Civil and Environmental Research www.iiste.org
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.8, No.1, 2016

The Impact of Urban Form Characteristics on Carbon Mitigation Process in Cities

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Abstract
Cities are the main emitters of carbon dioxide and other greenhouse gases (GHGs) that cause the most dangerous phenomenon on the planet which is climate change. The research in how to reduce the effects of this phenomenon should have the priority especially by urban planners and designers. It is known that cities form just 2% of the total earth area but they consume more than 75% of the total energy and release more than 80% of GHGs. Although, there is a rich body of research to reduce carbon emissions from cities, the relationship between carbon mitigation process and urban form characteristics still needs more research work. So, the research gab that should be covered by this paper is; there is a need to address the role of urban form characteristics as a crucial factor in carbon mitigation process at a city scale. In other words, this research attempts to answer this main question:Can a link between carbon mitigation process and urban form characteristics be founded? This research aims to determine the relationship between the urban form characteristics and the carbon mitigation process in cities.Many cities have already made their carbon mitigation processes. This paper analyses and focuses on the urban form characteristics that have had an impact in the accounting and processing carbon emissions indirectly in these cities. So, this research needs to verify why these emissions in these particular areas are different based on our own thesis which is there are different urban form characteristics that affect the amount of emissions and the mitigation process required. To explain this impact, the research has analysed many cases of carbon mitigation processes in cities and has concentrated on the large cities in three main continents which are Asia, Europe and the North America.This research has analysed models, tools and techniques for urban carbon and energy modelling and has evaluated their relationship with cities' urban forms. It has determined urban form characteristics by either studying urban form characteristics separately or studying the previous carbon mitigation efforts that mentioned some of urban form characteristics. This paper has presented the role of urban form characteristics in carbon mitigation process in the cities under review. It has identified common characteristics of urban form that are repeated as factors in plans and strategies of carbon mitigation.
Keywords: Carbon mitigation process, urban form characteristics, greenhouse gases (GHGs), climate change

1. Introduction

It is widely recognized that climate change is an urgent global challenge, and cities around the world must be at the front lines of meeting this challenge (Lamia, 2008).

The world-wide scientific community agrees that climate change will form one of the greatest challenges of the twenty-first century (Colette, 2009). The scientific community expects through climate models that the global temperature will rise by about 1.4 - 5.8 °C by the end of this century. This change would be the biggest climate change experienced for the past 10,000 years (Töpfer and Hunter, 2002). A clear indicator of climate change is that the years between 1995 and 2006 were eleven out of the warmest twelve years since the mid of the nineteenth century when records began (Prokosch and Hambro, 2009). In addition, sea levels have increased all over the world by 1.8 millimeters yearly between 1961 and 1993 and these levels jumped to 3.1 millimeters a year since 1993 (Prokosch and Hambro, 2009). All these signs point to the importance of cities to take a role in alleviating the causes of climate change because cities contains the largest percentage of population and they are the most contributors of carbon dioxide emissions as well.

As a result of climate change and its effects on human life, many scientific efforts have been carried out for the purpose of determining the reasons of this change and developing appropriate plans to mitigate its negative effects. These efforts have shown that the main reasons behind the climate change phenomena are greenhouse gas emissions (GHGs). These gases have the capability to stay for decades in the atmosphere and can prevent the long-wave solar radiation from returning to the space. The ratio of these gases plays the key role in the amount of the shortwave solar radiation that can warm the Earth's surface (McMullen and Jabbour, 2009) .

It should be recognized that there has been growth in the emissions of GHGs after the industrial revolution, but more than two-third of this amount is observed in the last four decades because of the acceleration in human activities (Prokosch and Hambro, 2009). Carbon dioxide is the most effective of the GHGs (McMullen and Jabbour, 2009).The main available methods to analyze monitor and provide information about the natural earth systems inside the atmosphere are:

- Observing systems: The first recognized effort started in 1980 to observe any abnormal phenomenon

related to climate change globally by at least 8 of satellites managed by the UN agencies, and;
- Modeling: Producing models to understand the different climate conditions that are connected with the atmosphere in order to collect data required and provide prediction for mitigation plans. These models are used for representing the past conditions and future speculation (Lamia, 2008).

Based on these methods, two main policies are suggested to reduce the negative impacts of climate change, namely adaptation and mitigation.

1.1 Adaptation

Adaptation is defined as reducing the forecasted effects of climate change through changing the conditions in order to constrain its negative effects (Prokosch and Hambro, 2009). Taking action upon these effects is called adaptation (Colette, 2009).

