Sustainable Design Treatments for Thermal Range

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Abstract. The research deals with the thermal range phenomenon at the inhabited areas. The shape and size of buildings varies according to the location, weather conditions and elements of the environment, thus exploring the nature, the negative effects, the causes and the elements of the human environment that help increase this phenomenon to the aim of developing the appropriate solutions to reduce the effects of the thermal range phenomenon. Hence emerged the issue of this research (The Absence of Comprehensive and Clear Sustainable Design Solutions to Reduce the Phenomenon of Thermal Range). In order to find solutions for this problem, a comprehensive conceptual framework was developed that illustrates a set of sustainable design solutions to reduce the phenomenon of thermal range. The theoretical framework application concepts on selected local study cases adopted to determine the extent to which these cases are met for the sustainable design solutions within the theoretical framework. By analyzing the results of the application, the selective local study cases showed that they did not acquire these solutions a matter that leads to the increase of this phenomenon and its multiple negative effects. The research concluded that the adoption of the sustainable design treatments within the theoretical framework is contributing to reduce this phenomenon that most of our local cities are suffering from.

Keywords: Thermal range, Sustainable design treatments, Elements of the built environment.

1. Introduction

Most of Iraqi urban regions and cities are suffering from the phenomenon of the thermal range or so-called the thermal island, which results in a negative effect on the daily life of the district or the city. This phenomenon is considered a major challenge that contradicts the sustainability principles. The research deals with a general knowledge framework of the thermal range phenomenon. This research divided into two parts. The first part brings into view a set of general definitions of this phenomenon in addition to a set of practical experiences of some regions and cities that suffer from this phenomenon.

In the second part of the research, the special framework application was discussed. This part included the formation of a special theoretical framework, the implementation of this framework in addition to the and final conclusions.

The cognitive problem of the research will be presented within the light of what mentioned above: (The Unavailability of a Clear and Comprehensive Sustainable Design Solution to Reduce the Thermal Range Phenomenon).

The aim of the research is presented as follows:(Providing A Theoretical Framework That Shows A Range of Sustainable Design Solutions That Can Be Adopted to Reduce the Of Thermal Range Phenomenon).
2. Part one: General Knowledge

2.1. General Definitions

Thermal range: Is a climatic term called the phenomenon of high temperature in the cities and large industrial regions compared to the surrounding rural areas, this term also sometimes called the thermal island [1].

The thermal range is a thermal phenomenon that is formed as a result of the local climatic changes caused by a mankind through various activities as a result of the establishment and development of the city or region, as one building can generate a different local climate than it was in the same location before the establishment of that building, the walls and tiled floors store the received heat during the day then reflect solar radiation after sunset to the surrounding atmosphere.

The phenomenon of thermal range depends directly on the total area covered by materials with great potential of heat absorption and storage such as asphalt, concrete and stone. The ratio of the reflected thermal radiation is relatively limited, in addition to the buildings and paved areas within the city, the industrial and commercial activities, in addition to the traffic all leads to the accumulative effect on the thermal environment, as a result of this accumulation; the temperature of the city increases and consists a high temperature area compared to other surrounding areas. This phenomenon is called (thermal or thermal island) [2].

Thermal range: It is a phenomenon that occurs in the built-up areas in which the human lives. The temperature in this area is 10 degrees Celsius higher than the surrounding environment. High temperatures in these islands are due to the increased absorption of sunlight by urban components, such as concrete and roads, floors that paved with asphalt, which have less reflective ability and higher thermal capacity than those found in the natural [3].

The thermal range is also defined as a range in which the temperature rises contrary to the surrounding temperature distribution.

This range, which is usually found in cities, represents a heat peak, which shows the decreasing of temperature by moving away from it in all directions, a phenomenon that exists in different regions of the world with different size and forms according to the location, weather conditions and urban and architectural characteristics [4].

