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SCOPE OF MODELING FOR URBAN LAND-USE LEADING TO CLIMATE CHANGE

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Abstract: Climate has a direct effect on the way we live, work and recreate now and in the future. It is inextricably linked to urbanization, and its impacts can be seen everywhere, with major and visible impact in low-lying and delta areas. There exist evidence that climate change will increase the prevalence of certain natural hazards, including extreme weather events. Climate change impacts affect all countries, with developing countries and the poor being the most vulnerable. An urban area has land uses defined as residential, commercial, institutional, public spaces, open and recreational spaces, transportation and infrastructure. In some cities, industrial land use is also identified. These urban spaces act as the largest contributor to economic activities. As the urban areas can be a victim of the ill-effects arising from climate change can hamper the development at large. Rising population and densification of urban areas that too with expanding spatial horizons, the urbanization posing to threat the climate. The larger a city, more will be needs for transportation, housing, and other land use requirements. In general, it all will generate an enormous demand for electricity. Urban centers in the coastal regions pose a major threat to the effects of climate change. The developing countries and urban centers thereof are mostly vulnerable as the citizens are striving to survive and stabilize. Earlier attempts as made for the climate change effects are limited to different specific effects. The paper discusses the scope of developing a model based on land use interventions for climate change. A case of Surat city is discussed here with revealing the scope of work based on the discussed intervention.

Keywords: **Climate Change, Economic activities, Land use, Surat, Urbanization**

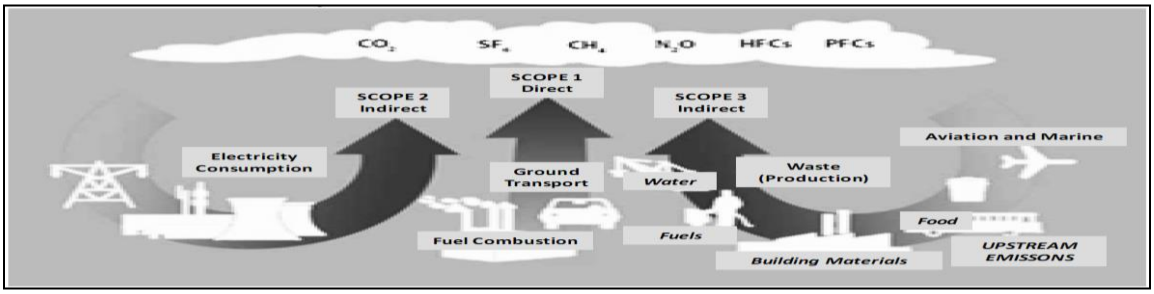
I. INTRODUCTION

Climate has a direct effect on the way we live, work and recreate now and in the future. It is inextricably linked to urbanization, and its impacts can be seen everywhere, with major and visible impact in low-lying and delta areas. There exists evidence that climate change will increase the prevalence of certain natural hazards, including extreme weather events. Climate change impacts affect all countries, with developing countries and the poor being the most vulnerable. However, instead of viewing vulnerability to climate change as an additional concern, cities can mainstream resilience into existing efforts. Increasing urban resilience and viewing climate change as an opportunity

rather than as a threat requires innovative ideas and immediate action in land use planning (World Bank Institute, 2015).

