ECOLOGICAL PLANNING AND STRATEGY ANALYSIS FOR THE AREA IN ARID DESERT

GU Xuanyuan

PhD student, Tongji University

Email:guxuanyuan@vip.sina.com

Abstract

Climate change has become the focus of the world. Today the ecological environmental protection and energy saving technologies are maturing. Planning and Construction need to fundamentally change the traditional concept and methods, and use advanced technology to achieve harmony between man and nature. Arid desert region, as the planet's most fragile ecological area, where people developed through building activities to improve the living environment and alleviate further deterioration, is the typical region with great research value.

In this paper, through the analysis of this kind of regional climatic conditions, three special characters were underlined to be aimed at urban planning. The most important element is water supply, which safeguard all the biology. Then is energy saving, because the main method to keep a comfortable temperature in the high-heat area is to supply large energy, and normally solar energy is affluent in arid desert. In addition, we also need to resist wind and fix sand to protect the living environment.

The traditional building wisdom, as the reference of modern planning for the area in arid desert, is worth of learning. For example, shadow space was used to promote the convection between the hot and cold in small scale to get breeze in micro-environment. And building material with heat insulation like soil and thick brick was used widely to refuse the heat wave outside. In addition, Karez is one of the most outstanding achievements in desert people have done, which even affecting on people’s drinking supply today.

According to the analysis on regional climate character and traditional building wisdom above, some strategies in urban planning were proposed. The first was

compact layout, including the function layout of land use, building layout of space combination and residential unit layout with special community mode. The second was to build an efficient transport system and road network to advance the comfortable degree and decrease the consumption of nonrenewable energy. The third was to use local plants to establish green system with different levels and irrigation technology. The fourth was to suggest characteristic image and guideline on buildings, which could cope with high-heat and dry environment at the beginning and through historical accumulation gradually becoming a regional artistic and cultural value.

Finally, by using the low carbon planning concept and appropriate environmental protection and energy saving technologies effectively, the living environment in arid desert would be improved. As one of the new domain people try to explore to apply to climate change, the area in arid desert is expected to become the new home of the human.

Keywords: Climate change; Urban planning; Arid desert

Introduction

Land desertification is a global environmental issue. Since the existence of historical records, in China, there are 12 million hectares of the land have been turned into deserts, while at present, the desertification area has accounted for over 18% of the national land area[1]. To trace the reasons, most (accounting for 95%) of the land desertification was caused by human factors[2]. Therefore, doing a good job of protecting the land, developing and utilizing the land in a scientific way and conducting ecological comprehensive development rectification in planning and human constructions shall play an important role of relieving the desertification problem and improving the human habitats.

This Paper is based on the research of ecological planning strategies of extreme dry desert areas, and it is aimed at improving human life and working conditions through the ecological development construction activities of independent areas under typical climate conditions and intervening the desertification process through ecological measures.

1 Energy conservation and emission reduction have become the hot topics of the research of current planning and construction

Since the 2009 Copenhagen Climate Conference, the issue of climate warming has caused the broad concerns of the whole world; although the parties of the Conference failed to reach a consensus at the end, they have put the slogan of “Saving our mutual earth” into their schedule.

Meanwhile, the research of worldwide environmental protection and energy conservation has been booming. For example, a Masdar City has been planned for construction in the deserts areas of United Arab Emirates, and it shall be constructed into the world’s first “environmental protection city” that is totally dependent on solar energy to realize self-sufficiency and self-containment, and the zero emissions of waste water and auto emission and CO_2. Its goals of zero emission, zero waste and sustainable environmental protection have provided important experiences for the planning and construction of deserts area.

Starting from the Eleventh Five-year Plan, the environmental protection concept of energy conservation and emission reduction in China has been transformed from the original research and appeals into practical numeral planned targets, and the performance assessments have been conducted on the local governments and mayors. Not only has the nation promulgated a series of laws and regulations, enhanced the relevant policy system of energy conservation emission reductions, but also invested in ten major energy conservation projects, totaling more than 500 energy conservation projects[3]. On such a basis, the practice research of ecological planning and construction has entered the substantial stage.

