# Intrusion in the Delta: Soil salinity in Egypt’s disappearing farmland

Beck Osterland
Centre of Geographic Sciences

## Background

The Nile River Delta fans out across the otherwise barren landscape of northern Egypt, an oasis visible from space. It is here that the waters of the longest river in the world spill out into the Mediterranean Sea, creating a massive floodplain which for thousands of years, it has provided human populations with water, fertile soils and food. Most of Egypt’s 100+ million people live within the Delta, and almost all the country’s (and region’s) agriculture is centralized here.

The Delta, and the farms that rely on its resources, have faced several environmental pressures in recent decades. Increased urbanization has contributed greatly to lost farmland as the population has soared. But the combined impact of dams upriver, which impede the sediment that makes the delta so fertile, coupled with sea-level rise due to climate change has caused serious soil degradation. The result of these processes has led to increased soil salinity in area of the delta closest to the Mediterranean Sea.

This project attempts to visualize the spatial distribution of this stress within the Nile River Delta through the production of Landsat 8 OLI band ratios and a spectrally-derived index. By employing these methods, this project hopes to better visualize the concerning intrusion of the sea into this cradle of humanity and agriculture.

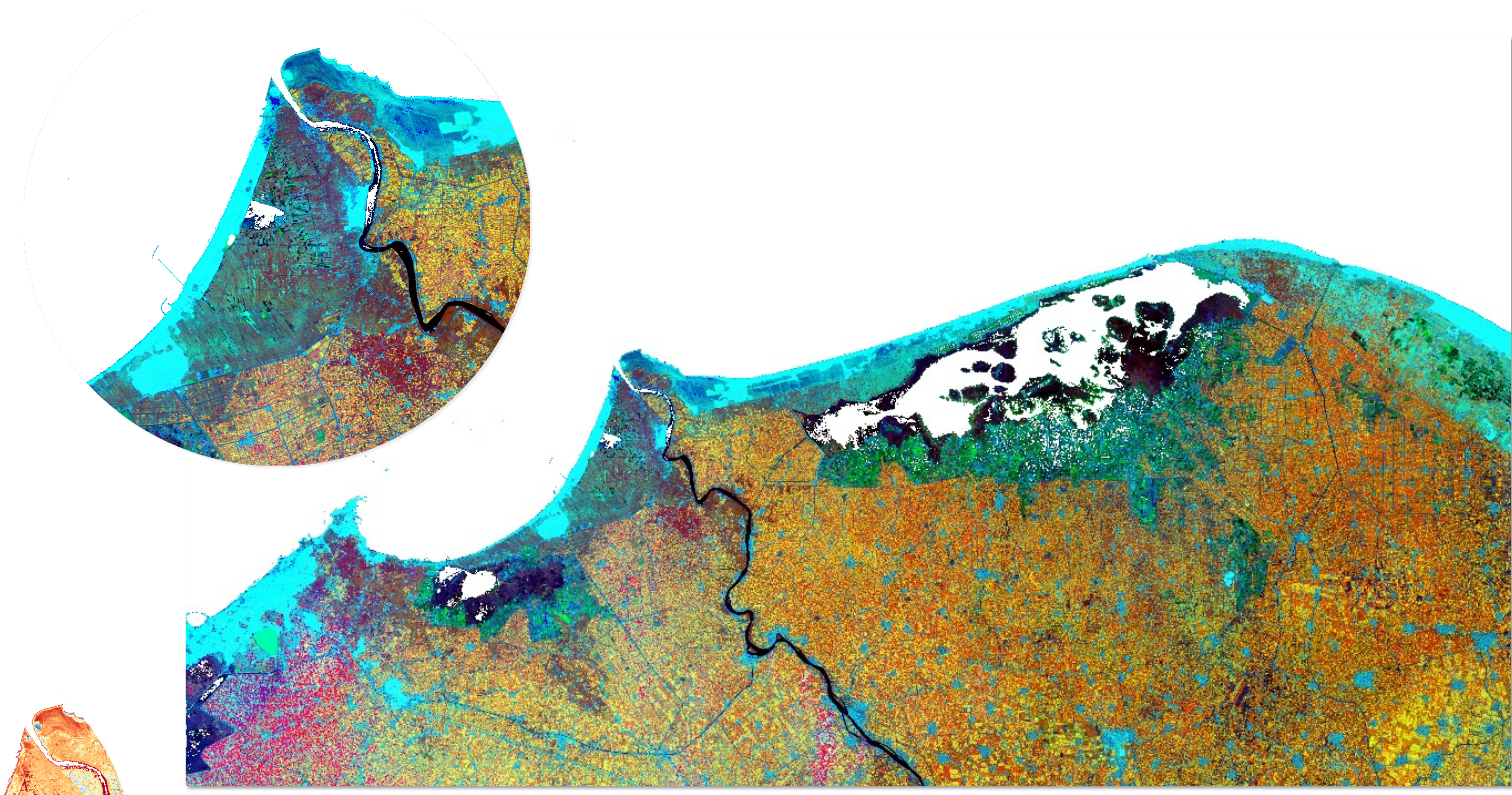
## Study Area

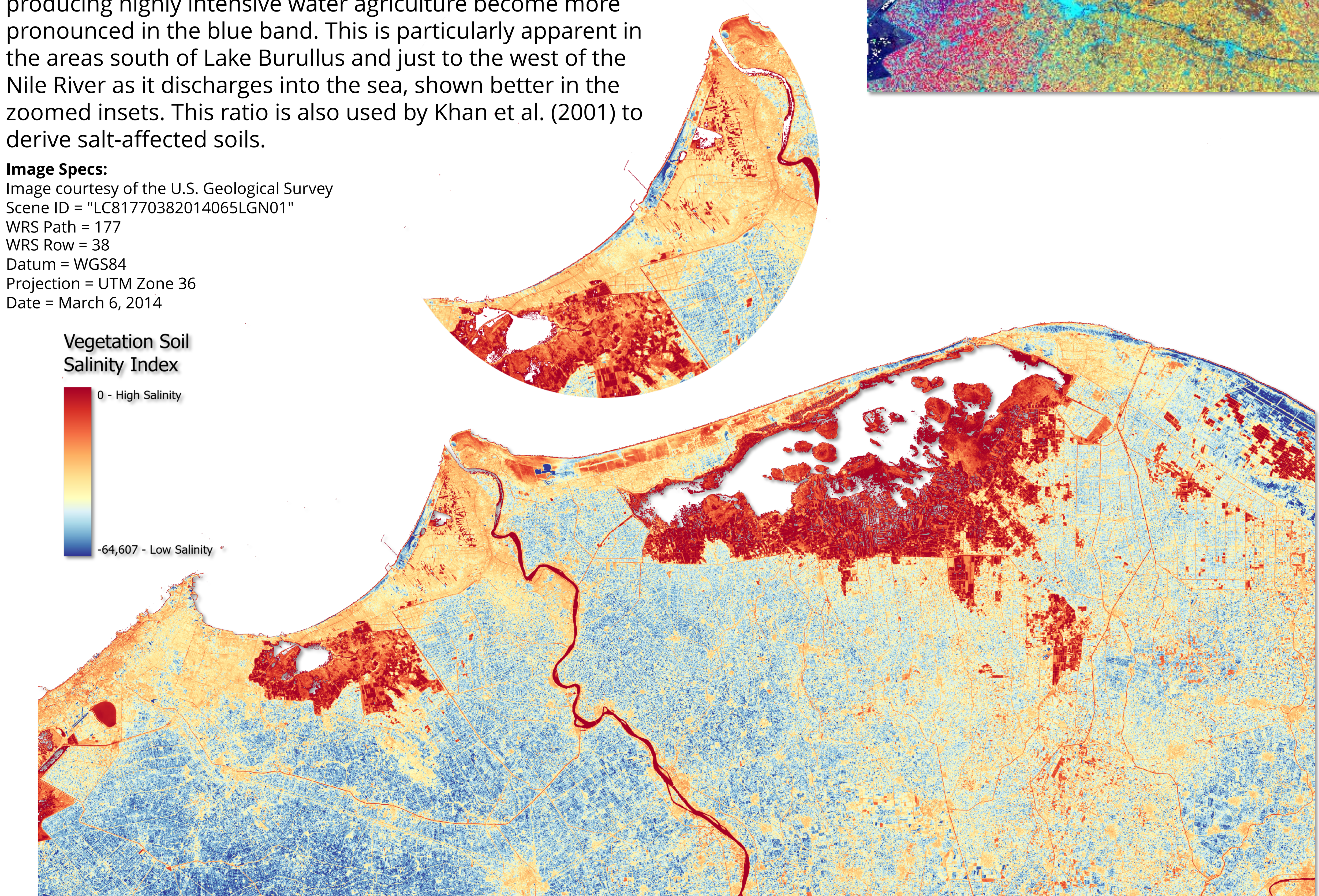
The project looks at a single Landsat 8 scene taken over the northwestern portion of the Delta, near the coastal city of Alexandria on March 6, 2014.


