



Low-Carbon Green Space Construction in Urban Communities

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ABSTRACT

Low-carbon green space is an integral part of low-carbon communities. It promotes the sustainable development of communities by increasing "carbon sinks" and reducing "carbon sources". This article analysed the direct and indirect carbon emissions resulting from green space construction in communities, and proposed the improvement strategies from the three perspectives, planning, design and technology applications in low-carbon green space. The planning of low-carbon green space involves increasing carbon sinks, improving the quality of community green space, optimizing the night view of green space and selecting local seedlings. The design can incorporate low-carbon materials and interplanting designs. The low-carbon green space application technology can include vertical greening, green roofs, rainwater utilization, energy-saving lighting and waste recycling. The sustainable development of communities can be effectively promoted through the low-carbon construction of green space.

INTRODUCTION

Global carbon dioxide emissions from construction industry account for about 40% of the total global carbon dioxide emissions, and carbon dioxide is the major gas leading to the "greenhouse effect". Because of the growing global concern about the "greenhouse effect" and climate change, various countries are devising their low-carbon strategies and measures (Philip Davies & Mohamed Osmani 2011). Regarding the construction of communities, energy-friendly communities (Fesanghary et al. 2012) and communities with low energy consumption (Agnieszka Zalejska-Jonsson 2012) have been widely developed. Currently, China is a big carbon emitter (Yang & Yanan 2013) and must take effective measures to reduce its carbon emissions. Therefore, low-carbon development has become a national strategy of China's economic development (Ping Jiang et al. 2013). It is clearly stated in China's "Twelfth Five-Year Plan" that "to follow the international trend of green and low-carbon development, low-carbon strategy is imperative".

Low-carbon community is a new community building model that has emerged in recent years (Xu et al. 2013). Low-carbon community refers to those that aim at minimizing the consumption of natural resources and energy in all their activities, and reducing carbon emissions to the minimum or even to "zero" (Fong & Lee 2013). Community environment mainly consists of two parts, the artificial building system and ecological green space system. The functions of community green space include the provisions of environmental protection, landscape space and leisure facilities.

Community green space is an important indicator of the quality of the community environment. Current researches mostly focus on achieving the low carbon emissions of the artificial building systems of the communities, and have yielded fruitful results. Low-carbon buildings can be realized in the design and construction phases (Gabriela Zapata-Poveda & Chris Tweed 2014). Building technology and the application of energy analysis tools are also very important for the construction of low-carbon communities (Fiona Hamilton-MacLaren et al. 2013, Saad et al. 2013). Urban green space plays an important role in maintaining the carbon oxygen balance of the city and reducing the heat island effect (Francesco Primo Vaccari et al. 2013). But so far, the research on low-carbon green space construction on the community scale is relatively weak. Therefore, it is necessary to study the low-carbon construction approach of communities through green space under the new situation.

COMMUNITY GREEN SPACE EMISSIONS AND LOW-CARBON STRATEGIES

Community green space emissions: Community green space mainly has two types of carbon emissions: carbon emissions for direct or indirect reasons. The former is mainly the result of transportation, installation, transmission of green space construction elements as well as night lighting. Indirect emissions mainly refer to additional emissions caused by unreasonable secondary transport, maintenance, management, processing and duplicate lighting (Fig. 1).

Community green space low-carbon strategies: Increasing

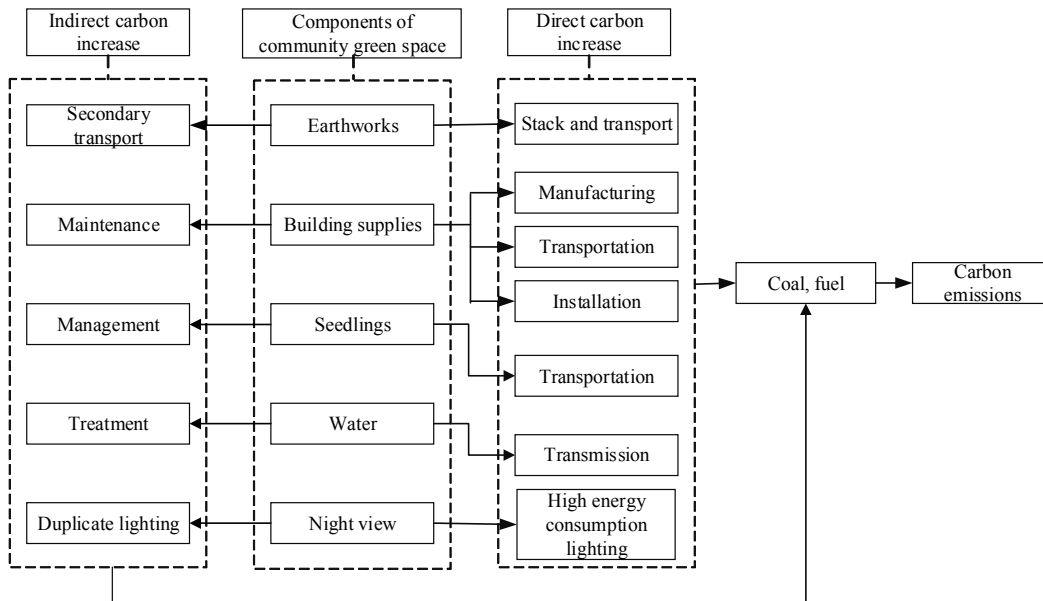


Fig. 1: Carbon emissions from community green space.

