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Adaptable Building and Urban Planning for Better Climate Change Impact Assessment

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Abstract

Buildings use 40% of global resources, 40% of global energy, and 25% of global water. Urban areas are the complex interaction of natural and human and with huge concentration of population. However, urban planning and building design play very important role to increase capacity of adaptation in urban areas and address in the urban planning system. Therefore, lack of link between urban development and adaptable building for climate change impacts assessment cause to adverse climate change impacts. Adaptable building planning can assess or minimize climate change impacts and as an adaptation technique and policy can reduce the amount of GHG and support mitigation policies. Based on environmental situations and geographical positions variety of solutions are available to make adaptable buildings. The new technics are required: 1) to promote adaptable building benefits and suitability (e.g. simplifying the system, ownership, long term bank loan, and insurance); 2) to promote the knowledge and suitable tools to increase the feasibility to adapt (e.g. Make it transparent by clear policy and framework, make a bridge and fill the gap of information, and introduce an easy, simple system to encourage different sectors to participate); 3) to promote public and private to invest by firm land use regulations and environmental policies (e.g. improve efficiency, linking adaptable building to air pollution or health problems and more obligations). This paper aims to show how adaptable building in urban areas reduces amount of greenhouse gases, and air pollution and also how adaptable building design can support and address mitigation and adaptation.

Keywords: Climate change; Urban planning; Adaptable building; Mitigation and adaptation

Introduction

Adaptable building cannot be successful without mitigation and adaptation policy integration [1-3]. The meaning of adaptability in urban planning and adaptable building design is so deep and it is linked with culture innovation, technology, research and development [4,5]. The most sophisticated relation between adaptable building and climate change is about how different elements contribute to adaptation. Therefore, effective climate change assessment in adaptable building design in urban planning is related to the urban components and GHG emission [6]. Adaptable building for climate change assessment takes into account different parameters of mitigation and adaptation. These parameters are related to the amount of energy consumption for space heating, electronics, lighting, air conditioning, and refrigeration. The amount of the energy consumption in urban area is related to the climate and climate change impacts, urban area; the seasonal energy increasing and decreasing [7]. According to UNEP-SBCI Sustainable Building and Climate Initiative, building use over 40% of global energy, 40% of global resources, and 25% of global water. UNEP-SBCI project mentioned some key factors which are linked to climate change. 1. The building sector has a very big portion of the global economy by 111 million employees and 10% of global GDP (USD, 7.5 trillion). 2. Over 60% of the world's electricity consumed by the residential and commercial buildings. 3. Current buildings cannot support energy sufficiency policies because most of them have below standard quality. 4. The building sector is one of the largest GHG contributors to global GHG emissions. 5. In developing, countries building sector by new green policies and design will create so many opportunities and participates in 40% of the GDP. 6. Building sustainability provides healthier society and environment [8]. Except from Canada and Russia the global temperature rising, increases energy consumption in commercial and residential buildings for cooling systems [9,10]. European countries have serious steps for greening Europe by zero carbon policies by 2050 [11]. In Europe buildings by 40% of the total energy use and 36% of CO_2 emissions [12] have a considerable impact on climate change. Climate change adaptation consists of actions in natural or human interaction related to actual or expected climate, climatic stimuli or their effects, in order to reduce harm or exploit benefits [13]. The adaptable buildings in adaptable/feasible urban planning system to assess climate change impacts and support mitigation policies. The aims of this article theoretically are based on increasing building and urban capacity for effective adaptation and better climate change impacts assessment. Since buildings are the biggest land-uses besides the other land-uses they have the biggest impact on climate change. Secondly, there is a correlation between adapting to climate change in urban planning and building adaptability. Linking urban adaptation policies to build adaptability has same goals and provides a clear framework for better implementation. Also, in terms of the level of planning this article can show how significant is the impact of climate change at the local level and how buildings and cities can assist for better climate change impact assessment. Moreover, this is not just matter of climate change also this is the right place to reduce the amount of the energy consumption and improving the quality of environment and lives. Saving the amount of money that has spent on energy in term of the time can cover the money that spends on technologies and materials in adaptable housing.

