

AGRICULTURE LANDSCAPE PLANNING BASED ON BIOTOP AREA FACTOR IN YUNLIN, TAIWAN

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ABSTRACT: Agriculture has been the primary industry in Yunlin area for hundreds years. It contributes to industrial and living landscape which continuously represents vivid cultural landscape of the area. The strategies of landscape planning in Yunlin area not only emphasis on improving landscape and environment, but also focus on sustaining agricultural culture through landscape planning. In addition, ecological consideration and adapt-for-environment land use guidelines should be applied for local environmental development in order to meet the goal of sustainable environment planning. In this case, Yunlin area's local industries and economy can continuously develop in the process of landscape improvement considering social, economic, and ecological dimensions. The strategies demonstrate the concept of green infrastructure (G.I.). Therefore, this study uses biotope area factor (BAF) to analyse environmental resource of Yunlin area in order to contribute to agricultural landscape planning. The results show: 1) Yunlin area can be categorised into different sub-area of land use according to BAF. The categories include agriculture land, forest land, transportation land, water conservancy land, building land, public infrastructure land, recreation and leisure land, mining land, and the land for other use. 2) The calculated BAF value of Yunlin area is 0.6 which shows large proportion of green space. 3) The major landscape development strategy is increasing BAF value. This could be achieved by infrastructure development strategies of Public land and the expected BAF value would be 0.8.

1. INTRODUCTION

"Landscape" is an area perceived by people, whose character is the result of the action and interaction of natural and human factors. Industrialization and commercialization changed the urban and rural landscape character, natural and ecological environment are being destroyed, and local landscape features are gradually disappearing. In recent years, Improvement and maintenance of nature environment, landscape and cultural has become a focus of government policy.

In Yunlin area, agricultural development has been the main industry development throughout the centuries, which created the landscapes of life and production, and presents the endless vibe of rural cultural landscape of Yunlin. The agricultural areas and water environment are closely related within Yunlin. Agriculture development and agricultural activities have brought many environmental problems, such as land subsidence, seawater intrusion, floods, soil salinization and environmental pollution.. To Sustain and ensure the continuation of the agricultural cycle and achieving the sustainability goals of ecological, production, living and in Yunlin, the concept of Green Infrastructure (G.I.) and operations strategy of Biotope area factor (BAF) are applied to ensure the rational use and protection of land for landscape environment improvement.

2. THEORY AND LITERAYURE

2.1 Green Infrastructure (G.I.)

Green Infrastructure is mainly to investigate the interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions. The ecological framework includes environmental, social, and economical networks (Mark A. Benedict, Edward T. McMahon, 2006). Green infrastructure planning is a means of ensuring that the region's natural life support systems are maintained and providing a range of benefits to improve the liveability and sustainability of the region. It is an important tool to help drive the sustainability led environmental, economic and social renewal (North West Green Infrastructure Think-Tank, 2006).

Green infrastructure encompasses a wide variety of natural and restored native ecosystems and landscape features, including conserved natural areas such as wetlands, woodlands, waterways, and wildlife habitat. A green infrastructure network connects these ecosystems and landscapes in a system of hubs, links, and buffers (Figure 1). It is surrounded with diverse and natural ecosystem, and preserves local ecosystem and landscape character to increase eco-efficiency. (Mark A. Benedict, Edward T. McMahon, 2006). 1) hub : hubs anchor green infrastructure networks and provide space for native plants and animal communities, as well as an origin or destination for wildlife, people, and ecological processes moving through the system. 2) link or corridor : corridors are the connections that tie the system together. These connections are critical to maintain vital ecological processes and the health and biodiversity of wildlife populations. 3) buffer : buffer zones that protect the natural function of the network from potentially damaging external influences such as pollution or land drainage.

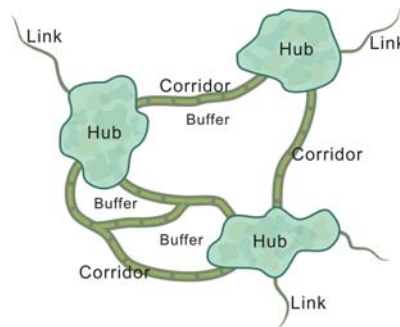


Figure 1. A Green Infrastructure Network Connects Ecosystem and Landscape in a System of Hubs, Links (Corridors) , and Buffer.