“carbon sinks” and reducing “carbon sources” are two ways to achieve low-carbon goals in community green space. “Carbon sinks” and “carbon sources” are two opposite concepts. “United Nations Framework Convention on Climate Change” defines “carbon source” as the processes, activities and mechanisms by which the carbon dioxide is released into the atmosphere, and defines “carbon sink” as the processes, activities and mechanisms by which the carbon dioxide is absorbed from the atmosphere. In forestry, “carbon sink” mainly refers to the processes by which the plants absorb atmospheric carbon dioxide and fix it in vegetation or soil, and thereby reducing the concentration of this carbon dioxide in the atmosphere. Emission reduction aims at the sources of emissions, and “carbon sink” is to increase the carbon dioxide absorption by afforestation. Community green space construction includes planning, design, construction management and other links, and therefore low-carbon goals can be achieved by controlling these links (Fig. 2).

COMMUNITY LOW-CARBON GREEN SPACE CONSTRUCTION

Low-Carbon Planning of Community Green Space

Improving the function of carbon sinks in community green space: By improving the greening rate, green coverage rate and the three-dimensional vegetation quantity, the community green space construction can increase the “carbon sinks” to improve the ecological environment of the community (Muñoz-Vallés et al. 2013). China’s current

evaluation indicators of community green space construction mainly include the greening rate and green coverage rate, which do not fully reflect the true quality of green space. Compared to lawns and shrubs, trees have a higher eco-efficiency and a stronger “carbon sink” effect. Therefore, the three-dimensional vegetation quantity should be incorporated as a community green space indicator, in order to maintain the carbon-oxygen balance of the community (Mediha Burcu et al. 2012). As a greening indicator, the three-dimensional vegetation quantity overcomes the limitations of traditional green indicators, and can more accurately reflect the rationality of community green space structure. Moreover, this indicator can also reflect the eco-efficiency level of the whole community, and thus can be used for a more comprehensive and accurate description of the quality of community green space (Philip James 2012).

Improving the quality of community green space: The upgrading of the community green space quality can enhance the sense of identity and belonging among community members. This can lower the probability of using vehicles to find recreational sites outside of the community, which in turn can effectively reduce the carbon emissions. Community is a crucial habitat for residents, and the attractiveness of community green space is related to various factors: The layout planning of community green space should meet the needs of community members through the creation of spaces for getting into contact with green, earth, people and water. The layout should combine features of

