QUARTERLY STATUS AND TECHNICAL PROGRESS REPORT

Title: Evaluation of Spatial, Radiometric and Spectral Thematic Mapper Performance for Coastal Studies

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1. Problems

Only one TM image of our Delaware Bay test site was available (P014, R033, 12/13/82) and due to snow cover it was unsuitable for marsh vegetation (biomass) studies. To solve the problem one of our Chesapeake Bay test sites was activated and an available high-quality TM image ordered (P015, R033, 11/02/82). Due to the delay in transmitting additional TM data from Landsat 4, four more scenes of similar test sites were ordered (P014, R032, 11/27/82 and P012, R031, 9/10/82). Pictures and tapes for all scenes have been received.

2. Accomplishments

The majority of our most recent efforts have been to modify our computer software (a version of the Pennsylvania State ORSER package) to read and analyze CCT-AT and CCT-PT formatted data. This task is nearing completion and we will have an operational version of the software within two weeks.

An area along the southeastern shore of Chesapeake Bay was subsetted from the November 11, 1982 TM image. This area, known locally as Vaucluse Shores and situated at approximately 37°25'N latitude, 75°59'W longitude, has historically supported a large community of SAV. Wetzel (1982) reported a stable seagrass bed approximately 140 hectares in size and dominated by Zostera marina and Ruppia maritima. The subsetted TM image was enhanced and classified using an ERDAS 400 system. The results were compared with a chart published by Wetzel indicating the distribution of both Zostera and Ruppia.

We have continued to refine our radiative transfer models describing the irradiance reflectance of a water column containing SAV. These efforts will continue until the spring when we can conduct field measurements to verify our models.

Radiative transfer theory was used to model upwelling radiance for an orbiting sensor viewing an estuarine environment. The environment was composed of a clear maritime atmosphere, an optically shallow estuary of either clear or turbid water, and one of three possible bottom types: vegetation, sand, or mud. Upwelling radiance was calculated for each case in TM bands 1, 2 and 3 and MSS bands 4 and 5 using data available in the literature. A spectral quality index was defined similar to the equation for apparent contrast and was used to evaluate the relative effectiveness of TM and MSS bands in detecting submerged vegetation.

3. Significant Results

Computer analysis of the Vaucluse Shores TM image resulted in a bottom feature classification that correlates well with the findings of Wetzel (1982). One must keep in mind, however, that at least 18 months separate Wetzel's measurements and the TM image.
Disagreements within the classification are most often associated geographically with a large offshore sand bar. The classification agrees best with areas reported by Wetzel to be inhabited by Zostera. Most of the areas indicated by Wetzel to be inhabited by Ruppia were classified as sand. This is intuitively correct because by mid-November most of the Ruppia dies back exposing the underlying sand.

If one considers only the spectral aspect of the problem, the effectiveness of a sensor to discriminate between submerged features is determined by the inherent contrast between the features and the absorbing and scattering properties of the water column and atmosphere. In optically shallow water, holding the atmosphere constant, the inherent contrast between submerged features appeared to be the most influential factor. As the optical depth of the water increased, the optimum sensor band for detecting a submerged feature shifted towards those for which the water was most transparent.

Perhaps the most significant result of this research thus far is the extent to which it has highlighted the need for optical data of high spectral resolution. We have become concerned about the variation in optical characteristics of natural waters and bottom features across sensor bands. This research has shown, for example, that under certain conditions the apparent contrast between two submerged features may decrease to zero at some intermediate depth and then increase for yet deeper depths. Without detailed knowledge of the variation in optical properties across sensor bands, this could not have been predicted.

4. Publications


5. Recommendations

If no TM data is available for any given test site, investigators should be encouraged to request TM data for other yet similar sites, until more data becomes available for the prime site. This procedure has helped us save much time as far as learning to analyze TM data and getting good preliminary results.
A project is being developed with State agencies to use Landsat 4 TM to study the environmental degradation of Delaware's inland bays (Rehoboth Bay, Indian River Bay, etc.) These bays are shallow, their shorelines are overdeveloped (e.g. summer homes, marinas, etc.) and as a result the pollution concentrations are reaching dangerous levels. The State is proposing to analyze TM data on our ERDAS system to study turbidity plumes and circulation patterns in the bays and map changes in vegetation around the bays.

We have found that all major wetland vegetation species can be clearly discerned in TM imagery. The spatial resolution of TM data appears to be better than 30 meters, i.e. it seems to be closer to 25 meters than 30 meters.

A significant amount of the submerged grass beds in the Choptank River/Chesapeake Bay are large enough to be resolved in TM data. In many cases, the number of pixels represented is on the order of 10. If it is possible to differentiate between submerged vegetation and other submerged features as well as water features, TM data would become quite valuable for inventorying submerged plants. At the present time, this is done by aircraft and aerial photography and in many cases is prohibitively expensive.