DOCUMENTATION

NDWI(Normalized Difference Water Index):

Normalized Difference Water Index (NDWI) can refer to one of two remote sensing-derived indexes related to liquid water: to monitor changes in water content of leaves, and to monitor changes related to water content in water bodies. The NDWI index is most appropriate for water body mapping. The water body has strong absorbability and low radiation in the range from visible to infrared wavelengths. The index uses the green and Near Infra-red bands of remote sensing images based on this phenomenon. The NDWI can enhance the water information effectively in most cases. It is sensitive to built-up land and often results in over-estimated water bodies.

Values description: Values of water bodies are larger than 0.5. Vegetation has much smaller values, which results in distinguishing vegetation from water bodies easier. Built up features have positive values between zero and 0.2.

NDWI = (Green - NIR) / (Green + NIR)

NDVI(Normalized Difference Vegetation Index):

Normalized Difference Vegetation Index (NDVI) quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs).

NDVI=(NIR-Red)/(NIR+ Red)

Healthy vegetation (chlorophyll) reflects more near-infrared (NIR) and green light compared to other wavelengths. But it absorbs more red and blue light. This is why our eyes see vegetation as the color green. If he could see near-infrared, then it would be strong for vegetation too. Satellite sensors like Landsat and Sentinel-2 both have the

necessary bands with NIR and red. The result of this formula generates a value between -1 and +1. If they have low reflectance (or low values) in the red channel and high reflectance in the NIR channel, this will yield a high NDVI value. And vice versa. Overall, NDVI is a standardized way to measure healthy vegetation. When they have high NDVI values, they have healthier vegetation.

How NDWI & NDVI are useful in earth observations?

NDWI (Normalized Difference Water Index) and NDVI (Normalized Difference Vegetation Index) are both useful in Earth observations for different purposes:

NDWI (Normalized Difference Water Index): NDWI is a remote sensing index that measures the presence and extent of water bodies within an image or a region. It is particularly useful for assessing and monitoring water-related features such as lakes, rivers, reservoirs, wetlands, and coastal areas. NDWI values provide information about the abundance of water content and can be used to track changes in water bodies over time. NDWI is commonly used in applications such as water resource management, flood monitoring, drought assessment, and mapping of aquatic vegetation.

NDVI (Normalized Difference Vegetation Index): NDVI is a widely used vegetation index that provides information about the health, density, and vigor of vegetation. It quantifies the difference in reflectance between near-infrared (NIR) and red wavelengths of light, which allows for the assessment of vegetation greenness. Higher NDVI values indicate healthier and denser vegetation, while lower values indicate sparse or stressed vegetation. NDVI is extensively used in applications such as land cover mapping, crop monitoring, forest health assessment, drought detection, and studying ecosystem dynamics. It helps in understanding vegetation growth patterns,

detecting changes in land use, and assessing the impact of environmental factors on vegetation health.

Both NDWI and NDVI are valuable tools for analyzing and interpreting satellite imagery in order to gain insights into Earth's land and water resources. They play a crucial role in environmental monitoring, resource management, climate studies, agriculture, and various other fields related to Earth observations.

What are the possible sources of noise which can affect NDWI & NDVI estimation?

The estimation of NDWI (Normalized Difference Water Index) and NDVI (Normalized Difference Vegetation Index) can be affected by several sources of noise. These noise sources can introduce errors or uncertainties in the index values, impacting their accuracy and interpretation. Some of the possible sources of noise that can affect NDWI and NDVI estimation are:

Atmospheric Effects: Atmospheric conditions, such as clouds, aerosols, and atmospheric scattering, can affect the incoming solar radiation and alter the reflectance values of the vegetation and water surfaces. This can introduce errors in NDWI and NDVI calculations, particularly in areas with significant atmospheric interference.

Sensor Noise: Noise originating from the sensor itself, such as sensor noise, calibration errors, or radiometric artifacts, can introduce inaccuracies in the measured reflectance values. These errors can propagate into NDWI and NDVI calculations, leading to distorted index values.

Shadows: Shadows cast by objects, topography, or clouds can affect the reflectance values of vegetation and water surfaces, leading to inaccuracies in NDWI and NDVI estimations. Shadows can result in

reduced reflectance values, which may affect the index values, especially in areas with complex topography or varying illumination conditions.

