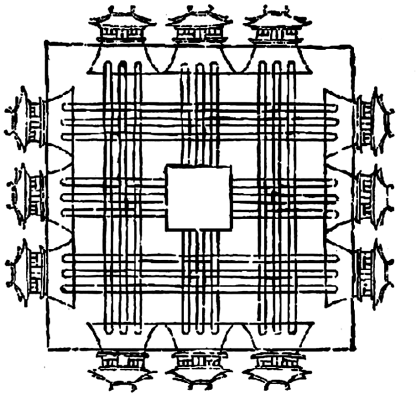
Distributed Green Space System: An Implementable Green Infrastructure for the City

Dr. Fan Fu[1], Caijun Zhao[2]
[1] *School of Architecture and Engineering, North China University of Technology,*
[2]*School of Landscape Architecture, Beijing Forestry University*

Review of Urban Green Space Systems

In the early cities, green spaces were not considered as important, because cities arose as settlements against natural and rural environments. There were intentionally no green spaces allocated in the central areas of the ancient Greek cities. Munford (1961) notes in reference to the Acropolis of Athens that "the course Rock seems as if it is never covered with anything but buildings". There was scarce vegetation and a few trees were planted for shade in the agora to comprise a fraction of the public place. The public green spaces for activities were located outside the city while the green spaces inside the city were private gardens, buffers around sacred places, orchards, or most likely, undeveloped lands. The Miletus Plan from conception had not cared about green spaces and other natural conditions like rivers, lagoons, and hummocks, and lasted in Europe until the 18th Century. Therefore, it is not a surprise that Vitruvius did not mention green space in his classic *De Architectura*.

In ancient China, things were similar. The Book of Craftsman, official technical guide of East Zhou Dynasty (771B.C.-256B.C.), showed the basic principles on city planning. The grid plan (fig.1), similar to the plan of Miletus, seems to have no room designated for green spaces. In most cases, green spaces for the public were outside cities, however a remarkable exception was the city of Beijing (fig.2) built in the Ming Dynasty (1368-1644), where the Jingshan Hill over 45 meters in height was piled behind the Forbidden City and ten thousand trees were planted in 272 ha at the Temple of Heaven for the sake of Fengshui (Fu & Zhao, 2008).



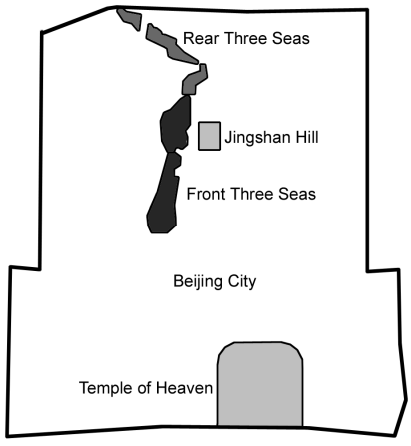


Figure 1. Grid city format **Figure 2. Beijing in Ming Dynasty**

In addition, the natural lagoons west to the Forbidden City were extended and converted into a series of lakes called the Three Front Seas and Three Rear Seas. The former became royal gardens with the Jingshan Hill and the Temple of Heaven, while the latter existed as large public green spaces. However, the element of water proportionately dominated the spaces instead of the trees, and its essential purpose was to supply water and for shipping and flood control. Thus, green spaces were not paid enough attention to and were therefore not systematically planned, even if they did exist and did contribute to form systems in ancient cities.

It has been since the Industrial Revolution that green space has been considered important to the city. Urban sprawl and overpopulation and pollution caused by industrial development made the living and working conditions of city dwellers atrocious. Thus, urban green space was regarded as a necessary method to improve the public environment and ease social tension. As a result, public parks occurred as typical green spaces in cities. They were called “lungs of a great city” by Camillo Sitte (Munford, 1961), and their implementation spread from Europe to America. Nevertheless, it was not until the development of the Boston Emerald Necklace project that the consideration of green spaces as a holistic organizational system gained prominence. In the last century, research and practice on green space systems and their applicability in the city has been a major part of city planning and landscape architecture. As critical issues such as climate change, ecological crisis, and fast urbanization continue to increase, the green space system strategy is gaining increased implementation as a major part of green infrastructure, primarily for its integrated and interdependent ecological, recreational, and cultural/historical considerations. Green space systems evolved throughout time, from greenheart to greenway. The distributed green land system is a concept similar to greenway, attempting to solve current problems of urban green space planning.