2.2. Factors and causes of the of thermal range phenomenon

The factors and causes of this phenomenon varied between natural and artificial factors. The factors behind this increasing phenomenon in the city can be summarized as follows:

1- The Geographic location of the city

Topographic characteristics and micro-climate conditions are considered permanent influences that cannot be eliminated or controlled [5].

2- The space of the city or region:

Cities of considerable amount of population, industry and vast spaces alongside with the dense of traffic caused the emitting of height energy from these activities which increase the concentration of this phenomenon, as a study in Colombia and Maryland conducted in 1981 that in 1968 when the population was 1000 people was the maximum difference in the temperature is one degree Celsius comparing with 1974 the population increased up to 20 thousand people that the difference became 7 degrees Celsius in temperature.

On the other hand, the industrial activities within the city have changed the amount of clouds and rainfall that occur in and around the city. Some studies have shown that rainfall levels are higher during the weekdays than on weekends and holidays [5]. Structural density within the city or region This means that the percentage of built area. This built area increases as the percentage of construction increases. The possibility of availability of gardens and green spaces, which greatly reduce the concentration of the phenomenon, is reduced. This factor is proportional to the factor mentioned before, the higher the density of population, the greater the density of construction in the city or region [5].
4 - Reflection Coefficient:
Roads and parking spaces with dark asphalt surfaces absorb solar radiation, which greatly increases the phenomenon, unlike light-colored buildings and roofs that reflect a large part of the solar radiation. The green areas reduce the heat intensity and help cool the air by evaporating moisture [5].

5 - Height of Buildings:
The high and convergent buildings increase the heat degrees, which emitted by human activities and may reduce the speed of the air, this air greatly helps to expel the heat generated within the city in the upper space as in Figure 1.

![Figure 1. The difference between air movement in rural areas and air movement in the city, Source [5].](image)

Other secondary factors of the thermal range phenomenon:
A group of secondary factors that are considered to be the causes of the phenomenon including:
- The decreasing of the lost net land-based radiation from the streets and roads of the city because of the narrow streets and high buildings and the lack of open space between the buildings out to the sky.
- The increasing of the thermal storage obtained by the walls of the buildings and asphalt roads during the day and the decreasing of the thermal storage during the night (asphalt-paved streets contributed significantly to the absorption of the heat).
- Heat emission from human sources through the consumption of energy in homes, motor vehicles on the roads, fuel engines at factories or workshops and the generators of electricity in the city.
- Several buildings considered as a windbreak.
- Transportation traffic increases harmful emissions from vehicles.
- Materials commonly used in the urban areas on the pavement and ceilings, such as concrete and asphalt, which are characterized by their thermal conductivity. Glass and other surfaces contribute to absorbing and reversing sunlight
- Lack or absence of the green areas in the urban cities.
- Lack of artificial water areas.

Consequential negative aspects of the thermal range phenomenon [6]:
- The Increase in energy consumption for cooling and conditioning buildings.
- The Increase in the proportion of pollutants emitted into the air as a result of the fuel burning to generate electricity.
- Increasing the proportion of ozone gas in the ecosphere due to the high temperature, the presence of ozone in the upper layers of the atmosphere protects the Earth and humans from harmful UV rays. Being near the surface of the earth makes it a major cause of the formation of smog.

2.3. Previous cases
Vancouver City:
- Vancouver is the third largest city in Canada. Occupies space of approximately 2877.4 square kilometres. Compared to the larger cities of Toronto and Montreal, Vancouver is the city with the most thermal range phenomenon. The urban areas of Vancouver have been growing continuously.
due to the replacement of plants and green belts with the residential, commercial and industrial asphalt or cement buildings. As a result of this process, the surface temperature of this city rises [7]. (2), the downtown of Vancouver is warmer than the countryside and districts. The upper part is cooler than the rest parts of Vancouver due to the vegetation. Most of the farms are medium-temperature in the Fraser River Valley as in the map in Figure 3.