1.2 Mitigation

Mitigation is the process of slowing down the process of climate change to achieve fewer impacts than expected (Prokosch and Hambro, 2009). Reducing emissions of greenhouse gases is an example of mitigation (Colette, 2009). Mitigation has been at the heart of the climate negotiations from the outset. As the next round of negotiations focuses on what developing countries might do about mitigation, the topic remains highly relevant (Schofield, 2008).The importance of mitigation is demonstrated in the United Nations Framework Convention on Climate Change (UNFCCC) report that shows that global emissions of Co2 are set to increase from 38 Gt in 2000 to 61 Gt in 2030, an increase of 1.5% annually. Twelve of the developing countries will form the most of the growth(Nellemann et al., 2009) . Under the mitigation scenario, global emissions rise in 2015 at 41.81 Gt Co2 and then decrease to 29.11 GtCo2 in 2030 which is 25% less than emissions in 2000 (Schofield, 2008). This means reducing the amount of carbon dioxide emissions by more than a half in the same period under mitigation policy. For mitigation purposes, an analysis of the balance of emissions and their possible changes could be undertaken to identify priority sectors (buildings, transportation, industry, energy efficiency, waste and agriculture and forests) (Glemarec et al., 2009). Mitigation policy has been applied in many cities around the world, but focus on the large cities such as New York and the capitals is important because they contribute more to reduce the effects of climate change.

2. Carbon emissions in cities

The urban population in the world has increased ten times through the twentieth century. By the next decade; about 500 cities will be occupied by more than a million citizens. Some of them will have more than 20 million residents (Lamia, 2008).

Cities, economic growth, energy demand and quality of the environment are all related. Urban areas in cities consume more than 75% of global energy, and produce for more than 70% of global emissions of carbon dioxide (Bhatt et al., 2010). According to UNEP, UNHabitat, 2005: urban activities will be responsible for 80% of global Co2 emissions (Croci et al., 2009). However urban areas also hold the maximum promise of mitigating climate change (Bhatt et al., 2010). Urban population increased gradually in the last six decades and it is expected to grow steadily in the future while rural population will continue to decrease in the future.

2.1 Urban energy and carbon modeling

In the last decade of the twentieth century, the scientific evidence of climate change demonstrated that if cities continue with 'Business-As-Usual' (BAU) then this would mean allowing the absolute value of global temperatures to rise. It will reach a level never experienced before by human society with serious implications for livelihoods and natural environmental systems (Mulugetta et al., 2010) . BAU assumes that people will continue behaving just as they have been (Agnew et al., 2009). In addition to research in producing and developing models, there are many scientific efforts trying to classify these models into categories. One of these studies has divided energy and carbon models into five sets of models which are: top-down models, bottom-up models, accounting frameworks, simulation models and optimization models. Some of these models have limited applications while others are widely experienced (Bhatt et al., 2010).

The large percentage of energy consumed by existing buildings is for space and water heating as well as for lighting and appliances (Lomas, 2010). The existing building stock is becoming one of the key targets for public policy, and research work has demonstrated that interventions in existing building stocks can substantially reduce carbon dioxide (Co2) emissions (Lomas, 2010).

2.2 Urban form and scale studies

There have been many studies that addressed the role of urban form of cities in the amount of carbon dioxide emissions. Some characteristics of urban form have emerged in these studies that affect the amount of carbon dioxide emissions such as: land use distribution, compactness, area, urban planning, density, urban growth and shape. They describe the way to evaluate different types of urban planning at global, regional and city scale in existing urban forms. Some of these studies evaluates city places to find the suitable areas to change energy system to the renewable one (Talen, 2010). Others investigate the impact of compacted urban forms of large cities on emissions produced by transportation sector (Sharma and Mathew, 2011). While some of them try to measure the energy consumption rate in different housing densities (Brien et al., 2010). An energy research explains the role of urban planning in the transformation from a system of fossil fuel energy to a renewable energy system (Stremke and Koh, 2010). The growth of urban areas leads to more problems and challenges that need to be addressed (Schwarz, 2010). Carbon dioxide emissions increase in urban areas through the use of energy because of the urban warming phenomenon (Toshiaki, 2008).

On the other hand, the most recent studies illustrate that urban forms have a great impacts on the successful extent of mitigation technologies implementation (SatoshiIshii et al., 2010). Emission reduction could be achieved by a clear development plan for a city growth (Hankey and Marshall, 2010).

These studies confirmed the existence of a relationship between urban form and the amount of carbon dioxide emitted. In this research the relationship between urban form characteristics and carbon mitigation process which involve emissions and reductions will be determined.

2.3 Urban Form

Urban areas make up just 2% of the world's surface but consume between 60 and 80% of commercial energy (Lamia, 2008). Urban form predetermines characteristics of energy use and emissions, but, also potential contribution of mitigation measures (Yamaguchi et al., 2003).

A study of many cities in the USA has suggested that an appropriate urban form is a key factor to facilitate carbon management (Dhakal and Shrestha, 2010). There is a variety of urban characteristics in cities and it is necessary to verify which of them can be considered as a relevant drivers of emission indicators (Croci et al., 2009). The effect of urban form appears on different sectors and subsectors in a city.

Several studies have shown that urban form significantly influences commuting patterns, but it only partly explains the travel behavior of individuals (Ferreira and Batey, 2011). The way we choose to build our cities will impact transportation greenhouse gas emissions (Hankey and Marshall, 2010). Urban form can affect mode choice and travel distance (Hankey and Marshall, 2010). In addition, urban form provides an overarching system under which urban infrastructures related to buildings and transportation should be optimized (Dhakal and Shrestha, 2010). The distribution of land use of a city is associated with carbon dioxide emissions from transportation sector (Agnew et al., 2009).

