

The study of green space ecological benefits of Chiayi City

Hao-Hsuan Huang, Hui-Wen Huang, Hsueh-Sheng Chang

(Hao-Hsuan Huang, National Cheng Kung University, Urban Planning; Taiwan, No.1, University Road, Tainan City 701, Taiwan (R.O.C.), p2697107@mail.ncku.edu.tw)

(Hui-Wen Huang, National Cheng Kung University, Urban Planning; Taiwan, No.1, University Road, Tainan City 701, Taiwan (R.O.C.), makil@pchome.com.tw)

(Associate Professor Hsueh-Sheng Chang, National Cheng Kung University, Urban Planning; Taiwan, No.1, University Road, Tainan City 701, Taiwan (R.O.C.), changhs@mail.ncku.edu.tw)

1 ABSTRACT

The importance of the urban green space is often mentioned in planning. However, in many important city for the provision of urban green space is usually limited to the smallest area or population of provisions of the proportion of green area. And the urban green space has offered recreation, maintained other functions such as ecological species variety besides beautification of landscape, the green land of city offers importance space of urban environments and activity, and in 1987 World Commission on Environment and Development (World Commission on Environment and Development, WCED) published "Our Common Future" so that people began to energy-conservation and reduce carbons, sustainable development, green space in urban planning occupy an indispensable role has been demonstrated more. But the value of the urban green space is unable to be direct or indirect to be reflected by land value, for example: the trade price of agricultural land use than other types of land prices are still low, and has not considered the compensation results of the ecological benefits when the farmland conclude the business. Land prices can not be displayed for the urban green space as a whole, led to the idea of the importance of urban green space is still insufficient. Therefore, this research hopes to quantize the ecological benefits of urban green space, as in the past to review the transaction price for the lack of urban green space an important factor, as well as the hope of the future value of urban green space to eco-efficiency as a review of the transaction or evaluation criteria.

So this research for four to explore the ecological benefits of urban green space: storm water run off reduction, carbon fixing, air clearing, energy conservation, use CITYgreen5.0 as model platform, to study the ecological benefits of the four-oriented computing the value of this study was to select Taiwan's Chiayi City as the scope of the study, hoping to get Chiayi City ecological benefits of green space program value for future urban planning changes in land use at the time of an important frame of reference, and to the ecological benefits of urban green space has been attached great importance.

2 INTRODUCTION

In people's lives, urban green space add many natural elements for environmental, whether it is provided in people's leisure, flowers and trees to beautify the landscape. In addition, the green space brings several important ecological service function: regulation of urban micro-climate, reduce stormwater runoff, carbon sequestration effect of reducing air pollution, energy conservation ,etc. As the rapid progress of global information and technology, many important cities in the international community are facing serious problems of urbanization. Taiwan is to narrow the crowded geographical characteristics, urbanization and population crowded situation even more evident, there are different vegetation density and structure in different types of urban land use, its ecological benefits are also different, the current ecological benefits of green space from the initial qualitative analysis to quantitative assessment, from distinguish the characteristics of research to a universal model of research and development trend (Li and Zhao, 1998; Zhu et al., 2002; Li et al., 2003; Lang, 2004), the importance of green space provided ecosystem services should be re-attention because the city's ecological service functions of green space and urban environmental improvement and sustainable development concepts each other.

CITYgreen is developed by United States Forest Service for research model of eco-efficiency assessment software. There are more than 200 cities in the United States use CITYgreen models to

the formulation of environmental management and control policies, land-use policies, forest protection policies and so on. No one in Taiwan assess the ecological benefits of similar sets of software, land-use planning is based on the types and intensity of population basis for planning, the open space for the parks, squares and green are lack of consideration. Therefore wish to take advantage of the provision of ecological-oriented city as a future green space or public based on spatial planning considerations.

In this study, CITYgreen 5.0 model for the research base, combined with analysis of Chiayi City high-resolution satellite images to identify vegetation, and selected suitable parameters used to assess the current Chiayi City plaza, parks and other public space eco-efficiency, quality of urban living environment, green space planning and preservation and urban planning area of public space review have great significance.

3 STUDY AREA AND METHOD

3.1 Local geographical and social conditions

Chiayi City, located at the southwestern Taiwan, the third city in southern Taiwan, and is located at latitude 23 ° 29 ', longitude 120 ° 27', belonging to the subtropical climate and 15.8 kilometers east-west width, 10.5 kilometers long from north to south, covering an area of 60.0256 square kilometers, the total population of 274,213, an average density of 4568.27 persons/km, green space area about 40% of Chiayi City.