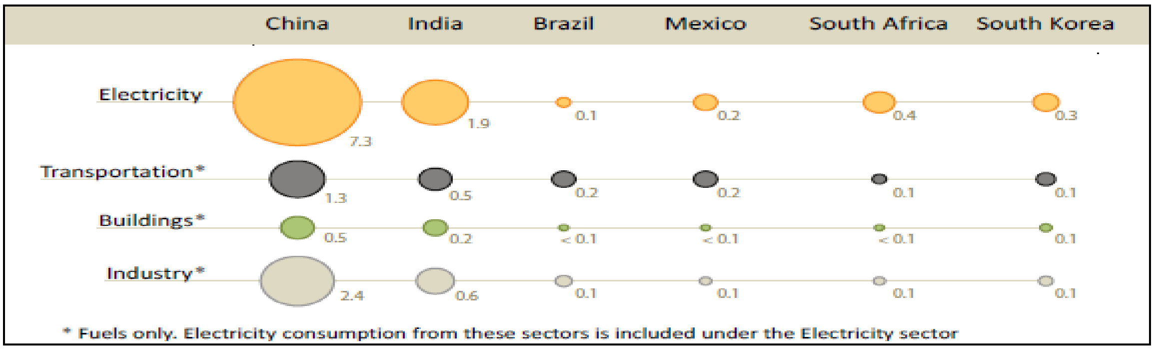
India is among the top most populated countries in the world, and it is among the fastest developing nation adopting technological advancements. As an effect of efforts of the National Government in India, the cities are becoming more and more technology friendly. Also, with the development of smart cities, the consumption of electricity will increase as theses both have a direct relationship. It will be inducing more and more GHGs resulting in the climate change (Carbon Finance at The World Bank, 2009). Fig. 1 below shows a relationship that the development of urban areas will not only lead to increased consumption of electricity, but the GHG will also be contributed by increased ground transport, fuel consumption, building material production and consumption as well (refer to Fig. 2). An estimate of UN World Urbanization Prospects states that by 2030 in India, urban population will reach 609 million leading to per capita GDP of USD 4,205 and subsequent electricity demand will rise to 2499 TWh.

Figure 1 Scope of Urban Greenhouse Gas Emissions



Source: (World Bank Institute, 2015)

Figure 2 Projected 2030 baseline GHG Emissions by Sector and Country



Source: (World Bank Institute, 2015)

Rising population and densification of urban areas that too with expanding spatial horizons, the urbanization posing to threat the climate. Present proposal expects to include study the urban spatial expansion with land use changes, population densities, transportation, building activities, electricity consumption, area-wise changes in climate and such in the past and existing situation. The motive of the attempt to address the identification and to model the level of vulnerability incorporating parameters leading to climate change in the urbanized area.

II. LITERATURE SURVEY

Recent work in 2016 by Rajashree Kotharkar et al. on the Land Use, Land Cover, and Population Density impacting on the Formulation of Canopy Urban Heat Islands. The researchers carried out the study through Traverse Survey in the Nagpur Urban Area, India. Their work discusses an observational study that explored the impact of land use/land cover, and population density on the formation of canopy Urban Heat Island (UHI) in Nagpur. The study aims to compare the UHI canopy hotspots and heat sinks on urban land use/land cover, and population density as the main determinants in urban areas. Traverse (Rajashree Kotharkar, 2016). A study conducted by Aisa Henseke et al. in 2015 revealed climate-change sensitive residential areas and their adaption capacities by urban green changes. It was focusing on identification of residential areas most affected by climate change according to surface cover structure and demographic characteristics in City of Linz, Austria by using satellite images and demographic data (Aisa Henseke, 2015). Jugen Breuste et al. in 2015 contributed through a marathon study on green infrastructure predicting for urban sustainablity. Through a special issue (SI) “Green Infrastructure for Urban Sustainability” of the Journal of Urban Planning and Development (JUPD) they aimed to bridge the knowledge gap between urbanization and it's quantitative and qualitative impacts on urban green; challenges and opportunities for urban green infrastructure facing climate and demographic change. Also, they showcased best practices of planning and managing urban green infrastructure (Jugen Breuste, 2015).