2.2 Biotope Area Factor (BAF)

Since 1980, Berlin government established a Biotope Area Factor, and to use this factor to regulate the required natural environment in the city, also to preserve and create habitable area for species. The BAF values are applicable to the habitat quality of land use under various developments and use structures - residential, commercial, and infrastructural land use- and formulates ecological minimum standards for structural changes and new development (Senate Department for Urban Development of Berlin, 2009). The regulation measures to promote high quality urban development, to improve microclimate and air quality, protection of soil function with water resources management, and to increase fauna and flora biotopes.

The BAF is calculated from the ratio of the parts of areas of a site that have a positive effect on the ecosystem or the biotope development to the total area of the site. It expresses the area serves as a location for plants or assumes other functions for the ecosystem. The BAF values range from 0.0 to 1.0, where 1.0 is the full width or height of the "ecologically-effective". The biotope area factor could be a standard within the scope of landscape planning. The biotope area factor represents the sum total of the individual ecological function areas of a site in its actual state. The individual parts of a plot of land are weighted according to their "ecological value" and their "ecological significance". BAF is an efficient and convenient indicator for environmental maintenance improvement under landscape health and sustainable development.

3. METHODS

3.1 Tools- GI and BAF

3.1.1 G.I.

Green Infrastructure can be used as a guide for Yunlin's landscape conservation and management, It includes the features : 1) As a basis for sustainable resource management. 2) To contain the function of biological diversity. 3) To provide a variety of leisure and LOHAS activities. 4) To enhance the value of environmental landscape. 5) As the blueprint for regional development. 6) Yunlin is full of diverse cultures, histories and ecological environments.

The procedures of land planning and assessment for using Green infrastructure : 1) GIS (Geographic Information System) to identify the regions of settlements, natural environment and cultural resources. 2) To establish land planning from the aspects of environment, society, and economy. 3) The decision of development priorities are based on the sustainable usage of planning and resource maintaining of the land. 4) To concentrate on the sustainable land usage and resource maintaining to analyze the existing developed region of Yunlin. To establish distinguish and structure analysis for G.I., and to decide the regional development term.

3.1.2 BAF

Use GIS to identify the regions with 1/5000 aerial photos for regional mapping and to classify areas into 9 land use types (agricultural land, forestry land, transportation land, hydrological land, construction land, public facility land, recreational land, mine Industry land, other regulation district). Calculate the total biotope area factor by formulas and regional value calculations. **Biotope area factor (BAF) = Ecologically-effective Surface Areas / Total Land Area.** In this calculation, the individual parts of a plot of land are weighted according to their "ecological value". **Ecologically-effective Surface Areas = surface type × ecological value.**

3.2 Study Area Description – Yunlin County

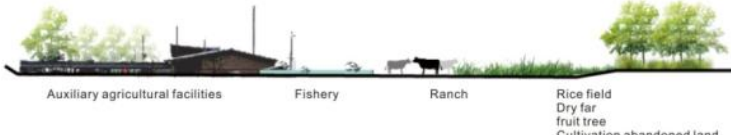


Yunlin is located in the south-central part of western Taiwan. Administratively, it is divided into 20 townships and cities, Include urban, rural, village, settlement, farmland and irrigation. Yunlin has also nurtured a diverse nature and culture in landscape. It is geographically broken up into mountains, plains and coastal regions from east to west, and which plains account for 87% of the county area. The flat and fertile soil of the wide western alluvial plain in Yunlin is most suitable for agricultural development. 2006 Yunlin County statistic shows land used for direct production (agricultural land, forestry land and fishery land) account for 66.45% (86,836 ha)of the county area.

4. RESULTS

4.1 Calculation of the BAF for Yunlin County

Yunlin County is classified into nine land use types, (agricultural land, forestry land, transportation land, hydrological land, construction land, public facility land, recreational land, mine Industry land, other regulation district), each land use types has been given an "ecological value" for its BAF (Table 1).