![Figure 2. Vancouver's downtown surface temperature. Source: Camilo Pérez Arrau, 2007](image_url)

![Figure 3. The next map shows the surface temperature of Vancouver CMA on July 17, 2004. We consider a surface heat islands when the temperature is at least 5 degrees above the average of the CMA, Source: [8]](image_url)

The conclusion of the above mentioned, we find that the disappearance of green areas, vegetation and green belts in Vancouver contributed to the thermal range phenomenon increasing in spite of the cold weather of the city. Vancouver suffers from a thermal range because of the replacement of vegetation by asphalt and concrete.

Masdar City:
Masdar is an Arab city that harmonizes with its environment. It is considered as an emerging global center for renewable energy and clean technologies, similar to the Arab countries that proceeded. Masdar is a model of sustainable urban development, both regionally and globally, the city is considered as a profitable commercial project, feasible and viable through providing the best environment for life and work with minimal environmental damage.
Several sustainable treatments have been used in the city to match global climate change and to find safe enhancement for energy.
Energy Management: Masdar City reduces energy consumption by circulating the best world's energy-supplement and commercially efficient technologies by distributing stringent building efficiency guidelines concerning thermal insulation, low-power lighting specifications, windows glazing proportion, natural lighting utilization, intelligent meters, building management intelligent systems, integrated distribution management system and power management system extending throughout the city to control electric load over electric power transmission net from generation to consumer.

Transportation services: In response to the priorities of Masdar master diagram, which aims to encourage a walking community, there will be a wide choice of public and personal transport that will ensure easy movement through the city. As a result, walking and using of self-propelled transport will be the ideal means of transport to reach many places in the city. This is considered a result of the planners' focusing on the creation of many shaded sidewalks and wide corridors throughout the city.

Building materials: The carbon amounts caused by construction works are significantly reduced through eco-friendly supply chain. Masdar City contributes to reducing the overall economic impact of the materials used in the city through a detailed assessment process of materials and products that considering environmental, economic (including costs and quality) and social aspects. In addition to the above, the city uses more sustainable materials and better solidity than conventional materials. This includes the use of slag concrete (industrial waste) to replace cement, significantly reducing the level of carbon emissions caused by traditional concrete, as well as providing better performance and greater strength. In addition, recycled and developed aluminum was tested in cooperation with Masdar City, the result is achieving high standards of performance that exceeded international standards.

Examples of materials used in Masdar City Buildings:
- 100% of timber comes from sustainable forests.
- 90% of recycled aluminum used in interior facades.
- Slag-based concrete reduces the environmental impact of carbon by 30-40%.
- Using watercolor free of volatile organic compounds may harm human health.
- Reinforcement bars are made of 100% recycled steel.
- Masdar City represented one of the cities that tried to control the phenomenon of thermal range and reduce its impact through a series of sustainable treatments, the most important of which is energy management, sustainable transport services, in addition to the use of sustainable building materials that contribute to reducing and limit this phenomenon.