Thomas A. Wall et al. in the year 2015 proposed a dynamic adaptive approach to transportation and infrastructure planning for climate change and explored the San-Francisco-Bay-Area. They proposed an emerging general strategic planning method using dynamic adaptive planning (DAP), to account for deep uncertainties by building flexibility and learning mechanisms into plans that enable continuous adaptation throughout implementation. Paper first reviews uncertainty in general, introduces what is meant by deep uncertainty, and then introduces DAP (Thomas A. Wall, 2015). Wenting Zhang et al. in the same year discussed over land use optimization for rapidly urbanizing city regarding local climate change taking an example of Shenzhen city of China. The approach discusses a genetic algorithm-based multi-objective optimization (MOO) approach was developed that addresses the objectives for future land use to make a sound land use plan for Shenzhen in 2020, a rapidly urbanizing city in China suffering from Urban Heat Island (UHI) due to its fast land development. The MOO provides a set of Pareto solutions and then the decision maker or planner can choose from the set of solutions (Wenting Zhang, 2015). Work by Eeva-Sofia Säynäjoki et al. in 2015, identified the role of urban planning in encouraging more sustainable lifestyles. They discussed results produced by a hybrid life-cycle assessment model, which attributed the end-to-end emissions of supply chains to end users, consumption that is not related to housing or ground transportation was found to account for 30% of regional greenhouse gas emissions on average (Eeva-Sofia Säynäjoki, 2015).

Another study by Albert Hans Baur et al. in 2014 discussed the urban climate change mitigation in the Europe beyond the role of population density. The study specifically analyzes the **importance of population density in the reduction of urban greenhouse gas emissions** in Europe. For this, drivers of both carbon dioxide (CO_2) emissions from transport (for 134 cities) and total urban greenhouse gas emissions (CO_2 eq emissions) of 62 cities across Europe are investigated (Albert Hans Baur, 2014). The work of Deyong Yu et al. of 2011 identified improvement in the ecosystems services are essentially required by integrating the urban land use planning. The study aims at the **application of ecological principles to develop an integrated urban land-use planning** for Panyu case that could optimize the urban ecosystem. The Panyu is classified into four functional zones (Deyong Yu, 2011). Ji Han et al. in 2009 evaluated the land use in rapidly growing urban parts in China and discussed the case of Shanghai. The paper highlighted the investigation of not only the socio-economic factors driving urban area growth but also the physical elements affecting urban land's spatial distribution through remote sensing and multivariable regression methods (Ji Han, 2009).

Lam et al. in the year 2000 attempted the use of the genetic algorithm to optimize the land use development plan in Hong Kong. In this paper, the genetic algorithm (GA) is used to solve the 0-1 programming problem in which some new land-use plans are identified in Hong Kong so as to minimize the total development and transportation cost (Lam & Yanfeng, 2000). It is the first work to apply GA for land-use problem and practice. Back in the year 1993, Vedia F. Dokmeci et al. proposed a multiobjective land use planning model. They presented a generalized **land-use model to determine the most efficient utilization of land** based on two related objectives: (1) Maximization of return; and (2) minimization of the sum of weighted distances among the different land-use units. The problem is solved according to each separate objective. (Vedia F. Dokmeci, 1993)

III. TECHNOLOGY GAPS

For deriving an intervention, there are gaps identified after carrying out a study of past efforts through the literature review. A research problem may be formulated for growing cities where the land use, population densities, GHG emissions due to diverse reasons can define a relationship between itself that makes cities vulnerable to climate change. A measure that allows a combination of RS, GIS and GA (or other statistical and/or simulation tool) a system to measure the urban expansion based effect of climate change is nowhere existing. Once a model is formed, it can then be utilized to provide intervention in existing situations as well as to have policy implications and decision-making for future development of cities. Mentioned above are preliminarily identified parameters to fill a missing link leaving to it with no past efforts in such a manner. If a researcher is making an attempt thoroughly and standardizes a model, it will help in developing an approach for Indian cities become systematically, sustainable.

IV. PROBLEM DEFINITION

Cities are growing in India at a faster rate compared to the past. Not only natural population is rising but, the cities are facing population expansion due to migration as well. The increased population not only generate pressure on resources but also it makes to cities grow and expand. The larger a city, more will be needs for transportation, housing, and other land use requirements. In general, it all will generate an enormous demand for electricity. In addition to this requirement, the smarter ways of operating services and facilities in a city will also generate total demand for electricity. Non-Conventional Energy Sources (NCES) of power generation have not proved yet to be of intensive use for catering demands, however, to an extent, in pieces, the NCES can satisfy some partial demands. Conventional sources of electricity generate a larger proportion of GHGs that make these cities more vulnerable to climate change.

