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Classifying Wetland Vegetation Through Remote Sensing

The classification of vegetation by remote sensing involves the use of satellites and other remote sensing devices, as well as the knowledge of the spectral features of the local vegetation to determine plant cover and its overall role in the landscape.

Vegetation classification by remote sensing first requires measuring the electromagnetic radiation of ground objects by a satellite (such as LANDSAT) or airplane. Second, it requires spectral knowledge of the vegetation in question. In this case, the vegetation must first be manually examined for its reflection frequency. To make things a little more complicated, many plant species reflect differently during different seasons. This is observable in how leaves on trees in the spring appear to be a paler green than they do later on in the summer. Therefore, it is important that the remote sensing device must be situated in both space and time, as the time of the year could affect the reflected wavelengths of the vegetation.

If one knows the exact electromagnetic frequency that a particular species of plant reflects, then in theory one should be able to determine all areas that particular plant species is located on the image. This would be no exception in wetland systems, where unlike other plant systems, each type of plant tends to grow in a very specific niche from all other plants, leaving very broad monocultures.

Overcoming the Difficulties of the Floristic Gradient

A common difficulty in determining the exact assemblages of species on a map is the fact that most plant groups just don’t abruptly change into another. In other words, one can’t put a distinct boundary on where one species ends and another begins, and neither can the remote sensor. In wetlands, vegetation analysis also proves difficult because invasive species that are often found intermixing with natural monocultures can make it difficult for a remote sensor to discern exactly where an invasive species is intruding. Fortunately, GIS software allows the computer to more easily detect these changes in floristic gradients.

One possible solution to this problem is called fuzzy modeling, which Foody discussed in his 1994 paper. Fuzzy modeling is a mathematical model that plays a role in describing the gradual gradient of change from one vegetation type to another. Tapia, Stein, and Bijker also discussed fuzzy modeling in their 2005 paper, and use as an example for their model an Amazonian forest region in Peru.

Schimdtlein and Sassin (2004) also discussed the difficulty of determining the floristic gradient, even when using remote sensing. Their solution also involved mathematical modeling, based off of past observations using high-resolution airborne imagery. This study found a strong agreement between the model and ground-based observations, thus supporting the accuracy of mathematical modeling in GIS.

Schmidt and Skidmore tested the concept of remote sensing on a Dutch wetland in 2002. They found that the spectra of different vegetation types from the wetland were significantly different. Since the different vegetation types can be separated based on simply spectral data, this signifies that remote sensing was indeed an option for mapping the area.

Practical Approaches to GIS and Wetland Remote Sensing

So far the development of GIS and remote sensing has been discussed, however, there are many recent studies that show this technology in action. When monitoring certain invasive plant species in wetland areas, remote sensing and mapping has proved a very useful tool. Maheu Giroux and de Blois (2005) used remote sensing
to produce distribution maps of the invasive reed *Phragmites australis*, based on information gathered from panchromatic and color aerial photographs. Remote sensing enabled a fast and accurate examination of an area that would otherwise be difficult to monitor manually. Cózar et al (2005) used remote sensing in a similar fashion to categorize and study a relatively little-known lacustrine Ibera wetland in Argentina. They used satellite-measured reflectance in order to determine both spatial and temporal relationships and to classify the area into three different regions. Also, remote sensing allowed for the identification of disturbed regions where anthropogenic activities had started to have detrimental effects on the lakes and wetlands. Again, this area would have proved a difficult and expensive task to perform manually, and some of the relationships discovered may have been otherwise overlooked.

This technology can also be used to great effect in monitoring wetland restoration, and important rising subject. Hester and Mendelssohn's 1999 work on monitoring a brackish wetland in Louisiana that is recovering from an oil spill a decade ago shows how useful this tool can be. With the help of satellite imaging and remote sensing, the authors were able to monitor vegetation areas that were impacted by the oil as well as areas that were deteriorating because of other anthropogenic effects.

**Conclusion**

The combination of satellite imagery, manpower, and computer modeling is what makes the system of remote sensing so valuable. Although it is still sometimes easier or more cost-effective for smaller projects to rely on ground observations, remote sensing is proving a valuable alternative for projects requiring broad-scale or long-term observations.

**Annotated Bibliography:**


The Ibera wetland of Argentina was studied by use of both on-site measurements and remote sensing imagery. The intent of the study was to classify the regions of this otherwise little-known system. Using remote sensing to determine limnological variables, the wetland was classified into three different environmental regions. These regions also agreed with other ecological characteristics and monitor anthropogenic disturbances. This is a good example of how remote sensing and GIS make making overall observations about wetlands easier.


Fuzzy modeling describes a mathematical method of remote image classification of vegetation. The normal algorithms used for classification can often be problematic because vegetation in reality does not transfer along 'hard' boundaries. Because of this, the remote sensor may become confused over this transition gradient. This paper describes the advantages and disadvantages of three techniques of image classification: maximum likelihood, artificial neural network, and fuzzy modeling. This is important if you want an accurate vegetation map of your wetland.

In Louisiana, a brackish marsh community recovering from a 1985 oil spill was investigated for three reasons: to evaluate its recovery from the oil spill, to compare the impact of the oil spill versus normal marsh deterioration, and to evaluate areas that fail to recover. Although much of the investigation was ground-based, remote sensing was used to assess which areas were most impacted by the oil. It was found that the rates of land loss in areas impacted by the oil spill were not significantly different than those of areas that were not impacted. Further manual experiments showed that the cause for the loss of wetland was due to increased flooding stress and decreased marsh elevation rather than the oil. This study shows how remote sensing can be used as a helpful secondary orientation tool, even if the main study is ground-based.


Often monitoring an invasive species is the first and most important step in its eventual control. In this paper the authors used remote sensing to produce distribution maps of the invasive reed *Phragmites australis*. This was based on comparing information gathered from panchromatic and color aerial photographs. It was found that the color photographs detected the invasive better than the panchromatic. It was also noted that the study area would have been difficult to monitor manually. This study shows one of the many advantages of this technology over manual observations. It also shows how the technology can be used in monitoring a wetland both spatially and temporally.


A wetland remote sensing system is tested in this paper on a Dutch wetland. The authors found that the spectra of different vegetation types were significantly different, signifying that remote sensing was indeed an option for mapping the area. The authors suggest that with further developments, this technology could prove very useful in mapping wetlands.


A common difficulty in determining assemblages of species on a map is the fact that most plant groups don’t simply abruptly change to another. In other words, you can’t put a distinct boundary on where one species ends and another begins. This is a problem with remote sensing. In this paper, the authors attempt to spatially model some of these ‘floristic gradients’ using a Bavarian meadow as an example, checking their mathematical model against ground-based observations. This is important to GIS because in order for remote sensing to be a viable tool, it must be able to provide accurate data.
This paper furthers the research on fuzzy modeling, fast-becoming a valuable aid to spatially modeling vegetation patterns in remotely sensed data. The test area in this case was an Amazonian forest region in Peru. Again, fuzzy modeling is more appropriate for vegetation classification than the standard remote sensing algorithms, because of the gradual nature of vegetation covers.