Effectiveness of adaptation to climate change (section 2). The section 2.1 identifies criteria urban planning for better climate change

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impact assessment (review methods and approaches). 2.2. Investigates capacity to adapt in the building sector by linking (energy consumption and emission). (Section 3) illustrates the effects of adaptation in urban planning and building sector is a key factor in climate change and supports mitigation policies. (Section 4) is about discussion and conclusion the remarked issues.

Adaptation to Climate Change

Adaptation to climate change is human efforts towards mainstreaming multidisciplinary science, societies and decision making, with different spatial and temporal impacts of climate change [14]. Buildings and urban are highly interconnected. Integrating urban planning system and building sector are part of win-win climate change impact assessment. Time is important to assess impacts of climate change and reduce the amount of loss and destruction [15]. Obtaining the acceptable achievements of adaptation policies is an interesting dilemma for policymakers. In-situ adaptation is possible and easy to implement, and very suitable to see the results as short term. On the other hand, In-situ adaptation in the location which is out of the plan or marginalized due to any reasons, and where situation are expected to be worse, most probably we have maladaptation. Urban planning system and building are dynamic that needs to become more feasible and transformational in nature instead of protecting current practices [16]. Coupling the prominent role of the city monitored and different climate change scenarios, apparent role of adaptation in urban areas becomes significant.

Adaptation to Climate Change in Urban Planning Context

Since climate change impact has an extreme impact on (urban-regional) level and according to the available literature adaptation to climate change cities are identified as key players for better adaptation to climate change impact assessment [17-20]. Cities appear vulnerable to different impacts of climate change as well as their spatial and temporal functions. Turning climate change into an action plan, project, and program in urban planning system supports experts to build and design resilient cities [21] and improves capacity to adapt in urban areas, which relates to urban planning feasibility to manage, control, and forecast the climate change impacts. However, cities are the complex system and adaptation requires identifying different drivers in the system under adaptation [22,23]. These complex systems are components such as variables, concepts, relationships, and evaluation metrics [24]. Rapid urban population growth, increased urban share on climate change impacts. More than half of the world population live in urban areas and it is expected by 2050 two third of the population live in urban areas [25]. Urban areas have an effect on the expected climate change scenario. The future climate change on mitigation depends on a number of variables which are directly and indirectly in adaptation [26]. Human activities on land development, deforestation, and urban development [27]. Urban development covered 2 percent of the world and they have over 70% GHG emission [28]. Cities are the first responders to climate change impacts. In fact, cities are where climate change happening and climate change happens in cities. Therefore, we can identify factors that necessitate adaptation to climate change in urban areas. Firstly, the world urbanization trend shows that in future two-thirds of the world population lives in cities [29]. The cross-sectoral dimensions of climate change are equally important in urban areas. Although, researchers found that there are potentials to integrate energy sector, housing, urban transportation, urban planning system into climate change policies. Secondly, the economic development and economic activities in urban areas are accompanied by huge environmental and climate change impact [30]. Human activities in urban areas have rooted in urban and regional economies. Thirdly, urban form and density provide quality of urban environment and quality of living. There are many links between urban energy, urban transportation, and physical characteristics such as size and amount of open space [31]. Fourthly, urban geographical location is a key factor for adaptation to climate change. Urban environment is formed by natural land transformation to the built environment by changing levels of exposure [32]. There are some facts like pleasant environment and less need to cooling or heating system. The geographical location in urban adaptation policies such as the amount of the precipitations (snow and rain) precipitation duration and spatial and temporal patterns provides a situation for better implementation. Fifthly, population growth and migration rate exceed from appropriate human and environmental development and minimizes effective adaptation. Rapid population growth limits urban resources and more impacts on the environment by destructive overusing of the urban environment. Sixthly, the urban function is important when cities are the centre of economic and industrial development [33]. Long-term climate change impacts assessment through adaptation policies and linking urban functions to the climate change increase capacity to adapt. The feasible economic efficiency of adaptation measures reduces the cost of current and future climate change impact.

