

# Detecting Abandoned Farmland through Harmonic Analysis and Gray-Level Co-Occurrence Matrix(GLCM)<sup>†</sup>

- In the Case of Yeongdeok-gun, North Gyeongsang Province, South Korea -

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## I. Introduction

Abandoned farmlands refer to the agricultural lands which has not been cultivated for more than 2 years. The presence of the abandoned farmland has negative impacts on human and natural environments, for example, reducing agricultural production, deteriorating local communities, and increasing the probability of wild fires and soil erosion. While appropriate managements are required, detecting those via field surveys or any type of manual works always involves a great level of efforts, time and budget.

Remote sensing technique is used as a supplement to the manual efforts. Commonly adopted method is to detect the abandoned farmland from other types of land use, using attributes derived from the satellite or aerial imageries. The choice of the attributes determines the accuracy of the classifications. Commonly, the attributes are two types: temporal and spatial. Examples of temporal features are vegetation phenology extracted from Vegetation indices (VIs) (Cheng *et al.*, 2021; Jakubauskas *et al.*, 2001; Li *et al.*, 2021). Examples of spatial features are spatial distribution extracted from texture information (Cheng *et al.*, 2021; Haralick *et al.*, 1973). While each type is used for classification separately, only a few studies took advantage of the diversification of attributes by adopting the two types together.

Under a belief that the detection accuracy can be improved by using both of the temporal, spatial, and socio-environmental characteristics in this study we aim to detect abandoned farmlands through attributes extracted time-series analyses, as well as the attributes from the textural analysis. For temporal features, Harmonic analysis is used to decompose a vegetation

index time series into multiple sine and cosine components of various frequencies, and extracted the magnitude of each (Lee *et al.*, 2020; Yoon and Kim, 2020). For spatial features, Grey Level Co-Occurrence matrix (GLCM) is used to extract fourteen texture features considering four directions. We use Sentinel-2 satellite imagery data and compare the accuracy from Support Vector Machine and Random Forest classification.

The study site is Yeongdeok-gun, North Gyeongsang province, South Korea, the province with the second largest agricultural land in the country. Although the main industry in Yeongdeok-gun is agriculture, the cultivation area decreased from 3,139 (ha) in 2,000 to 2,048 (ha) in 2020 and rice production also decreased from 14,836 (ton) in 2,000 to 8,650 (ton) in 2020. The study period is from Jan, 2018 to Dec, 2020. Abandoned farmland tends to have a good quality of natural resources, so there is a need for strategy to reuse abandoned farmland. The finding of this research would give guidance to local governments when detecting abandoned farmlands, and establishing the local policies of abandoned farmlands to prevent possible negative consequences. Our study can contribute to improve effective land use for policy for policy makers and city planners.

## II. Analytical Design

### 1. Data

#### 1) Sentinel 2 - Level 1C

Sentinel 2 has high temporal resolution of five days and a high spatial resolution of 10 meters. High temporal-spatial resolution is suitable for detecting small-scale farmland.

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Sentinel 2-Level 1C (L1) Top-of Atmosphere (TOA) data from 2018 to 2020 in which the area of cloud cover is less than 30% of the area.

## 2) Vegetation Indices

In this study, three Vegetation indices (Vis) were selected to obtain the differences between abandoned farmland, paddy, and field. The vegetation indices are NDVI (Normalized Difference Vegetation Index), NDWI (Normalized Difference Water Index) and SAVI (Soil Adjusted Vegetation Index). NDVI is commonly used index, it quantifies vigor of vegetation. NDWI represents the presence of vegetation liquid water as a value. SAVI compensate for the influence of soil background.

## 3) Reference Data

The reference dataset is the complete survey of abandoned farmland in Yeongdeok-gun made in 2020, from Yeongdeok-gun. The data is based on the photo-interpretation and field survey.

## 4) Socio-economic Variable

Some farmland is abandoned because of geographical features, but there are also socioeconomic causes: population, migration rate, and distance from the road. Therefore, in addition to spatio-temporal features extracted from satellite images, this study seeks to include socioeconomic variables. By doing so, the accuracy of the detection of abandoned farmland can be improved and the cause of its abandonment can be checked.

## 2. Method

In the first step, prepare the Sentinel 2 satellite images, and second, through harmonic analysis and GLCM, characteristics of each land-cover type is derived (Tamiminia *et al.* 2020). Lastly, the lands are classified into farmland abandonment, paddy, field and orchard by Support Vector Machine (SVM) and Random Forest (RF). We examined the model performance based on the overall accuracy, Kappa coefficient, and producer's and user's accuracy for abandoned farmland class.

## 참고문헌

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