The Problems of Large Scale Green Space

The Mall in L’Enfant’s Washington D.C. plan was a prototype proposed as a large city green space strategy. Subsequently, Central Park in N.Y.C. started a city green space pattern, noted by the introduction of a large green space in the center of the city. Though this pattern became more complicated in Howard’s Garden City by adding green corridors and greenbelts, a large park still lied in the core. In this pattern, there is a hierarchy of green spaces in which the larger spaces are at the top of the hierarchy and small spaces receive the least consideration. Large green spaces are believed to be more important, and are thought to provide better visual aesthetics than small spaces. This design approach has been, and continues to be cloned worldwide. However, it is important to note that this design strategy does not function well in all scenarios. Munford (1961) believed that the Mall was only serving a good aesthetic purpose, but that it failed to consider what a plan ought to serve for. It in fact segregates the areas that should be closely linked together. Central Park also physically and socially splits the city and people of different socio-economic and ethnic groups who are as a consequence segregated in the park’s vicinity. Particularly in the first decades after the park’s completion, it was a park

for the wealthy. The working class comprised a fraction of the visitors due to their distant location to the park (Waxman). In addition, as experienced in Beijing, China, dwellers prefer smaller green spaces in close proximity to their living environments, as these prove more convenient than distant larger spaces. As a result, small green spaces are more frequently used for recreation, leisure, and exercise-related activities.

Figure 3. Re-allocation of split Central Park in Manhattan

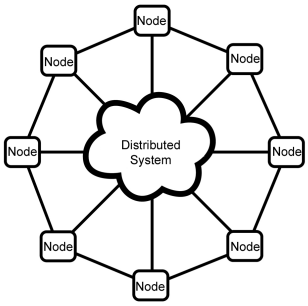
Although large-scale green space is essential for the city, its over-emphasis within the system will cause imbalance in the whole. First, large green spaces in the city means fewer medium and small spaces due to land-use limitations; consequently, more large green spaces also means less access to green space by the common citizen. As an example, dividing Central Park into three parts and reallocating each part to one of three areas, downtown, midtown and uptown (fig.3), would make green space available to more local dwellers. Furthermore, visitors cannot reach every part of such a large green space in a limited amount of time. Thus, the more attractive places are overcrowded, while others are seldomly approached. Moreover, large green spaces are hard to supervise. Central Park was one of the most dangerous places in New York City with high crime statistics (Vitullo-Martin, 2003). In addition, large green spaces are usually situated in suburban environments due to the increasing difficulty in finding large enough sites in the highly developed urban areas where the green spaces are most needed. As a result, large green spaces cannot solve the problem of central urban areas' lack of green spaces. Lastly, the cost to build, maintain, and update a large green space is much higher than that of a series of small ones with the same total combined area.

Unfortunately, few planning entities acknowledge this problem and large scale green spaces are still planned in cities around the world, especially in rising cities eager to catch the eye through splendid plans. This trend ignores the key functions of green spaces and disregards the user's senses. What it stresses is a graphic image of the city, one that may be a striking mark on the map. The Beijing Olympic Forest Park of 680 ha. forms a huge central park in the northern part of Beijing. It is hard to imagine that the citizens in the southern, western and eastern parts of the city would spend more than an hour by public transportation to visit the park when their experience which is limited by walking, makes their sense of the space overwhelming.

Therefore, a large scale green space might work well as a single independent entity, but it is not a good strategy when considering the whole city's green space system.

A Distributed Green Space System

A distributed green space system might be an alternative strategy for a city's green space system. This concept borrows ideas from distributed systems of computer science. A stand-alone supercomputer is powerful but inconvenient. It is extremely expensive in building, maintaining, and updating, but only a few users can use it. Moreover, no one can use it when it crashes or shuts down. The distributed system solves these problems since a cluster of the microcomputer can work as a stand-alone supercomputer with lower building, maintenance, and updating costs (fig.4). Each node runs a part of a larger task; meanwhile, each user can also run other tasks on the nodes in idle time. Thus, the efficiency to usage increases. More importantly, when a node crashes, or stops to maintain and update, other nodes in the system will not be impacted. In addition, updating any node or adding new nodes will make the system more powerful. Similarly, a small green space node can function well independently, and can work with other nodes to replace the function of the single large green space. Moreover, a distributed green space system is a dynamic system in which nodes can be continuously added to or updated to match increasing requirements, a quality that fulfills the changing demands of quick city development.