Adaptable building to climate change impacts

Adaptability refers to design characteristics includes spatial, structural, and service strategies that allow physical artefact a level of visibility in response to changing operational factors over time. It does not mean these changes in buildings are finished work, but is increasing the capacity and feasibility of changes over time by functional, technological, and aesthetic metamorphosis in society [34]. This is a shifting paradigm for supporting current "form" and "functions" towards immediate decision making and move towards a "context" and "time based" view of design. Level of adaptability in one terraced dwelling, one semi-detached house and two individual dwellings is different. Buildings contribution to the amount of GHG emission and their size and design can impact on the quality of the urban environment (pollution, wind direction, temperature, and precipitation). When outdoor temperature is high the only adaptation option is increasing energy consumption [35]. There are some effective criteria that can support building adaptability policies. Firstly, flexibility or enabling minor shifts in space planning. The main concepts of flexibility in term of the time have changed. Flexibility is as early stage planning action reduces cost and increases ease implementation for potential bigger future impact. In the 21th-century building, flexibility means providing shelter for people in big number especially for working groups [36]. Secondly, convertibility or allowing for changes use within the building. Convertibility refers to placing some functional changes to reduce construction cost and time by predicting current and future needs. All these changes under convertibility answer to needs which are in large spatial and temporal scales. Thirdly, expandability or facilitating additions to the quantity of space in a building. Changing in building size and shape for using more space in the vertical and horizontal expansion [37]. New building technologies using and installation requires space. Expansion buildings and capacity for increasing the size of the spaces means better use of energy, resources, and increase successful/win-win adaptation to climate change. Therefore, buildings have a big impact and at the same time, they have a big capacity to assess these impacts. There are very low ties and contact between the built environment and the surrounding environment.

Adaptation for better mitigation

The 5th Assessment report of the intergovernmental panel on climate change addressed the sustainable development comes from a combination of mitigation and adaptation [38]. In this report they justified that the adaptation and mitigation integration is climate resilience, or capacity socio-biological systems to assess climate change impacts. Mitigation and adaptation, integration for better climate change assessment drags more public and private sector to participate. According to United Nations population project, the world population will increase and by 2050 the world population reaches about 9 billion. Millions of people move to cities and the situation in Africana and Asian countries become very difficult [39]. Rapid urbanization and population growth have realised 900 billion tonnes of carbon dioxide. The main reason for increasing carbon dioxide is industrialization and huge land use change for urban areas [40].

Figure 1 shows how adaptation and mitigation on climate change have different causes, but for effective climate change impacts assessment they integrate and co-partner. Per capita emission in the future can assess by current, appropriate adaptation policies and increase capacity to integrate future climate change impacts into adaptation and mitigation. Therefore, reduce the destructive impact of development by increasing adaptability and upgrading project efficiency causes orchestration between mitigation and adaptation objectives for better implementation of projects. These projects, as the outdoor climate (land-use and urban planning) or indoor (building adaptability) outdoor condition push people to consume more energy in indoor and indoor energy consumption more GHG emission. Increasing urban and building adaptability reduces such unpleasant circumstances.

Sustainability and Adaptability

Adaptable housing is seriously challenging the sustainable development and sustainable policies. European countries have special attention and concerns about sustainability. Adaptable housing improves quality of life by improving building capability for fitting new technologies and increasing better use of water, waste management, and as result lifetime durability and affordability. Adaptable housing not only need to the current answers also they need to answer the future needs and future sustainability too. Therefore, time and cost [41] contribute to achieving the sustainability and adaptability goals. So, sustainability and adaptability are not so far from each other and sustainable building is an adaptable building. The link between adaptable housing and sustainable housing is the capacity for adaptation for better mitigation and Carbon Emissions and Energy Consumption plays a very important role. The amount of energy consumption usually is linked to the amount of the carbon emission where most of the cooling and heating systems directly or indirectly have biomass source.

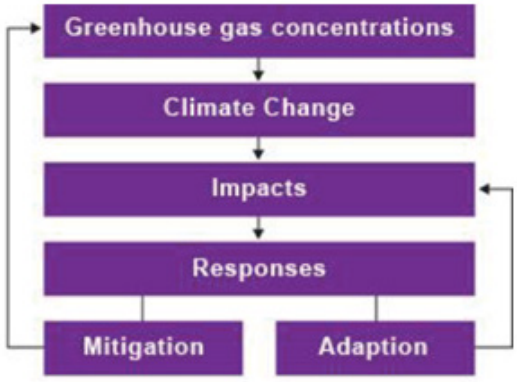

Figure 1: Relationship between mitigation and adaption.

