Assessing the Sustainability of Agriculture Using Geospatial Techniques: A Case Study of Kotmale Catchment Area, Sri Lanka

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Abstract

Agriculture has been central in almost every society since the Neolithic revolution. It does not only provide a source of food but is also one of the leading factors of biophysical and socioeconomic footprints. Agriculture is playing a larger role in the commercial and rural development by earning foreign currency and rural livelihood. In particular, Sri Lanka has been known as an agricultural country since the colonial period, and it has matured after its independence. Unsustainable agricultural practices have led to socioeconomic and environmental issues in developing countries. The agricultural land located in the mountainous areas of Sri Lanka has become dilapidated due to poor agricultural techniques, coupled with the physical properties of the area and socioeconomic factors. Ensuring the sustainability of agriculture is essential in the mountainous areas of Sri Lanka because more than 66% of its labor force engages, both directly and indirectly, in domestic and commercial agriculture.

To support sustainable agricultural planning, this study primarily aims to assess the sustainability of agriculture in Kotmale Catchment Area (KCA) in Sri Lanka using geospatial techniques. It is located in Central Highland (CH) of Sri Lanka and covers 572 km^2 with its altitude ranging from 681-2505 m above the Mean Sea Level (MSL). Its latitude coordinates are 7°6'32.80"N and 6°47'33.12"N, and its longitude coordinates are 80°50'21.26"E and 80°34'31.34"E, which encompasses the whole south-central mountain. Both primary and secondary data were collected, and an online survey was also conducted to gather experts' opinion on suitability factors. The Analytic Hierarchy Process (AHP), combined with Multi-Criteria Decision Making (MCDM), were the methods employed for the land suitability assessment with Food and Agriculture Organization (FAO) standard. The following approaches were also performed: a household questionnaire survey, assessment of soil erosion prone area using the Revised Universal Soil Loss Equation (RUSLE) model, and review of agricultural policies. Thirteen factors have been analyzed under three criteria, i.e., environmental, social, and economic, in AHP and MCDM. Two hundred questionnaires were collected by selecting 20 Grama Niladhari Divisions (GNDs), covering the lower, middle, and upper

part of the catchment. A few regulations of the Soil Conservation Act were crosschecked with results of the AHP and MCDM.

The results were discussed under four approaches, namely land suitability, conservation of natural resources, human resources development, and policy; all with the aim to achieve agricultural sustainability. I found out that 48% of agricultural lands in KCA are highly suitable (S1) for future farming; suitable agricultural land is mainly located in the lower part of the catchment. From the results of the RUSLE model, soil erosion is revealed to be the most serious environmental issue, and 44.1 % of the area above the accepted level. The household survey shows that 64.6% of farmers are not aware of basic soil science and 72% are willing to learn, provided that learning materials are and significant propagation is needed. Although farming is restricted in areas above 1,500 m, 33.6% of the total tea land and 83.3% of Chena land are located in such areas. Regarding the cultivation of slope above 60% degree were not made significant influences. Soil conservation programs and agricultural related policies should be strictly enforced, as provisioned by the Soil Conservation Act.

The novelty of this research has been achieved by using two approaches: socio-economic data have been used to build a socially accepted agricultural sustainability model, and land related policies have been crosschecked with results of AHP and MCDM to establish policy-oriented approach. The findings of this study can be used as proxy indicators for agriculture planners and decision makers to ensure the agricultural sustainability of KCA. Moreover, the selected criteria, factors, attributes, and policy of this research can be adjusted accordingly based on the available data to increase its applicability in other areas.

Keywords: Soil erosion, agriculture land sustainability, Kotmale watershed, MCDM, AHP