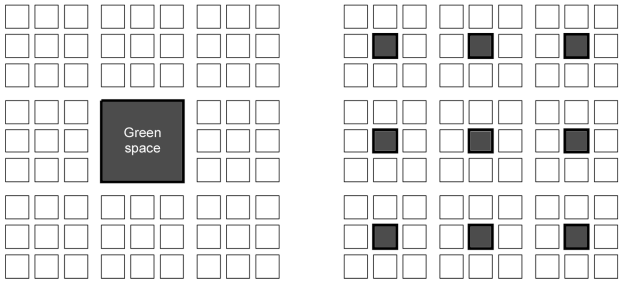


Figure 4. Distributed system **Figure 5. Single large space vs. distributed spaces**

Compared with a concentrated large green space, a distributed green space system can serve the city more efficienty. First, green spaces are distributed with more balance in the city so that more users can reach them. With the same total combined area, the number of small available spaces is certainly bigger than a single large space. Thus, the former can have more dispersive distribution throughout the whole city (fig.5). As a result, local dwellers live closer to green spaces, and use them more conveniently without long travel.

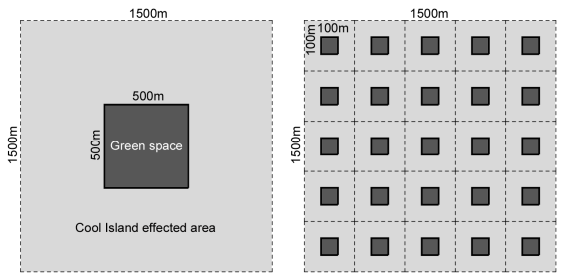
Secondly, distributed green space system can improve the living conditions of local dwellers and improve social relations. Research claims that the amount of green spaces in the living environment is positively related not only to people's health condition but also to people's social relationships. On the contrary, people in living

environment with less green spaces are more likely to have feelings of loneliness and a shortage of social support (Maas, et al., 2009). Daily visits to these green spaces is considered to be an act of community. Dwellers are more likely to have stronger feelings to cherish the green space and be more willing to be involved in the building, management and maintenance work. In addition, research proves that more greenery in residential is conducive to an area of less crime (Kuo, et al., 2001).

Thirdly, the distributed system can benefit from designated focused uses for a variety of green spaces to avoid duplication of services and activities. Though a green space could be multi-functional, some green spaces with specific features could minimize services provided. For example, a green space specifically preserving historical values may not need excessive recreational services; and human activities should be restricted or prohibited in protected wetland and wildlife reserve. Therefore, distributed green space system can strategize allocation of services with green spaces better than a large space that usually integrates most services.

Fourthly, distributed green space system works well ecologically. A common claim by planners to create large green spaces is based on research showing that only large green spaces, larger than 3 ha., can serve as a cool island in an urban context (Li, 1999; Liu et al., 2008). However, there is evidence that smaller urban green spaces, based on 0.1 ha., can also reduce temperature significantly (Shashua-Bar et al., 2002), and that the influence of parks on air temperatures appears to be restricted to the dimension of a parks' width (Jauregui1990; Spronken-smith & Oke, 1998). Therefore, the cool island effect of 25 well-balanced 1 ha. green spaces can be the same as that of a single 25 ha. green space in a 225 ha. urban area (Fig 6). Additionally, the distributed system can more efficiently handle flash floods after heavy storms, which increasingly occurs as the climate changes (Fig 7). More importantly, the distributed pattern can conserve biodiversity in a city. When a green space is damaged by pollution, development or fire, wildlife can move to other green spaces. On the other hand, when such a disaster happens in a single large green space, the effect can be worse.

The distributed green space system does not absolutely oppose larger green spaces, especially those emerged in special natural or historical context. Instead, it focuses on the balance of the whole system, refusing imbalanced allocation of green spaces caused by the intentionally concentrated large green space.