According to the UNDP report in 2016 [42], the energy consumption in building and housing and for building and housing is one-third of the world energy consumption and it is one-quarter of the world GHG emission. The population growth and the world building sector development are expected by 2050 building sector using more than 50% of the world energy (UNDP, 2016). Table 1 shows the amount of the energy consumption in building sector and from 2015, and based on that forecasted for 2030, and 2050.

Since, global warming is the most serious impact of climate change the statistics show that space heating is the most energy consumers with the highest emission; 1405 emission with policy coverage ($MtCO_2$) out of total 2817 million not only is the biggest consumer sector also most of the energy have wasted for cooling and almost 50%. However, lightning is the second cause of energy consumption in buildings built with less emission in comparing to the other uses of energy in buildings and 730 emissions with policy coverage ($MtCO_2$) out of total 1156 million tons of energy for lightening purpose. Water heating 372 emissions with policy coverage ($MtCO_2$) out of 1114 million ton energy and space cooling with 375 emissions with policy coverage ($MtCO_2$) out of 893 million ton energy consumption is the last contributor to energy consumption in the building and the last contributor to climate change.

Linking a huge amount of energy consumption to the building sector and looking at the future and demands in the future and showing how the building sector contributes to climate change. Assessing current climate change impacts in building sector improves the quality of life in urban area, improve the national economy by cutting energy consumption, as a result improves local government, and contributes to future climate change impact assessment A below 2°C pathway requires reducing global energy and process-based carbon dioxide (CO_2) emissions by 60% in 2050 compared to 2012 (UNDP, 2016).

Conclusion

Assessing current challenges in urban climate change cannot be successful just by mitigation policies is impossible. Where cities are the biggest contributors to climate change and GHG emission, but adaptation is important for better climate change impact assessment. Urban design and buildings are part urban planning and anthropogenic

North America	38.1	47.1	56.9
Western Europe	29.8	34.3	36.9
Eurasia	9.8	13.1	14.9
China	57.2	79.3	84.6
India	15.8	32.1	57.6
Japan and Korea	9.8	10.9	11.1
South East Asia	15.6	23.8	32.3
Australia and New Zealand	2.1	2.7	3.4
Latin America and Caribbean	19.3	29.1	43.1
Middle East	8	12.7	18.3
Africa	18	30.4	56
World	223.4	315.4	415.2

Table 1: Building floor area growth to 2050 by region Billion m2 2015 2030 2050

impact of human on the environment by changing land cover and land-use. The changes in land under urban and building development can be adaptable under adaptation policies. Assessing climate change impact of increasing urban and building adaptability not only supports adaptation policies also supports mitigation policies too. Temperature, wind, cooling, heating, energy consumption, the amount of emissions, and spatial and temporal changes of precipitation relate to adaptation first and then mitigation. Effectiveness impacts climate change happens when we identify the important sectors and inappropriate scale. Assessing climate change impact through adaptation policies increases capacity to adapt to other sectors and in the different level of decision making. Identifying urban scale and building sector as the most contributors to climate change by huge land-use and land cover change. Climate change impact assessment by appropriate criteria identification. Identification of the new techniques and criteria in adaptation to climate change by promoting adaptable building and sustainability for the high quality of the environment and human societies. Introduce and provide the adaptability, knowledge. And at the end provide a strict policy for the public and private sector. Statistics show that building is the biggest energy consumer and the biggest contributor to climate change impacts. Knowing capacities, opportunities, and barriers in current building sector guides decision makers, policy makers, urban designers, Planners, and stakeholders to pay special attention on energy consumption and efficiency in the building sector. There are many new affordable technologies that can provide what the building sector needs for better and effective mitigation policies in the building sector. Building for people after food is the most important need and governments always have many plans and promises for the building. Providing building for people is not enough and people need to live in the house with the best quality of cost-effective energy it does not matter whether these houses are luxurious or affordable buildings for the middle class or poor people. The lifetime economic living cost in term of the energy and emission creates a good living condition. Moreover, middle or low-class families encourage buying these houses and avoiding living in informal houses. So, the numbers of the beneficiaries are countable. Families save money, living in the clean environment, helping national policies and saving energy at the local level, improving the relationship in community, increasing quality of environment and quality and life.

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