Dry desert areas belong to the extremely feeble areas of the ecological system, and the effective utilization of energy and resources shall play an outstanding role in the aspects of energy conservation and emission reduction, and the ecological transformation on human habitat is not only an active intervention of the adverse environmental condition, but it is also an important research practice for the present planning practice of our nation’s low-carbon cities. Hence, an in-depth transformation on the production mode, life style and the basic planning concepts has been formed.

2 The Climate Characteristics of Extreme Droughts and Key Planning Points

The dry desert areas are widely distributed worldwide, and in our nation they are mainly distributed in the northwestern areas, which feature dry climate and scarce rain, sparse vegetation, and relatively such fewer humanity scenes as the population and cities, and are the areas that manifested the feeblest ecological system[4]. In the localities, it is extremely tough to conduct general outdoor activities, and with regard to such aspects as the air’s temperature, humidity, wind speed and heat radiation,

they most manifest the environmental characteristics of discomfort, thus affecting the working efficiency and human health. However, the areas' annual sunshine hours are all over 3000 hours, and are featuring the excellent conditions of utilizing the solar energy. Therefore, regarding the climate characteristics of these kinds of areas, their planning and constructions are mainly manifested in the following aspects：

a) Water cycling and intensive utilization

b) Sufficient utilization of solar energy

c) Windbreak and sand fixation through planting measures

d) Construction of comfortable human habitat

3 Drawing Experience from the Traditional Architecture Wisdom

Although these areas feature adverse conditions of natural environment, they have inspired the boundless wisdom of human being, especially regarding the constructions of the traditional architecture, which reflect the great achievements made by the locals in their fights with the nature. Through such special construction modes, they have been fighting against the threatening climate condition, which worth to be learned in modern planning and construction. For example：

3.1Sufficient utilization of shadow and gray space to form local temperature difference counter-flows

In the architecture and planning of these areas, the retaining walls on the roofs, narrow lanes and deep window holes are utilized to form the shadow and gray space; due to the dry climate, there is a big difference between the temperature in the shade and in the sunlight, therefore local air counter-flows can be easily formed, thus increasing the degree of comfort in local areas. Therefore, in the planning, the complex space construction is usually adopted in the courtyard so as to provide the shadow space in different times and different locations (Halike, 2005) , and meanwhile, through the shadow and gray space to organize the public open space, to form the main outdoor activity sites of the residents.

3.2Thick walls are laid with local insulation materials to fight against the high temperature

Local clay or bricks are mostly adopted for the traditional architecture, which feature excellent thermal properties, are heat-insulated and sound-insulated, without

chemical reactions, and the material units are small and they have stronger plasticity and elasticity, and even in modern time, they can be used in combination with stone, wood and steel materials, and they also cost lower.

3.3Kariz water gathering system

Kariz is an artificial facility used for the farmland irrigation and residents drinking by intercepting the underground water in areas with specific landform conditions, and it is the life line for the local agricultural production and residents' livelihood. Through an underground water collection, an enclosed channel that is shaded and protected from the wind is formed, thus greatly reducing the water vaporization, so it is a typical example of scientific use of water through human constructions. (DENG, 2010)