## Band Ratio

The RBG colour composite at right is comprised of three simple band ratios: **R = B3/B4; G = B5/B4; B = B2/B4**. Band ratios were created using the ARI tool in Catalyst Focus while also applying a mask so only terrestrial areas were included. Dividing the Landsat 8 Green band (higher reflectance of healthy vegetation, and urban features) by the Red band (higher reflectance of stressed vegetation), the resulting ratio provides an image where there is greater distinction between healthy and possibly salt-stressed vegetation.
The same can be said for the NIR band over the Red band, where high values of healthy vegetation in the NIR band are kept relatively bright while the bright values of stressed vegetation in the Red band diminish the values upon division and improve spectral contrast. The combination of these two ratios in the red and green colour guns gives an indicator of healthy vegetation, ranging from highly healthy presented in bright yellows to decreasingly healthy plants in oranges and darker reds. The Blue/Red ratio provides a good indicator of water-logged soil, as well as urban features. The higher reflectance of farms in close proximity to inundated areas or producing highly intensive water agriculture become more pronounced in the blue band. This is particularly apparent in the areas south of Lake Burullus and just to the west of the Nile River as it discharges into the sea, shown better in the zoomed insets. This ratio is also used by Khan et al. (2001) to derive salt-affected soils.

**Image Specs:**
Image courtesy of the U.S. Geological Survey
Scene ID = "LC81770382014065LGN01"
WRS Path = 177
WRS Row = 38
Datum = WGS84
Projection = UTM Zone 36
Date = March 6, 2014






## Index

While few spectral indices cannot directly pick up salinized soils, several indices are able to derive validated estimations of soil salinity based on vegetative growth. The Vegetation Soil Salinity Index (VSSI) has been proven by multiple studies (Dehni & Lounis, 2012; Nguyen et al., 2020) conducted in similar geographies to accurately derive an indicator for soil salinity that can be closely compared with in-situ measurements ($R^2$ = 0.77).
VSSI is created using the formula: **2 x Green – 5 x (Red + NIR)**. The index utilizes similar bands as the ratio composite, and essentially looks at the difference between green and Red+NIR band responses and delivers a range of -64,607 to 0, where numbers closer to 0 represent pixels showing higher possible soil salinity.

## References & Disclaimer

Dehni A, Lounis M (2012). Remote sensing techniques for salt affected soil mapping: application to the Oran region of Algeria, Procedia Eng., 2012; vol. 33: 188–198.

Khan NM, Rastoskuev VV, Shalina EV, Sato Y (2001) Mapping salt-affected soils using remote sensing indicators - a simple approach with the use of GIS IDRISI. Ratio. 5–9

Nguyen, K. A., Liou, Y. A., Tran, H. P., Hoang, P. P., & Nguyen, T. H. (2020). Soil salinity assessment by using near-infrared channel and Vegetation Soil Salinity Index derived from Landsat 8 OLI data: a case study in the Tra Vinh Province, Mekong Delta, Vietnam. Progress in Earth and Planetary Science, 7(1), 1-16.

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