Study on quantification of relationship between land use and productivity based on Global Scale spatial information

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1. Introduction

Land is the stage on which all human activity is being conducted and the source of the materials needed for this conduct (Helen Briassoulis, 2000). With the economic development and human needs, the word of land use was brought up and the impacts of land use change also attracted the most attention. For example, large scale environmental phenomena like land degradation and desertification, biodiversity loss, habitat destruction and species transfer (Meyer and Turner 1996) fall in the same category as all of them are caused by land use changes. The other important thing which we should be concerned about is that the productivity of land is different and unsuitable uses of land will result in a negative influence on economic development. So, it is crucial to clarity the relationship between land use and economic development or productivity. It will enable us to explore more effective ways of using land in order to avoid environmental and economical damage.

The goal of this paper is to understand the relationship of land use and productivity. We employed semi-parametric analysis to discuss the relative of land use and GDP at world scale based on GIS mesh data.

2. Method and Data

The GIS data which we used in this study contains Economic-geographical and land use information for all of the world at 1×1 degree level for 2003. Actually the land use spatial data is deficient in quantity. So we divided satellite picture into many 0.5° meshes and calculated the percentage of different land use type by 1° mesh. The various types of land use are forest, grassland, cropland, wetland, bare area, urban, snow/ice and water bodies. Then we integrated the Economic-geographical and land use data by using the software of Arcview GIS.

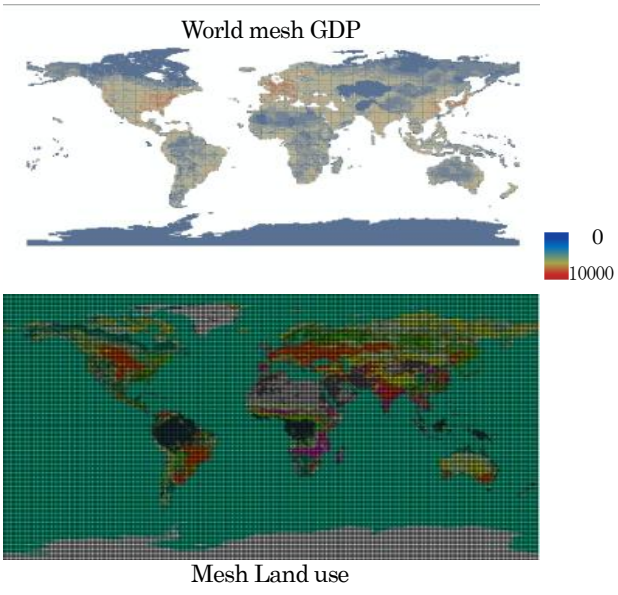
The economic-geographical data includes GDP, and transportation factors. We also used some Natural climate data such as temperature, precipation, etc.

This study employed semi-parametric analysis to understand the relationship between land use and GDP. The relational equations that we set are expressed as follow:

$L=c+\varepsilon*f(G)+\alpha*countryid+\beta*natural\ climate\ factors+\gamma*transportation\ factors+\delta*other\ factors$

Where L denotes types of land use, and G is GDP of each grid. Transportation factors include the length of road, railway, bridge and tunnel of each grid. Other factors include distance to river and coast.

As this study focus on the relation of GDP and land use, we employed natural climate factors, transportation factors and other factors as control variables.



