Cumhuriyet Üniversitesi Fen Fakültesi
Fen Bilimleri Dergisi (CFD), Cilt:36, No: 3 Ozel Sayı (2015)
ISSN: 1300-1949

Cumhuriyet University Faculty of Science
Science Journal (CSJ), Vol. 36, No: 3 Special Issue (2015)
ISSN: 1300-1949

A review of the role of green roof in achieving environmental dimensions of sustainable development

Mahjabin RADAEI[1,*], Mahshid RADAEI[2]

[1]*MS of planning, management and training of Environment, Tehran University*
[2]*MS of architecture, Science and Art University of Yazd*

Received: 01.02.2015; Accepted: 06.06.2015

Abstract. Today, by following classic model of development and blind following of stereotype models of urban development as ignoring the local conditions, not only non-sustainable conditions are created in the city, but also it leads into house instability. One of the major results of present era changes as the era of dominance of technology and economy, human being is completely separated from nature and is in unstable path and it leads to full destruction of environment and living conditions on earth. Green roof is one of the new approaches of architecture and urbanization and it is used to increase per capita of green space, promotion of environment quality and urban sustainable development. Green roof is built with the goal of turning dead space of roofs to dynamic space and it is live ecosystem providing good environment capability for urban environment and it can be more productive and sustainable. The present study aimed to evaluate the role of green roof and its convergence with sustainability principles. The study method is descriptive-analytical and qualitative. To review the role of green roof in achieving sustainable development environmental dimensions, at first we explained the sustainability, sustainable development and its environmental dimensions. Then, by comparative method, environmental dimensions of sustainable development and green roof were compared and investigated. The study findings showed that urban green roofs with the improvement of air quality, reduction of surface wastewater, reduction of urban Thermal Island, establishment of thermal balance in internal and external environment of building, creation of natural habitat, biodiversity and increasing life of operation from roof insulation are positive step to improve quality of urban environment. Thus, green roof as one of the basic architecture elements like a source and assures continuity of important benefits for nature sustainability and human development. As a symbol of artifact constructs, it acts well to improve environmental quality consistent with environmental dimensions of sustainable development.

Keywords: Green Roof, Sustainability, Sustainable development, Environmental dimensions

1. INTRODUCTION

The buildings being made to create shelter for human being should use the best type of consistency with environment. The key factor of sustainable life continuance starts with reduced confusions and human being is the main source on earth. It is not possible unless by increasing the presence of natural elements in his life and high adaptability of human being with nature. The cities as activities focus centers and human being life to regulate sustainability; they should accept structures and function based on natural systems. Civilization history of human being is interrelated with climatic changes history and environmental conditions. There was a one-way relation between environment and human activities and only the first affected the second one and there was no feedback among them. However, today there is a serious issue for human being, perception of consequences of human civilization and changes and the effect of human activities on climate and environment. In new scenarios, there is a two-way relation between human and environment and the nature of climate and environment and human activities both affect each other (Rao, 2006:52). By designing the spaces, human being gives value to the environment living in it and finds his existence in it. What we call environment is like scene and the features of its scene affects the role as made in it and physical structures of environment on role and functions

* Corresponding author. *Email address: Mahjabin Radaei*

Special Issue: The Second National Conference on Applied Research in Science and Technology

can be affected (Shaterian, 2013:69). The development of science and technology in the current world causes the comfort and welfare of human being. This development creates new problems as using fossil fuels, environmental pollution, extensive changes of weather and some other problems for human being. In the current world, sustainability approach is raised as a solution being under question as recognized as new achievements by western human being in the past century (Monshizade, 2004:57). Sustainability approach in the recent century with the emergence of environmental movements is a concept to present environmental policies. This new concept with various interpretations based on perspective of each specialization considered a general goal and it was ability of human being for his life over time. Urban green spaces as necessary component of cities in their metabolism play important role and their shortage can make serious problems in the life of cities. Urban green spaces have social and ecological return and the most important effect on cities are environmental functions or their ecological return making the cities suitable for environment.

The development of urban green space and its fair distribution in urban centers as consistent with urban construction is one of the major challenges of contemporary metropolises. The open and urban green spaces mostly don't have direct economic values and development of constructions with macro benefits in short-term in local and state investor can increase using land at service of short-term economic benefits and development of urban green spaces compared to other investment types is of less financial support (The organization of parks and green spaces of Tehran Municipality, 2008:13). Green roof is one of the new approaches of architecture and urbanization and it is used to increase green space per capita, improvement of quality of environment and urban sustainable development (Sebghati, 1992:23). Green roof is built with the aim of turning dead space of roofs to dynamic space. These roofs are considered as semi-public and private spaces but they are effective on urban ecological return and good quality of urban life. This study emphasizes on function of green roof and it is an interdisciplinary research as creating a link between environment and architecture with a new view.