4 Planning Counter-measures

4.1 Compact Layout and Concentrated Functions

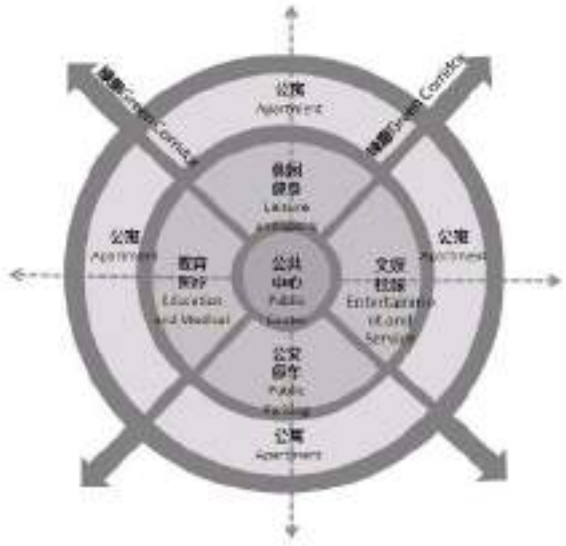

Figure 1. Diagram of functional configurations

In dry desert areas, due to the vast land and sparse population, the construction conditions are hard; generally it is necessary to have compact layout so as to reduce the invasion of the wind and sands. As for the public service facilities that are constructed in one period, it would be favorable to have concentrated layouts, have compound functions and comfortable environments so as to form intensive public cores and reduce energy dissipation and waste. Meanwhile, the service scope of the public service centers shall be moderately expanded, so as to reduce the construction volume.

The residential neighborhood shall be laid in a compact way so that, on one hand,

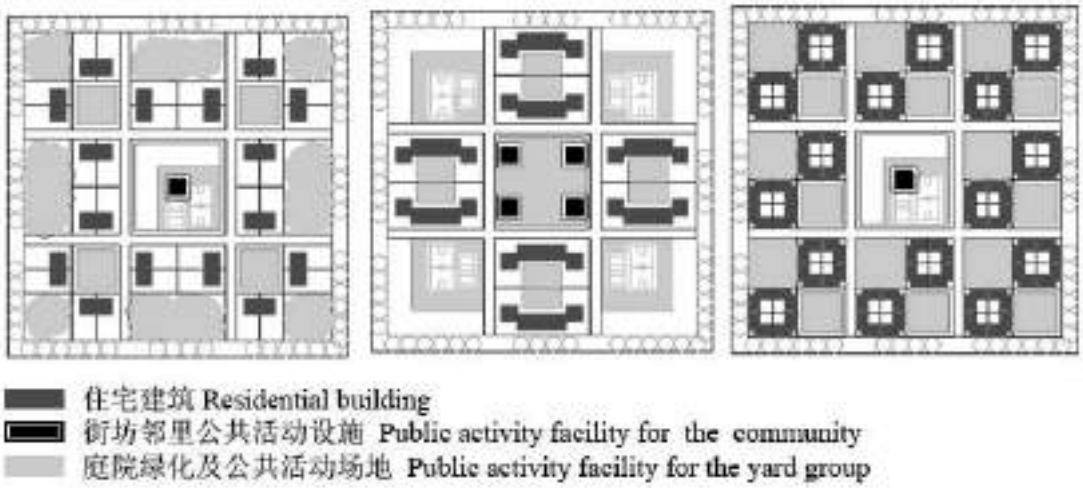

Figure 2. Diagram of functional layouts

shadings can be provided between the adjacent buildings, and, one the other hand, the visual concerns between the neighbors can play a soothing effect on the environmental psychology of the residents in the desert areas. It is possible to learn from the enclosure mode of residential layout, so that the shade space can become the activity centers of the neighborhood with mutual supervision and mutual cares.

4.2 Separate Setups of the Road System

The urban roads, due to the differences in the supporting transportation tools, shall be somewhat separated. As for the traffic of motor vehicles, according to the principle of convenient and flexible, the roadway should be settled down to every garage, but meanwhile, the driving time of the vehicles should be limited and public transportation should be encouraged by making endeavors to create more comfortable and efficient running conditions. As for the traffic of non-motorized vehicles and pedestrian traffic, efforts shall be made to provide special routes that are relatively shaded and moistened so as to reduce the discomfort of slow moving traffic. Therefore, roads for motorized vehicles and non-motorized vehicles or walking traffic shall be set up separately, and the road environment shall also be designed separately; while reducing the construction costs, these measures can create comfortable environments of walking traffic and biking traffic. It is also necessary to make efforts to adopt the design without the pedestrian lanes for the designs of the road cross sections and set them up with shadows.