Sun Angle and Solar Zenith: The angle of the sun and solar zenith angle at the time of image acquisition can impact the reflectance values of vegetation and water surfaces. Varying sun angles can introduce variations in the incident solar radiation, leading to differences in reflectance and potentially affecting NDWI and NDVI estimations.

Sensor Geometry: The sensor's viewing angle and geometry can influence the reflectance values captured by the sensor. Variations in sensor geometry, such as off-nadir viewing angles, can introduce distortions in the reflectance measurements, affecting the accuracy of NDWI and NDVI calculations.

Calibration and Preprocessing Errors: Errors in radiometric calibration or preprocessing steps, such as atmospheric correction or geometric correction, can introduce noise or biases in the reflectance values used for NDWI and NDVI calculations. These errors can impact the accuracy and comparability of NDWI and NDVI estimates.

Mixed Pixels: Pixels in remote sensing imagery often contain a mixture of different land cover types or surface materials. This mixing of different features within a pixel can lead to spectral confusion and affect the accuracy of NDWI and NDVI estimations, particularly in areas with heterogeneous landscapes.

It is important to consider and account for these potential sources of noise when interpreting NDWI and NDVI values, and to apply appropriate preprocessing techniques and correction methods to mitigate their effects.

What are the different types of Satellite image resolution?

Satellite images are available in different resolutions, which refer to the level of detail or spatial resolution captured by the satellite sensor. The resolution of a satellite image determines the size of the smallest ground feature that can be distinguished or resolved in the image. Here are the different types of satellite image resolutions commonly encountered:

Spatial Resolution: Spatial resolution refers to the level of detail or ground coverage represented by each pixel in the image. It is typically expressed in meters per pixel or pixel size. Higher spatial resolution images have smaller pixel sizes and can capture more detailed information.

Common spatial resolution categories include:

Very High Resolution (VHR): Typically refers to satellite images with a spatial resolution of less than 1 meter, often ranging from a few centimeters to around 50 centimeters per pixel. VHR images are suitable for detailed mapping, urban planning, infrastructure monitoring, and other applications requiring fine-grained information.

High Resolution (HR): Refers to satellite images with a spatial resolution ranging from 1 to 10 meters per pixel. HR images provide good detail and are useful for land cover mapping, environmental monitoring, agricultural assessments, and regional planning.

Medium Resolution (MR): Represents satellite images with a spatial resolution ranging from 10 to 30 meters per pixel. MR images are commonly used for land cover classification, vegetation analysis, and global-scale monitoring.

Low Resolution (LR): Refers to satellite images with a spatial resolution coarser than 30 meters per pixel. LR images are suitable for regional and global-scale analysis, climate studies, and large-scale environmental monitoring.

Spectral Resolution: Spectral resolution refers to the number and width of spectral bands or channels captured by the satellite sensor. Each band represents a specific range of the electromagnetic spectrum. Higher spectral resolution images provide more spectral information, allowing for better differentiation and analysis of land cover types, vegetation health, and other surface characteristics.

Radiometric Resolution: Radiometric resolution refers to the number of bits used to represent the digital values of each pixel in an image. It determines the range and precision of the recorded radiometric values. Higher radiometric resolution allows for a more detailed representation of brightness or reflectance levels, enabling better distinction between subtle differences in surface properties.

Temporal Resolution: Temporal resolution refers to the frequency or time interval at which satellite images are acquired over a specific area. It is crucial for monitoring changes over time, such as vegetation growth, land use dynamics, and environmental variations. High temporal resolution datasets capture frequent revisits to the same location, enabling the analysis of short-term or seasonal changes.

These different types of satellite image resolutions offer various trade-offs between detail, coverage, and acquisition frequency, depending on the specific application requirements and the capabilities of the satellite sensor.

Do you think NDWI is useful for estimating water quality parameters?