However, other studies concentrated on the effects of compacted urban forms. The benefit of building compactness is to reduce the surface area to volume ratio which is beneficial to area required for urban growth, but it also reduces access to solar energy, daylight, and fresh air (Stremke and Koh, 2010). Some studies determine general criteria of urban forms such as, accessibility, density, diversity, and connectivity (Brien et al., 2010). Other research has demonstrated the relationship between urban form with the natural environment and the community. The impact of mega-cities on the natural environment is being felt far beyond their geographic boundaries which makes the study of the possibility of carbon emissions mitigation very important (Jaber et al., 2005). On the other hand, there is a relationship between urban form and the behavior of individuals related with energy consumption (Ferreira and Batey, 2011). These attitudes give an indication that the urban form has associated with a lot of variables that control the emissions of carbon dioxide from cities. Therefore, the study of their impact on the mitigation process is of great significance.

3. Case study

To explain this relationship the research has analyzed many cases of carbon mitigation processes in cities and has concentrated on the large cities in three main continents which are Asia, Europe and the North America. The cities under review should have three main characteristics;

1- They have already made their carbon mitigation processes
2- They completed their urban form characteristics
3- They have mentioned the urban form characteristics as effective factors in their carbon mitigation processes.

This paper explains this relationship in the first city of these cities under review (Shenyang) in details and the other cities, just concentrated on the urban form characteristics that could be extracted. So, the paper has determined the main urban form characteristics that affect the process of carbon mitigation in cities and has made the relevant conclusions.

3.1 Asian Cities: (Shenyang and Hong Kong)

China is the second contributor nation of GHG in the world with about 20% of global emissions just after the USA based on the UN review in 2009 (McMullen and Jabbour, 2009). Therefor; Chines cities have the importance in the process of carbon mitigation as the first emitter nation in Asia.

3.1.1 Shenyang

China gives the evidence that the more urbanized societies are the larger contributors in GHGs emissions. The amount of 84% of energy consumption is consumed by cities in this country. Shenyang has 12980 Km2 of land area and located in the middle of Liaoning province as the capital of it. The number of its population exceeded seven million in 2010.While the consumption of electricity in the same year is 20783 MW.

In the process of calculating the GHGs of Shenyang city, there is an attempt to clarify the relationship between inventory analysis and low carbon policy making. This relationship could be interpreted as the clear inventory analysis leads to easy policy making for low carbon emissions from urban areas. The study illustrates that emissions from the urban sectors in Shenyang are divided into two sets: 71.4% of emissions are inside the city boundaries and 28.6 of emissions are outside.

The methodology in this process is divided into five main sections. Firstly, it gives the scope of the process that describes which emissions to be calculated. These emissions are released both inside and outside the city boundaries. The definition of system boundary in this process depends on the spatial (geographic) and life cycle perspectives. Secondly, it presents a classification of emission inventory and emission factors. This study mentioned the classification of the international program of climate change (IPCC) of GHGs. IPCC refers to three types of these gases released in the city of Shenyang which are Co2, Ch4 and N2o. Nevertheless, it could be seen that this study didn’t use this classification. However, it suggested its own classification which involves three main layers (Xi et al., 2011):

- Identify Two main areas of emissions: inside and outside the city boundaries.
- Divide emissions into four groups based on their resources e.g. energy, industry.
- Divide these groups into subgroups which are to be more detailed.

The inside boundary emissions included electricity and heating energy consumption, while the outside emissions referred to the disposal of waste (landfill) and the emissions released by flights. On the other hand, the study has divided emissions into two types: direct and indirect emissions, which means the emissions released directly from industrial activities and that are released due the energy consumption. Based on this classification, Shenyang has 25 sectors. This analysis results in identifying the different sectors according to their amounts of GHGs emissions. The final classification of this process is emissions by districts and counties that achieved base on the use of GIS tools to show the spatial distribution of GHG emissions in the city (Xi et al., 2011).

To sum up, the nature of inventory processes relies on the detailed information. This process considered the amount, source, situation of emissions based on its own classifications. This method could facilitate the process for stakeholders to take the logical decision. The most relevant information in this study to our paper is that this study presents land use and districts distribution as important factors in emissions calculation. These two factors in fact, are two of urban form characteristics that should be considered in our research. This process also mentioned the importance of studying cities at the local scale according to their specific circumstances, even though were their similar studies have carried out on similar sizes of cities in the same country. So, the methodology of this study might be useful in terms of emissions calculation, especially in the section of districts emissions. However, our research needs to verify why these emissions in these particular areas are different based on our own thesis which is there are different urban form characteristics that affect the amount of emissions and the mitigation process required.