3. Part Two: Special Application Framework

3.1 Formation of the theoretical framework (sustainable design treatments for thermal range phenomenon):

First: treatments on urban fabric level:
1- Using the idea of integrated urban fabric, it protects buildings from wind loaded with dust and sand and reduce the amount of direct radiation falling on the outer walls.
2- Protect the footpaths from external climatic conditions by narrowing them, taking into account the covering or shading parts of these footpaths by using buildings or other complementary elements such as trees or wooden umbrellas, which permeated with climbers.
3- The use of trees, plants, water spaces, green areas within streets, squares and pedestrian paths, taking into account using defoliate plants in winter to benefit from the sun.
4- Heading towards the Interior-oriented horizontally, where the building heights ranging between (1-3) floors.
5- planting thick green belts towards winds which loaded with heat and dust to cool and purify the air before entering the buildings.
Second: Sustainable treatments at Building Design Level:
1. Interior-oriented horizontal architecture through using internal pavements and minimizing the external openings as a protection against the sunlight and hot sandy wind.
2. Ventilation should take into consideration when designing the external openings of the building; a slot should be above the main opening to exile the hot air.
3. Construction of the exterior walls of the buildings to be thick with high thermal capacity materials in addition to the using of cavity walls.
4. The use of natural cooling devices such as courtyards and air towers and the air catchers to bring air and achieve natural ventilation within the spaces of buildings.
5. Using the rough finishing and light colors, especially white because it has the ability to reflect the heat.
6. Internal courtyards and external buildings spaces should be coordinated by planting trees and placing water elements in soothing air temperature.
7. An extent, cornices, fractures in the facades of the building and the uneven surfaces of the building are the main factors to provide a lot of shade.
Figure 9. Sustainable treatments at Building Design Level: 1-Interior-oriented horizontal architecture, 2-Ventilation design, 3- cavity walls, 4-courtyards and air catchers, 5-courtyard vegetation, 6-, cornices, fractures in the facades of the building. Source: [5].

Third: Other Design Treatments

The green roof treatment:
When using this treatment, these results would be observed:
- The Green roofs of buildings have the ability to improve the thermal performance of the roofing system through insulation so as to be considered an insulating layer.
- Shading is reducing surface temperature. The plants shade that ceiling preventing sunlight from reaching directly to the surface.
- The evaporation process cools the air, as plants absorb water through their roots and release water from liquid to vapor.

2-Using of certain technologies for clean or alternative energy:
- Magnetically levitating train for transport purposes
- Artificial trees
- Hydro power plants
- Solar and wind power plants

3- Green parks within the area or city: in order to reduce the thermal range phenomenon pollution.
Table 1. Special Application Framework

| No | Category | Secondary changes |
|----|----------|-------------------|
| 1  | Sustainable Design Treatments on the integrated urban fabric level (Urban design) | Using the idea of integrated urban fabric. The use of trees, plants, water spaces, green areas within streets, squares and pedestrian paths. Heading towards the Interior-oriented horizontally, where the building heights ranging between (1-3) floors. Planting thick green belts towards winds which loaded with heat and dust to cool and purify the air before entering the buildings. |
| 2  | Sustainable Design Treatments on the building design level (Architectural design) | Interior-oriented horizontal architecture through using internal pavements and minimizing the external openings. Ventilation should take into consideration when designing the external openings of the building; a slot should be above the main opening to exile the hot air. Constructing the exterior walls of the buildings to be thick with high thermal capacity materials in addition to the using of cavity walls. The use of natural cooling devices such as courtyards and air towers and the air catchers to bring air and achieve natural ventilation within the spaces of buildings. The use of the rough finishing and light colors, especially white because it has the ability to reflect the heat. Internal courtyards and external buildings spaces should be coordinated by planting trees and placing water elements in soothing air temperature. An extent, cornices, fractures in the facades of the building and the uneven surfaces of the building are the main factors to provide a lot of shade. |
| 3  | Other design treatments | The green roof treatment | Magnetically levitating train for transport purposes. Using of certain technologies for clean or alternative energy | Artificial trees | Hydro power plants | Solar and wind power plants | Green parks within the area or city |

4. Application
The section’s goal is to apply the theoretical framework to selected local samples in order to determine the extent to which the local sample has achieved these design treatments that reduce the thermal
range phenomenon in our urban areas and cities, from the urban fabric integration to the design of the building.

4.1 Applicable study cases:

Al-Kadhimiya District in Baghdad:
The Kadhimiya is one of the most important Islamic cities in Iraq, its importance emerges from the presence of the two imams of Musa al-Kadhim and Muhammad al-Jawed (peace be upon them) [9].

The ancient Kadhimiya area, adjacent to the Kadhimiya Mosque with its radio concentric design bazaars and twisting alleys, is a clear embodiment of the organic model with its integrated fabric with high climatic and environmental treatments. Figure 10 illustrates the pattern of alleys, on which the compact traditional houses are held.