Table 1. Land use types and Ecological Value of BAF

Land Use Types	Ecological Value of BAF	Land Use Pattern
Agricultural Land	0.6	<p>Agricultural Land Ecological Value of BAF : 0.6</p>  <p>Auxiliary agricultural facilities Fishery Ranch Rice field Dry far fruit tree Cultivation abandoned land</p>
Forestry Land	0.95	<p>Forestry Land Ecological Value of BAF : 0.95</p>  <p>Artificial bamboo forest Artificial forest Natural bamboo forest Natural forest</p>
Transportation Land	0.2	<p>Transportation Land Ecological Value of BAF : 0.2</p>  <p>Port Railroad Highway street Airport</p>

Land Use Types	Ecological Value of BAF	Land Use Pattern
Hydrological Land	0.4	<p>Hydrological Land Ecological Value of BAF : 0.4</p> <p>sea area Road for flood control Hydrological construction Ditch Cistern Reservoir Lake River Dredging river Canal Bank Sand bar</p>
Construction Land	0.2	<p>Construction Land Ecological Value of BAF : 0.2</p> <p>Other religious building Funeral parlor Under construction Industrial facility Production field Storage field Commercial facility Wholesale Service industry Residential building</p>
Public Facility Land	0.2	<p>Public Facility Land Ecological Value of BAF : 0.2</p> <p>Weather station Power station Water facility Gas station Social welfare facility Public facility Government School College Hospital Environmental protection facility</p>
Recreational Land	0.4	<p>Recreational Land Ecological Value of BAF : 0.4</p> <p>Cultural facility Outdoor recreational field Athletic field Recreational facility Park, grass land, square</p>
Mine Industry Land	0.25	<p>Mine Industry Land Ecological Value of BAF : 0.25</p> <p>Mineral facility Quarry facility Salt industry facility</p>
Other Regulation District	0.55	<p>Other Regulation District Ecological Value of BAF : 0.55</p> <p>Engineering residual soil Barren land Disaster land Vacant land Military facility Bush land Grass land Swamp</p>

As a county with agriculture as its long term main development, Yunlin preserved a relatively complete green space. The BAF values of the existing development in Yunlin average over 0.6 (Figure 2), which means Yunlin has an excellent land resources and environmental conditions. Located in the eastern mountains in Yunlin, Linnei and Gukeng have BAF values average over 0.8. They contain a complete ecological landscape of mountains, forests and rivers, with high suitability as a habitat for plants and animals. The west coast of Yunlin has a low BAF due to its Industrial district, hydrological land and construction land use. Douliu City, Dounan Township and Huwei Township are classified as urban living circles, which are primarily residential buildings and commercial areas. They have BAF values under 0.4, while the values of other townships are over 0.5.

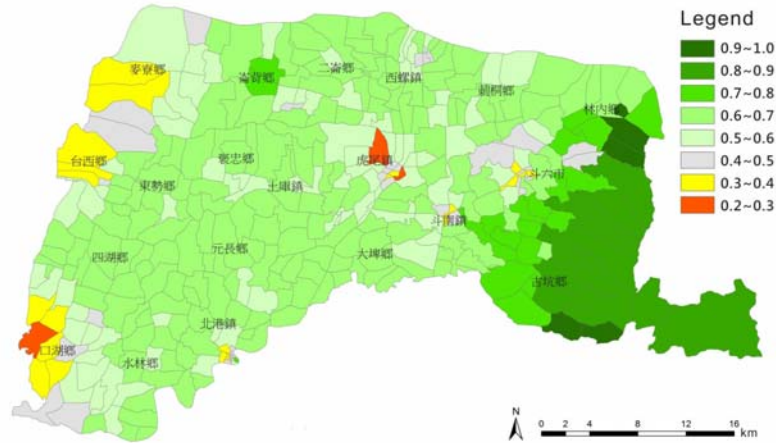


Figure 2. The BAF Values in Yunlin

4.2 To promote greening area by the concepts of sustainable development in living zone, ecological zone and production zone

To transform the land use types of Yunlin into living zone, ecological zone and production zone. Besides water and mountain areas, Yunlin possesses ecological zones less than 30% of the whole county. With living zone close to production zone, the high-density land use not only increases the speed of land damage, but also influences air circulation, water quality and landscape visualization. Therefore, the concept of surrounding living zone with green spaces and the planning of build green networks by traffic green belts are applied to increase the green area and adjusted the BAF value (Figure 3), in order to improve the ecological situation of the existing sites.

