

**Spatial Analysis of Ecosystem Service Value  
Changes in Baguio City, the Philippines,  
Based on Land Use/Cover Changes**

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**Ronald Canero ESTOQUE**

# **Spatial Analysis of Ecosystem Service Value Changes in Baguio City, the Philippines, Based on Land Use/Cover Changes**

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**Ronald Canero ESTOQUE**

# Abstract

Baguio is a hill station city and the summer capital of the Philippines. It is the only hill station in Asia established by the Americans during the early 20<sup>th</sup> century to serve as a convalescence-cum-recreation center. Due to its rapid urbanization in recent decades, Baguio's natural environment, fragile ecosystems (e.g. forest) and the ecosystem services and amenities they provide (e.g. gas/climate regulation, water supply and regulation, recreation and cultural) are now in jeopardy. There is hence an urgent need to assess its status and the trend of landscape changes in this hill station before further irreparable environmental damages occur.

The main objective of this study is to project the potential future changes in the land use/cover (LUC) and ecosystem service value (ESV) of Baguio City and elucidate their implications for future landscape conservation and urban development planning. Geospatial data such as Remote Sensing (RS) satellite imageries, socio-economic and fieldwork data and other relevant secondary data (e.g. ESV coefficients), and tools and techniques such as geographic modeling (GEOMOD) and Geographic Information Systems (GIS)-based Analytic Hierarchy Process approach were used to (1) assess the LUC and ESV changes from 1988 to 2009, (2) investigate the driving forces of urbanization and spatial explanatory variables for LUC change, and (3) project the future LUC and ESV changes from 2009 to 2020 under two different scenarios. Scenario 1 is based on the trend of LUC change from 1998 to 2009, whereby built-up may continue to expand in any area. Scenario 2 is based on the trend of LUC change from 1998 to 2009, but with full protection and conservation of the forested areas.

The LUC change analysis revealed that from 1988 to 2009, Baguio city had been transformed physically from what it used to be a hill station with an attractive natural landscape into a highly urbanized multi-functional city. This is indicated by an almost 3-fold increase in its built-up area at the expense of its forest cover, cropland and brushland. The urban LUC change patterns showed an alarming trend because in recent years there had been an increasing pressure

on the remaining valuable urban green spaces to be converted into built-up. Baguio's urbanization had been driven by interrelated socio-economic and physical factors such as population growth, socio-economic opportunities and the establishment of schools and universities. The city's favorable cool climate played a major role in the context of each of these factors and in the overall urbanization of Baguio. The spatial explanatory variables that influenced the patterns of urban LUC change in Baguio include the distance to the city center, growth nodes, major roads and tourist spots, elevation, slope and the annual population growth rate at the *barangay* level.

The LUC changes from 1988 to 2009 greatly affected the total annual ESV of Baguio city, which decreased from US\$5.35 million in 1988 to US\$2.15 million in 2009. Coupled with rapid population growth, the LUC changes also affected the human-to-ESV (H-ESV) ratio in the city, which decreased from 1:31 (US\$/year) in 1988 to 1:7 in 2009. The scenario-based LUC change projections showed that if built-up continued to expand in any areas, the city's annual ESV in 2020 would be about US\$1.41 million with an H-ESV ratio of 1:4. However, if the remaining forest cover could be fully protected and conserved, the city's annual ESV in 2020 would be about US\$1.97 million, with an H-ESV ratio of 1:6. The scenario-based modeling of future LUC and ESV changes highlights the urgent need to strengthen the implementation of environment-related policies, and adopt the concepts of LUC change and ecosystem services in the context of landscape conservation and urban development planning. The natural environment and ecosystem services of Baguio city are extremely important in fulfilling many important roles, including those of the summer capital and a major tourist destination of the country.

From a scientific standpoint, this study has contributed not only to the understanding of the past and potential future landscape and ESV changes in Baguio City, but also methods and techniques related to LUC change modeling and ESV changes monitoring. Specifically, this study has introduced a technique for calibrating the GEOMOD LUC change model, new

measures of accuracy for LUC change modeling, and an index (H-ESV ratio index) for monitoring the potential impact of LUC changes and population growth on ecosystem services.

**Keywords:** Baguio; Ecosystem Services; GIS; Land Use/Cover; Modeling; Remote Sensing

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# Acronyms/Abbreviations

AHP	Analytic Hierarchy Process
APGR	Annual Population Growth Rate
BDUPP	Baguio and Dagupan Urban Planning Project
BLISTT	Baguio, La Trinidad, Itogon, Sablan, Tuba, Tublay
CAR	Cordillera Administrative Region
CLUP	Comprehensive Land Use Plan
CPDO	City Planning and Development Office
DAO	DENR Administrative Order
DENR	Department of Environment and Natural Resources
ERDS	Ecosystems Research and Development Service
EO	Executive Order
ESV	Ecosystem Service Value
FAO	Food and Agriculture Organization
FMS	Forest Management Service
FOC ratio	False alarms to Observed Change ratio
FoM	Figure of Merit
GIS	Geographic Information Systems
GPS	Global Positioning System
H-ESV ratio	Human-to-Ecosystem Service Value ratio
HOC ratio	Hits to Observed Change ratio
IPCC	Intergovernmental Panel on Climate Change
JAXA	Japan Aerospace Exploration Agency
LUC	Land Use/Cover

MA	Millennium Ecosystem Assessment
MGB	Mines and Geosciences Bureau
MOC ratio	Misses to Observed Change ratio
NAMRIA	National Mapping and Resources Information Authority
NSCB	National Statistical Coordination Board
NSO	National Statistics Office
PD	Presidential Decree
RA	Republic Act
ROC	Relative Operating Characteristic
RS	Remote Sensing
TRFIC	Tropical Rain Forest Information Center
UN	United Nations
UNEP	United Nations Environment Programme