NDWI (Normalized Difference Water Index) can be useful for estimating certain water quality parameters, particularly those related to the presence or concentration of specific constituents in the water. However, it is important to note that NDWI alone may not provide direct measurements of water quality parameters. Instead, it can serve as an indicator or proxy for certain characteristics or conditions related to water quality. Here are a few ways NDWI can be relevant for estimating water quality parameters:

1.Algal Blooms: NDWI can help in detecting and monitoring algal blooms in water bodies. Algal blooms, which can be associated with poor water quality, often result in a high concentration of chlorophyll-a in the water. NDWI is sensitive to changes in chlorophyll content, allowing for the identification and tracking of algal blooms, which can be an indicator of potential water quality issues.

2.Suspended Sediments: High concentrations of suspended sediments in water can impact water quality. NDWI can help in assessing sediment loads in water bodies, particularly in rivers, estuaries, or coastal areas. High NDWI values may indicate higher turbidity caused by suspended sediments, which can be an important water quality parameter to monitor.

3.Water Clarity: Water clarity is another aspect of water quality that can be indirectly estimated using NDWI. Higher turbidity will interfere with the EM radiation in the RGB scale, by absorbing & reflecting differently compared to a high clear water. Clearer waters with lower levels of suspended particles or dissolved substances tend to exhibit higher NDWI values. Monitoring changes in NDWI over time can provide insights into variations in water clarity, which can be influenced by factors such as sedimentation, pollution, or nutrient inputs.

4.Vegetation Cover: While not directly related to water quality parameters, NDWI can be useful in estimating the extent of aquatic vegetation or submerged aquatic plants. Dense vegetation cover in water bodies can impact water quality by affecting factors such as dissolved oxygen levels, nutrient cycling, and habitat availability for aquatic organisms. NDWI can help identify areas of dense vegetation growth, which can be relevant for understanding ecological dynamics and potential water quality impacts.

It's important to highlight that NDWI provides an indirect estimation or indication of certain water quality parameters and should be used in conjunction with other measurements, field sampling, or laboratory analysis to obtain more precise and comprehensive assessments of water quality. Additionally, the specific relationship between NDWI and water quality parameters can vary depending on local conditions, the type of water body, and the specific constituents of interest.

Do you think NDWI & NDVI are useful in all seasons?

NDWI (Normalized Difference Water Index) and NDVI (Normalized Difference Vegetation Index) can be useful in all seasons, although their effectiveness may vary depending on the specific characteristics of the study area and the seasonal variations in vegetation and water dynamics. Here's a closer look at their utility across different seasons:

NDWI:

Wet Seasons: NDWI is particularly valuable during wet seasons or periods when water bodies are more prevalent or have higher water content. It can effectively differentiate between water bodies and other land cover types, making it useful for mapping and monitoring lakes, rivers, wetlands, and floodplains.

Dry Seasons: While NDWI may be less informative during dry seasons when water bodies shrink or become less abundant, it can still be helpful for identifying water sources such as reservoirs, groundwater recharge areas, and irrigation canals. Additionally, NDWI can assist in detecting areas of drought stress in vegetation, as reduced soil moisture content affects plant health.

NDVI:

Growing Seasons: NDVI is highly useful during growing seasons when vegetation is actively growing and abundant. It provides information about the vigor, density, and health of vegetation. Monitoring NDVI during these seasons can help assess crop health, vegetation productivity, and land cover changes.

Winter Seasons: NDVI can still be valuable during winter seasons, especially in regions with persistent vegetation or areas where winter crops are grown. Although vegetation may be less dense or dormant, NDVI can capture differences in vegetation cover and help monitor changes in land use or vegetation patterns.

It's important to consider that the effectiveness of NDWI and NDVI can be influenced by factors such as cloud cover, snow cover, and vegetation phenology (i.e., the timing of growth stages). Cloud cover can limit the availability of cloud-free satellite imagery, affecting the frequency and continuity of observations. Snow cover can hinder the accuracy of both NDWI and NDVI, as snow reflects differently in the near-infrared and red spectral regions. Vegetation phenology influences the relationship between NDVI and vegetation conditions, as the reflectance properties of plants change during different growth stages.

In summary, while NDWI and NDVI have utility in all seasons, their effectiveness and applications may vary depending on factors such as the presence of water bodies, vegetation type, seasonal variations, and the specific objectives of the analysis. Adaptation and careful interpretation of these indices based on the seasonal context and environmental conditions are essential for maximizing their usefulness.