Al-Sadr district in Baghdad:
Al-Sadr district is located in Iraq, Rusafa, to the east of the province of Baghdad. It was established in the 1960s to settle population of southern Iraq in Baghdad, which was planned on the basis of the four-block system, Quadratic planning, where the division of the blocks locks the residential blocks between them, which are divided into residential houses. When enlarging any part of the Satellite imagery of the area, we observe that it reflects one repeated pattern, which represents one of the most important values prevailing in the modern style. Although there is more than one design within this pattern, but it is not enough to achieve the desired aesthetic diversity, resulting in monotony, especially when repeating the same model on the opposite sides of a street, Figure 11 illustrates the pattern of orthogonal streets that determine the divisions and forms of residential plots.

![Figure 10. Parts of Kadhimiya City, residential and Population Density, the Use of Organic Patterns, Source: [10]](image1)

![Figure 11. Parts of Sadr City, residential and Population Density, The Use of the Gridiron Pattern [11]](image2)

Description and analysis of local study cases according To a design concept:
- The selected sample (Kadhimiya) shown that the most residential buildings are distinguished in one building form which is the fenced compound dwellings; it is characterized by the inner courtyard. In this type of building, the boundaries of the residential building are within the boundaries of the land which leaves no further space outside. The only respite of the residential unit is the interior courtyard whereas it is considered the main center of the family activities. (Figure10).

The case is in the second selected sample (Sadr City) is different, where there are three types of residential units which are the separate, semi-detached and semi-contiguous type. The existence of the building block within the boundaries of the plot may leave the outside spaces that used as walkways, outdoor gardens or car garage, whereas the interior courtyard of the traditional house was the only open space within the residential unit. Theses leftover spaces have a negative climatic effect, the disintegration of the urban fabric and the increasing of the solar acquisition during the hot season is a result of their ad adjacency.
- Through the satellite imagery (Kadhimiya) city planning has been adopted both types the linear and radio concentric type for climatic necessities represented in gradual gradient spaces resulting a difference in passing air pressure which leads the continuous air movement within the fabric in addition to the social necessities as privacy and gradation from the public to private. While the second sample (Sadr City) was adopted gridiron design, resulting in a monotonous urban fabric unsuitable for climatic conditions.

Description and analysis of study cases, according to the physical condition:
Considering the design method applied to the urban planning level in each of the two study cases, this section will review the design method as follows:-
- Relating the first case, we note that the housing units with cubic shapes and solid from outside, which achieves the lowest thermal acquisition of solar radiation during hot times. With building adjacent, they form a high building density and a huge size relative to the surface area, reducing the exposition of the surface area to the solar radiation. Because of the residential units adjacent, there is little importance of the orientation. The closer the buildings, the less important the orientation is. The average number of floors is (2) was due to the majority of traditional residential unit’s compliance with a fixed number of floors which is two floors, this is one of the basic features in the traditional residential areas characterization. In the second case, we find a variety of housing units forms. The divergent building blocks of residential units, leads to an increase in the number of interfaces exposed to solar radiation because of the formation of scattered sizes lead to increased thermal acquisition, the average number of floors is (1.5), this percentage was due to the horizontal extension of construction because the large areas of residential plots.
- Concerning the physical condition of the street spaces in the first sample, we note that the organic pattern of narrow and twisting alleys achieved local climate due to the continuous curves in the street space, which achieve a change in orientation, which helps thermal stabilization by stagnation of cold air down the street. These bends help to form shaded and sunny areas at the same time, which creates a continuous movement of air within the urban fabric, theses air movements are free of dust particles and grains of sand, which settle down the alley due to continuous bending.
- Relating the dimensions of the vertical section of the residential street, represented in the index as (L / W) was between (1: 3-4), which considered as a great climatic fit to the harsh weather conditions in Baghdad, especially during the summer, this ratio increased the shaded area of the alley. The length and width of the street is a response to the harsh climatic environment where the alleys used as channels for the movement of air control and distribution.