Figure 3. Diagram of motorized lane and non-motorized lanes

Parking lots or garages shall be deployed with shading facilities so as to reduce the energy consumptions of the vehicles' pre-cooling. The outdoor concentrated parking lots can be provided with integral sunshade panels and meanwhile they can be combined with the solar energy heat-collecting panels so as to supplement the municipal power supply, or provide the charging services for the electric automobiles. What is worth mentioning is that since the technologies of electric automobiles have become increasingly mature, in the future urban planning, the deployments of charging stations shall also be taken into considerations.

4.3 Humanistic Outdoor Spaces for Public Communications

Regarding the outdoor spaces for public communications, in order to strengthen the comfortable feeling of the environment, sunshade system shall be provided, which can be divided into three levels：

a) Pedestrian lanes: By utilizing arbor for shading, meanwhile, combining with the shades of the bushes on sides of the pedestrian lanes, the counter-flows of cool air can be enhanced and the temperature can be reduced with the water scenes in local areas.

b) Shaded activity sites: Through constructing the solar gathering and adumbral system in the sites of public activities and combining with the water scenes, a small climate environment can be created. The special light and shadow effects, while enhancing the shaded areas, can also manifest landscape characters.

c) Shaded gray spaces: Shaded corridors should be provided to form a transition between the indoor space and outdoor space.

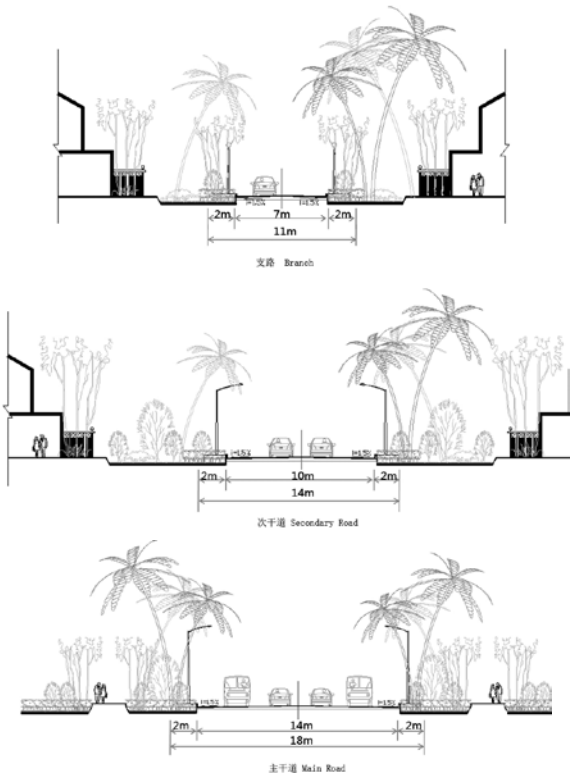

Figure 4. Road cross-section diagram with motorized lane and non-motorized lanes separated

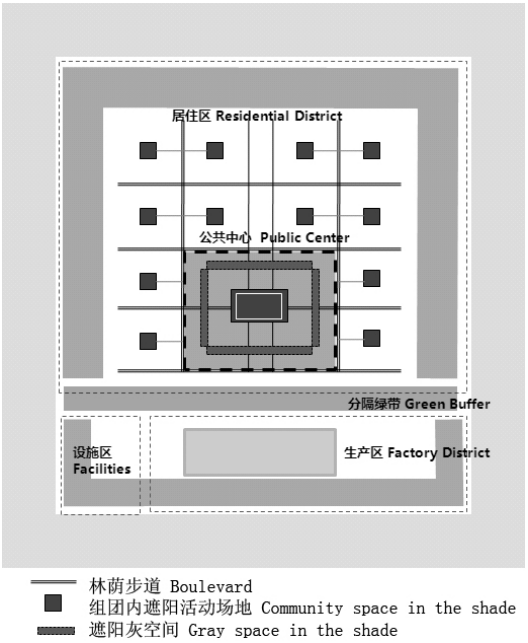

Figure 5. Diagram of outdoor spaces with public communications

4.4 Set up Green System in Different Layers

The planting costs in the dry desert areas are extremely high, and the planting effects of most local plants