2. STATEMENT OF PROBLEM AND AIM

Environmental problem is one of the basic current city issues and it is in contradiction with natural environment as urban development is with the dominance of buildings, industry, transportation and economic activities on natural spaces and this dominance is changed as dominance of city on nature over time and it also provides urban extensive pollution. The result of this trend is imbalance and inconsistency between human being and nature disturbing ecosystem relations. By development of cities, natural environment values are exposed to destruction. Urban dwellers are deprived of natural attractions and social and mental problems are manifested. The population concentration in cities and marginal areas of cities and inconsistency between services growth and urban infrastructures namely in developing countries, urban regions are turned into non-sanitary and polluted places and are encountered with wastewater disposal, healthy drinking water, etc. (Zebardast, 2004:156).

The developers of private sector in construction increase the percent dedicated to green spaces by various methods to the total building infrastructure to reduce costs and achieve high profit in building construction and establishment of parks and residential buildings with green natural landscape at extensive scale is impossible with this rapid development of great cities (kralli, el al. 1996,32). High value added of earth and low green space area caused that green roof technology in Iran metropolises is a good alternative due to improvement and sustainability of quality of urban environment. Based on the pollutions of dust entering from southwestern countries to Iran and pollutions of petrol fuel endangering the health of people in big cities, considering the environmental effects and positive effect of green roof is necessary. The present study aimed to study the role of green roof and its convergence with sustainability principles. Thus, green roof

as one of the basic elements of architecture, its role and evaluation in achieving environmental dimensions of sustainable development can be evaluated.

3. STUDY METHOD

This study after perception of sustainability, sustainable development and presentation of definition and history, focused on presenting environmental dimensions of sustainable development. To do this, at first theoretical basics are investigated and then, final dimensions and criteria in a comparative comparison based on analytical view of researchers and evaluation of experts' opinions are extracted. The study method is descriptive-analytical and qualitative. The data collection measure is library studies, written resources, documents, maps, objective observations. The data analysis is content analysis. Finally, to review the role of green roof to achieve environmental dimensions of sustainable development, green roof with conceptual proposed model by comparative model can be investigated.

Investigation of concepts

- **Sustainability**

The term sustainability widely is used to describe the world in which "human and natural systems together "can continue life to the far future (Bahraini, 2001:38). John Ehrnfiled says " I define sustainability as permanent actualization of human being and other creatures on this plant". Sustainability is the result of a culture but it is accumulated over a long time. In the modern and objective and technological world, many symptoms of disease are seen leading to anthropogenic and natural inefficiencies. The problem is not building green spaces, space construction is important. Sustainability is a feature belonging to systems (Fort Mire, 2008:46). The term sustainability is used regarding self-survival and self-compensation ecosystems with definite toleration limit. The system leading to ecosystem durability and live creatures, population, societies and ecosystem can renovate against the external effects and changes. In other words, they have sustainable power. Sustainability in a system indicates fundamental continuity over time. This sustainability is created only with changes. Sustainability naturally is described as power of a system in coping with recovery against external problem and the system can protect its building condition over a long time (Miller, 1987:27). The term sustainability is defined as:

Sustainable, means stable, durable, what is fixed. In sustainability, there is an inherent tension in sustainability between development, stability (for coherence) and change capability (for growth) and sustainability belongs to the phenomena balancing this two-way relation. This relation is ascending (Pakzad, 2002:43). The definition of sustainability is similar to a philosophical game but its fulfillment is deterministic. There is a reality in this term and we can and we should make efforts for it. It is possible that its full achieving escapes us. The more we continue the research, we consult and we are encountered with its difficult selections and we can make the life of future generation as tolerable (Tabibian, 2011:78).

- **Sustainable development**

The term sustainable development was raised for the first time formally by Brantland (1987) in our common future report. This term refers to its wide concept as correct and efficient use of natural resources, financial resources and human resources to achieve a good consumption model with using technical facilities and good structure to fulfill the needs of current and future generations as continuously (Bahreini, 1999:280). This definition is based on two initial concepts:1- The concept of needs: Including the conditions to survive an acceptable model for the life of all people, 2- Concept of limitations: The limitation of environment capacity to fulfill the needs of current and future generation to establish normal life process.

The concept of development is equal to growth. The development defines a qualitative concept and it is equal to increasing life quality and some issues as health, training, welfare, freedom of

speech, etc. The concept of development sustainability includes some concepts. It means that sustainability of environment ecosystem, sustainability of natural resources, economic development sustainability and welfare and human development sustainability. Thus, sustainable development is creating economic, social and political space guaranteeing the good living quality and it can maintain the issues as sustainable (Hosseinzade Dalir, 2001, 93). We can say that sustainable development means the management of using natural, human and economic resources beside environment protection as economic, social and political progress of societies can be achieved and various dimensions of human development namely welfare increase can be brought as sustainable and continuous for current and future generation (panahi et al., 2003:12). Sustainable development is the one encountering the current generation needs as fulfilling the future generation needs is not endangered (WCED,1987). Based on this definition, before any society achieves sustainability, the justice among the generations should be fulfilled. The social-economic development should be fulfilled as when costs are impost on future generations, the effects of economic activities are minimized and when vital and necessary activities impose costs on future generation, the damage should be compensated fully (Abdoli, 1997:28). Another definition is presented for sustainable development and it is presenting solutions about physical, social and economic models of development to avoid some issues and destruction of natural resources, destruction of living systems, global pollution, climate change, increasing population, injustice and low quality of life of people.