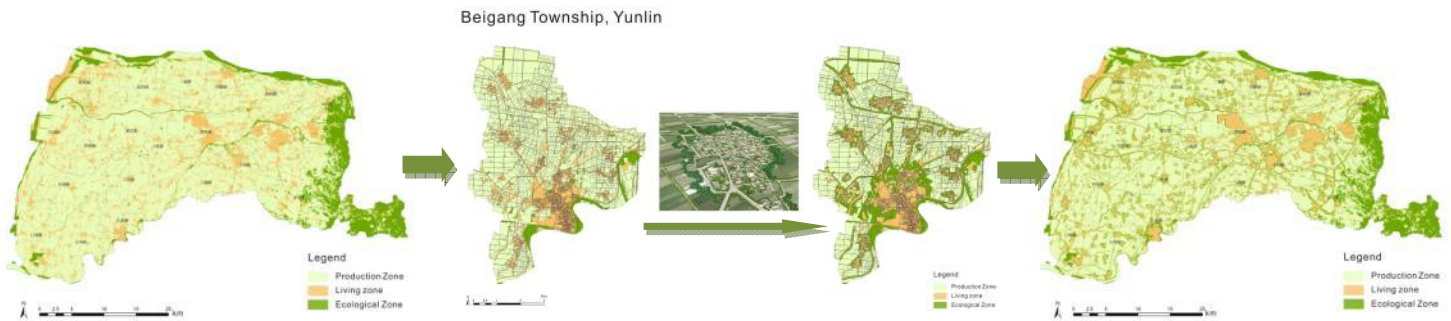


Figure 3. Build Green Networks in Yunlin

“Green landscape” is the harmonious between living, ecological and production. Each community and township should increase green covered area by several ways in communities and living areas, to enhance total green coverage, to reduce carbon emissions, and to conserve water source. The value of BAF after greening upgrade to 0.71, it is expected to increase 12,053 ha of total green spaces (Table 2).

Table 2. Calculate the Total Biotope Area Factor

townships and cities in Yunlin	area for townships and cities (m ²)	green area	value of BAF	increased greening area (m ²)	value of BAF after greening
Mailiao Township	92,035,100	48,134,357	0.523	9,274,240	0.62
Erlun Township	60,960,600	37,673,651	0.618	6,857,909	0.73
Lunbei Township	57,406,500	35,936,469	0.626	5,961,537	0.73
Xiluo Township	49,780,300	29,121,476	0.585	5,512,199	0.70
Citong Township	57,398,000	36,103,342	0.629	5,179,411	0.72
Linnei Township	51,693,200	39,493,605	0.764	2,697,427	0.82
Taixi Township	61,264,400	32,286,339	0.527	8,334,745	0.66
Douliu City	91,343,900	51,243,928	0.561	5,504,026	0.62
Tuku Township	47,375,100	28,235,560	0.596	5,743,351	0.72
Huwei Township	68,790,600	35,495,950	0.516	4,653,949	0.58
Baozhong Township	35,605,600	21,719,416	0.61	4,224,293	0.73

townships and cities in Yunlin	area for townships and cities (m ²)	green area	value of BAF	increased greening area (m ²)	value of BAF after greening
Dongshi Township	46,380,300	29,312,350	0.632	5,385,618	0.75
Dounan Township	48,007,400	27,364,218	0.57	5,475,371	0.68
Sihu Township	73,751,500	46,537,197	0.631	4,651,736	0.69
Gukeng Township	166,516,000	136,210,088	0.818	8,593,146	0.87
Yuanchang Township	72,614,200	45,601,718	0.628	7,528,003	0.73
Dapi Township	44,239,500	27,428,490	0.62	5,010,620	0.73
Kouhu Township	75,050,800	36,099,435	0.481	5,806,803	0.56
Beigang Township	41,405,100	21,696,272	0.524	5,393,165	0.65
Shuilin Township	72,365,600	45,300,866	0.626	8,747,458	0.75
total	1,313,983,700	810,994,724	0.62	120,535,008	0.71

4.3 Water Conservation –From the Mountains to the Sea

Agricultural areas are closely related to water environment. The protection concept is a series of water resource conservation from the mountains to the ocean (Figure 4): Installation of pervious concrete, porous asphalt, paving stones or bricks in urban and rural areas, allow precipitation to percolate through areas that the stormwater through to the soil below. Use natural systems to purify storm-water and grey-water, while also creating habitat for wildlife. Through this series of water conservation measures to create a healthy landscape for Yunlin.