that adapt to the local climate are not strong. Therefore, the landscape function of planting should be somewhat weakened, and the functions of windbreak and sand fixation and ecological nourishing should be elevated accordingly. Regarding different land sections and different planting needs, emphasis should be given to a green system with different position, different investments and diversified plant arrangements.

a) Outer sand protection green belt: In the vicinity of the planned areas and the directions from which the sandstorms are coming, the green belt for windbreak and sand fixation should be planted. The importance of providing such greening belts is similar to that of the setup of the flood wall and they shall be arranged and their seeds shall be selected in a scientific way, basically giving less consideration to the landscape effects. Meanwhile, nursery gardens shall be set up in their surrounding areas for cultivation and planting observations, which form a mutual enhancements and supplementations with the green lands of windbreak and sand fixation. By this way, the green belt can be maintained through timely supplementary planting. The planting vegetation in such green belts need to have concentrated irrigations with drip irrigation technology through the municipal water pipelines.

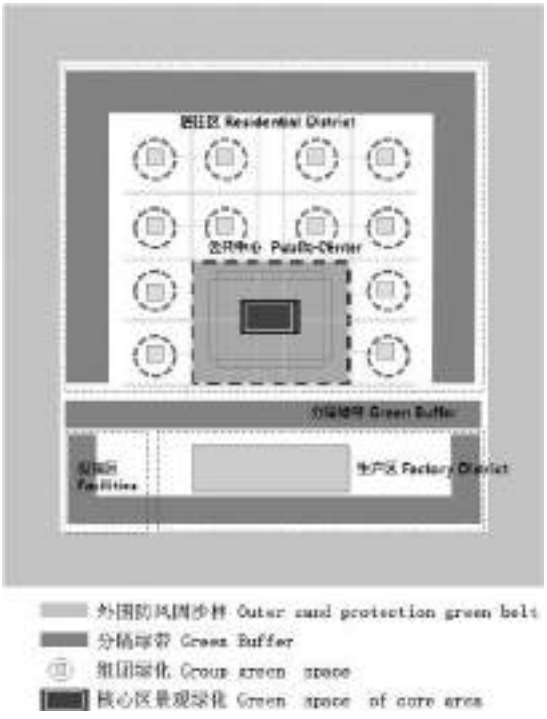

Figure 6. Diagram of outdoor green system layouts

b) Inner sand protection green belt: Green belts with certain heights shall be set up in the surroundings of the areas where there are intensive resident activities, which shall feature both the function of windbreak and sand fixation, and the function of landscape and shadowing. As a result, while the residents can be protected from the harms by sandstorms, they can also acquire a psychological cooling sensation through visual effects and elevate the degree of comfort. Such kinds of green belt have concentrated irrigations with drip irrigation technology through the municipal water pipelines also.

c) Group green space: Courtyard green space shall be set up in the residential building groups which are combined with the resident activities, which mainly feature the landscape and shadowing functions, and somewhere the arbors planted with flowers for appreciation. They shall be irrigated with reused water after anaerobic effluent treatment from living waste water.

d) Green space in core area: Intensive and high efficiency green space shall be provided in the public core areas, which mainly feature the landscape and shadowing functions; Meanwhile, the hardened ground surface and arbor planting shall be combined with each other ,and sometime the lawn patches and flowering plants for appreciation are also needed. They shall be irrigated in a concentrated way through the municipal water pipelines.