Sustainable development considers all technical, social, cultural and environmental aspects (Rasul, F., 1993, 35). Sustainable development is not as sustainable development of each of economic, social or environmental subsystems alone and not meaning the increase of sustainability of these subsystems. Also, it attempts to balance economic growth, ecological renovation, environmental protection and social progress and the difficulty of this challenge is turned into a major concentration in researches all over the world (Batten 2002 and Rayli, 2001).

Chart 1. The dimensions of sustainable development.

- **Environmental dimensions of sustainable development**

In the current conditions, cities are encountered with risky environmental issues. Considering environmental issues and environment protection is not a new issue in city, urbanization and urban design.

The famous work of Yan Mac Herg (1969) and his consideration of capacity, protection of sensitive land, land ecological planning were valuable bases of new concepts of sustainability (schneider, 1978:94). The cities should be examples of environmental consistency. Based on ecological limitations and environmental effects, each stage of city development and each aspect of urban design, ranging saving in energy consumption in buildings to regional transportation network and performance of commercial and industrial sectors in cities should be considered (designing America,1995:156).

A sustainable society considers the major ecological limitations and searches for social sustainability and high quality of life. It applies comprehensive and full solutions and is based on justice and equality, it relies on significance of societies (collective life) and it requires accounting all social and environment costs of private and state decisions (Selman, 1995:33). To achieve environmental goals of sustainable development, four strategies should be considered:

1- stabilizing renewable resources consumption or those being renewed, 2-Optimization of using non-renewable resources and minimizing natural resources consumption based on their natural growth, 3-Minimum production of waste and pollution as absorbed in scale and capacity of local and global environment, 4-Creating healthy environment for future generations and fulfilling basic needs of human and society (Edwards,1999:124). Panahi et al., in a study referred to dimensions of sustainable development environment as:1- Maintaining the balance of natural ecosystem, 2- Combination of development affairs with environment, 3- Planning and natural management, 4- Optimal use of water and soil and energy resources, 5- Replacing renewable resources, 6- Planning and management for unexpected events, 7-Control of environmental pollution (Panahi et al., 2003:15). Based on the studies, environmental dimensions of sustainable development in a proposed analytical model are divided in five main branches (Chart 2).

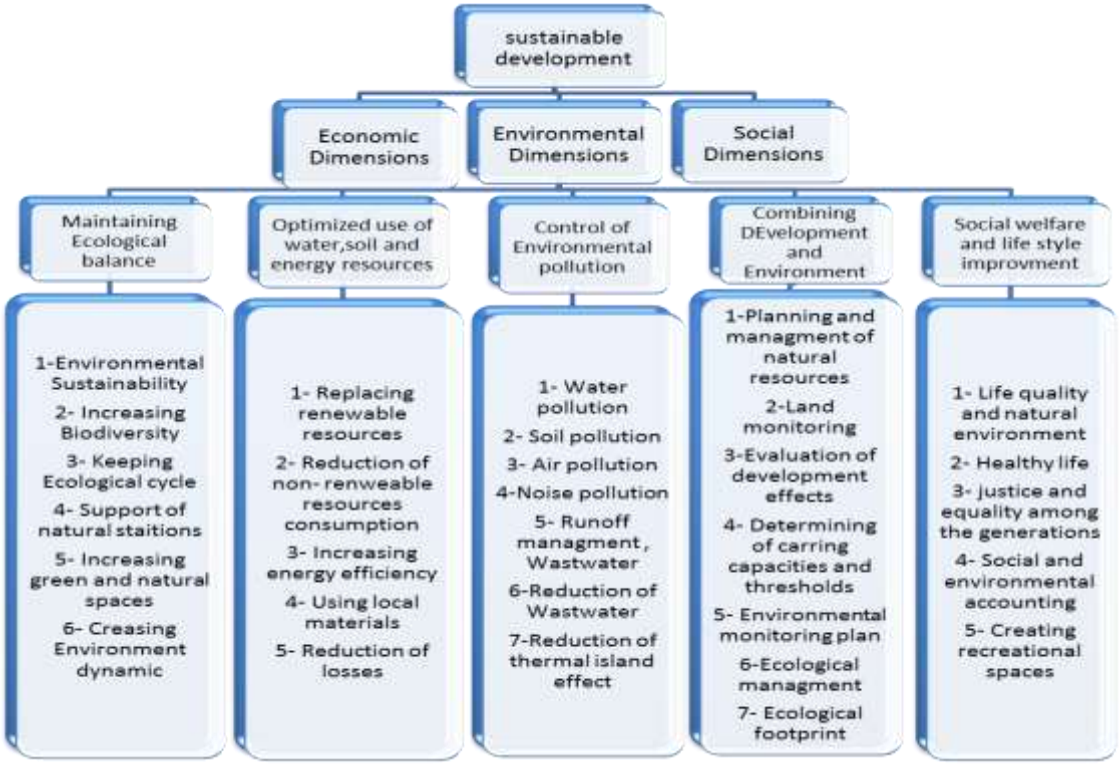

Chart 2. The proposed analytical model from environmental dimensions of sustainable development (Source: Authors).