Relating the second sample, we find that the gridiron pattern of the straight streets makes them passages full with dusty and uncontrolled movement of the air. The (L / W) index is higher than that in the first sample to (1: 5.5-6,) resulting in a huge, sunny open space. This is due to the garden and frontal setbacks imposed by the new planning legislation. It is designed primarily to accommodate vehicle movement, ignoring the climatic appropriateness to be provided to a residential area within Baghdad's dry hot climate. We find that the length of the streets in the second sample reaching (460 m -1010 m) while the width of the street is (12 m) as average. The increasing length and width of the streets are in response to the requirements of gridiron planning, ignoring the hot and dry climate of Baghdad.

4.2 Final Results and Discussion:
- Baghdad city considered a hot, dry area as it is characterized with its high rates of solar radiation, especially in summer; we suggest the adoption of connected or semi-detached housing unit’s pattern, for the purpose of increasing the adjacency of residential units and reduce the solar radiation exposition.
- within climatic necessities, It is preferred to adopt both types the linear and radio concentric type planning of a residential neighbourhood in the city of Baghdad, characterized with continental climate, in order to create a gradual gradient creates a continuous air movement within the urban fabric as a whole due to differences in air pressure resulting from the change in the size of the road.
- As the climate of the study area is hot (dry), therefore we need to smooth the atmosphere, especially during the summer through various means, including the use of fountains and dense vegetation areas
on both sides of the road space in urban squares, which leads to reducing the air temperature and create a relatively mild climate compared to the general climate due to the ability of these trees to absorb heat and moisturize the atmosphere by vapor water in addition to shading.
- Concerning the road space forestation, the selection of trees planted on the sides should be of seasonal tree type. This kind of trees give good climatic characteristics as they grow a dense of leaves in summer to give the shadows but shed these leaves in winter, allowing the sun to transmit into the urban space. To achieve this goal, a correct spot and appropriate tree type should be chosen. In a hot, dry climate of Baghdad, it is preferable to use round shape trees and be cultivated in groups to get the appropriate shadows.
- The selection of the structural form of buildings should be based primarily on the climatic appropriateness of the dry, hot climate conditions and then other functional and aesthetic requirements are considered. Therefore, the selection of the truncated structural forms nearby rectangular in their shape would be more effective in the continental climate of Baghdad city.
- The effectiveness of the climate performance of the building does not work in isolation from the surrounding urban space, therefore the distance between the opposite buildings must take into account, to ensure both functional and climatic appropriation at the same time It is mentioned here that the purpose of determining the ratio of the height of the building to the width of the opposite street space is (Reducing the transmission of solar radiation into the urban space - control the wind penetration to the street, especially during hot times).
- Relating the finishing materials, it is preferable to reduce the use of asphalt tiles in the urban spaces tiling, especially the urban squares, because of its significant effect on reducing the climatic effects of the urban fabric as a whole by increasing the reflected solar radiation.
- The paving should be reduced in the streets dedicated to the vehicles. Other materials with a lower reflectivity, such as stone or bricks should be used in finishing the paths and passages dedicated pedestrians.
- The organic street style is recommended with curved forms to control the air movement as well as increasing the shade, in relation to the angle of sunlight transmitting and the surrounding building height.