4.5 Elastic Reservations and Rapid Construction

Since during the initial construction phase of the dry desert areas, it mainly features the intensive construction, with the smooth operation of the energy and ecological system as the main goal; when the development of an area is relatively stabilized, it will, just like most of the cities and towns, attract more people to settle down here and practice their occupations, which expand the city functions. Therefore, in the planning, it is necessary to provide the possibility of future expansion so as to avoid the damages to the newly formed green belts and the ecological system caused by the expansions of the growth borders of cities.

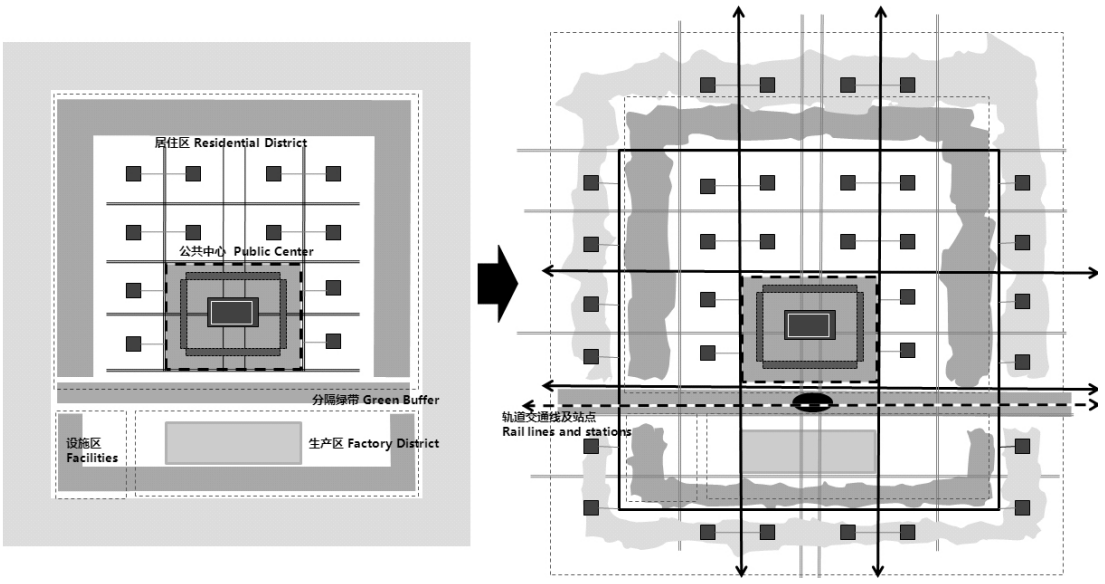

Figure 7．Diagram of cluster expansion and transformation

a) The planning of road networks shall mainly be based on square grids, with

reserved possibilities of outward expansions.

b) Protect most of the living vegetations, which is potential to be transformed into urban green belts with different functions in the process of urban expansion.

c) New area shall be developed with the form of blocks so as to avoid removing and reconstruction.

d) Since the civil engineering activities are mostly conducted outdoors, it is necessary to elevate the construction speed and efficiency and shorten construction periods. For the engineering facilities which need constant maintenance and some functional blocks with shorter utilization periods, they would be preferable to adopt the modular components, which feature elasticity of transformations, or the modes of out-site production and on-site installations can be adopted so as to elevate construction efficiency.