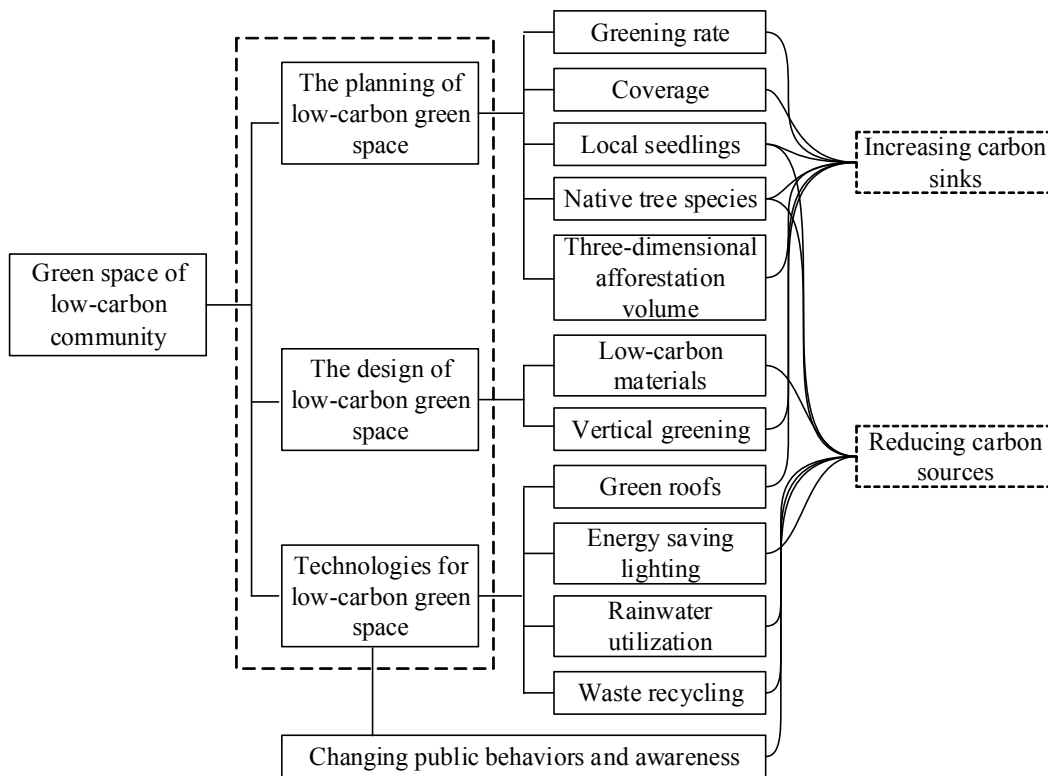


Fig. 2: Low-carbon strategies for community green space.

centralization and decentralization. There should be green centre for public activities, while other pleasant places should be designed with the most convenient access. Community green space should have rich and varied combinations that are well organized and clearly structured, and also excellent amenities catering for the needs of people of different ages, genders and occupations.

Optimizing green space night view: Community night view is an important part of community landscape construction. Community night view consumes a great deal of power. Since the vast majority of China’s electricity is generated by burning coal, this produces large amounts of carbon dioxide and causes the greenhouse effect. Currently, the night view construction in community has the problem of serious waste. With neither a unified plan nor originality, the construction of night view in many communities is a waste of energy. Green space in many communities has a variety of lighting (Helga et al. 2012), and the duplicate and excessive lighting has caused severe light pollution. Therefore, the community night view needs a rational planning, which should be based on the principle of “energy conservation with highlights”, so as to improve the community environment quality while reducing energy consumption.

Selecting local seedlings: Real estate development has an increasingly higher demand on green landscape. For better aesthetic effect of the green space, some communities use a variety of uncommon or large-sized seedlings in green space construction, making the organization of seedlings very difficult. However, the vast majority of cities in China lack seedling reserves. The gap between supply and demand is huge, which is especially true for large-sized seedlings. Therefore, the long-haul transport of seedlings becomes the only way to solve the problem, and energy consumption during transportation is enormous. Planners should carry out research on the conditions of the seedlings near the city, and try to use local or nearby products to achieve “energy saving & emission reduction”.

LOW-CARBON DESIGN OF COMMUNITY GREEN SPACE

Choosing low-carbon materials: Hard landscape in green space construction consumes huge amount of cement, stone, bricks and other materials. The production of these materials has high energy consumption, and carbon emissions can be effectively reduced by controlling the use of these green space materials. Specific measures include the following:

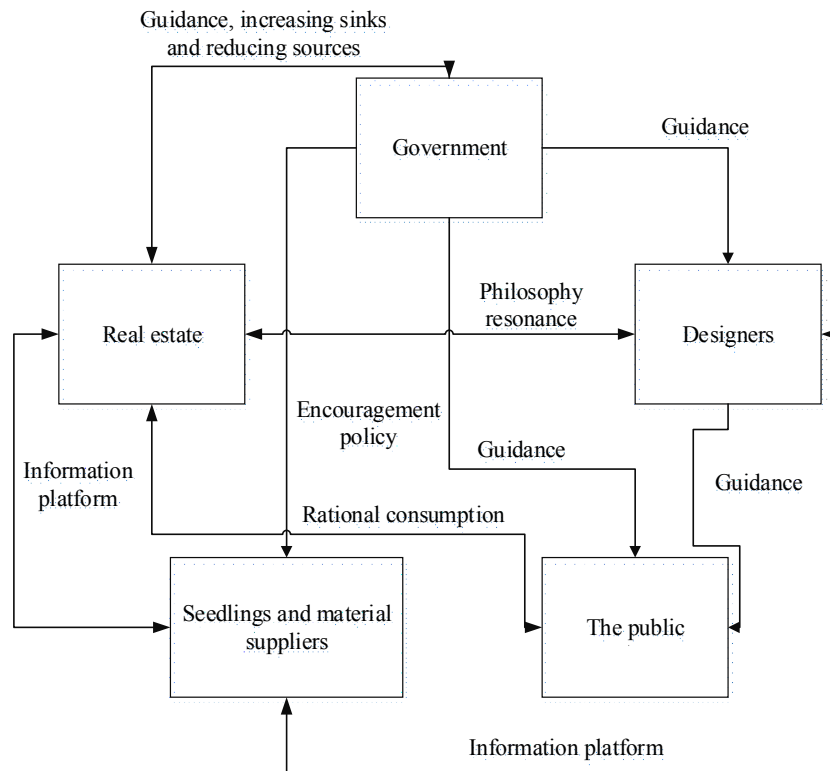


Fig. 3: Coordinated demand for low-carbon community green space.