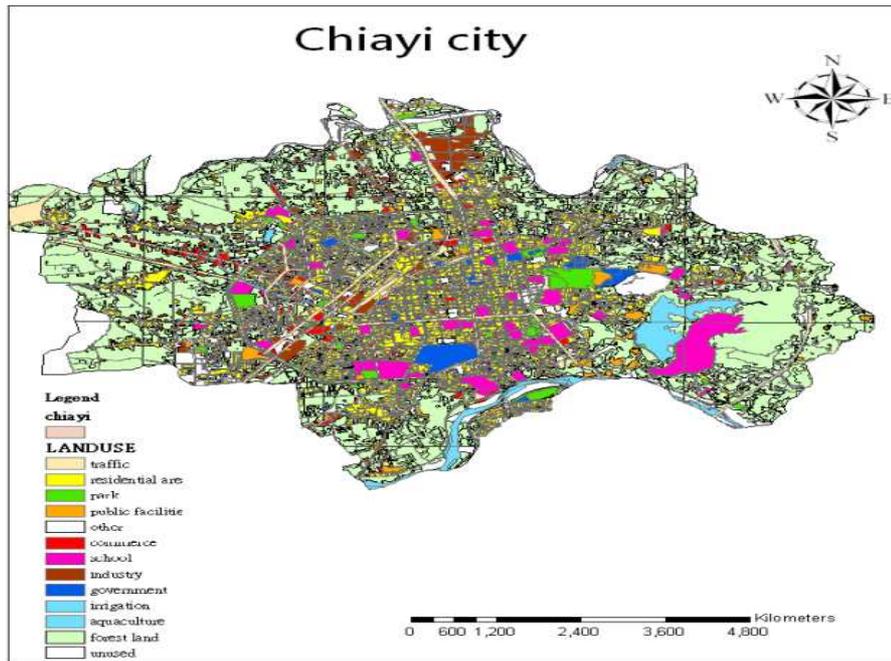


Fig. 1: Chiayi City land-use zoning plans

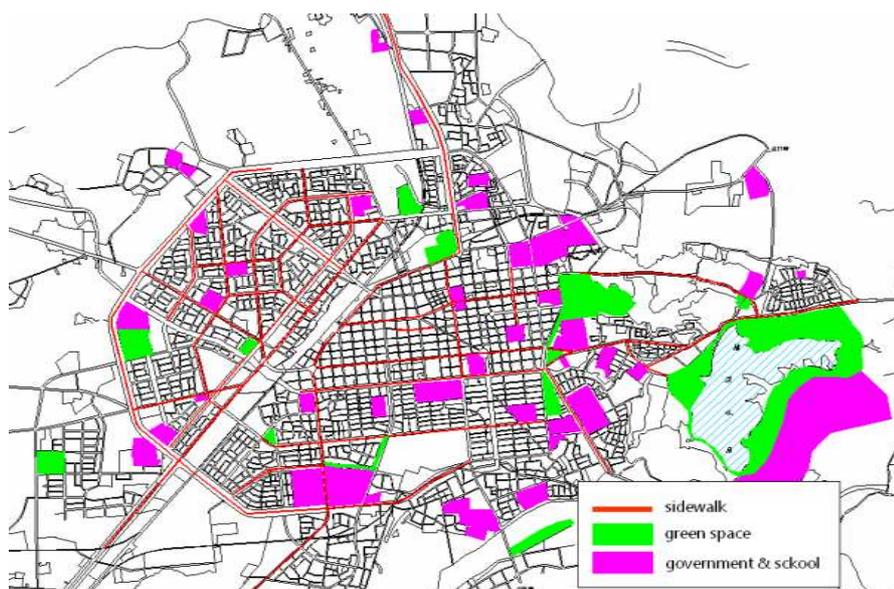


Fig. 2: Chiayi City green space distribution

3.2 Structure and function of CITYgreen

CITYgreen analyzes regional ecosystems based on the characteristics of each case study area including trees, buildings, impervious surfaces, air-conditioners and land cover. Study area characteristics are drawn on a base aerial photograph as themes, from which the percentages of surface area covered by buildings, impervious surfaces, canopy, and available planting space are calculated and used to develop a base characterization of the site in its existing configuration.(William et al., 2005)

In this study we employ CITYgreen, a GIS-based modeling application developed by the American Forests (American Forestry Association, 1996). CITYgreen model output includes storm water runoff, carbon sequestration rates and storage, and the potential for removal of air pollution (SO₂, CO, O₃, and CO₂) through deposition to green space vegetative surfaces.