➢ Green Roof and its definition

Physical development of cities leads to the destruction of surrounding natural environment and agriculture fields. In urban buildings, flat roofs with high costs are designed to protect the building against rain and snow and mechanical tools. The flat roofs " don't have architectural aesthetics and they can not have any role in enrichment of the value of architecture in building.

In the early 60s, by considering the quality of environment in urban texture and environmental challenges of big cities namely in central areas, the thermal island phenomenon in city and energy wage started a new approach called green roof in its current meaning from northern Europe (The organization of parks and green urban space, 2010:13). In Iran, based on historical ground of

using mud in Iran architecture, moss and mudstone and different herbs on roof of various areas of country as Azarbayijan, Gilan and Mazandaran, mountainous and villages mostly use this covering. Its good example is rural houses in Masule in which the roof of lower houses act as the yard of upper houses (Ansari et al., 2006:28). Locurbuzie and Frank Loid are the first modern supporters of roof or porch as applied green space. Locurbuzie was the first one in 21th century who applied green space. He introduced five principles for modern buildings and green roof and roof garden is one of the five principles. A green roof is the one that a part or total of it is covered with vegetation and soil or with growing cultivation area. The term green roof is sometimes used for the roofs considering the concepts of green architecture as solar panels or photolytic planes.

Green roof is the roof on which plants grow and herbal variety of such structure can be covered with artificial grass to have a roof garden as covered with the plans used in landscape design. Making the roof green needs the plants as resisting against dull environment of roof under low-water conditions, freezing , etc. The type of selected plants is different based on weather and climatic conditions.

The major role of green roof is observed mostly in management of water of raining, water recycle, reduction of greenhouse gas, biodiversity in live urban creatures (plants and animals), protection of earth crust, avoiding ultraviolet ray to the building, improvement of air, temperature reduction, making hot weather mild, avoiding fire in building, reduction of the influence of electromagnetic ray, improvement of climatic quality and ventilation in city, creating pretty urban landscape, suitability of urban spaces, reduction of air pollution, energy storage, reduction of noise pollution, reduction of costs of maintenance and repair of ceiling of building, creating clam area in crowded areas of city, increasing new spaces for recreational activities, also as a lab for different research and educational projects. In addition, green roof plays important role in reduction of energy consumption and as fuel consumption optimization is one of the important items in the life of citizens, its application can be useful.

Green roof and its adaptation with environmental dimensions of sustainable development:

- **Green roof and control of environmental pollution**

Reduction of noise pollution:

The noise in streets is an important problem in urban areas. Green roofs increase noise insulation in roof system. The quality of noise insulation performance depends upon the type of system and thickness of layer. The increase of bed depth to 15-20 cm improves the reduction of noise. But green roof with deep layer doesn't provide any high profit. Noise waves in green roof are issued in frequencies of 500-1000 Hz (Bradley Row, 2010, 6). The layers of soil, air and vegetation in green roof are porous and they enable the influence of noise into growth environment and due to the interaction between the layers and noise, the noise is reduced. Green roofs instead of noise reflection, absorb it and the building is insulated against noise to 8db (Hancock, 2006, 211).

Air pollution reduction:

The plants absorb air pollutants via their holes and separate their particles with their leaves and they can also break special organic compounds as poly aromatic hydrocarbon in plant textures or soil (Baker&Brooks, 1989:81). Green roofs can be effective on reduction of carbon Dioxide in atmosphere by two methods: 1- They are the main component of plants and are absorbed and decomposed naturally in plant textures via photosynthesis and in soil bed via bush and root, 2- Reduction of energy via building insulation and reduction of urban thermal island effect (Bradley Row, 2010, 2). Green roofs purify the dust particles and dangerous materials. These roofs improve

microclimate by making environment air as humid (Johanson, 2004, 122). 1.5 m green lawn provides the adequate oxygen of a person annually. One m2 of green roof can eliminate 200g of air suspending particles in a year (Wpeck, 1999, 93).

Reduction of the load of wastewater channel systems:

Green roof is effective eon reducing surface water, improvement of their quality and reduction of wastewater flow. The compressed roofs with the bed depth 150mm annually and about 75% and extensive green roofs with bed depth 100 can keep about 45% water. The water retention in winter is considerably lower than summer. These results are based on the change of evaporation and transpiration and raining (Berndsson.et al, 2008:58). One of the most important effects of green roof is keeping rain water during the flood of rainfall. The wastewater channels in cities should be wide. The mostly the surfaces are made of impervious materials, less water can penetrate in soil. It means that wastewater channels receive heavier load and wastewater plays important role in water pollution. Green roof receives 75% of one inch rainfall and wastewater channels can be improved (Wpeck, 1999, 92). The water storage of rainfall in the best depends upon the type of green roof, humidity in soil, soil composition and its depth, slope of roof, vegetation species and severity and duration of rainfall. As the flow is released in a long-term duration, it can help maintenance of urban water against flood and reduction of water descending corrosive potential.

