around 40% of all non-outbreak insect (Birds as Environmental Indicators, 2009). As birds are high up in the food chain, they are also good indicators of the general state of our biodiversity. When they start disappearing or showing some unnatural changes in their behavior in mass number, it means that something is wrong with our environment and that it is a high time to analyze the problem and to take necessary action. Hence to analyze the effect of building material on biodiversity we have used the effect on birds due to the use of different building materials.

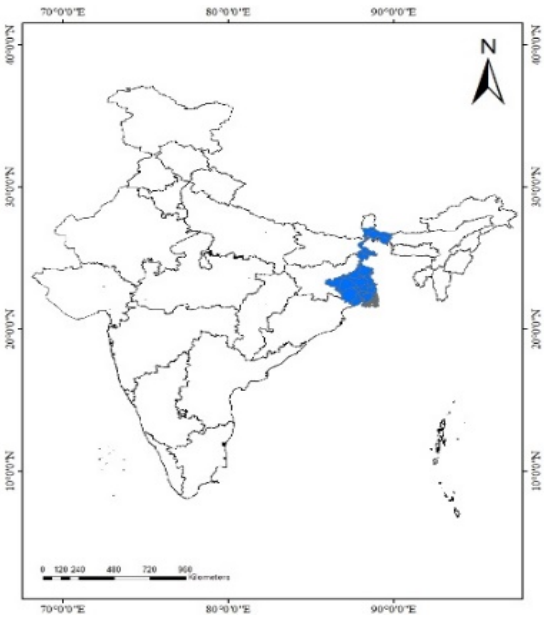
II. MATERIALS AND METHODS

In our survey we have chosen total fourteen survey lines 500m each from fourteen wards each in Kolkata metropolitan area. Out of this fourteen wards seven are chosen from the area where the surrounding buildings are mainly of old architectural design which was constructed before independence based on exposed brick structure with lime mortar remaining seven lines we have chosen in areas where surrounding houses are mainly of modern architecture which was constructed after independence based mainly on RCC structure, glass building and fly ash brick as building materials. All fourteen sites are chosen keeping other factors such as vegetation, traffic intensity, human footprints same. In each survey line three points are chosen that is on start middle and end point on this survey line with 250 m gap. The frequency and richness of bird's species are observed within 30m radius in each of this three point for 10 minutes for each points. The time of starting our survey is from 6:00 AM morning when the birds more seen and during winter season.

III. STUDY AREA



- Color areas in map denote the survey Ward where old buildings are present
- Color areas in map denote the survey Ward where new buildings are present made with modern building materials.



The above map shows the location of West Bengal in India and the Ward map of Kolkata city along with the chosen wards for our survey.