3.1.2 Hong Kong

The process of Hong Kong demonstrates the impact of urban density on building energy design in high density cities. Explaining the energy situation is the base action to evaluate the energy consumption in this city. The methodology of this process depends on three steps which are:

- Discuss the major consideration for energy efficiency in high density conditions.
- Define the major forms of energy sources
- Define the energy situation in the city sectors e.g. residential, commercial

Exploring the statement of the subject, highly concentrated load centers and compactness of land-use patterns benefit the energy distribution. It is crucial to collect the required data about the situation of energy consumption by buildings in Hong Kong in order to find the base year consumption. This will give the benefit for evaluating the reduction plans and strategies in the target years. Hong Kong has different densities in its districts. Both population and building densities are various from high to medium and low densities. Most energy resources in Hong Kong are depending on the fossil fuels, for instance electricity power stations and natural gas for cooking. Hong Kong contained many sectors: residential, commercial, industrial and mixed used. The residential sector is the largest use of the total land use and consumes the largest percentage of energy.

Many processes of Asian cities have realized that the high population density and the existence of industrial activities affect the land surface temperature and carbon emissions associated to be higher. On the other hand, other processes have accounted the concentrations of GHGs in the cities but they include emissions from several sources and are not related only to emissions from buildings of urban areas. Therefore, these indicators are not accurate to be taken into account in calculating the quantities of emissions.

3.2 The Europe cities

The importance of studying the European cities is because that more than 80% of the European people live in these areas. It is argued that the urban form characteristics such as density and compactness are an influence factors on the local environment. On the other hand, urban planning influences the urban form.

The most relevant study to this paper about the Europe cities is the study of Schwarz, 2010. The study has analyzed 231 cities around Europe based on their urban forms. It identified the most relevant indicators, selected the most effective indicators that have strong relationships between them. Finally, it grouped the European cities according to their urban forms characteristics. The study showed that there are many differences in European cities urban forms (Schwarz, 2010).

This study gained benefits from organizations related with urban form in European cities. One of them is the European environment Agency, which classified European cities into three categories: The southern European cities which are the densest and most compacted, the northern or central cities that have lower densities, looser, discontinuous urban structures and larger built-up area per citizen. The third category is the western European cities which have graded densities from the centers to suburbs. The study also presented many urban form indicators from previous studies that showed various concepts.

Although the study followed the right definition, but it gave absolute judgments in its introduction, for instance, the European cities are compacted while the North-American cities are sprawl, compactness integrated with sustainability. The study suggested that analysing the urban form of a city puts in the picture the future challenges and the potential problems that could arise from urban development. It also referred to the different requirements of organizing development to be suitable for different types of urban forms.

The carbon mitigation process in this study depended on two types of indicators which are landscape metrics and socio-economic indicators. In the landscape analyzing, it used maps of land use and land cover to find out the urban form parameters such as fragmentation and edge density. While, it took into account the population number, population density and the administrative boundaries of the city, in its socio-economic analysis. The process relied on the most recent publications which compared cities based on five characteristics of urban form: complexity, centrality, compactness, porosity and density.

The methodology of this process involved three main steps: data collection, minimizing indicators and grouping cities. The process identified a set of eight indicators for urban form classification of European cities. These indicators are: the area of discontinuous urban fabric, edge density, mean patch size, number of patches, compactness, index of the largest patch, population number and population density. The process enabled to define eight groups of European cities according to these indicators. The study chose the most suitable definition for urban form to be used. This definition brings together the physical structure and size of the urban fabric, and the population distribution in the named area.

3.2.1 Sustainable Urban Metabolism for Europe (SUME): the impact of sustainability on the future urban planning.

The project presents three factors that are believed to be the main drivers of dynamic processes of urban development. These drivers are: population growth, the economic status and the ability to adapt the technological inventions. The project tried to find a link between the urban metabolism issue and the concepts of spatial development in urban areas. The main purpose of this project is to allow cities to be more sustainable in their urban growth in the future. The project explores that the continuous urban growth in the European cities is depending on the forces of local market more than urban planning (Schremmer et al., 2009).

The methodology of this project is to analyze the future path of urban growth which leads to define the urban forms typology, such as densities and spatial patterns. This analysis is resulting in classifying the patterns of transformation, for instance, the pace and the direction of growth. After that, the project will be able to develop many scenarios of various periods for urban areas inside Europe. This will enable urban planners to predict the sustainable path of urban development.

The project developed its own model called; dynamic, spatially explicit model of urban metabolism. This model gives the opportunity to the planners to estimate the structural changes in urban areas and their effects on the material use and energy consumption. In addition, it takes into consideration the impact of the future planning and renovation processes on the local environment (Schremmer et al., 2009).