5. Conclusions
- The selective applied samples were varied in their patterns (organic and gridiron pattern). The organic pattern was ideal in its response to the climatic influences. Therefore, the thermal range phenomenon was less effective, especially in the early stages of the urban fabric design. However, when the requirements of modern life changed with its transportation, this urban fabric design has been disintegrated, especially after the constructing of wide streets. The phenomenon of thermal scale began to increase.
- Gridiron pattern and new designs (foreign designs) are not climate-friendly (It shows the increasing in concentration and intensity of the thermal range phenomenon) especially in the hot, dry climate of Baghdad.
- Within a dusty, hot and dry climate such as in Baghdad, a curved and winding street is preferable, in order to control the hot, dusty air movement in addition to the formation of a fine micro-climate environment that reduce the concentration of the thermal range phenomenon.
- Concerning forestation as a factor in reducing the thermal range phenomenon, it is preferably using seasonal trees within the urban fabric because of the great effect in covering the sun during the hot season (summer) and allows the solar access to the urban fabric during the cold season (winter).
- Concerning street orientation, thermal range phenomenon and Baghdad climate, it is preferable to direct the streets towards the north-northeast and south-south-west direction to increase the climatic efficiency of the area in addition to achieving the largest solar acquisition during the winter and less solar exposition during the summer, the result is to reduce the concentration of thermal range phenomenon.
- Relating the orientation of the facades and walls of buildings, thermal range phenomenon, Baghdad climate (the eastern and western fronts receive higher thermal energy than the North and South), It is preferable to orient the long facades of buildings in (north and south) direction. As for eastern and
western façades and walls of the buildings, it is better to adjacent buildings to obtain natural shading which reduces the thermal acquisition and thus reduce the concentration of thermal range phenomenon.

- Relating the building and finishing materials within thermal range phenomenon, it is preferable to use sustainable building materials that contribute to reduce and limit this phenomenon. Concrete surfaces and asphalt pavement materials increase the temperature of ambient air. Therefore, asphalt pavement should be restricted only in vehicular traffic areas not in open spaces, urban squares and pedestrian areas. It should be replaced with other materials such as stone for the purpose of soothing the local climate of the urban fabric. Also, it is preferable using light colors in finishes to increase their ability of reflection to minimize buildings absorption of solar radiation, as coating surfaces in white help to reduce the phenomenon of thermal range.

6. Recommendations

It is difficult to eliminate this phenomenon because it is linked to several factors that are difficult to eliminate but its implications can be reduced by following sustainable design treatments that lead to control and limit its effect within areas as follows:

- The use of light colors for the surfaces and walls of buildings to increase their ability of reflection to minimize buildings absorption of solar radiation, as coating surfaces in white help to reduce the phenomenon of thermal range
- Reduce the exposure of asphalt surfaces in car parks and roads to solar radiation through forestation. Increasing forestation within cities to soothe hot weather through evaporation process.
- Elimination of inactive air points in the cities by directing them to the prevailing winds to diffuse and fading the accumulated heat.
- Minimize cars usage.
- Controlling carbon dioxide emissions and other polluting gases are one of the important ways to control pollution by controlling waste of plants and polluted places by using filters.
- The adoption of clean energy method, free of the toxic gases and harmful substances by using solar panels and underground heat, windmills, waterfalls and clean transportations.
- Artificial trees considered as an innovative way to reduce global warming and purifying the air.
- There are studies for new methods to prevent or reverse solar heat, such as artificial clouds, sulfur scattering, mirror windows and white paint.
- Increase open spaces to ensure moderate air movement
- Increase vegetation areas throughout cities.
- Increase the number of open water bodies, streams and channels of running water within and around the city.
- Reducing air pollution by controlling sources of pollution.
- Coordinating height, forms, orientation, and locations of buildings to moderate the movement of air at most times.
- Extensive use of vegetation to filter air pollutants.
- The use of new possible alternatives in the transportations and communications within cities and replace the causes of pollution.
- Planting the largest number of trees through an environmental strategy targeted at considerable residential communities.
- Vegetation of plants over building roofs that can store a considerable amount of heat. This solution will not be effective unless it is on a large scale and must be through careful study of all environment variables, only one building shown contains a plant surface among a huge number of buildings, which means that this building unnoticeable influence. Officials must interfere to legislate laws that oblige the owners of buildings, especially the huge ones to vegetate the roof surfaces.

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