IV. RESULT AND DISCUSSION

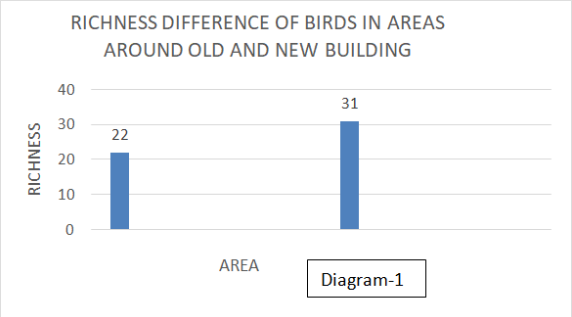


Diagram-1

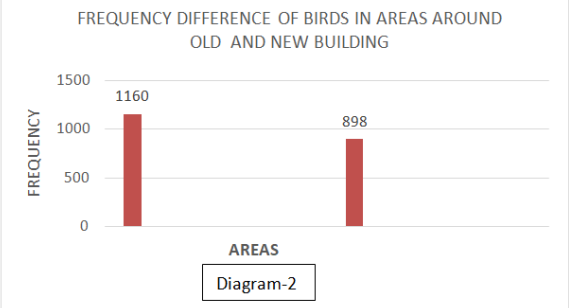


Diagram-2

Here in this diagram 1 we can see that bird species richness in places where there is a presence of old building is less than in places where new building is present. This may be due to the reason that old abandoned building made with lime mortar and lime mortar is breathable which absorbs and release moisture. When dust and soils gets deposited on the corners of walls and inside it allows insects to grow and other invertebrates which is not seen in areas where new building are present. Few birds fly and come in large number in such places of old buildings to feed on those invertebrates this may help to increase the frequency of few certain bird species in the area such as house crow, rock pigeon which feed on this rodents and insects, the non-availability of space between old buildings also seems to attract this birds to perch in large numbers which decreases the richness of the species in the area. In modern residential building areas the building use modern paint with putty and some building also use ecofriendly material such as fly ash. This do not allow the growth of any such insects or plants on building corner also the presence of trees around buildings provide fruits which attract good number of species increasing the bird richness of the area but the frequency of dominant birds such as rock pigeon and house crows decreases due to the unavailability of insects and rodents which are normally available from corners of old buildings.

V. GLASS BUILDING AND ITS IMPACT ON BIRDS

The increase in the number of construction and high rise building is creating a heavy toll on its numbers. Increasing number of birds are dying every year due to collision on high rise glass building. This could be due to the reflection of trees and surrounding habitat on glass which often may confuse the birds when they fly another reason could be the transparent windows confuses the birds and they collide while flying through it. After surveying in Kolkata city for winter season we found that more richness in birds are found in a place where building and vegetation are present but in places where building with glass panel fitted as alternative to concrete there has been considerable reduction in bird species and only species that are found around is Rock pigeon, black kite and house crow. Well this may be due to the reflection of sun from glass which do cause a glaring effect and also due to less place for bird to create their nest on glass building as there is no lintel or verandah or ventilator. Some of the technique which can be implemented to eradicate this problem is one can build a window grill outside glass window so that bird can understand. Using a curtain inside the room so that the glass is not transparent. Anti-reflective window screen and Glass art on windows can be another important aspect as it may both reduce the collision rate but also it increases the visual satisfaction for humans (Horton, 2013). Fixing the glass in different angle in building can also reduce the reflection which may reduce the collision and also give an innovative approach to the building design.

VI. CONCLUSION

The impact of building materials on birds which is an indicator of biodiversity as analyzed in this paper found that diversity in ecosystem is more where there is less pollution along with building which are mainly made from flyash bricks and RCC. However the number of birds in the areas where buildings are made with lime mortar and building with exposed brick surface shows high frequency but low richness. The introduction of fly ash brick can be a turning point in this effect of biodiversity and environment due to their ability to lessen the release of greenhouse gas into the air thus reducing the global warming. Although sustainable building materials usually cost more however it has been found that that many green and environmental friendly strategies and with little shifting from the conventional system made it cost the same or sometime even cost less than traditional technique. If we blend the right amount of green technologies which is less in cost with techniques that cost the same or slightly more than we may make a green building project that costs the same as a conventional one and sometime even less(Masterbuilder, 2013). The use of lime mortar is much more breathable than cement mortar as it absorbs and release moisture and is more compatible with the change in climatic condition in India where the weather is mostly humid in nature. Furthermore lime as a material is much more flexible and porous and the reason the insects and rodents are found mostly in the corners of building where lime mortar

are used is because of its tendency to release moisture. The birds are as a result are attracted to this rodents and feed on them which in turn produce a control in the ecosystem. So we need to explore more on the use of lime and flyash as alternative to cement so that we can build a green environment for the near future and also reduce the effect of greenhouse gases in the atmosphere produced during cement manufacture. India is diverse and consists of two of the world's 25 biodiversity hotspots as a reason of their extraordinarily high levels of species-richness (Amlesh, n.d.).Hence to protect this diversity Government must lay a foundation and more economy for the research institutes so that more innovation may develop and construction companies should join their hand to bridge the gap between common people and green innovations.

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