The software allows investigators to predict the outcome of various development scenarios by easily modifying (via data menus or software) the amount and type of land use change for a delineated study area. ESRI's ArcView 3.3 and American Forests' CITYgreen 5.0 were used for analyses presented in this paper.

3.3 Database

According to Chiayi City land-use zoning plans and Chiayi City 2008 air photographs(fig. 3) as a basis for analysis of information, the existing land-use zoning in Chiayi City in the following table:

Land-use type		
name	type	Area(km ²)
Chiayi	industry	1.90
	park	1.44
	aquaculture	0.04
	traffic	7.67
	irrigation	2.05
	public facilities	1.21
	green space	24.35
	school	2.44
	government	0.81
	residential area	9.72
	commerce	1.35
	unuse	5.28
	other	1.77
Total		60.03 km ²

Table 1. the existing land-use zoning in Chiayi City

In this study, Chiayi City in 2008 according to the air photographs, using ArcView convert air photographs to grid file(fig. 4), and the original categories of land-use in order to rearrange blocks of different colors, organized into seven land-use types easy to analyze as follows: Urban : Commercial and Business, Urban : Industry, Urban : Resident, Impervious Surfaces: Paved: Drain to open ditches, Trees: Impervious understory, Trees: Grass/turf understory: Ground cover < 50%, Water area.

name	type
Chiayi	Urban : Commercial and Business
	Urban : Industry
	Urban : Resident
	Impervious Surfaces: Paved: Drain to open ditches
	Trees: Impervious understory
	Trees: Grass/turf understory
	Water area

