Remote Sensing and AI Techniques to Monitoring Lakes and Rivers Water Quality in Africa. A Systematic review on Applications and Challenges

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Key words: Remote sensing

SUMMARY

Remote sensing provides continuous, precise, and long-term datasets for water quality research. To enable a better water ecosystem, various datasets and robotic methods are needed to monitor water quality in both large and small water bodies. This paper presents a comprehensive review of recent advances in using satellite data and AI technology to analyze the water quality monitoring of African lakes and rivers.

Most water quality studies have been conducted in Egypt, South Africa, Kenya, Chad, Malawi, and Ethiopia. These countries primarily utilize remote sensing data with a model for their water quality studies.

In most studies, the methodologies used to determine water quality parameters vary according to several factors, including satellite type, study area, and correlation analysis methods. Thus, each water body requires a specific method for evaluating its water quality.

We evaluate multispectral, hyperspectral, and radar satellites, alongside machine learning (ML) and deep learning (DL) models for parameters such as chlorophyll-a, turbidity, total suspended solids (TSS), and colored dissolved organic matter (CDOM). Our findings indicate that Sentinel-2 MSI and Landsat 8/9 OLI are the most widely used sensors, while random forest (RF) and convolutional neural networks (CNNs) achieve the highest accuracy ($R^2 > 0.85$) for chlorophyll-a. Data fusion techniques enhance turbidity mapping by 20–30%, and hybrid models that combine physics-based and ML approaches show promise. Challenges include atmospheric interference, limited in situ data, and model transferability across lakes.

Future research should focus on enhancing water quality monitoring by combining data from

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various sensors, integrating physical models with artificial intelligence, and utilizing big data processing platforms to provide more accurate and reliable estimations of water quality parameters. Additionally, future studies should also focus on river water bodies, which are sources of life.

Keywords: Remote sensing, Water Quality, AI, Lake, River, Africa

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