- **Green roof and ecological balance**

Ecological cycle:

Disturbance in ecosystems in close future has negative consequences directly on basic system and life support (Rao, 2006:132). The current technology created extensive waste in environment nature and its imbalance and it mostly destroyed human being as an element in this cycle. Nature applies the elements for recovery of natural and anthropogenic damages (Bromand, 1991, 58). Urbanization growth had negative effect on green spaces and if the green spaces as ecological structures in cities are consistent with spatial distribution, they can be important ecological functions namely in the processes of weather resources. Today, the cities need special attention in terms of recovery of nature and green urban space as the nature in city, in extension, composition and distribution are requirements of sustainable development and these areas can be sustainable from ecological aspects (Majnunian, 1995:62).

Environmental sustainability:

The development of residential, service, agriculture and industrial areas and unsuitable use of natural resources, environment destruction, accumulation of environment pollution, reduced biodiversity, increasing warming, ozone layer depletion, etc. can be important in changing natural trend of ecosystems.
Environmental sustainability emphasizes on reduction of using natural resources and renewable energy, avoiding energy source loss, reduction of waste generation and emphasis on re-use of waste and using recycling materials in nature and reduction of pollution in industries and agriculture)(Elliott,2006,98). As it was said about the role of green roof, green roof reduces using non-renewable energy, renewable energy storage, reduction of pollution and environmental sustainability can be fulfilled.

Biodiversity:

Considering biodiversity is one of the important issues in urban environment (Luckett, 2009:64). Biodiversity as an important factor in human and environment survival not only is effective on survival of human society, but also it is effective on survival quality. Elimination of biodiversity means coping up with living space for a species instead of dividing habitat among various species.

At local scale, architects and urban planners can be effective on biodiversity. The planners can plan as the landscape bed includes all living examples or special items in a region. Thus, locating urban developments is of great importance and it is development of house construction projects not cutting sensitive corridors and consider open spaces in the developments as a part of local landscape matrix linking habitat areas (Aminzade, 2011, 142). Green roofs by reducing the effects of compressed commercial and residential development and can help the revitalization of alternative vegetation (Van,et al., 2005,1040). Green roof has potential power in providing plant life, using local vegetation species consistent with ecosystem of region and using natural materials.

- **Green roof and optimal use of water, soil and energy resources**

Protection of energy resources:

Today, due to increasing growth of energy consumption in the world and based on shortage of resources of fossil fuels and environmental pollution of their combustion, the necessity of using renewable energy is increased. One of the ways to reduce fossil fuel consumption is construction of buildings as the less energy is required for cooling and heating (Chalfoun, 1991:56). Sun light is the greatest energy source as human being didn't use it in energy production (Nasiri, 2000, 99). The importance of buildings with energy efficiency is not ignored. Based on rapid reduction of energy reservoir, energy shortage and increase of environmental pollution, innovative solutions are required to end energy consumption. IN modern buildings, the consumed energy volume is increased to provide the comfort of internal environment of building (Global Journal of Environmental research, 2003: 12). The most important feature of green roofs is moving along nature principles. Green roofs reduce energy exchange of building. At hot air with air temperature 95F, the temperature of roof reaches 175F. The plants convert heat and humidity of soil via evaporation to humidity and this leads to cool air of building. At cold weather, heat losing speed depends upon the humidity of lower layers. Averagely, an extensive green roof increases 25% of insulation (Szewczyk, 2003, 30). Green roofs can reduce negative effects of buildings in local ecosystem and energy consumption in building and they can have important role in the changes of energy flow in building (Dunnett and Kingsburry, 2004, 112).

Water resources protection:

The issue of water and reduction of using it namely under current conditions is one of the important issues. Water consumption reduction is one of the main factors of energy as the advantages of using green roof. Green roof as the first layer on earth storages water in its drainage layer and the stored water is presented to plants gradually. In arid areas in which water consumption per capita in summer is high to make the buildings cool, green roofs due to the effect on reduction of temperature of building and air control can reduce water consumption. Green roofs system is designed as its lower layer is insulation, drainage and can prevent the penetration of root into the roof. Thus, the garden without irrigation can be happy one month in summer. The maintenance period can be twice a month. The applied plants in roof gardens should resist dryness and they should need less care and they should be adapted with the soil changes. One of the most important effects of green roof is keeping rain water during strong rainfall with effective role in keeping water resources and its pollution reduction.

Loss reduction:

The efforts to make everything with a few tools and dedicating much time are important as the product should not be wasted. Thus, any product made by man should be used many times and after it can be recycled. This type of production, consumption recycling and production with

economic model of communities can be consistent (Rudofsky.1964, 2001). The materials being used to make green roofs are provided of recycling resources. For example, porous bricks and using waste of materials of building can save the costs of green roof and can eliminate the costs of dumping waste and the cost of their transfer. Green roof provides a unique opportunity to use roofs to improve economic cycle (Mahmoodi et al., 2012, 73).

