Spatio-temporal assessment of Tuz Gölü, Turkey as a potential vicarious calibration site

What are the scientific (or decision/policy) goals?

- To perform an independent assessment of Tuz Gölü, a site in Turkey proposed for the vicarious calibration of satellite sensors, in terms of its spatial homogeneity as expressed in the visible and near infra-red wavelengths over a 25-year period (1984-2009).

Site description

- Tuz Gölü is an ephemeral lake in the central Anatolian region of Turkey, approximately 150 km south-east of the city of Ankara (lat. 38.50°, long. 33.20°) at an altitude of 905 m above mean sea level

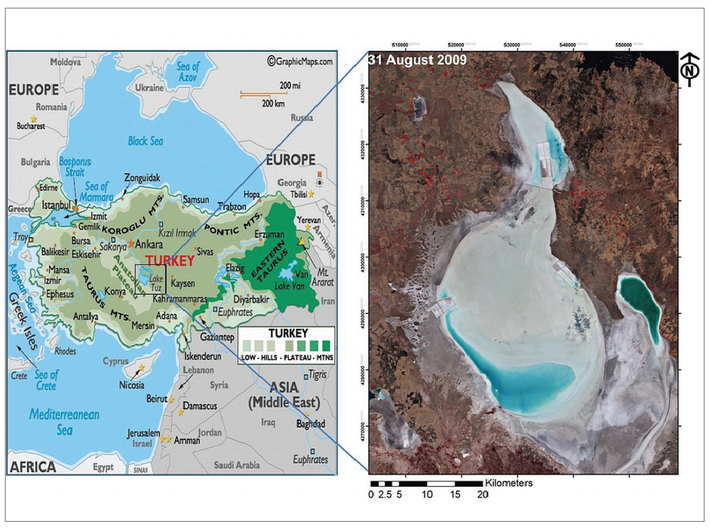

Figure 1: Tuz Gölü study site

What are the sources of data? (satellite, airborne, in situ, other)

- A time series of cloud-free Landsat TM images for July and August were obtained from the NASA Land Processes Distributed Active Archive Centre (LPDAAC). These were atmospherically corrected using the ATCOR-2 software and a standard atmosphere (mid-latitude summer).

What other information and models are being used?

- Spatial statistics :
  - Getis statistic (Gi*)
  - Coefficient of Variation (CV)

$$G_i^*(d) = \frac{\sum w_{ij}(d)x_j - W_i^*\bar{x}}{s\left[W_i^*(n - W_i^*)/(n-1)\right]^{1/2}} \quad (1)$$

