

I. INTRODUCTION

1.1. Background

Climate change is one of the major challenges faced by the world today. The phenomenon of climate change occurs due to the increasing amount of greenhouse gases in the atmosphere, especially carbon dioxide (CO₂), because carbon (C) can absorb and reflect long-wave radiation, causing an increase in Earth's temperature (Irma and Gusmira, 2024). One of the factors that increases carbon emissions is due to human activities such as deforestation and land use change. Continuous deforestation and land use change can cause carbon stored in forest biomass to be released into the atmosphere. In addition, land conversion can also reduce the content of organic matter in the soil and cause changes in the carbon stock of an ecosystem due to the loss of aboveground biomass. As a result, the earth's temperature becomes hotter, which then triggers various impacts on the environment, such as extreme climate change, various kinds of ecosystem damage, and loss of biodiversity (Surtani, 2015).

Vegetation has an important role in efforts to reduce the impact of climate change that occurs because plants can absorb carbon dioxide (CO₂) from the air through photosynthesis and store it in the form of biomass. Vegetation functions as a natural carbon sink that helps reduce the amount of carbon in the atmosphere (Rahmadanti, Santosa, and Pramesti, 2023). According to a report by the Ministry of Environment and Forestry in 2022, Indonesia's forest area reached 125.76 million hectares of land. As a country with a large forest area, Indonesia can be said to have a strategic role in climate change mitigation. One of these forest areas is in Wonosalam village.

Wonosalam Village is one of the villages in Wonosalam sub-district, Jombang district, East Java. Wonosalam Village has its own geographical characteristics because it is located at the foot of Mount Anjasmoro and has a variety of land cover, such as forests, plantations, and moorlands (Andreani, 2024). Most of the land is dominated by natural vegetation and smallholder plantations, making Wonosalam Village a potential carbon sink forest area. Although still dominated by natural vegetation, Wonosalam Village is currently experiencing the

impact of high levels of land conversion (Febrianti, W., Budianto, S., Lela, F., Evitasari, D., Priyadarshini, R., Suryaminasih, P., 2023). Forest areas in Wonosalam Village have been converted to non-forest land uses, such as plantations, agricultural land, and settlements, affecting carbon stocks in the area.

Carbon stocks in various land covers can be estimated using remote sensing technology. The estimation process is based on the vegetation index value of an area and carbon stock data obtained from field surveys. This data is then analyzed using the regression method (Situmorang, Sugianto, and Darusman, 2016). One of the satellite images that can be used to estimate carbon stocks is the Landsat 9 image. According to (Faturrahman, Sukiyah, and Jamal, 2023), the Landsat 9 image is a remote sensing satellite with the latest sensors capable of capturing images in various color and temperature spectra. Thus, Landsat 9 imagery can be used to estimate carbon through land cover and vegetation analysis.

The study aims to estimate carbon stocks on various land covers in Wonosalam Village using the NDVI vegetation index obtained through data analysis of Landsat 9 imagery. The utilization of both methods is based on their ability to provide accurate information on vegetation conditions. Landsat 9 imagery provides multispectral data covering various wavelengths of light that are useful for land cover analysis to calculate the vegetation index. While the NDVI vegetation index calculation method, although it has a simple formula, is still sensitive to vegetation conditions in the image, the results are more precise. The research is expected to help in providing up-to-date and accurate carbon stock data, especially in Wonosalam Village, which has various types of land cover. The data obtained will be the basis for good land management to increase carbon stocks. The data generated later can provide knowledge and information on the size of carbon stocks used to support government efforts in climate change mitigation. The results of this study can be useful for local communities, policymakers, and other parties concerned with environmental conservation efforts, especially in Wonosalam Village and its surroundings.

1.2. Problem Statement

1. What is the total estimated carbon stock of different land covers in Wonosalam village using the NDVI vegetation index and Landsat 9 imagery?
2. Is there a significant relationship between NDVI vegetation index values and carbon stocks on various land covers in Wonosalam village?
3. Are NDVI vegetation index and Landsat 9 satellite imagery-based carbon stock estimates closely related to vegetation density and diversity in the field?

1.3. Research Objectives

1. Estimating the total carbon stock of different land covers in Wonosalam Village using the NDVI vegetation index and Landsat 9 imagery.
2. Analyzing the significant relationship between NDVI vegetation index values and carbon stocks on various land covers in Wonosalam village.
3. Knowing the relationship between the results of NDVI vegetation index-based carbon stock estimation and vegetation density and diversity data from field observations.

1.4. Hypothesis

1. Estimated carbon stock values can be obtained using the NDVI vegetation index and Landsat 9 imagery.
2. There is a significant relationship between NDVI vegetation index values and carbon stocks on various land covers in Wonosalam village, Jombang.
3. There is no relationship between the results of NDVI vegetation index-based carbon stock estimation and the density and diversity of vegetation in the field.

1.5. Research Benefits

1. Provide information on the estimation of total carbon stock in various land cover types in Wonosalam village, Jombang.
2. As a reference for future research
3. As input for further land management decision-making, especially in maintaining ecosystem balance and reducing the impacts of climate change.