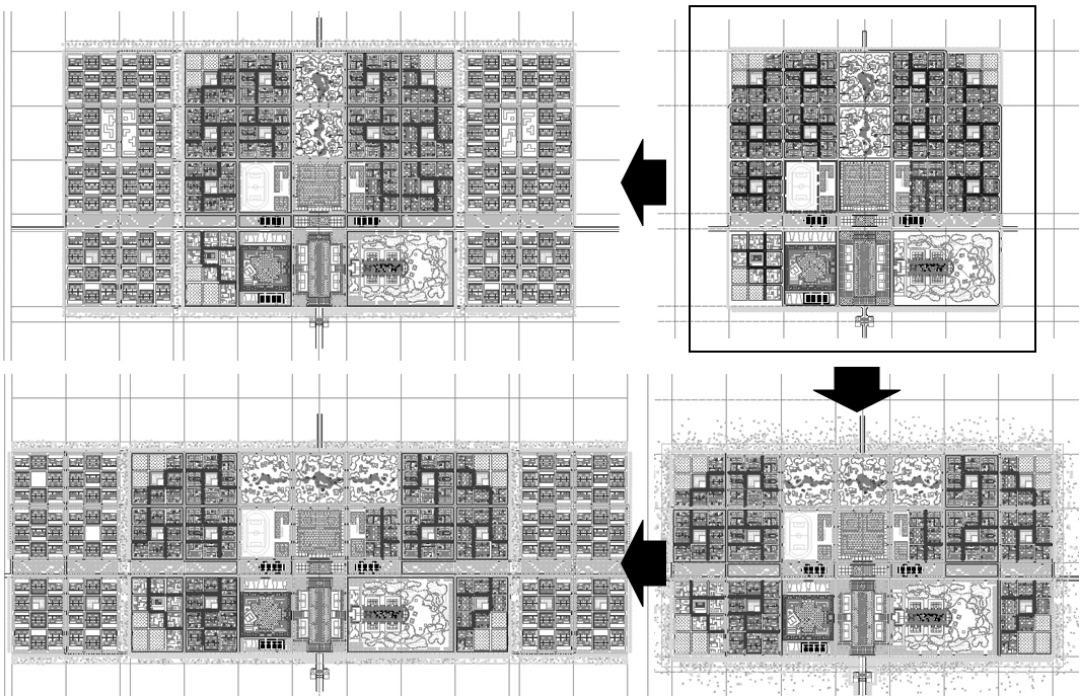

Figure 8. Diagram of urban growth

5 Relevant Ecological Technical Assurances

During the process of realizing the above planning measures, the applications of energy conservation and environmental protection techniques are indispensable, especially regarding such aspects as the reclaimed water utilization, electric generation with solar energy and windbreak and sand fixation. At present there have

been rapid progress in domestic and foreign energy conservation and environmental protection techniques; however, although some techniques are advanced, they do not feature the conditions for wide applications, either because the technical process is too complicated or the costs are high, or they are too particular about some preconditions. Nevertheless, dry desert areas are bound to be the important areas for human beings to fight against the nature through science and technology, and the steps of their research and exploration shall never cease.

In the following, some of the relatively mature ecological technologies that are suitable for uses in the dry desert area are selected so as to ensure the realization of the measures.

a) Greening plantations and plant irrigation techniques: Generally there are three kinds of irrigation techniques as border irrigation, furrow irrigation and drip irrigation, among which the drip irrigation technique features the most advantages. Based on a simple principle, the drip irrigation technique drip the water onto the precise locations of the plants. Compared with the open type irrigation which has 40% water used efficiently, the efficiency in the use of water with the drip irrigation technique can reach as high as 70～80%, so the limited amount of water can get maximum benefit. It not only can effectively save resources, control evaporation, but can also reduce the plants needs on fertilizers, prevent the soil's salinization and prevent weed growth.

b) Techniques of windbreak and sand fixation: There are generally such three categories as biological sand fixation, engineering sand fixation and chemical sand fixation.(LIU, *et al*, 2002)

Biological sand fixation technique: establish artificial vegetations or protect and restore natural vegetation, and generally it is necessary to provide mechanical or chemical sand fixation techniques as supplements. Local plant species shall be selected first for the biological sand fixation.

