# Factsheet # 7
## Monitoring Spatiotemporal Heterogeneity of Arid Wetlands

**UW**

**R** emote
**S** ensing &
**G** eospatial
**A** nalysis
**L** aboratory

*Understanding multiscale dynamics of landscape change through the application of remote sensing & GIS*

**Introduction:** Wetlands are valuable ecosystems that benefit society. They allow for gradual recharge of groundwater, provide critical habitat for plants, fish and wildlife, control erosion, mitigate water pollution, provide food and recreational bases for people and contribute to healthy water cycles and lake levels. Current wetland change analysis has focused on using multi-spectral, multi-temporal imagery such as NASA Landsat satellites to track wetlands change. However, Landsat satellites do not have a high spatial resolution and therefore cannot detect change in wetlands smaller than 1.2 ha. Multiple dates of aerial photographs have been used to detect wetland change on a finer scale, however relying solely on aerial photography may only allow for comparison of wetland change between a few suitable dates. The technique described below combines the use of satellite imagery, aerial photographs, and climate data to improve remote sensing techniques for monitoring the spatiotemporal heterogeneity of arid wetlands.
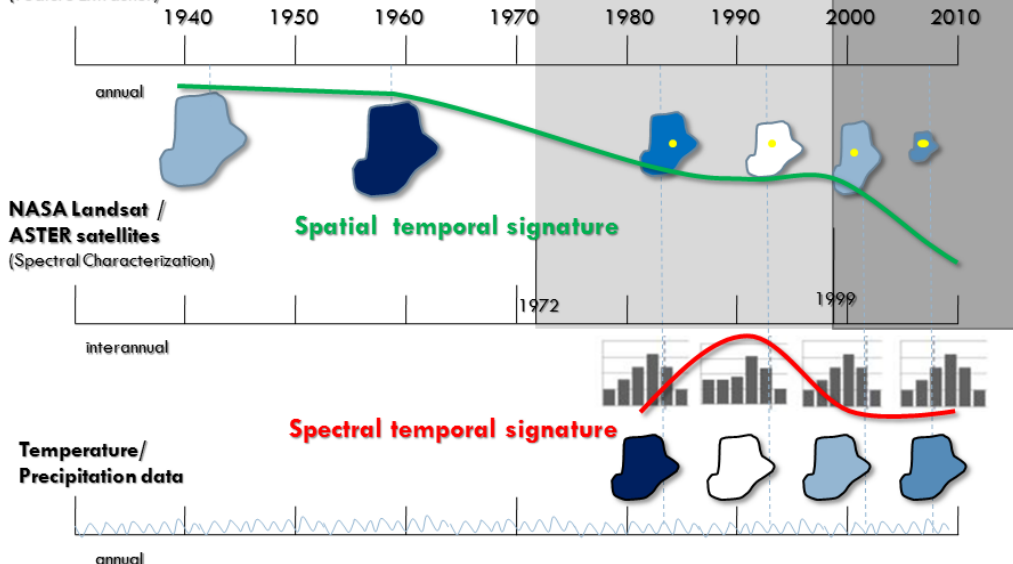


**Figure 1.** Project concept.

**Change detection using principal component analysis**. Principal component analysis is a technique used to detect change over time. This technique tracks the change of reflectance (DN values) of the centerpoint of each wetland over time. The DN values are derived from Landsat satellite imagery, which have a high temporal resolution and are available at no cost. Principal component analysis determines the amount of relative change occurring at each wetland over time. A high amount of change suggests land conversion or a wetland that is in the process of drying up.

**Applications.** The results from this technique help us understand wetland dynamics and the potential factors that may influence wetland change such as land use decisions or climatic changes. This technique can also be used to help identify wetlands less vulnerable to climate change for long-term preservation. Similar techniques to those developed in this study can be extended to other arid regions of the world.
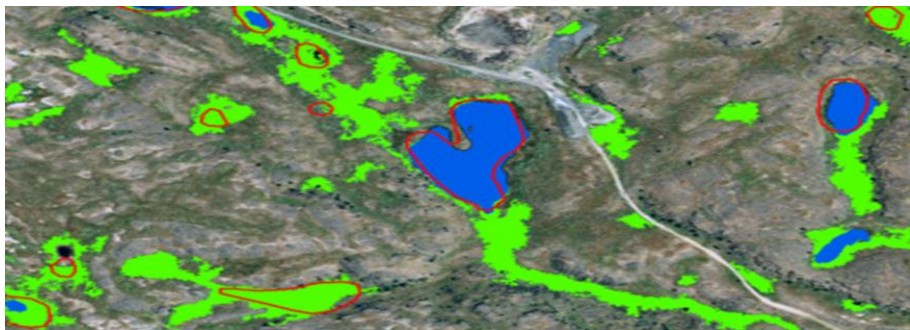


**Figure 3.** Results (in blue & green) compared to US Fish and Wildlife Service wetland National Wetland Inventory dataset (in red).

**Wetland delineation using hierarchical object-based feature extraction.** Hierarchical object-based feature extraction attempts to mimic the human eye by grouping similar pixels into objects. After initial segmentation objects are then classified using an operator-built algorithm. Development of the algorithm is an iterative process and the operator must be trained in feature recognition to build an effective algorithm.

Remote sensing of wetlands has traditionally used pixel-based classification. While pixel-based classification relies on spectral signatures to classify each pixel, hierarchical object-based feature extraction allows for use of additional variables such as texture, shape, and thematic layers to segment and classify features. This process can improve accuracy results especially with images that do not have high spectral resolution, but may have high spatial resolution, such as aerial photographs.

This technique uses low-cost aerial photographs with high spatial resolution, but low spectral resolution (only RGB), to delineate wetlands and classify them as either open water or emergent wetlands.

### Hierarchical object-based feature extraction



a) Photo of wetland

b) Aerial image of wetland

c) Image after segmentation
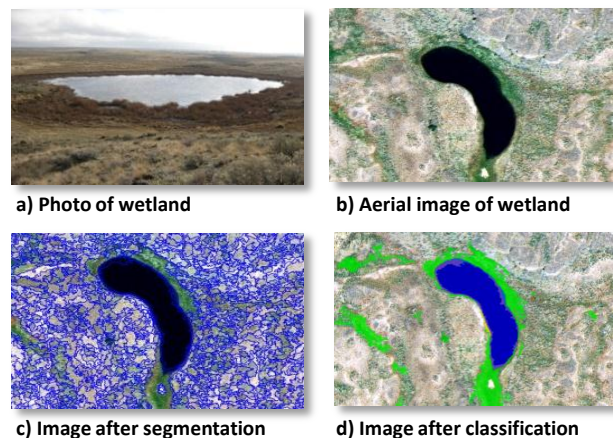
d) Image after classification

**Figure 2.** a) an example of one of the wetlands, b) aerial imagery used for delineating the wetland using OBIA, c) OBIA segmentation, d) final classification result.



Wetland Delineation → Change Analysis → Applications: Policy Evaluation / Reserve Selection

**THE ISSUE:** It is difficult to monitor the spatiotemporal heterogeneity of small wetlands. This technique combines high spatial resolution (hyperspatial) aerial photography with high temporal (hypertemporal) resolution and multi- spectral imagery to analyze change of wetlands on a finer scale than currently available.

*THE KEY QUESTIONS:*
*Can we improve remote sensing techniques to monitor the spatio-temporal heterogeneity of small arid wetlands at a low cost?*

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