Table 2. Land-use type in CITYgreen

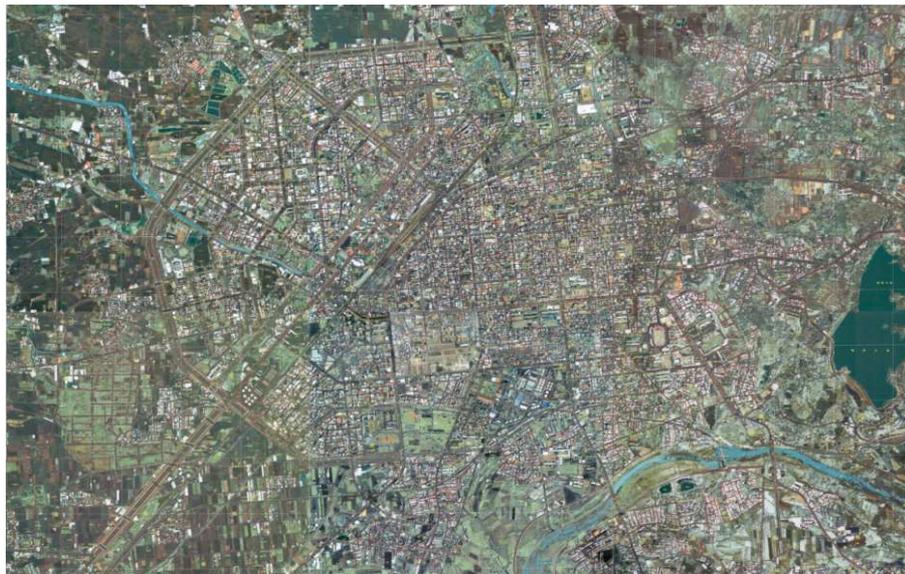


Fig. 3: Chiayi City 2008 Air photographs

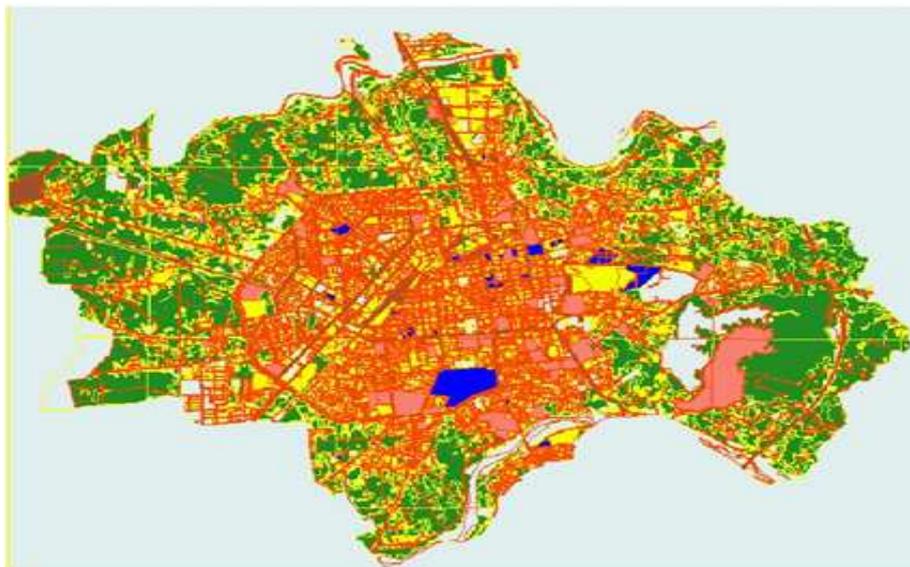


Fig. 4: Chiayi City 2008 Air photographs convert to grid file

4 ANALYSIS AND RESULT

After calculating the results of model analysis to compare different types of land in Chiayi City, the percentage of the total area, 46% are urban land sites (commercial, business, industry, resident), 40% green space (impervious understory, grass / turf understory), 8% impervious surface (paved), 6% are water, urban land is divided into commercial areas, residential areas and industrial zones, and the main computing green eco-efficiency of land use types impervious understory and grass / turf understory two types Chiayi City and then the main high street tree species and tree species into the data analysis, the urban green space to reduce air pollution, floods, as well as the reduction of carbon dioxide brought about by eco-efficiency. In accordance with the purpose of reducing the amount of green space to be Chiayi City of eco-efficiency value.

Carbon sequestration rates and storage

According to the present socio-economic conditions in Taiwan and the Taiwan Power Company is estimated that each 1-ton reduction in carbon dioxide emissions reduction equivalent to NT 756 dollars (National Science Council Report, 2005), by calculating the green space after the Chiayi City carbon sequestration capacity of 1734.24 Public tons / year of carbon dioxide absorption capacity of 13.5 tons / year, reducing annual carbon and thus has come to rise to the ecological benefits of 1,321,291.44 dollars

Sequestration	1,734.24
Storage	13.5
Total	1747.74

Table 3: CO₂ sequestration rates and storage unit : ton/year

Removal of air pollution

The green space in Chiayi City of air pollution by reducing the volume, divided into the following five major sources of air pollution to discuss the project to do, SO₂, CO, O₃, PM₁₀, NO₂, calculated through the model reduction of SO₂ a year of 117.5 lbs / year , CO to reduce the amount of 40.17 lbs / year, O₃ reduce the amount of 423.18 lbs / year, PM₁₀ reduction of 321.75 lbs / year, NO₂ reduction in the volume of 263.05 lbs / year; software then different air pollution reduction project is converted to the value of In this study, the reduction of air pollution has been the effectiveness of the total amount of 100,492 dollars (unit: NT).

item	Lbs/year	Dollar (NT/year)
SO ₂	117.5	45,449.95
CO	40.17	3,094
O ₃	423.18	28,263.9
PM ₁₀	321.75	23,073.05
NO ₂	263.05	611.1
Total	1,165.65	100,492