The SUME project concentrates on the analysis of urban development patterns taking in consideration their impacts on the use of materials and energy consumption in order to establish strategies for the urban growth of European cities. The base point of this project is to provide a clear view of how European cities developed through time. This will explore the typology of urban form and its impact on the resources flow. Then, apply the approach of metabolism to the urban growth context into the modeling process for the purpose of time and space to be introduced. Based on the urban form patterns, it will be able to explore the impact of urban forms on the resources flow in European urban areas. Finally, SUME project will draw strategies in urban planning according

to the acquired knowledge that could be achieved from urban form analysis.
The SUME project suggests the integrated policy packages which could be applied at the national and the local scale in Europe cities. This policy involves four principles to be considered in laying out sustainable urban plans which are:

- Minimize the density in the new urban areas and low density old parts of the city.
- Locate the high density new districts only in areas with high level of accessing of public transportation,
- Reduce the travel distance by using mix used urban areas.
- Minimize moving from the city centers towards suburbs by improving the thermal conditions at building and public spaces level.

The project supports the idea of the type of urban planning in the European cities has a great impact on the sustainability. It realized that the role of urban planning in the European cities is weaker than uncontrolled processes of growth in the present urban forms.

Generally, urban planning affects the urban form of a city. On the other hand, measuring the sustainability of a city depends on the amount of GHGs emissions that released by the urban activities in this city. Therefore, the project flows in parallel with our research thesis, which is there is an impact of urban form characteristics on carbon mitigation process. Two cities are analyzed to explore the applications of SUME project which are Geneva and Athens.

3.2.2 Geneva

Land-use and the ranges of age are the main two urban form factors considered to classify buildings in Geneva. These buildings have different uses of energy such as heating, cooling and hot water with consideration of the outdoor temperature to evaluate energy loads.

It is possible to classify buildings into categories according to their land-use and the ages of buildings. This will allow determining the impact of land-use factor in the amount of energy consumption and Co2 emissions. Geneva has many sectors such as residential (dominant), industrial, commercial and mixed use. In order to collect data regarding purposes of energy use, it is important to recognize the amount of energy use per purpose, such as, cooling or water heating. It could be explored the distribution of energy and Co2 consumption in different zones in this city. This will provide the accurate vision of which type of reduction strategy to be suggested. So, the process of evaluating the energy conversion techniques and calculating the new energy consumption and Co2 emissions will be more accurate.

3.2.3 Athens

The city was divided into a large group of cells for the purpose of analysis density, urban land use, pattern of the buildings, age and the accessibility to public transportation lines. Most of the information that was adopted came from a general census of population and buildings in 2001. This information included population number, jobs, and buildings. The continuous and discontinuous urban area in Km2 obtained from CORINE 2000.

Estimate the number of population and other data for the year 2050 in two periods considering the increase of floor area per person in the first stage, while it remains the same after 2020. The study established it classification on the on-site density which resulted in seven classes graded from single family to dense multi-story. It also defined the distribution of population and jobs over the city. Then, it divided population into two categories: inside and outside the urban zones.

This study is an application of SUME scenario for urban development which has three policies. First, consider the main public transportation lines to be the most concentrated areas in population and jobs in new developments. Second, increase densities in exist urban areas that have more accessibility to the public transportation. Finally, encourage the renovation and rehabilitation for the existence urban areas to improve their performance related with energy consumption reduction.

Two scenarios are represented in this study: base scenario and SUME scenario. The differences between them are summarized in three points: population number settled outside urban metabolic zone border, new urbanized densities and the distribution around the public transportation lines. It is clear that these three points are crucial factors of urban form of any city.

3.2.4 The UK cities (Leicester)

The study of Firth and Lomas in 2009 is an attempt to develop carbon and energy model in order to estimate the energy use and carbon emissions from the existing residential buildings in the city of Leicester. It relied on developing the BREDEM-8 model into the community domestic energy model (CDEM). The study classified the residential building stock based on two indicators: type of building and the date of construction. It obtained the required data from national census and other surveys. It illustrated the current status of residential buildings and investigated the impact of energy consumption improvements on the carbon emissions reduction. Modelling methodology of this process depends on three main steps which are:

- Identify the amount of heat gained and lost inside the buildings for the purpose of calculating the energy required for air conditioning.

- Speculate on the possibilities offered by techniques of thermal insulation possible to improve the physical properties of buildings.
- Conduct calculations required to predict the amount of reducing energy used for air conditioning in each category of buildings (Firth and Lomas 2009).

The inputs required for the purpose of analysis, including detailed description of the energy-consumed by buildings. Expectation required for each class of buildings helped to disseminate the method of calculating energy consumption and carbon emissions for this category at the national level.

A type of building forms an important factor in this process to calculate the energy used in air conditioning inside the spaces of buildings. It gives the necessary information on the number of exposed external walls and exposed to the heat exchange processes. In addition, the age of buildings gives an indication of the techniques used in construction in terms of insolation conventions. As the energy required adapting the internal spaces depend on the total built-up area and the value of the thermal insulation of structural components. The projected energy consumption and carbon emissions reduction will be made based on the last three decades climatic data.

3.3 The North America cities

3.3.1 Canada cities (Toronto)

In Canada, the EnerGuide label, initiated by Natural Resources Canada, shows annual energy consumption for major home appliances under conditions of normal use (or an energy-efficiency ratio for air conditioners), with ratings ranging from the most energy-efficient to the least energy-efficient in each product category (Kennedy 2010). In 2001, the EnerGuide and ENERGY STAR programs began to cooperate on their labeling provisions.