Use environment-friendly green space materials, because using lasting and easily maintained green space materials can save energy and lower the generation of solid wastes; use sustainable raw wood materials, such as plantation timber from well managed forests rather than those from primeval forests; choose low energy consumption materials without affecting the properties and service life of green space materials, because the heavy industry generally has a high energy consumption. When possible, choose building materials that require little maintenance (such as painting, re-treatment or waterproof treatment), or the materials whose maintenance has a minimal impact on the environment; buy locally produced green space materials, because transportation not only consumes energy, but also produces pollution.

Interplanting design: Plant landscaping is the mainstream of green space construction in Chinese communities. Plant landscaping should emphasize interplanting, with “trees as motif, while combining shrubs and grasses”. Stereoscopic flora with different layers should be built. The rational flora design not only improves the green scenery but also the three-dimensional vegetation quantity. It can produce an active “carbon sink” effect to effectively improve the

ecological environment of the communities.

APPLICATIONS OF LOW-CARBON TECHNOLOGIES

Vertical greening and green roofs: Vertical greening (Katia Perini et al. 2011) and green roofs (Nicholas et al. 2010) help reduce the surface temperature of buildings in summer, and thus play a role in energy conservation. Moreover, vertical greening can increase the effectiveness of landscaping and the green looking rate, while the roof gardens can expand the green space and provide additional place for activities. Due to increased difficulties, the construction and maintenance of green roofs tend to have higher carbon emissions than ground green space. Therefore, the choice of materials, reasonable design, and scientific construction should be stressed in the construction of roof gardens.

Rainwater utilization: Many cities in China have scarce water resources, and their supply and demand is a prominent issue. The routine management of community green space requires large amounts of water resources annually, in which the tap water takes up the large majority. From the water source to communities, tap water goes through the process of water diversion, purification and distribution, which consumes a great deal of energy. In communities,

water-saving construction of green space should be vigorously promoted. On the one hand, drought tolerant plants should be chosen to reduce water consumption; on the other hand, reclaimed water and rainwater should be utilized to reduce the use of tap water for irrigation. For example, sunken green space can be adopted to increase the rain permeability. Permeable pavements can be used to allow the rainwater to infiltrate into the soil, while reducing the runoff; the elevation of the site can be modified to collect the rainwater resources (EneDir Ghisi 2006); community rainwater storage facilities can be built. These and other measures can effectively reduce the consumption of artificial water supply.

Choosing energy-saving lighting: The construction of community night view requires the use of spotlights, floodlights, garden lights and other lighting fixtures. There are two types of wastes in the use of lighting fixtures. First, in order to create unique shape of lighting fixtures, the design is becoming increasingly complex, with too much emphasis placed on decoration but little on lighting itself. Second, many lighting fixtures still use high-energy light sources, such as incandescent lamps, high pressure sodium lamps, and chlorine lamps. The LED lamps are safe to use, and have low energy consumption. Their energy consumption is much lower than that of incandescent lamps under similar lighting efficiency, and therefore LED lamps are especially suitable for public places. Designers should make lighting “energy friendly and beautiful” by balancing between the decorative and lighting functions of the lighting fixtures.

Waste recycling: To reduce resource consumption during community green space construction, waste materials should be reused when possible. For example, using removed wood or metal to lower the pressure on landfill and to conserve natural resources; buying locally produced green space recycled materials, which can prevent the solid waste pollution, reduce energy consumption in production, and save natural resources; cellulose insulation products, floor tiles produced from vegetation or plastic timber produced from recycled plastics are typical examples of waste recycling; minimizing the use of pressure treated wood, and using plastic timber as a substitute to natural wood where possible.

SUGGESTIONS

Low-carbon planning, design and material applications can effectively control and reduce carbon emissions in community green space construction. However, it should also be noted that community green space construction starts from the control indicators proposed by the government. After the planning and design by the designers and construction by real estate developers, the community green space is finally put into public use. The successful implementation of

community low-carbon green space relies on the collaboration between governments, developers, suppliers of materials and seedlings, designers and the general public (Fig. 3).

The main duty of governments is to develop standards and incentives for the construction of community low-carbon green space, and to encourage the construction of low-carbon green space by compensating for the gap. At the same time, the governments should encourage the local seedling industry to build information platform so as to gain the market information. Designers should be fully aware of low-carbon strategy, and incorporate low-carbon design techniques into the planning and design of community green space. The obligation of the public is to promote harmonious community by adopting the low-carbon lifestyles and behaviors. Through a series of low-carbon measures, carbon emissions from the construction of community green space can be controlled at a reasonable level. By this means, the sustainable development of the community environment can be promoted.

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