Remote Sensing Analysis for Salinity Management of Seasonal Wetlands

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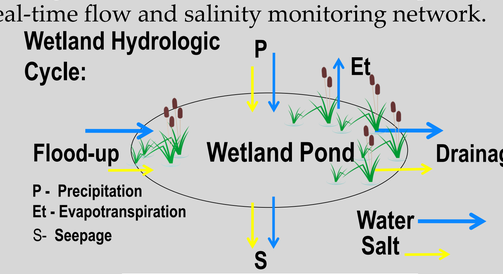
Abstract

Satellite imagery is being used to estimate seepage and evapo-transpiration (Et) in this model by estimating the expanding wetland footprint during flood-up (Sept through Nov) and the contracting wetland footprint during drawdown , or drainage, (Feb through Apr). Landsat multispectral images were examined to develop estimates of this wetland footprint over the flooded wetland season. These data are utilized in a decision support tool developed using the Water Evaluation and Planning (WEAP) model simulator. This decision support tool provides the information needed for wetland water managers to improve management and to meet State water quality objectives for salinity.

Background

A 170,000 acre wetland complex, including wetlands managed by the Grassland Water District (GWD), are located in California's Central Valley in Merced County. The GWD is divided into North and South areas which are further divided into subareas. Historically, these wetlands were created by annual floods along the San Joaquin River that inundated the floodplain and created habitat for native wildlife, and over-wintering waterfowl. Today, these wetland areas are managed artificially with water supply provided from the Delta. Data from a real-time sensor network located along channels and at the inlets and outlets to and from individual ponds is being used to measure and inform decision makers responsible for wetland salinity management. A decision support tool based on the WEAP model is being developed to aid wetland salinity decision making. This model will use data developed by the real-time flow and salinity monitoring network.

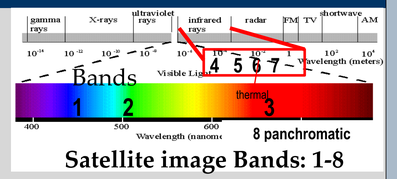


Objectives

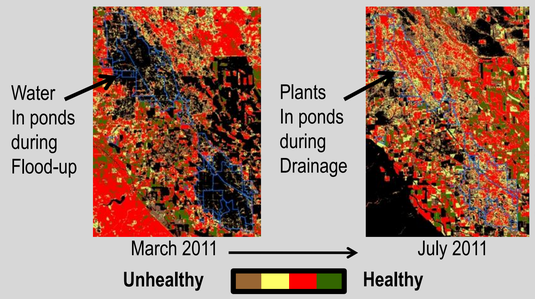
- Estimate the changing wetland footprint within the GWD wetland subareas during flood-up and drainage
- Employ remote sensing analysis and Normalized Difference Vegetation Index (NDVI) to estimate water in the subareas
- Develop additional methods to estimate wetland emergent vegetation
- Use estimates to determine wetland pond area as a percent of total area every two weeks

Methods

- Obtained Landsat 4 TM and Landsat 7ETM+ satellite images
- ArcGIS 10.0 used to import and analyze spectral images by comparison with those on NASA and other imaging websites
- Composite bands sets were created in ArcGIS 10

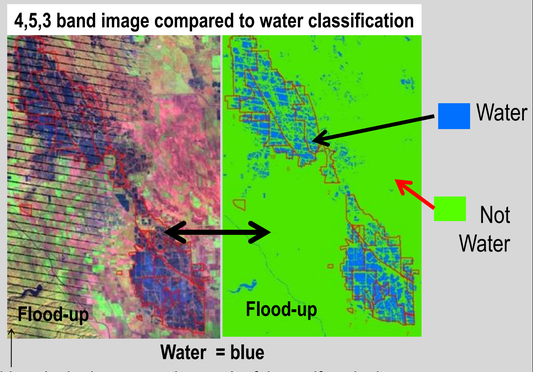


Satellite image Bands: 1-8

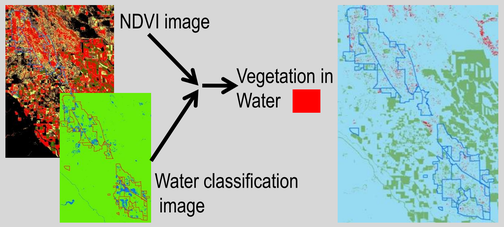


Vegetation Image Analysis:
- Normalized Difference Vegetation Index (NDVI) is a traditional method to indicate vegetation using bands 3 and 4
- Vegetation appears brown, yellow, red, then green indicating increasing plant health.
- Black indicates water, rock, and barren ground.