$$CV = \frac{S}{x} \quad (2)$$

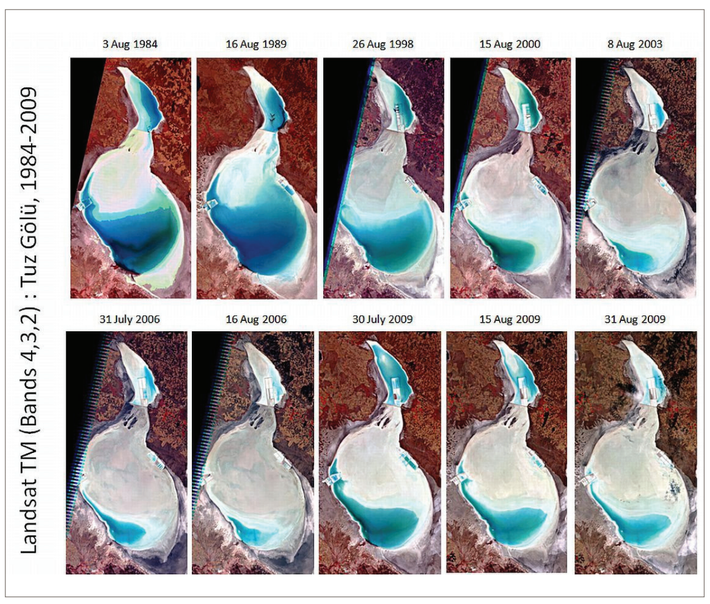

Figure 2: Landsat TM used in the study

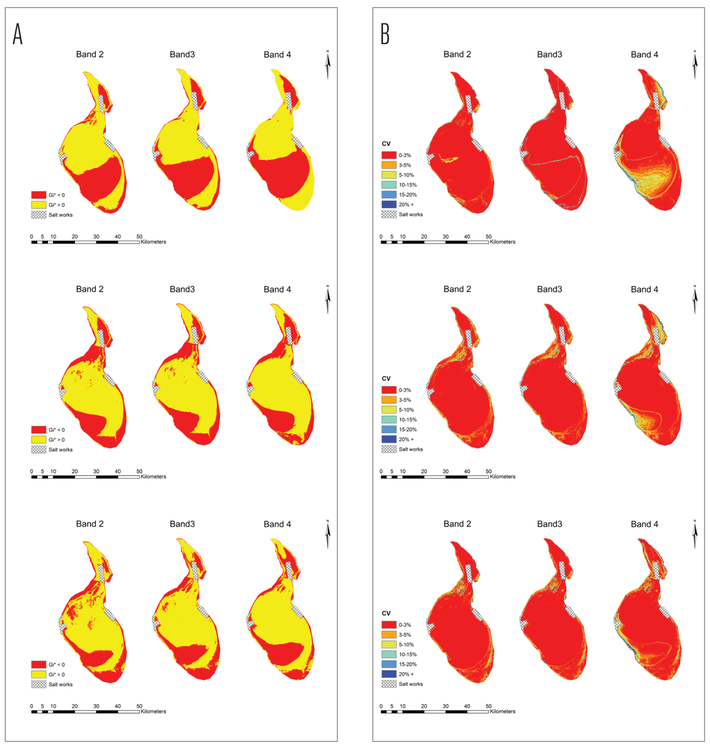

Figure 3: (a) Getis statistic map (b) Getis statistic in TM bands 2, 3 and 4 for the months of August 1984 (top), August 2000 (middle) and August 2009 (bottom).

What are the definitions and quality requirements for the key measurements and data outputs?

For a surface to qualify as a test site suitable for calibration and atmospheric correction, it has to satisfy the following criteria (Thome, 2001, Teillet et al., 2007, Kneubuhler et al., 2006).

1 The site should have high spatial uniformity over a large area to minimize mis-registration and adjacency effects due to light scattered from outside the target region.
2 The site should have a reflectance factor greater than 0.3 across all wavelengths averaged over all angles in order to provide higher signal-to-noise ratio (SNR) and reduce uncertainties due to the atmospheric effects.
3 The surface of the site should have flat spectral reflectance to reduce uncertainties due to different spectral response profiles when multiple sensors are involved in cross-calibration.
4 The surface properties of the site (reflectance, BRDF, spectral) should be temporally invariant to reduce BRDF and spectral surface reflectance effects.
5 The site should be situated in arid regions with low probability of cloudy weather and precipitation.

For this study (1), (2) and (4) lead to the following criteria:
1 Criterion 1: Gi* > 0;
2 Criterion 2: CV < 3%;
3 Criterion 3: HDRF > 30%;
4 Criterion 4: Persistence of 1 – 3 over time.

Date (YYYY-MM-DD)	Time (GMT)	Cloud Cover (%)	Solar Zenith Angle (degrees)
1984-08-03	7:50:51	0	33.39
1989-08-16	8:01:06	0	35.28
1998-08-26	8:00:04	0	36.77
2000-08-15	7:59:06	0	34.51
2003-08-08	7:58:19	0	33.03
2006-07-31	8:14:43	0	29.04
2006-08-16	8:14:54	0	32.31
2009-07-30	8:16:43	0	29.55
2009-08-15	8:16:57	0	32.73
2009-08-31	8:17:12	4	36.38

