**Derivation of LST from satellite images**

**Steps:**

***Digital Number (DN) to Spectral Radiance (L****λ****) Conversion***

As an object's temperature rises above absolute zero, it emits thermal electromagnetic energy (K). The signals obtained by the thermal sensors (ETM+) can be transformed to at-sensor radiance using this concept. Equation 5 is used to measure the spectral radiance (Lλ) (Landsat Project Science Office, 2002).

 (Eq. 5)

Where “gain” is the radiance / DN conversion function's slope; DN is the digital number of a given pixel; and bias is the radiance / DN conversion function's intercept. This can also be written as:

 (Eq. 6)

where, QCALMIN = 0 and QCALMAX = 255, with QCAL = Digital Number (DN of each pixel).

The spectral radiances for band 6 at digital numbers 0 and 255, respectively, are LMINλ and LMAXλ. 3.2 W.m-2.sr and 12.65 W.m-2.sr are the results.

Equation 6 is simplified by substituting the corresponding values in Equation 7.

 (Eq. 7)

***Spectral Radiance (Lλ) to At-satellite Brightness Temperatures Conversion (TB)***

The radiant temperatures have been corrected for emissivity (ε) based on the characteristics of the ground cover. In general, vegetated areas received a score of 0.95, while non-vegetated areas received a score of 0.92. (Weng 2001; Molla 2020).  Following Artis and Carnahan (1982), the emissivity corrected surface temperature was calculated.

 (Eq. 8)

Where TB = At-satellite brightness temperature (K), Lλ = Spectral Radiance in W.m-2.sr-1. μm -1 K1 and K2 = Pre-launch calibration constants K2 and K1. (These correspond to 1282.71 K and 666.09 W.m-2.sr-1. μm for the Landsat 7 ETM+ 6.2 band, respectively.).

***Land Surface Temperature (LST)***

The temperature values obtained above are compared to a black body. As a result, spectral emissivity (ε) corrections are needed. These can be calculated based on the type of land cover (Tariq et al. 2020) or by deriving emissivity values for each pixel from the NDVI values. Artis & Carnahan (1982) emissivity corrected land surface temperatures (St) were calculated.

 (Eq. 9)

where LST = Land Surface Temperature (LST) in Kelvin, λ= wavelength of emitted radiance in metres (for which the peak response and the average of the limiting wavelengths (λ= 11.5 μm) (Markham & Barker, 1985) are used),  ρ= h\*c/ σ (1.438 \* 10-2 m K), σ= Boltzmann constant (1.38 \* 10 -23 J/K), h = Planck's constant (6.626 \* 10 -34 J s), c = light velocity (2.998×108 m/s), and emissivity =ε (ranges between 0.97 to 0.99). Equation (10) is used to calculate the emissivity of a land surface.

 (Eq. 10)

Where Pv is the vegetation proportion, which can be determined using the Equation (11).

 (Eq. 11)

For ease of conversion, the above-derived LST unit is converted to degree Celsius using the Kelvin-degree Celsius relation (0oC = 273.15K). The use of degree Celsius data to interpret temperature intensity is fairly common.