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Analysis of Farming Environmental Efficiency Using a DEA Model with Undesirable Outputs

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Abstract

With the idea of sustainable agriculture, farming is not only about the production for food security but also need to consider the impacts for the environment during farming process. Environment issue needs to be considered more for the high-altitude agriculture as they often are located at the reservoir catchment areas which are important for conserving the water resources. There are always conflicts between high-altitude agriculture development and environmental conservation. Because of the extreme climatic events, find out the balance between these two issues becomes an urgent target for the government recently.

Thus, data envelopment analysis (DEA), which can evaluate the decision-making unit with multiple inputs and multiple outputs, was applied to assess economic and environmental factors in this research. The results of farm environmental efficiency score present the land use efficiency of each village under these two conflict issues. It can help government to reveal the un-efficiency area which should be improved first. Furthermore, the slack analysis of DEA reveals that reduction of pollution is the most important issue in the area.

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1. Introduction

In the last few decades, agriculture and food security became important issues because of the problems caused by global climate change. For a long term goal, sustainable agriculture is what people want to achieve.

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It not only needs to consider about the macroeconomics and provision, but also the environment issues such as water conservation, soil protection...etc. are also need to be concerned. (Y.C., Lin et al., 2013; A.J., Picazo-Tadeo et al., 2011,).

Limited land resources in Taiwan have resulted in the conversion of many agricultural production areas into built-up areas through urbanization, and more farming activities could not help but move to area at elevations above 500 meter which called high-altitude agriculture. It was increased by 9665 ha (16.9%) from 1995 to 2006 (Y.C., Lin et al., 2013). Some soil loss and runoff were caused by this change and the extreme climatic events made it even more serious. However, most of high-altitude areas are reservoir catchment areas for conserving the water resources in Taiwan. However, it is always difficult to find out the balance between high-altitude agriculture development and environmental conservation. Thus, this research intends to assess both economic and environment factors by farming environmental efficiency.

2. Materials and methods

2.1. Empirical research area

The study area is in south Taiwan, which has experienced increasing flood events that caused severe damage in the past decade. With global environmental change, the assessment of the environmental impacts and efficiency problems is worthy of our attention. The research area is located in the southwest of Taiwan (E120.3251° ~120.9576°, N23.0487° ~23.5864°) (see Fig.1.(a)). The distribution of land use in 2004 is showed as Fig.1.(b), forest land covers the largest area(106481 ha, 70.76%), followed by agriculture use land(27905 ha, 18.54%), other use land(7287 ha, 4.84%), water conservation use land(5547 ha, 3.69%), transportation use land(1446 ha, 0.96%), built-up use land(1325 ha, 0.88%), amusement and rest use land(296 ha, 0.20%), public facility use land(167 ha, 0.11%) and rock salt use land(28 ha, 0.02%).

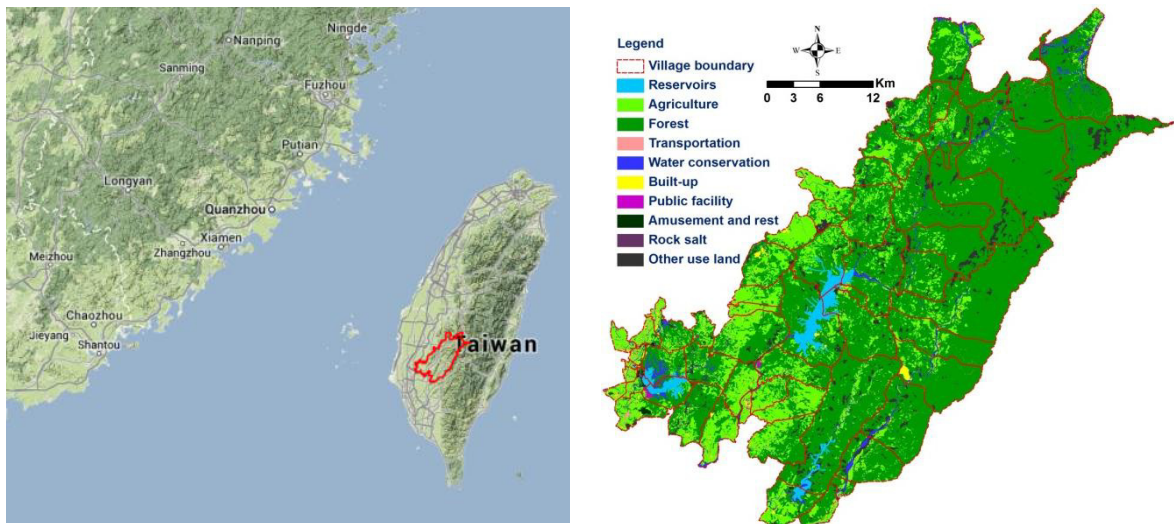


Fig. 1. (a) Location of empirical research area ; (b)The distribution of land use in 2005

2.2. DEA with undesirable output

DEA is a multivariate analysis technique for relative efficiency, which can evaluate the decision-making unit with multiple inputs and multiple outputs (Thanassoulis, 1993). As a characteristic of DEA, no prior

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