Table 1: Landsat TM data used in the study obtained from LPDAAC

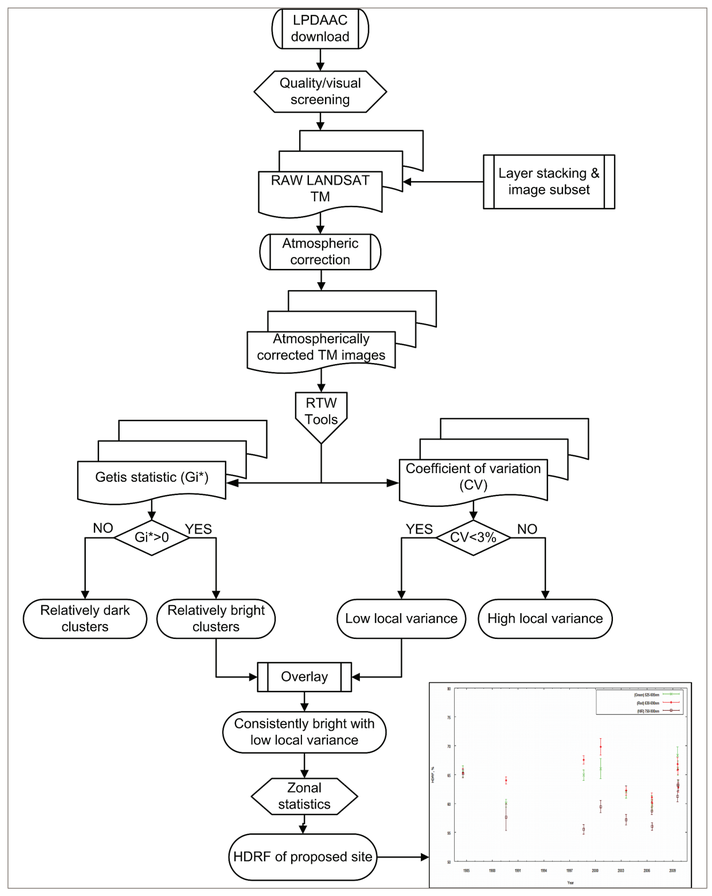

Figure 4: Two stage methodological approach

What is the impact of not achieving the quality requirements/goals for the parameters? (as above)

Any significant variation in points 1, 2, 3 and 4 will result to disqualification of the surface as a candidate test site for VC.

Are quality indicators assigned at every step of the chain or only the end product?

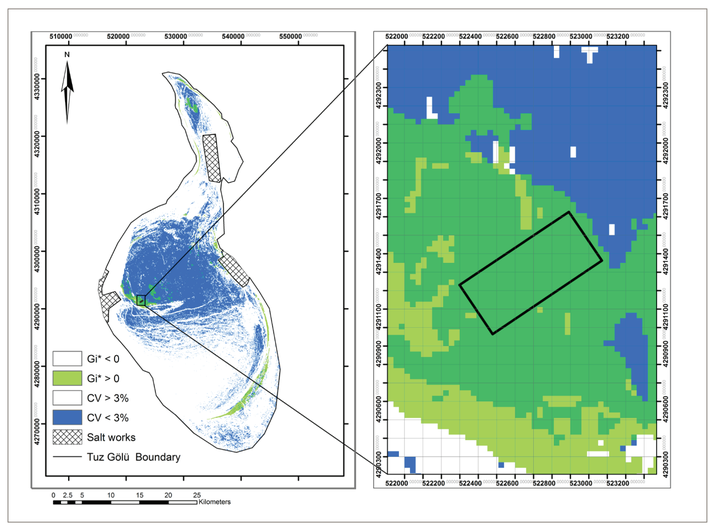

Figure 5: Spatio-temporal stability map for Tuz Gölü showing the proposed calibration site.

What are your recommendations for the way forward when thinking about quality of data within your study?

Natural targets such as salt pans have many advantages as vicarious calibration (VC) sites. However, they are functioning geomorphological systems, and as such, the location and extent of sub-areas which are suitable for use as calibration sites are likely to vary over time. Effective use of such sites requires understanding of the processes causing spatial and spectral variability and of their likely impact over the temporal and spatial scales involved.

If you have read about or used QA4EO, provide feedback on the role this played in your research.

QA4EO inspired this research as part of a broader effort to provide the scientific community with independent evaluation of the sites, methods and practices of vicarious calibration in EO.

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