Figure 4. Water Conservation

4.4 Land Use Allocation for Agricultural Landscape

Agricultural land could allocate parts of different percentage of land-use, such as natural forests, fruit ranch, vegetable farm, ranch, pond and compost. Partial mixed use of an agricultural land can be used to keep the land productive and protect water and soil resources (Figure 5).

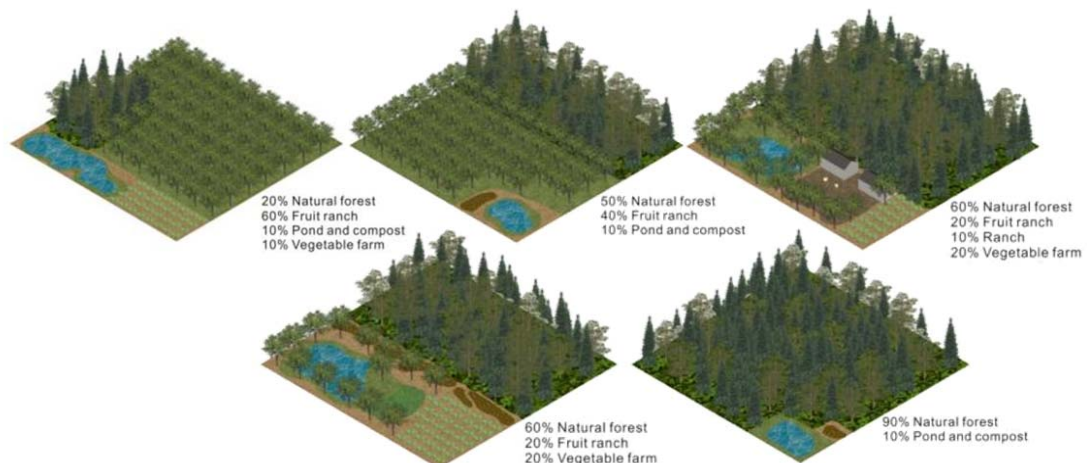


Figure 5. Land Use Allocation for Agricultural Landscape

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 The BAF as Indicators for Environmental Monitoring and Improvement

The BAF can be established primarily in landscape plans as an environmental planning parameter. Formulation of the BAF targets each year can be used as a guideline for environmental measures to achieve the goals of the protection of nature and landscape maintenance, creating a new garden city in Yunlin.

5.2 Vision of Landscape Conservation with Water & Green

"Smart conservation" is a proposed strategy for Yunlin with living zones, ecological zones and production zones. Coordinate the natural resource conditions and implement conservation programs, built a framework for environmental maintenance based on water resources and green belt. "Green belt" are protective screen which protect the area, and "water resources" are network to connect and nourish the whole area.

The future conservation program is to combine "green belt" and "water resources" (Figure 6), and to assist Yunlin in growing into a healthy and fertile agriculture landscape.

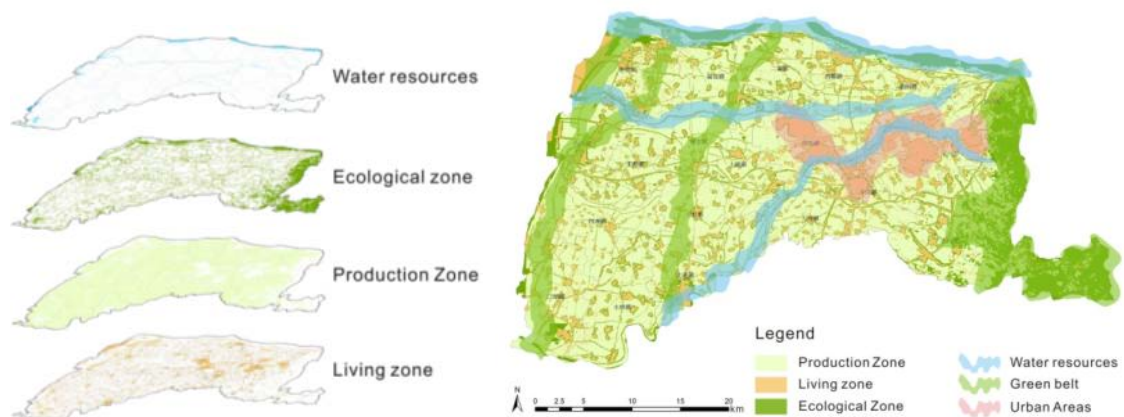


Figure 6. Vision of Landscape Conservation

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