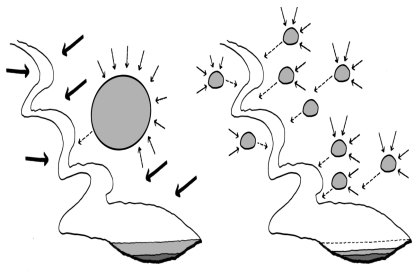


Figure 6. Green Space Cool island effect **Figure 7. Flash flood management**

Distributed Green Space System vs. Greenway

The distributed green space system and the greenway system (Fábos, 2009) share many of aspects in common. They both respect nature and consider the three key uses of green spaces, namely recreation, nature protection and cultural benefits. More importantly, both of them use the concept of network. However, there are some differences between them. First, they are applied in different levels. The distributed green space system is mainly used at the city level; however, the greenway is usually used at the regional and state levels. Secondly, the systems are composed of different patterns. The greenway emphasizes a physical link between green spaces, i.e. corridors in ecology, which could be natural corridors like streams and ridges, or artificial corridors like railways and promenades, and is used in practice to create connections among green spaces. On the contrary, the distributed green space system pays more attention to the layout of nodes, i.e. distribution of patches in ecology, implemented in balanced allocation. Finally, the greenway pays more attention to nature, while the distributed green space system focuses on optimizing the urban green space system. In summary, the distributed green space system could complement the greenway at the city level.

The distributed green space system allows corridors existing in the system, but these should be implemented discreetly and with caution. Much research proves that corridors can increase the flow of species that promotes biodiversity (MacDonald, 2003). However, there is still some evidence showing that corridors make bioinvasion more probable (Carlton, 1996). Proposed corridors might lead to bioinvasion in a city whose ecological environment is fragile. Dominant species, or other species able to flow along corridors, might invade other spaces, prey on or compete with native species, and cause ecological disaster by the loss of biodiversity in the network. Therefore, the main strategy to conserve biodiversity in highly developed urban areas is to increase the amount of green spaces, rather than use corridors without careful consideration. Furthermore, many planners use corridors in many projects for the sake of visual aesthetics, instead of ecological purpose; just like boulevards in the Hausseman's Paris Plan. In many cities, water corridors are implemented to create images like Venice and Amsterdam, even though the cities suffer from water shortages. Such approaches fail in creating ecological greenways.

Green spaces in a distributed system respect the context in which they are located, consider, conserve and reveal the natural conditions which they possess. Thus, even though there are no visual links among them, they still function as an entity, demonstrating the transition and evolution of urban ecological environment, just as a computer distributed system with wireless connection.

Conclusion

The purpose of the distributed green space system is to optimize the allocation of urban green spaces, and to maximize their ecological, cultural, and recreational benefits as a whole system. It neither simply excludes large green spaces from a city, nor spreads equidistant small green spaces of the same size within a city. Instead, it develops sustainable and implementable strategies for the city's green space system.

Acknowledge: Prof. Irma Ramirez of Cal Poly Pomona corrected grammar errors.

References

Carlton, J.T., 1996; *Marine bioinvasions: the alteration of marine ecosystems by nonindigenous species*. Oceanography, 9, pp. 36–43.

Fu, F., Zhao, C.J., 2008; *The rethinking of Fengshui.*'Scape, 1, pp. 63-68

Jauregui, E., 1990/1991; *Influence of a large urban park on temperature and convective precipitation in a tropical city*. Journal of Energy and Buildings, 15/16, pp. 457–463.

Kuo, F.E.; Sullivan, W.C., 2001; *Environment and crime in the inner city: Does vegetation reduce crime?* Environment and Behavior, 33(3), pp. 343-367.

Li, Y.M., 2004; *Research on the relationship between urban greening and the effect of Urban Heat Island*. Chinese Landscape Architecture, 1, pp. 72-75.

Liu, J.M.; Li, S.H.; Yang, Z.F., 2008; *Temperature and humidity effect of urban green spaces in Beijing in summer.* Chinese Journal of Ecology, 27(11), pp. 1972-1978

Maas, J.; Dillen, S.M.; Verheij, R.A.; Groenewegen, P.P., 2009; *Social contacts as a possible mechanism behind the relation between green space and health.* Health & Place, 15, pp. 586-595.

MacDonald, M.A., 2003; *The role of corridor in biodiversity conservation in production forest landscapes, a literature review.* Tasforests, 14, pp. 41-52.

Mumford, L., 2005; *The City in History*. Beijing: China Architecture and Building Press, pp. 123, 303, 350. [Chinese edition]

Waxman, S.; *The History of Central Park.* http://www.ny.com/articles/centralpark.html

Vitullo-Martin, J.; 2003; *Taking Back the Park from Crime*. New York: Gotham Gazette, http://www.gothamgazette.com/article/fea/20030721/202/467

Zhou, X., 2009; *Interview with Professor Julius Gy. Fábos*. http://www.youthla.org/2009/ 11 /interview-with-professor-julius-gy-fabos/