Methodology: Co2 emissions from buildings are connected with energy consumption by these buildings. They could be realized through the use of electricity for different household purposes, involving lighting, air conditioning and appliances, and also by using fuel directly. The amount of electricity and fuel consumption would be acquired by either the annual payments or the consumed energy as reported in the local authorities. In order to translate these data into an accountable amounts of GHG emissions, several processes should be done including the amount of energy used or sold, the source of energy and the equivalent amount of GHG emissions.

In this city the clustering of buildings, Land use, and urban planning are the clearer factors considered in carbon dioxide emissions.

3.3.2 The USA cities (New York)

New York City (Integrated energy planning methodology_ MARKAL).This study is an integrated urban energy methodology. It utilized MARKAL energy model in its methodology. It demonstrated this model and the way of its analysis and the development.

It has assessed the costs and benefits expected of the possibility of using alternative energy sources for the purpose of assistance in the process of making appropriate decisions in sustainability.

Determine the complicated relationships among the different energy sub-systems, for instance, resources, production, technologies of consumption and alternative resources. Analyze and evaluate the effectiveness of the whole energy system used for long t-term planning processes.

This process collected the required data from users directly to define the end-use energy demands for various purposes such as, lighting, heating water. It developed MARKAL model to determine the required energy in the present and in the future taking in account the entire energy system that involved production, distribution and consumption.

This process estimated the reduction in Co2 emissions from New York City by 12000, 29000, 36000, 40000 tons in the years 2010, 2015, 2020 and 2025 respectively (Bhatt, V. 2010,pp15).

The use of MARKAL model in this process required accurate information on energy used in buildings. This information is related with the type of use such as lighting, and land use type such as residential. It considered population density and production circumstances of energy demands and resources.

4. Summary and conclusions

Although each country and city under review has a different urban form which is represented by the composition of building stock (differences in age, construction, density, scale and composition, quality, climate and situation), there are many urban form characteristics could be shared among these cities have been determined as a crucial drivers for the process of carbon mitigation. Comparing cities for their carbon emissions, activities, and the policies (to mitigate carbon emissions) needs a very detailed and careful analysis to provide cities and their authorities with a menu of options for carbon dioxide emission reductions, allowing a city to choose the combination of actions that are both feasible and most strategic for their specific circumstances notably their urban forms.

The research has analysed carbon mitigation and sustainable energy systems in cities and has concentrated on three main continents; Asia, Europe and the North America. This paper has evaluated the carbon mitigation process which is involving models, tools and techniques in the cities at these continents. The connection has been made between urban form characteristics and carbon mitigation process through analyzing studies in urban form as an instrument for delivering carbon reductions. This connection has established an assessment and evaluation criteria to define the urban form characteristics that affects the carbon emissions and reduction process. Explaining the role of the urban form characteristics in carbon mitigation process enables the stakeholders to propose mitigation strategies towards sustainable urban forms of cities.

There are many differences between carbon mitigation processes in different cities such as reducing the dependence on the fossil fuels (Introduce cleaner fuels), Increase using of renewable energy, supporting local and decentralized power supply, focusing on energy efficiency and provide support and information to users. Various cities have analysed their urban forms with different methodologies in their carbon reduction endeavor.

An urban form of a city has offered possibilities in its efforts to reduce carbon emissions. On the other hand, it has restricted some limitations. So, the impact of urban form characteristics of a city on carbon mitigation process could be realized as:

1. The total area of open spaces (AOS) in comparison with the total area of building blocks (ABB).The ratio of AOS/ABB is as more as more beneficial.
2. The green areas and water surfaces against the dry urban areas. Green and water surfaces have a positive impact to reduce the air temperature and carbon dioxide emissions.
3. The climate situation according to the climate zones. The moderate climate zones required less energy used for air conditioning and water heating.
4. Population density (less is better) in terms of decreases the amount of carbon emissions.
5. The accessibility where transportation could access across the central and the downtown zones easily with less congestion nodes.
6. The construction age, materials and the techniques used in the building blocks such as using insolation and double glazing to reduce the different in temperature between inside and outside the buildings.
7. The land use distribution of the city sectors and the situation of energy resources which are related with the distance of carrying power to the building stocks.
8. The ratio of all industrial activities in the city to the other sectors (less is better).
9. The orientation of the urban form which involves the paths and the building blocks in order to gain the most benefit from the natural environment.
10. Clustering patterns of the building blocks especially in the domestic sectors, such as detached, semidetached and terrace.
11. The total area of continuous urban fabric
12. The vertical urban forms are more efficient than the horizontals in terms of energy used namely for cooling and heating demands where total area of roofs is less.

In order to make this information clearer, a comparison has been made among Asian, Europe and North American cities. The three numbers used as indicators for three continents' cities to compare between them. So, the number 3 means better than 2 and 2 means better than 1.