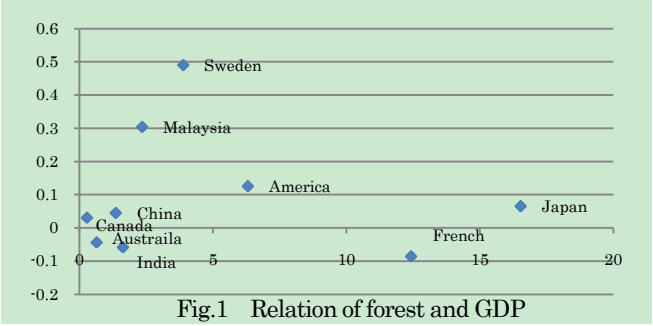


Fig.1 Relation of forest and GDP

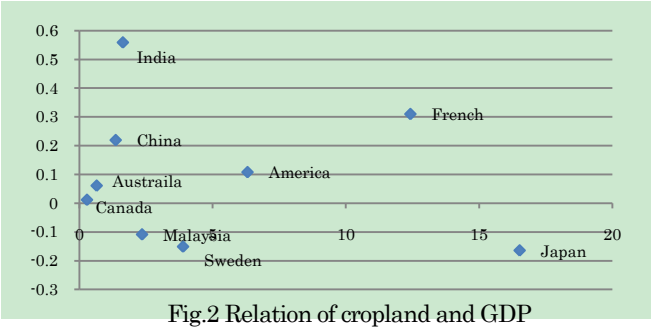


Fig.2 Relation of cropland and GDP

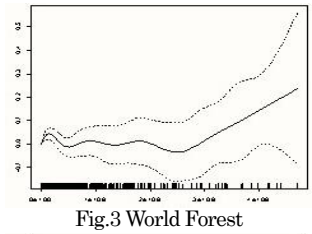


Fig.3 World Forest

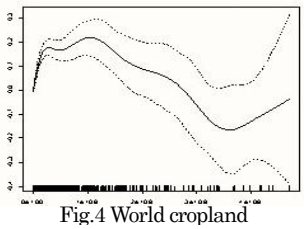


Fig.4 World cropland

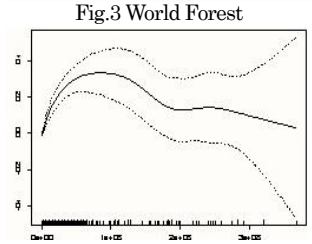


Fig.5 Cropland of Asia

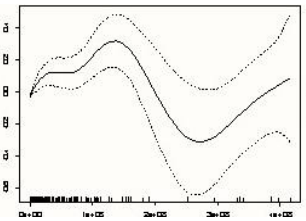


Fig.6 Cropland of Europe

Results of semi-parametric analysis

3. Results

At the first step, we picked up some developed countries and developing countries and analyzed the relation between land use and productivity only based on land use and GDP mesh data. The results were showed on Fig.1 and Fig.2. Horizontal axis expresses average of mesh GDP on the country level. Vertical axis denotes average of land use percentage of each mesh. 0 point is the world average of land use. In Fig.1, the percent of forest area per unit of Japan is close to America, but its mesh GDP is higher than America. In Fig.2, the percent of cropland per unit of Japan is smaller than America. So, we can deduce that forest preservation and biodiversity in Japan is better than America. The cropland productivity of Japan is higher than America. We can also say that agriculture is not Pillar industry in Japan. In Sweden average mesh GDP is not low and the percent of forest is very high, but the proportion of cropland below the world average. We consider that forest land has a positive impact on economic growth and the forest productivity is high in Sweden. Mesh GDP in China and India are similar. But the area of cropland in India is more than that of China. We estimate that the economic development of India depends on agriculture.

Second, we employed semi-parametric analysis to discuss the relation of land use and GDP. We also put in control variables such as transportation factors, natural climate factors and other factors.

In Fig.3, it shows the result of world forest. Our attention is that in high GDP area, the percent of forest is also high. We guess when economic development reaches a certain level, human focus will turn to environmental and ecological protection in developed countries such as Sweden, Japan. Fig.4 shows the world cropland conditions. With the increase of GDP, agricultural became reduce. Many agricultural countries transform themselves into industrial countries. In Europe, with the increased GDP, cropland increased, and then decreased. Finally, it shows the growth trend in Fig.6. We guess that it may be caused by the some agricultural protective policies. We also expect Asia's cropland will change with economic development like Europe.

4. Conclusions

The conditions of forest preservation and biodiversity are good in some developed countries such as Sweden and Japan. We estimate that some developing countries such as China and India will change their land use pattern with economic development like Japan, Sweden or French.

Acknowledgments

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