Green , G. & Gilbertson tested and proposed three methods to improve economic conditions and reduction of waste:1) Investment to improve efficient insulation systems to provide less humidity and high thermal comfort, 2) Investment on reduction of costs of house heating improving the general conditions of life and causing the allocation of incomes to other sectors as food, clothing, recreation, etc., 3) Reduction of house energy consumption leading to less reliance on fossil fuels and pollution reduction namely air pollution (Green, 1999 , 41). Increasing life of roof membrane (two or three times more) by protecting it against UV rays and weather damage, reduction of building materials by increasing life of roof and reduction of open maintenance and repair, energy protection, management of surface water, reduction of greenhouse gas emission namely carbon dioxide, reduction of consumption fuels all provided a ground to reduce waste and improve economic conditions.

- **Green roof and social welfare and improvement of life style**

Creating good and recreational spaces:

The cities mostly are barriers to nature and green space. The air of big cities is arid and the limited trees of cities can not reach adequate water to the city to make it cool. Air quality is of great importance in internal and external environment (Banting,2005,55). In some countries, food as vegetable is cultivated in the roof and this is of great benefit of two cases. First the required food is produced by the residents and second, housewives and the old and children can be involved in farming and it has positive effect on them from mental aspects. Reduction of visual pollution of organization constructs with hard texture and improvement of landscapes around the building by providing green space and landscape with soft texture and color variety of plants can make the residents and viewers as clam (Luckett, 2009, 61). Green roof provides natural and pretty spaces for recreation namely centralized green spaces in which the trees can be cultivated and the roof space is simialr to a garden or park and we can also use fountain or pool in it. Green roofs have great effect on interaction between human being and landscape.

The importance of communities and social interactions:

The alienation is one the cause of problems of all people around the world and this issue is emerged among people and their man-made environment (Hanna, 1958, 148). Social relation occurs at time and space. Proximity is the cause of starting social relation but merely conditions are not adequate and there should be consistency to keep these relations. The physical structure and performance divisions of space can be supportive or restricting the opportunities for relationship (Talebi, 2005, 161). Green spaces are those suggesting social place feeling. Green roofs by increasing the life scope and providing consistent space for building users can be used as a space for resting and recreation (Tufan, 2007:84). Green spaces are of great importance in terms of providing environmental needs of residents and in terms of fulfilling resting space and their social interaction.

Life quality improvement:

One of the criteria of quality of environment in each city is green spaces. The spaces in which the citizens can talk with safety and comfort. This issue is important as considering urban green spaces and applying policies releasing the people in cities of problems as hopelessness can link green space and environment and it is one of the most important duties of urban institutions

(Wright, 2000.34). The psychological and social effect of these spaces on citizens is one of the important issues as various countries dedicate great area of urban areas to this important use (Shahverdian, 2004, 14). Green roofs as a part of open urban spaces are the main factors in structure of urban view, improvement of ecological conditions, spending leisure time to increase the quality of urban environment.

❖ **Green roof and combination of development affairs with environment**

The researches regarding natural history of earth show evidences of full changes of natural systems. The increase of temperature, change of rainfall pattern, fluctuations of sea level, the changes in climate chemical composition and reduction of biodiversity are based on exogenous and endogenous environmental phenomena. Planning and correct management for survival of earth and improving the health of human and environment require control of pollution and materials recycling and renewable energy. The experiences show that sustainability at local levels can be implemented more but house construction projects in Iran raised in the form of earth preparation, small size of houses and mass production of housing, townships and new townships design can be in the form of main goal of development in urban suburbs and they have adverse effects on environment and landscape (Aminzade, 2011:149). If there is exact planning and optimized management in using various natural resources, achieving good goals with optimized consumption of these resources is good and it's unduly consumption is avoided. Thus, resources management is a great aid to achieve sustainable development (Baru, 1997, 61). Sustainability emphasizes on materials and energy cycle and protection of natural and functional processes of landscape as key factors required for improving human health (Kay, 1994, 30). The cities only cover about 1-6 percent of earth and they have great ecological trace as 100-300 times more than their extension (Rees&Wackeragel, 1994:104). Indeed, such rapid urbanization growth, has created serious socio-economic and environmental outcomes. This trend is continued until there is not balance in terms of open and green fields between urban networks and natural models and urban networks are controlling vulnerable ecological networks (Cook&Vanlier, 1994, 51). Green roof has great power in 1-Improvement of microclimatic conditions (due to humidity and creating cool air and reducing heat of environment), 2-Air pollution reduction (via absorbing carbon dioxide and dust particles and poisonous gas by plants), 3- Reduction of the effect of thermal island of city, 4-Reduction of cooling and health load of building, 5-Reduction of heating effects and urban weather changes, 6-Increasign biodiversity (potential power in plant life providing, using local plant species consistent with ecosystem of region, using natural materials), 7-Reduction of energy consumption, 8-Creating aesthetic attractions and natural aesthetics for recreation, 9-Farming fruits and vegetable, 10-Providing good spaces for users, 11-Increasign green and natural spaces, 12-Providing dynamics of environment can provide a ground for ecological sustainability. The green roofs can absorb various pollutants from climate ecological cycles or the earth and as a source or more than it can guarantee the continuance of important benefits for sustainability of nature and human development and it is a symbol of artifact constructs acting well to improve quality of environment consistent with the environmental dimensions of sustainable development. Thus, planning to use it is necessary.