Remote Sensing and GIS based operations are in developing state in India, and the cities are still due with transforming over digital operations. An analysis of existing land use on such a platform will help in understanding a city better. The Genetic Algorithm technique can then be used to model the city growth patterns with land use variations in a combination with population density and land use.

The researcher may focus on a study to develop a relationship between urbanized land use - urban area expansion and vulnerability to climate change. The need for such an intervention can well be justified in a case of Surat city that is explored here with in a brief.

V. Need for climate-change based land use planning in Surat

The city of Surat has administrative boundaries connecting to the Arabian sea after the urban administrative limit extension in the year 2006. The city has an area of 325 Sq. Km. where the population crosses a mark of 4.5 million (Registrar General & Census Commissioner, 2011). The density of population is about 136 ppha accommodating citizens migrated from across the nation. Surat provides an excellent opportunity for economic expansion with an availability of diverse prospect. The city is growing rapidly as it reported a population growth rate of 76.02% during the census of 2001 and 55.29% for the Census of 2011 (SMC, 2015-16). It is the eighth largest urban center in India. The industrial land use in the city is assumed to cross about 17% (i.e. 55.25 Sq. Km.). The industries established in Surat accommodates Chemical, food processing, diamond cutting-polishing, textiles, yarn-manufacturing, mechanical and IT sectors (about 50,000 units in operation). Major of these industries leverage a considerable amount of pollutants in the natural resources within and surrounding the city. The city has a destitute and weak public transportation that has led to citizens to shift to the private mode for local transit. Due to this, the roads are occupied by vehicles emitting different types of pollutants. The city has a tropical savanna climate which is moderated strongly by the Gulf of Cambay. Annual temperature in Surat varies about 27.2 ºC reaching to a maximum of 39 ºC during summers. The average annual precipitation is about 1192 mm. The city observes flooding on a yearly frequency with over flanking of Tapi river banks and the natural drain network passing through the geographical spread of Surat. The table 1 below shows the highest maximum and lowest minimum temperature along with highest daily rainfall and a monthly total of rainfall observed in Surat city for past a decade. It was reported that the Gujarat state has a rise in annual mean maximum temperature at a rate of +0.01 ºC (Rathore L. S., 2013).

Table 1 Temperature in Surat

Year	Temperature (ºC)	
	Highest Maximum(Date)	Lowest Minimum(Date)
2015	42.2(20)	21.6(02)
2014	41.8(24)	21.4(02)
2013	41.0(29)	21.2(20)
2012	40.6(02)	22.8(01)
2011	39.0(14)	18.5(4)
2010	41.2(13,25)	21.6(6)
2009	42.8(3)	22.0(24)
2008	41.0(23)	21,2(2,18)
2007	42.6(6)	21.6(4)
2006	39.0(21)	20.4(3)
ALL TIME RECORD	**45.6(15,1952)**	**15.0(3,1903)**

Source: (Indian Meteorological Department, 2016)

Above discussions suggest that the Surat city may provide an opportunity to be among the ideal cities to perform a climate change investigation based on the effect of land use changes.

VI. CONCLUDING REMARKS

Global efforts in past depict no strong relationship explored that may be existing between the land use changes and the climate change in an urban area. The attempt can be made for a tropical climate city like Surat. Wherein a hypothesis may be formulated followed by intense data collection and analysis. The data will also include spatial data on a temporal scale. Further, a model may be formulated based on the intervention establishing a relationship among the parameter values. The next task will be to validate the model and seeking generalization of the same. It may, later on, address support in decision-making process while carrying out the urban planning process for the development authorities.

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