Table 4: Removal of air pollution

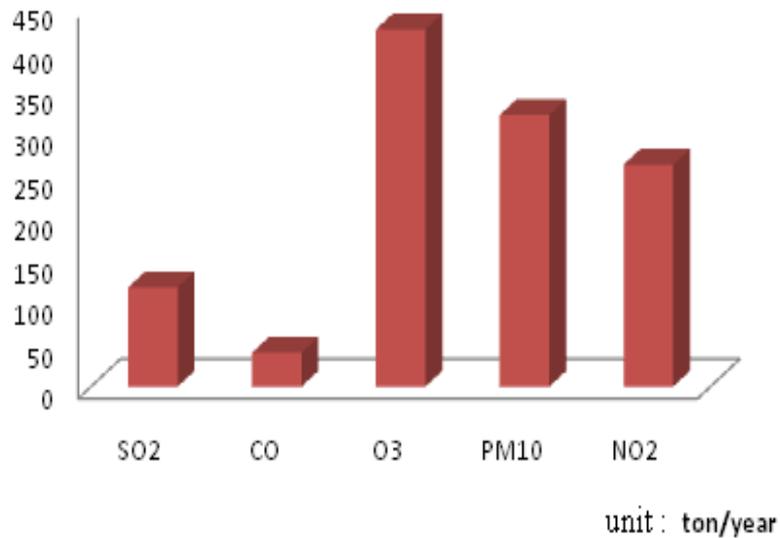


Fig. 5: Air pollution reduction

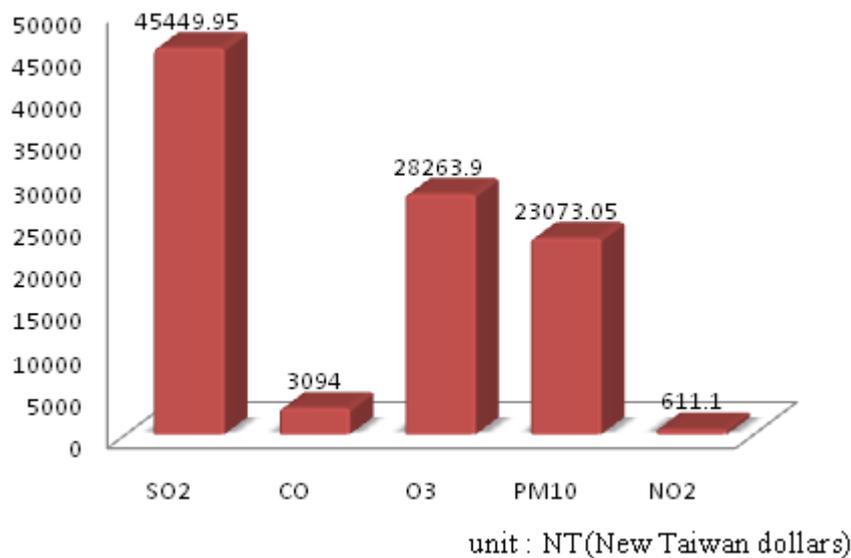


Fig.6: The dollar of air pollution reduction

Storm runoff reduction

Calculated through the software Chiayi City green space runoff reduction efficiency is about 314070.34 m³, Taiwan's average construction cost of the reservoir 12.33 ton / dollar (The Database Of Water Resources Models, 2006), it can be initially calculated Chiayi City runoff reduction efficiency 3,872,487.29 dollars .

5 CONCLUSION

After this study, the Chiayi City green space apart from leisure, entertainment features, many of the function we do not pay attention to eco-efficiency conversion of the amount found in Chiayi City could save a lot of expenditure, such as: carbon sequestration rates and storage of 1,321,291.44 dollars efficiency, removal of air pollution benefits for 100,492 dollars and storm runoff reduction benefits for 3,872,487.29 dollars, green space of the ecological benefits derived from the annual savings for a city so much money we are unexpected, and Chiayi City is still 5.28 km² of unused land, we can make good use of these lands, but also bring more benefits.

At the same time, the eco-efficiency conversion of the amount so that people can easily discover the importance of green space and value.

In this study, Green space is not only provide the ecological benefits, but also the energy saving and reduction carbon at the same time, regulate the function of the environment, hoping through similar studies so that Taiwan's people started to pay more attention to forest or agricultural land, such as the importance of green space in the focus economic development also be able to achieve the sustainable development

6 REFERENCES

- Li H, Zhao W Z (1998). Studies on the ecological effects of five urban green land in Beijing city. *Chin Landscape Architech*, 14(58): 36–38 (in Chinese)
- Li H, Zhao W Z (1998). Studies on the ecological effects of five urban green land in Beijing city. *Chin Landscape Architech*, 14(58): 36–38 (in Chinese)
- Li M C, Zhou L B, Mao L (2003). Urban greenbelt ecological benefits evaluation and prediction model based on RS & GIS technology. *Environ Monitor Chin*, 19(3): 48–51 (in Chinese)
- Lang K J (2004). Linear consociation equation set model of forest ecological benefits. *Chin J Appl Ecol*, 15(8): 1323–1328 (in Chinese)
- American Forestry Association, 1996. CITYGreen software module for ArcView GIS v. 3.x, <http://www.americanforest.org/productsandpubs/citygreen/citygreen5.php/>
- William D. Soleckia., Cynthia Rosenzweigb, Lily Parshallb, Greg Popec, Maria Clarkc, Jennifer Coxa, Mary Wiencke, 2005. Mitigation of the heat island effect in urban New Jersey, *Environmental Hazards* 6 (2005) 39–49
- National Science Council Report, 2005 , http://www.me.ncu.edu.tw/tfse/reportshow.php?news_id=207
- The Database Of Water Resources Models, 2006, http://hysearch.wra.gov.tw/wra_ext/Model/WTP1.htm