Engineering sand fixation——sand barriers which blockade the movements of sands through engineering measures, are divided into the two forms of flat layout and vertical layout.[5]

Chemical sand fixation——fix the flowing sands by utilizing the sand-fixing agents. Sand fixing agents can be directly sprayed on the ground or mixed with sand soil, and it can form a protective membrane with the sand soil, thus effective fix the sand and prevent the movements of the sand soil; meanwhile, absorb and reserve the rain water so as to ensure the vegetation viability and speed up the growth; for example,

the uses of water retention agents, ABT, and PG reagent.

c) The technique of geo-thermal heat pumps: Retrieve the heat from the shallow soil or underground water or release heat to them, and, through the geo-thermal heat pumps units distributed in the various rooms, directly change it into the heat wind or cold wind, or provide heating or chilling for the rooms.

d) The technique of reclaimed water recycling: Currently the membrane separation technique is adopted commonly but features high costs. The reclaimed water technique in combination with biological technique has gained certain market shares. And the technique utilizing the nuclear technique will be used to greatly reduce the costs, but which have not been widely promoted.

e) Solar power technology: Concentrated solar energy power station features low costs and high efficiency. The concentrated deployments of patches of solar energy heat collection devices can make the utilization of solar energy sufficient. In addition, the application of solar photovoltaic walls panels as hanging components on the building facades is also an effective means of reducing the energy consumption of single units.

Results

By using the low carbon planning concept and appropriate environmental protection and energy saving technologies effectively, the living environment in arid desert would be improved, especially from water supply, energy saving and wind resist and sand fixation. We can see from the historical immigration and the wisdom of people how to govern the diverse lands that even the environment is threatening but people will never give up to conquest new lands for living. As one of the new domain people try to explore to apply to climate change, the area in arid desert is expected to become the new home of the human.

Conclusions

The ecological planning and construction of dry desert areas manifest the human beings' splendid vision of improving the living environment through science and technology, mitigating climate change and creating a harmony relationship with nature. Amid the current era when the techniques of environmental protection and energy saving have been constantly maturing, the planning and constructions in many areas are still following the behindhand strategies and approaches, while such concepts of low-carbon, energy saving and environmental protection are still a mere formality. Therefore, how to concretely fuse the low-carbon concept in planning and

practically utilize appropriate techniques of environmental protection and energy saving is an important step that all the practitioners of planning shall be striving for.

Notes

1. Based on the statistics revealed by State Forestry Administration P.R. China, in 2011, the sandification land in China had reached 1731100km^2, accounting for over 18% of the national land area, affecting 30 national first class administrative regions (provinces, autonomous regions and municipalities). The desertification land in China had reached 2623700 km^2, accounting for over 27.33% of the national land area.

2. Excessive deforestation accounted for 32.4%, overgrazing 29.4%, overuse 23.3%, inappropriate utilization of water resource 6%, sand dune movements 5.5%, urban and factory and mine constructions 0.8%.

3. It is specified by the revised "Law of energy conservation", which was executed on April 1st, 2008 that the resource reservation is one basic national policy of our country.

4. This kind of areas usually features big temperature difference, enormous sand, and the soil layers have coarse quality and lack organic substances and are strongly salinized. The annual rainfall is less than 250mm, with some areas even having less than 20mm, while the annual evaporation capacity reaches 2400mm～3000mm. There is strong northwest wind, and there is a tremendous amount of sand blown by wind. The average temperature in summer is above 30 ℃, with the highest summer temperature

5. The flat-laid sand-buffer is made of such materials as the firewood, stalk, clay, tree branches, laths and pebbles, which can reduce the wind's speed and fix the sand surface. The vertical sand-buffer involves the setups of lines of blockages on the passing routes of the sand blown by wind so as to reduce the wind speed and deposit part of the sand, thus playing the functions of windbreak and sand fixation.

Acknowledgements

Part of the background research for this paper was supported by the practical project of "Permanent Camp Planning Competition in Gas Liquefied Plant of CNOOC". It was partly executed under the auspices of the project team.

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