Water Image Analysis:
- Multiple bands combinations provide verification of accuracy
- Thermal and panchromatic bands provide secondary verification
- ArcGIS 10.0 uses band combinations to classify images as water and not-water
- Band image and classification compared for accuracy
- Percent of area occupied by water (water classification) and NDVI data are graphed

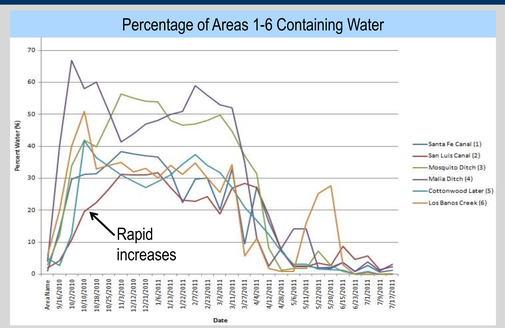


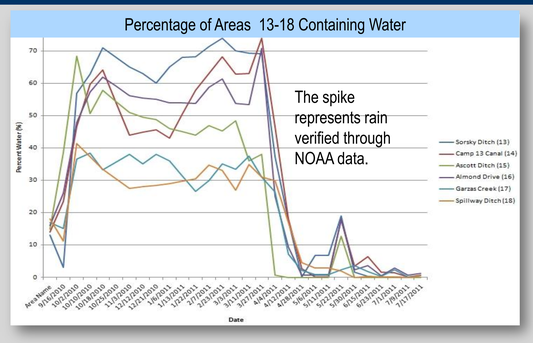
Lines in the image are the result of the malfunctioning scan line corrector (SLC) in Landsat 7 Satellite.

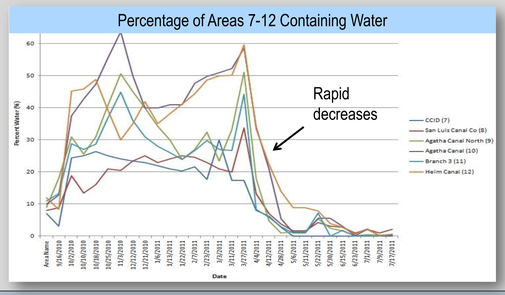


- Overlay NDVI data and water classification data to define vegetation in water
- Visually inspect images and adjust data to increase accuracy of results; small percentages of vegetation levels will not be classified by ArcGIS 10.0

Results



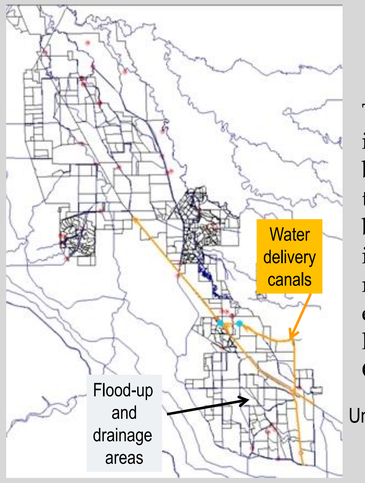




Graphs of percent water over time show that flood-up increases were rapid as expected for the GWD subareas. The level fluctuations during flood-up may be the result of seepage, precipitation or input of additional controlled water. During drainage, water levels decrease rapidly as expected.

Discussion

- Water Evaluation and Planning Software (WEAP) is used to forecast wetland drainage flow salt loads from each GWD subarea
- The percent water data provides an estimate of the wetland footprint to improve estimates of seepage and Et.



Unfinished WEAP model

The data from image analysis will be used to populate the WEAP model by providing information to make better estimates of salt loads in GWD.

- The WEAP model will incorporate real-time remote sensor data with calculated seepage and evaporation data from this method.

Conclusion

- Remote sensing can be used to determine the percent water in wetlands providing more accurate estimates of seepage and evaporation data for salinity management of the wetlands.
- Satellite image composite bands can be used to define the presence of water and vegetation, but visual examination and adjustments are required for verification.
- Overlaying the water and vegetation data provides estimates of emergent vegetation
- To prevent inaccurate data due to thick vegetation in water, satellite SLC interference, and clouds, careful analysis is required
- Aerial measurement shows method accuracy levels can be 90%. However, more data needs to be collected to give a statistical analysis of method accuracy.

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