4. CONCLUSION

Human fighting for continuing life in various urban, rural areas or even in space depends upon his adaptation with environment. The more the consistency of our habits with the forces in nature, the easier our life continuity. The easier the applied techniques in this consistency with environment, the higher the proximity with environment. The idea of sustainable city is based on environment, economy and natural resources protection as it leads to access to acceptable quality. The complete attitude to sustainable development is implemented when each of development aspects is studied in details and relevant planning is in executive, practical and exact levels. The close relation between various dimensions of sustainable development shouldn't be ignored. The

development sustainability triangle , economy, society and environment in recent years is discussed a lot and their periodization importance in macro policies of planning and policy making is obvious for all and it should be in macro priorities.

As it was said, the study on green roofs is of great importance by biological functions (increasing biodiversity, habitat for plant and animal communities, etc.) social (Recreational opportunities, increasing aesthetics, etc.), physical (control of flood, reduction of corrosion, temperature reduction, pollution reduction, energy storage, water quality protection, etc.).

Table 1- Comparative table of benefits of using green roofs in achieving environmental dimensions of sustainable development (source: Authors)

Advantages of green roof	Environmental dimensions
Protection of living variety and creating habitat, improvement of ecological quality, protection of ecological cycle, environmental sustainability	Ecological balance protection
Air quality improvement (purification of suspending particles), adjusting the effect of thermal island, exchange of oxygen and carbon dioxide, noise reduction (noise insulation), reduction of runoff and load of wastewater channel systems, avoiding flood and reduction of corrosive potential of water, increasing water quality and avoiding its pollution, increasing operation life of building insulation	Control of environment pollution
Reduction of artificial ventilation cost (cooling in summer), creating good and recreational spaces, establishing a place for recreation, establishing place for social interactions, Life quality improvement, increasing dynamics of environment, creating double green space, creating aesthetic attractions, thermal insulation.	Social welfare and life quality improvement
Energy saving, improvement of microclimatic conditions, reduction of pollution, reduction of heating effects and urban weather conditions, increasing life of operation of building insulation.	Combination of development with environment
Saving in energy consumption, using recycle materials, reduction of fissile fuel consumption, avoiding flood and reduction of water pollution, thermal insulation	Optimized use of water, soil and energy resources

Inadequate recognition of the benefits of green roof among managers and urban planners and private investors in construction and common people, low motivation in state or private sector, economic barriers with extra costs of green roof technology and lack of economic benefits recognition in long-term and not accepting probable risks due to some ambiguities in technical issues and new technology of green roof (the organization of parks and green urban space, 2010, 13) show that metropolises of our country besides the problems and barriers due to new nature of this technology and not finding their good position and arising costs didn't have created required infrastructures and legal facilities in this regard. In our country, the application of green roof was not common and based on environmental effects of green roof and shortage of green spaces in big cities, its application in country is necessary and it requires special motivations.

REFERENCES

[1] Aminzade, Behnaz. 2011. The sustainability view: The scope of house construction plans. The articles of sustainable urban development. Tehran University publications. Second edition.
[2] Ansari, Mohammad; Keshtkar Ghalati, Ahmad. 2006. The investigation of effective challenges and factors on non-development and development of green roofs in Iran. International journal of road and construction. NO. 62.
[3] Baru, G., Badri, Seyed Ali. 2003. Sustainable development, concept, value and practice. Journal of geographical researches. NO. 44. Mashhad.
[4] Bahreini, Seyed Hossein. 1999. Modernity, post modernity and in urbanization. Tehran University publications.
[5] Bromand, Firooze. 1991. International training of environment, scientific, technical training of UNSESCO. 17 Shahrivar publications.
[6] Pakzad, Jahanshah. 2002. Space quality. Abadi journal. NO. 37.

