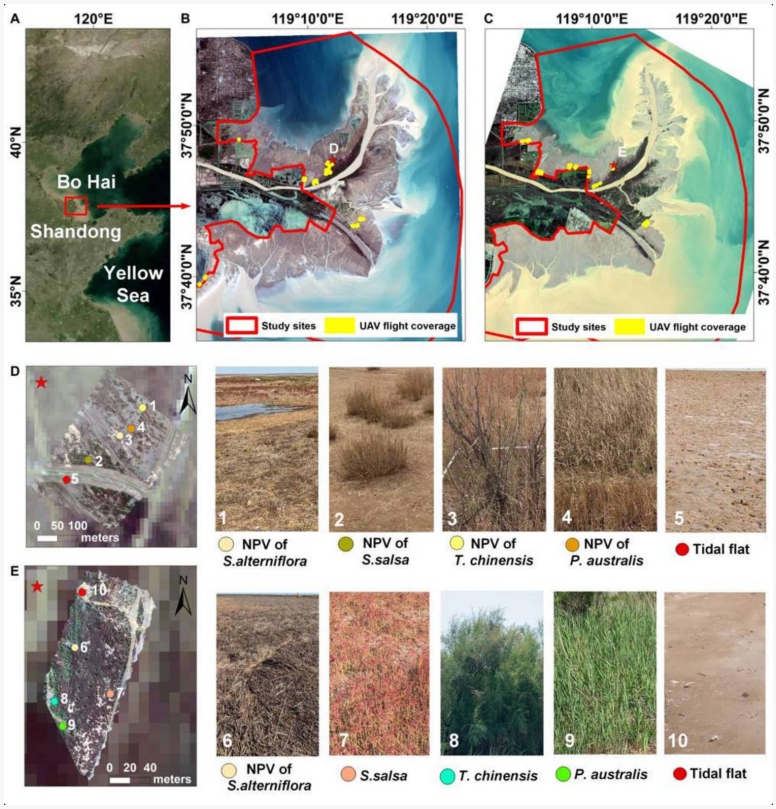
MINI improves saltmarsh carbon monitoring

GA, UNITED STATES, August 26, 2026 /EINPresswire.com/ -- A new hyperspectral index, moisture-insensitive non-photosynthetic vegetation index (MINI), enables more reliable estimation of vegetation cover in coastal saltmarsh wetlands under changing moisture conditions. By distinguishing non-photosynthetic vegetation, photosynthetic vegetation, and bare soil more accurately than existing indices, the method could improve wetland monitoring, blue carbon assessment, and ecological restoration in tidal coastal environments.



Study area and field validation sites in the yellow river delta.

Coastal saltmarsh wetlands are important blue carbon ecosystems that protect shorelines, stabilize sediments, support biodiversity, and store carbon in plant biomass and soils. Non-photosynthetic vegetation (NPV), including senescent leaves, litter, and low-chlorophyll structural tissues, plays a major role in long-term carbon storage. However, its coverage is difficult to estimate accurately across large tidal wetlands. Existing hyperspectral indices often rely on cellulose and lignin absorption near 2,100 nm, but these signals weaken as vegetation and soil moisture increase. Shortwave infrared bands may also suffer from low signal-to-noise ratios and atmospheric water-vapor interference. Based on these challenges, in-depth research is needed into moisture-insensitive remote sensing tools for saltmarsh vegetation monitoring.

Researchers from Capital Normal University, the Land Satellite Remote Sensing Application Center of the Ministry of Natural Resources, Jimei University, the University of Hong Kong, and the Protection and Management Center of Wetland and World Natural Heritage in Yancheng City reported (DOI: 10.34133/remotesensing.1055) the study in Journal of Remote Sensing on May 4, 2026. The article addresses the challenge of mapping wetland vegetation accurately under tidal moisture variation.

The study developed a moisture-insensitive non-photosynthetic vegetation index (MINI) to estimate the fractional cover of NPV, photosynthetic vegetation (PV), and bare soil (BS). Unlike conventional NPV indices such as the Cellulose Absorption Index (CAI), Continuum Interpolated NPV Depth Index (CINDIh), Lignin-Cellulose Absorption (LCA) index, and Shortwave Infrared Normalized Difference Residue Index (SINDRI), MINI uses visible bands at 621 and 690 nm. Combined with the Normalized Difference Vegetation Index (NDVI) in a triangular feature space, MINI showed stronger stability and accuracy under variable moisture conditions.

The team collected NPV, PV, and BS samples from the Yellow River Delta and measured their spectral reflectance under moisture levels ranging from dry to saturated. Derivative spectral analysis showed that the 600–900 nm range could reliably separate NPV from BS despite changing moisture. After testing possible band pairs, the researchers selected 621 and 690 nm as the optimal combination. MINI was evaluated using 160,000 synthetic mixed spectra and ZY-1 02D/ZY-1 02E hyperspectral satellite images acquired across three phenological stages and tidal levels. In simulated data, MINI achieved coefficient of determination (R^2) values of 0.80–0.84, root mean square error (RMSE) of 0.12–0.18, and mean absolute deviation (MAD) of 8.1%–9.6%. In satellite validation against unmanned aerial vehicle (UAV) observations, MINI maintained R^2 values of 0.80–0.82, RMSE of 8.16%–10.64%, and MAD of 6.24%–8.56%.

Suggested quote for approval: “MINI provides a practical approach for reducing moisture-related uncertainty in coastal wetland monitoring,” said the research team. “This method can help researchers better assess vegetation dynamics, ecosystem condition, and the carbon-storage function of saltmarsh wetlands.”

The study combined laboratory spectroscopy, derivative spectral analysis, synthetic spectral mixture modeling, satellite image processing, and UAV-based validation. Researchers measured reflectance spectra of wetland vegetation and soil samples, generated mixed spectra with known cover fractions, processed ZY-1 hyperspectral imagery, and used high-resolution UAV classification results as reference data.

MINI could support large-scale monitoring of coastal wetlands where tidal moisture changes reduce the reliability of traditional remote sensing indices. Its visible-wavelength design may also improve applicability across sensors with limited shortwave infrared performance. Future uses may include blue carbon accounting, wetland restoration assessment, invasive vegetation management, and long-term coastal ecosystem monitoring.

References
DOI
10.34133/remotesensing.1055

Original Source URL
https://doi.org/10.34133/remotesensing.1055

Funding information
The work is supported by the Yellow Sea Wetland Research Project (HHSDKT202403) and the National Natural Science Foundation of China (42071396).

Lucy Wang
BioDesign Research
email us here