

Evaluation of land use change and its implications using GIS data: Case study in Queensland in Australia

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1. Introduction

Land use change potentially has impacts on the carbon cycle in the region. Additionally, it can insert into or remove carbon from the atmosphere, influencing climatic events. Nowadays, there is increasing social and managerial interest in mitigating rising atmospheric carbon dioxide concentrations. The consequent impacts on climate have focused attention on the ecosystem service of forest carbon storage, including storage in harvested wood products (HWP). Tree plantation absorbs carbon dioxide from the atmosphere and keeps it in the form of wood products in residential buildings.

2. Objectives

This study had one main objective: to estimate sustainable carbon stocks through combining forest ecosystem carbon stock and harvested wood products carbon stock in a residential area in the state of Queensland in Australia. Two additional objectives emerged from the first: (1) to examine socio-economic impacts on land use change and (2) to draw a clear relationship between sustainable carbon stock and socio-economic trends.

3. Data Source and Research Methodology

To investigate land use change in Queensland, Australia between 1999 and 2005, we used GIS format land use data from the Queensland Land Use Mapping Program coordinated by the Australian Bureau of Agricultural and Resource Economics and Science. Following the purpose of the study, land use types were categorized into seven classes (Forest, Cropping, Residential, Nature conservation, Natural vegetation, Mining and Wetland). The land use trends were used not only for estimating sustainable carbon stocks but also to examine socio-economic impacts on land use change. The framework of methodology is shown in Fig.1. In order to calculate forest ecosystem carbon stocks, five carbon pools have to be accounted for under the United Nations Framework Convention on Climate Change (UNFCCC) as shown in equation 1.

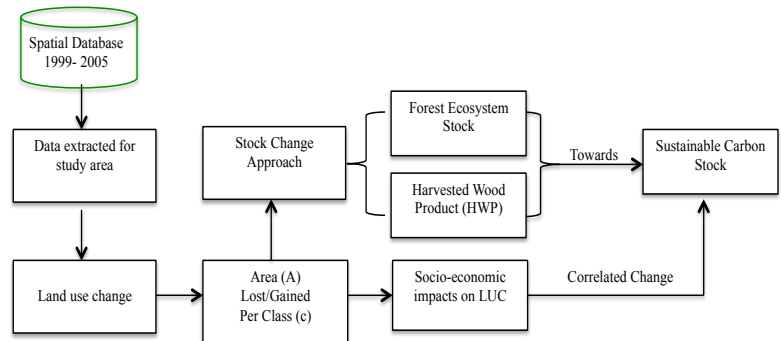


Fig. 1. Methodology Framework

$$C_{LUI} = C_{AB} + C_{BB} + C_{DW} + C_{LI} + C_{SO} \quad \text{Eq.1}$$

Where: C_{LUI} : Carbon Stock Changes for a land use category
 C_{BB} : Carbon stock for below-ground biomass
 C_{LI} : Carbon stock for litter

C_{AB} : Carbon stock for above-ground biomass
 C_{DW} : Carbon stock for deadwood
 C_{SO} : Carbon stock for soils

4. Results and Discussion

4.1 Evaluation of land use change and carbon stocks

In 1999, natural grazing vegetation occupied the largest proportion of total land (90%) and followed by nature conservation (4%), forest (3%), cropping (2%), residential (0.3%) and mining (0.03%). But by 2005, the percentage of those land use types had changed to 88, 6, 1.8, 0.5 and 0.05 percent respectively, showing –60 percent of forest and +150 percent of nature conservation. This research estimated the sustainable carbon stocks in forest ecosystems and residential areas through calculation quantities of harvested wood products.

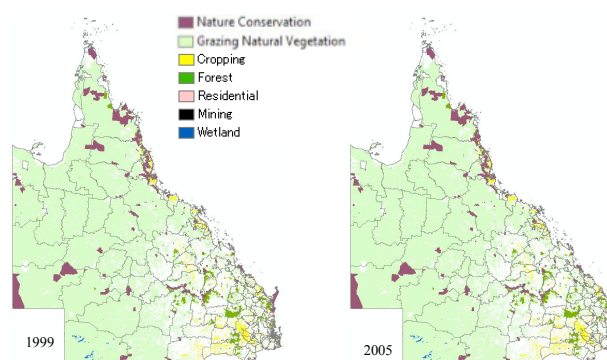


Fig. 2. Land use change between 1999 and 2005

4.2 Relationship between carbon stock and impact of socio-economics on land use change

In 1999, carbon stock in the forest ecosystem in Queensland was 433 Mt-C but it had changed to 356 Mt-C by 2005, as forest land area decreased by 18 percent. HWP carbon stocks in the urban and rural residential areas were 9 and 7 Mt-C in 1999 but 25 and 6 Mt-C in 2005. Queensland's population trend shows that unlike more heavily populated countries like Japan, the population is increasing gradually, mainly because of migration from outside and natural population growth. In terms of economic growth in Queensland, the economic growth rate was 6 percent in 1996 and 3.5 percent in 2000. But it had fallen to 0.2 percent by 2010. Average weekly earnings were A\$523 in 1990, A\$759 in 2000 and A\$1312 in 2011. It appears that the income of people in Queensland increased dramatically, although the state's economy was not healthy. At the same time, the unemployment rate was 8 percent in 1990 but had changed to 5.7 percent by 2011. As an overall trend, the change in land use reflects the increasing population mainly in urban areas, contributing to the accumulation of HWP in the urban housing. Consequently, although economic growth was trending downward, average weekly earnings nearly tripled between 1990 and 2011. Additionally, the unemployment rate of Queensland was reducing.

Table 1 Carbon stock change between 1999 and 2005

Year	1999	2005	Difference	Change (%)
Forest Ecosystem Carbon Stock (Mt C)	433	356	-76	-18%
HWP urban Carbon Stock (Mt C)	9	25	16	178%
HWP rural Carbon Stock (Mt C)	7	6	-1	-15%

5. Conclusion

In this study, the impacts of land use change on carbon stock in forest ecosystem and residential area were estimated. In the future studies, exploration of carbon stocks and flows will be focused to include anthropogenic activities, which enhance the concentration of carbon dioxide in the atmosphere. Results from these studies could help policy makers find ways to support sustainable carbon stocks, which could lead to a lower carbon society through the use of local wood products for a range of cost efficient and low-carbon footprint uses.

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Acknowledgement: This research was financially supported by the Environment Research and Technology Development Fund (K2413) of the Ministry of the Environment, Japan.