[7] Hosseinzade Dalir, Karim. 2001. The regional planning methods. First edition. SAMT publications. Tehran.
[8] Rao, Paninti Crishna. 2006. Sustainable development, economy and mechanisms. Translated by AhmadReza Yavari. Tehran University publications.
[9] Rasul F., Jalal. 1993. Regarding sustainable management of agriculture. Journal of economy of agriculture and development. NO. 4. Tehran.
[10] Organization of parks and green space of Tehran. 2008. The vertical development of green space. Green roofs.
[11] Sebghati, Iraj. 1992. Green roofs. The articles of green space seminar. Parks and green space organization publications. Tehran.
[12] Shaterian, Reza. 2013. Climate and architecture. Simaye Danesh publications. Tehran. Fourth edition.
[13] Shahverdian, Marzie. 2004. The investigation of effective factors on protection of parks and green spaces. Journal of municipality. Year 6. NO. 67. Tehran.
[14] Talebi, Zhale. 2005. Social relations in urban space. Journal of social sciences. No. 24.
[15] Tabibian, Manuchehr. 2011. City and criteria of fulfillment of sustainable city to reduce environmental outcomes. Sustainable urban development articles. Tehran University publications. Second edition.
[16] Tufan, Sahar. 2007. Life roofs. Journal of architecture and building
[17] Abdoli, Mohamamd Taqi. 1997. The effects of energy technology development on ecology. The center of Iran energy studies.
[18] Fort Mire, Racel. 2008. The big thoughts for a small planet. Translated by Abbas Mokhber. Architect jouornal. NO. 48.
[19] Majnunian, Henrik. 1995. Some discussion about parks, green space, recreation areas, deputy of urban services. Organization of parks and green space of Tehran city.
[20] Mahmoodi Zarandi; Mahnaz, Pakari, Neda; Bahrami, Hassan. 2012. Evaluation of the effect of green roof on reduction of environment temperature. Scientific-research journal of Bagh Nazar. The research center of architecture and urbanization. NO. 20. Year 9.
[21] Monshizade, Arezoo. 2004. Sustainable architecture (review of sustainability movement). MA thesis of architecture. Yazd University.
[22] Miller, J. T., 1987. Living in environment. Translated by Dr. Majid Khadum. Tehran University.
[23] Nasiri, Hossein. 2005. Sustainable development and development. Environment protection organization publications. Tehran.
[24] Banting .D. (2005)." Report on the Environmental Benefits and Costs of Freen Roof Technology for the City of Toronto". Toronto
[25] Berndtsson, J.C.,Bengtsson, L.& Jinno, K.(2009).Runoff water quality from intensive and extensive vegetated roofs, Jornal of ecological engineering ,35:369-380
[26] Bradley Rowe, D. (2010) Green roofs as a means of pollution abatment.Jornal of Environmental Pollution, 159:2100-2110
[27] Chalfoun. N.V, (1991)"The Houses Energy Doctor", an educational research and community service program at the college of architecture, the University of Arizona
[28] Cook,E: Vanlier .A.and Hubert.N.1994,Landscape Planning & Ecological Network . Amesterdom, Elsevier Pub
[29] Donnett,N.P.,N., Kingsbury.(2004). Planning Green Roofs and Living Walls. Portland (OR): Timber Press
[30] Edwards,B,(1999), sustainable Architecture, Architetural press, Oxford,UK
[31] Elliott,Christopher (2006). "Technical Sales Representative":Soprema Canada
[32] Global Journal of Environmental research 2 (1): 12-17
[33] Green, G. & Gilbertson, J, (1999), Housing, poverty and health: The impact of Housing investment on the health and quality of life of low income residents, Open House International 24(1) 41-53

[34] Hanna.Arendt, (1958).the human condition
[35] Hancock, Ken. (2006)"Energy Management Co- Ordinator, Physical Plant Services", Queens University, Toronto
[36] Johanson, Jackly (2004). :" Building Green: A guide to using plants on roofs, walls and pavement "Mayor of London, London
[37] Kay. J,and Schneider , E , (1994) . Embracing complexity: The challenge of the Ecosystem Approach. Alternatives 20:3, pp.32-9
[38] Kralli, M.N., H.D.,Kambezidis and C.A.,Cassios.(1996).Green Roofs , policy in cities with environmental problems , Fresenius Environmental Bulletin ,5(7-8):424-429
[39] LID. (2007). Green Roofs- Design Page, Low Impact Development Center. U.S.A. Citied on August 2010
[40] Luckeet , K.(2009).Green roof construction and maintenance.New York:McGraw-Hill
[41] Peck,S.W.,C.,Callaghan.(1999).Greenbacks from the Green Roos :Forging a new industry in Canada . P&A Peckand Associates, for CMHC/SCHL Canada
[42] Rees W: Wackernagel M. (1994). Ecological Footprints and Appropriated Carrying Capacity: measuring the natural capital requirement of the human economy pages 362-39
[43] Rudofsky , B .(1964) , Architecture without Architects , New York : Museum of Modern Art , distributed by Doubleday: Garden City, NY
[44] Schneider, D.M.et al. (1978).The Carrying Capacity Concept as a Planning Tool. Planning Advisory Service Report no.338. Chigago:American planning association
[45] Selman, p, (1995). Local sustainability, can the planning system help us get from here to there? T.P.R .66(3)
[46] Szewczyk,Z.(2003)."Designing for waterproofing and maintenance " Greening Rooftops for Sustainable Communities Conference: Chicago
[47] Van Woert, N.D.,et al . (2005). Gren Roof Storm water Retention: Effects of Roof Surface, Slope and Media Depth. J.Environ. Qual. 34:1036-1044
[48] Willis, Anne-Marie, (2000), The Limits of Sustainable Architecture, paper delivered at Shaping the Sustainable Millennium,Queenland University of Technology
[49] Wright. F.L. (2000).Brodacre city: Anew community plan, in: city Reader (Legate, R.T. and stout. F.Eds) Rutledge. London and New York