

GIS-based evaluation of multifarious local renewable energy sources: a case study of the Chigu area of southwestern Taiwan

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Abstract

The issue of regulating greenhouse gas emissions of developing countries is one of the main reasons for the US's retreat from ratifying the Kyoto Protocol, and this deserves particular attention in order to ensure that a robust international climate policy exists in the future. Enabling developing countries to move toward low-carbon energy systems would enhance the feasibility for their participation in mitigating greenhouse gas emissions. This study evaluates wind, solar, and biomass energy sources in a rural area of Chigu in southwestern Taiwan by means of analyzing technical, economic, environmental, and political implications in order to establish an evaluation model for developing local renewable energy sources. The adopted approach evaluates local potentials of renewable energy sources with the aid of a geographic information system according to actual local conditions, and allows the assessment to consider local potentials and restrictions such as climate conditions, land uses, and ecological environments, thus enabling a more-accurate assessment than is possible with evaluations on an approximate basis. These results may help build a developmental vision for sustainable energy systems based on locally available natural resources, and facilitate a transition of national energy and environmental policies towards sustainability.

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1. Introduction

The issue of global warming is becoming a great challenge which the international community must face in this century. The latest report of the IPCC (Intergovernmental Panel on Climate Change) in 2001 indicated that development heavily relying on fossil fuel energies will raise global mean temperatures by about 4.5 °C during the 21st century. Only with a transition toward a low-resource-consuming economy and the use of clean energy sources and technologies will it be possible to mitigate temperature increases to about 2 °C (IPCC, 2001). In other words, cutting energy consump-

tion and facilitating a transition of energy structures towards renewable energy sources have become necessary alternatives for humanity in order to stabilize the global climate system. This holds for both developed and developing countries.

Substituting fossil fuels with renewable energy sources is regarded as a significant measure for cutting global carbon emissions (Brown, 2003; Houghton, 1997; IPCC, 2001). Full use of these sources can help mitigate global warming in environmental terms, meet energy needs in economic terms, and provide employment for rural areas in socioeconomic terms (Thothathri, 1999; UNCSO, 2002; Yue et al., 2001). All these indicate their sustainability for global and local development. In addition to a legislative framework set at the national level for their promotion, locally based evaluations for developing renewable energy sources can provide a vital

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basis for evaluations at the national level, and thus enhance political effectiveness.

In this context, this study attempted to investigate the Chigu area of southwestern Taiwan as an example, and to establish a procedure for evaluating local renewable energy sources. With geographic information system (GIS)-based analyses, multifarious renewable energy sources were evaluated according to actual local land uses in order to provide more-integrated and accurate decision-making information for policy-makers and investors. The established model may help localities explore their exploitable resources, and this can possibly be expanded to conduct comprehensive surveys at the national level in order to estimate the entire potential of a country. These represent indispensable information for decision-making in order to build a sustainable energy system which enhances climate protection.

2. The study area and analysis of its renewable energy sources

The study area of Chigu is located in the southwestern coastal region of Taiwan, as depicted in Fig. 1. The region of Chigu covers an area of 12,560 ha, and contains a population of 25,769 currently. The absolute elevation in the entire area is no more than 10 m, while the average gradient is less than 5%. An ordinary agricultural area is located in the western part of the region (Fig. 2). This area has mostly been exploited as fish farms for many decades, among which many are falling into disuse. Overexploitation of groundwater for fish farming has since long led to land subsidence. The “special agricultural area” is cropland of good quality, and is used for food production. The main habitat where over half of the known population of the globally endangered migratory bird, the Black-faced Spoonbill

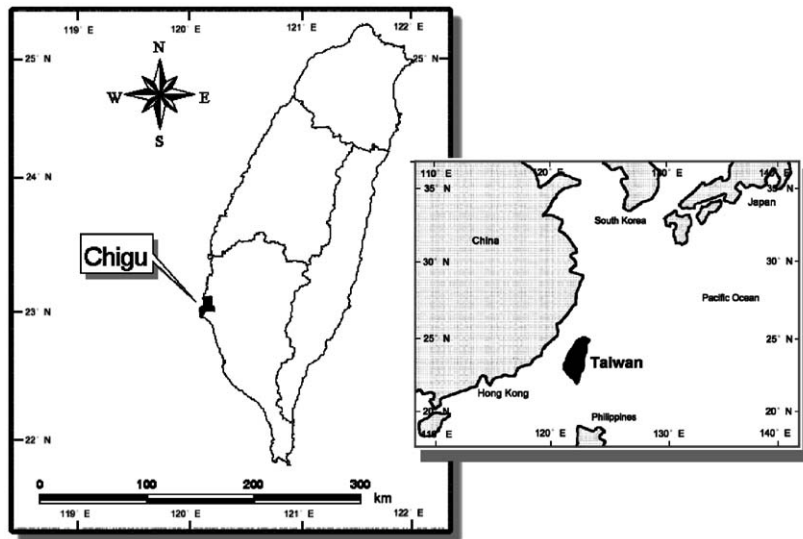


Fig. 1. Geographic location of the Chigu region in southwestern Taiwan.

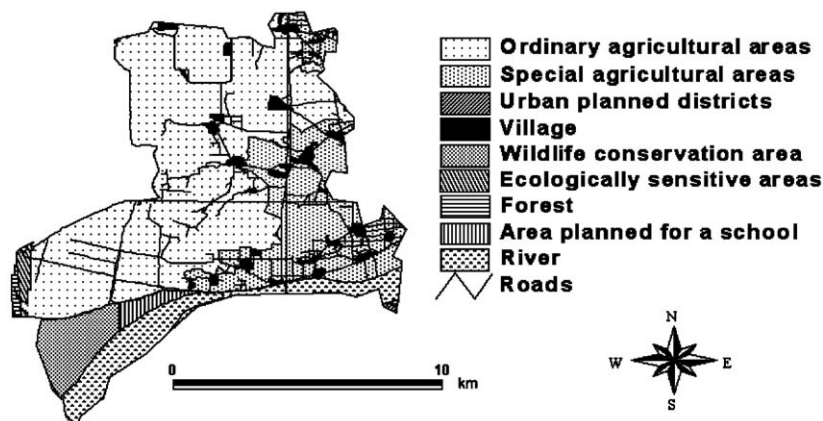


Fig. 2. Land use zoning at Chigu.

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