The data obtained from this comparison indicates that Asian cities have the best urban form characteristics in the green areas and water surfaces, the accessibility of transportation, the construction age, the land use distribution of the city sectors, clustering patterns of the building blocks, the total area of continuous urban fabric and the vertical urban forms. Conversely, the Europe cities have the best in the population density and the ratio of all industrial activities in the city. On the other hand the North American cities have the best characteristics in the total area of open spaces, the situation according to the climate zone and the orientation of the urban form. This comparison indicates that exist Asian cities could make their carbon mitigation processes more efficiently, less cost and few changes depending on their urban form characteristics.

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Biography:

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Research papers:

1- "The characteristics affect the architectural vocabulary cognition" in the fifth Iraqi Technological conference in the wisdom House in 2-4/5/1999.
2- "The impact of orientation by sunshine on the development of the commercial streets in Baghdad" in the Planner and Growth journal /No.27, year 18, May 2013.
3- "Climate Change and Carbon Mitigation in Cities" The International conference about sustainability in Iraq in May 2013.
4- "Finding a Scientific Method to Reduce Carbon Dioxide Emissions from Urban Areas in Iraq/ Baghdad as a Model in ""Journal of Environment and Earth science" in October 2014.

Figure 1. Shenyang

Figure 2. Hong Kong

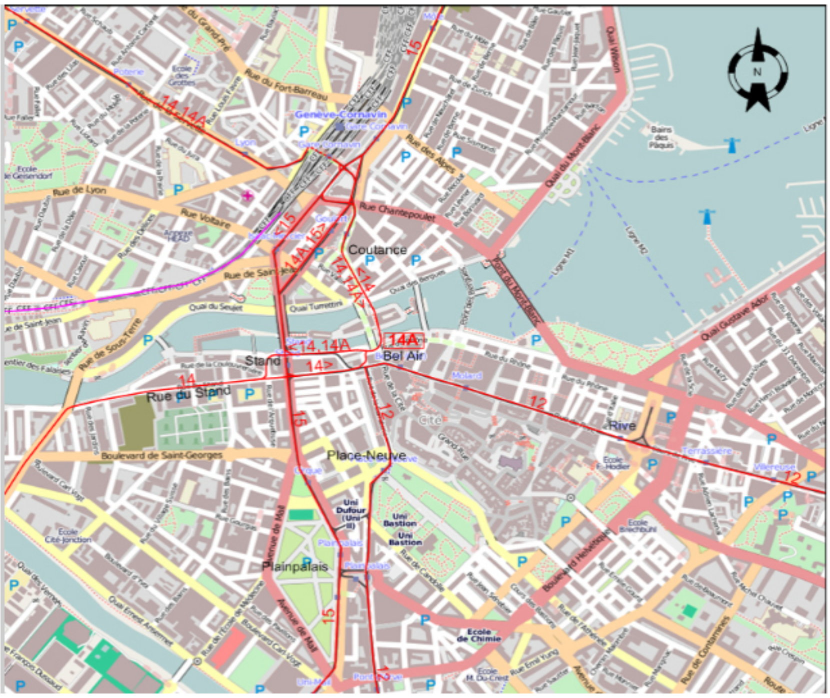

Figure 3. Geneva

Figure 4. Athens

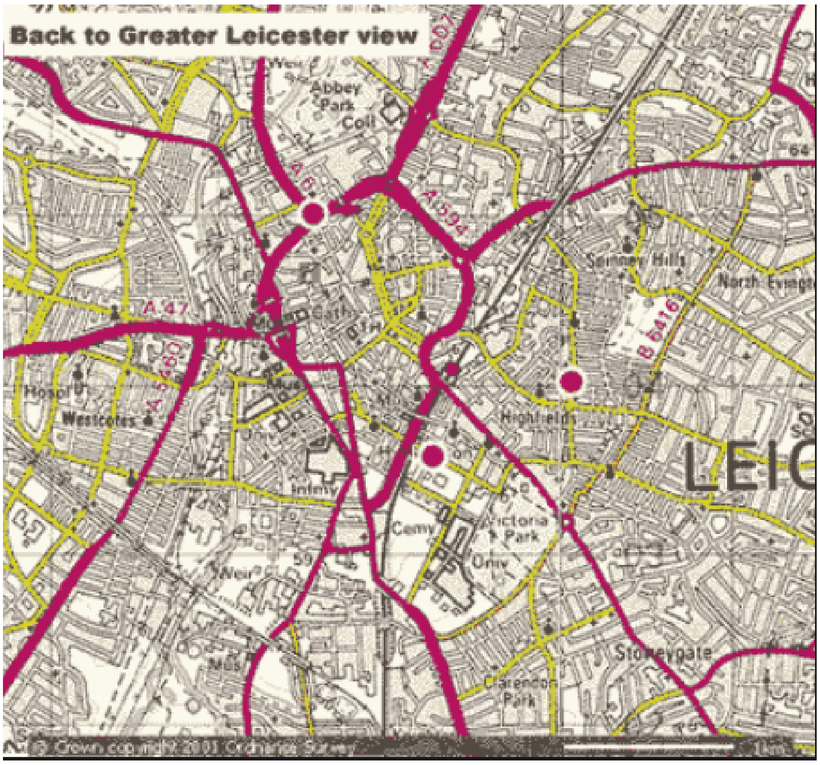

Figure 5. Leicester

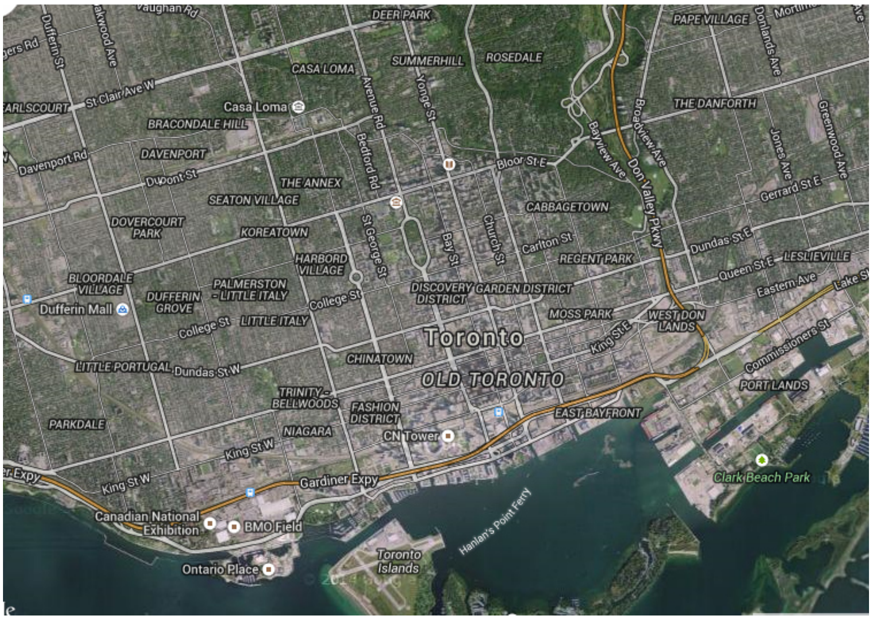

Figure 6. Toronto

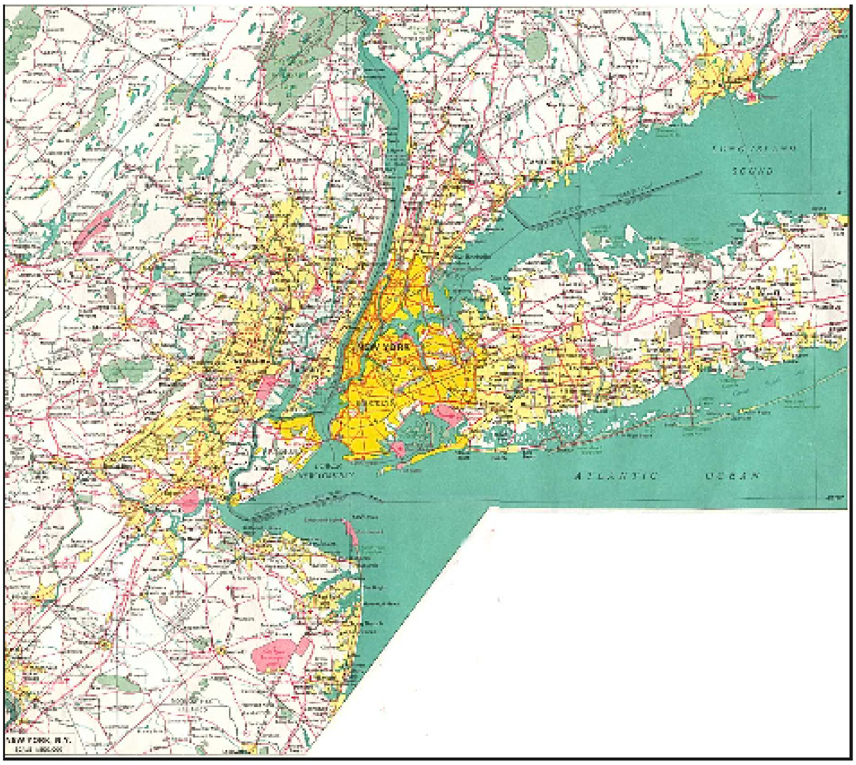

Figure 7 New York

Table 1. a comparison between three continents' cities based on the urban form characteristics.

No.	Urban form characteristics	Asian cities	Europe cities	North American cities
1	The total area of open spaces	2	1	3
2	The green areas and water surfaces	3	1	2
3	The climate situation according to the climate zone	1	2	3
4	Population density	1	3	2
5	The accessibility of transportation	3	1	2
6	The construction age	3	1	2
7	The land use distribution of the city sectors	3	2	1
8	The ratio of all industrial activities in the city	1	3	2
9	The orientation of the urban form	2	1	3
10	Clustering patterns of the building blocks	3	1	2
11	The total area of continuous urban fabric	3	2	1
12	The vertical / horizontal urban forms	3	1	2