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Remote sensing for vegetation monitoring in carbon capture storage regions: A review

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HIGHLIGHTS

- An overview of remote sensing systems and applications in vegetation monitoring.
- A review on detecting CO_2 leakage effect on vegetation using hyperspectral imaging.
- Identification of major issues on distinguishing CO_2 leakage-derived plant stress.
- Recommendation on an integrated remote-sensing monitoring system at CCS sites.

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ABSTRACT

Carbon Capture and Storage (CCS) is an emerging climate change mitigation technology which prevents carbon dioxide (CO_2) from entering the atmosphere, so as to reduce greenhouse gas emissions. Environmental monitoring in CCS sites is critical for ensuring that any CO_2 leakage and its effect on biota, especially vegetation, is detectable. It also plays an important role in creating a social license to operate and assuring the general public that the mechanisms for leak detection and remediation are in place. This review overviews current remote sensing technologies for vegetation monitoring of CCS sites/regions (with a focus on rangelands and pastures), including medium-to-high resolution satellite, aerial (both manned and unmanned aircrafts) and *in situ* sensors and methods. Our literature survey has pointed out that remote sensing, particularly hyperspectral sensors, can accurately detect CO_2 leakage derived effects on vegetation. It can compensate the two main drawbacks of operational systems for detecting these effects over large areas. One is the areas affected tend to be relatively small (1–15 m); and the other is symptoms in vegetation tissues tend to be similar to other stresses, such as nutrient or water deficiency. With this in mind, we have recommend that a comprehensive system should be put in place. It integrates continuous monitoring with ad-hoc detection to assess vegetation conditions in a planned CCS site. Site-based pheonocams and area-based medium-resolution satellite remote sensing sources can be used to compare any given point in time (e.g. the injection point) with the condition at the same location in the past. Before an injection commences, a baseline assessment should be conducted using the combination of high-resolution aerial hyperspectral imaging and medium-resolution long-term data from Landsat sensors. Further acquisition of high-resolution aerial imagery (ideally hyperspectral) is particularly useful following specific detected CO_2 leaking events. Aiming at bridging the gaps between research, development and implementation of CCS, this review will contribute to environmental and social impacts of sustainable energy policies, including climate change mitigation and environmental pollution reduction.

1. Introduction

1.1. Carbon capture and storage technology

Global warming is primarily a result of too much carbon dioxide (CO_2) in the atmosphere. CO_2 is predicted to increase substantially over the 21st century. Thus decreasing the total CO_2 output may significantly mitigate the effects and severity of future climate change [1]. This places a premium on developing technology solutions to minimize rises in atmospheric CO_2 levels. Carbon Capture and Storage (CCS) has

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