SPECTRALLY COMPARISON BEETWEEN TM 5 & ETM +7 BANDS

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Abstract

Landsat-7 Enhanced Thematic Mapper Plus (ETM+) sensor offers several enhancements over the Landsat-5 Thematic Mapper (TM) sensors, including increased spectral information content, improved geodetic accuracy, reduced noise, reliable calibration, and matching scenes were recorded by both, and improved spatial resolution of the thermal band. In this paper, we present some comparisons between Landsat-7 ETM+ and Landsat-5 TM imagery in order to quantify these improvements. Practically, we find that the ETM+ continues the record of TM observations, and, in many respects, substantially improves upon the earlier sensor. Specific improvements include lower spatial noise levels, improved information content, and geodetic accuracy of systematically corrected products to 50–100 m. These improvements are likely benefits for land-cover mapping and change detection applications.

Key words: Landsat ETM+ and TM Imagery, ArcGIS application, Statistics methods.

المقارنة بين الحزم الطيفية للتابعين ETM+7 و TM 5

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الخلاصة

التطور الحاصل في أجهزة التحسس للتابع الأرضي ETM+ 7 فرض وجوده عمليا بشكل أقوى وأفضل من التابع الأرضي TM 5 لاحتوائه لعدد اكبر بالحزم الطيفية وقابليته في عكس وتسجيل المعلومات، وهذا أدى إلى تحسين الدقة وقراءة المواقع الجغرافية والتقليل من التشويه، وكان جيدا في مطابقته للمواقع الممسوحة عند تسجيله البيانات (الرقمية). وهذه الميزة أدت الاعتماد عليه بالتقويم والمعيارية مع بقية المتحسسات للتوابع الأخرى. في هذا البحث، ولغرض التحسين واختيار الصور الفضائية الافضل، أوجدنا بعض المقارنات بين صور التابع ETM+ 7 والتابع TM 5. وجد عمليا، والذي أدى إلى أساس بقاء واستمرار التابع ETM+ 7 هو في تسجيل البيانات والمراقبة والذي أدى إلى تميزه وتحسين الصورة عن المتحسسات الأخرى للسلسلة التوابع TM 4, 5 حاليا. وهذا التحسن يحوي اقل مستوى تشويه موقعي لكثرة تسجيل المعلومات وانتظامه في دقة البيانات المأخوذة جغرافيا ومقدرته على التصحيح من ٥٠ إلى ١٠٠ متر.واحتمالية التحسن في الأداء أفادنا بالسيطرة وتخطيط لمناطق شاسعة وملاحظة الكثير من تطبيقات التحري أو الاستكشاف.

الكلمات المفتاحية:-المتحسس **ETM+** و **TM**برنامج نظم المعلومات الجغرافية الطرق الاحصائية

Introduction

The Landsat-7 mission, successfully placed into orbit on April 15, 1999, fig 1, continues the 29-year record of land remote sensing measurement that started in 1972 with the Earth Resources Technology Satellite (ERTS, later Landsat-1), [1]. From the beginning, Landsate sensors have provided calibrated multispectral measurements of land conditions, which have proven valuable in tracking the Earth's terrestrial forests, grasslands, agricultural activity, urban growth, and surface hydrology, [2]. Landsat's success is revealed not only in the diverse applications of the acquired information but also the many application of cover-land remote sensing systems that are now actively monitoring the Earth. The recent launch of Terra, with the MODIS, ASTER, and MISR sensors, combined with Landsat-7 Enhanced Thematic Mapper Plus observations, comprise a major US commitment to study potential changes in the Earth system at the beginning of the 21st century [3]. The Landsat-7 mission represents a significant change in operations in comparison to Landsat-4 and 5. Following design studies in the mid-1970s, Landsat-4 Introduced a new sensor system, the Thematic Mapper (TM), to replace the original four-spectral band Multispectral Scanner (MSS) flown on Landsat-1, -2, and -3. The TM instrument significantly refined the original MSS sensor, with more spectral bands (seven vs. four), finer spatial resolution (30 m), and improved radiometric precision (8 bits vs. 6 bits) [4,6]. the competitiveness of the observations in comparison to other satellite. The new sensor design was called the Enhanced Thematic Mapper (ETM). The ETM instrument incorporated a new, 15-m panchromatic band, as well as a 9-bit analog to digital converter. The panchromatic band was added to provide higher spatial resolution observations, as a compliment to the 30-m multispectral measurements. The spectral bandpass of the panchromatic band covered the visible and near-infrared portions of the spectrum (0.5–0.9 mm), [5]. the Landsat-7 ETM+ mission could easily exceed the Landsat-4 and -5 missions, simply because so much had been learned with respect to radiometric calibration, geometric accuracy, and image quality[3].

Methodology

The main objectives of the present work consist of three stage; first, define The work area from source image for one scene (Mosul city of north east Iraq) and geometry matching will be doing with correct coordinate system (WGS_1984_UTM_Zone_38N), second, track, and detect the changes spectral band and define many effects on it. Third, Spatial Analyst, many processes are represents cell or pixels from some or all scenes of images, such us, cell statistics, zonal statistics and Neighborhood statistics, and finally, reflectance the results and illustration in graphs and tables, in order to find spectrally bands Comparison between ETM+ 7& TM 5.

Study area

The study area is located North East of IRAQ involved centrist MOSUL city, it is clear in fig 2, the Tigris river is middles the scene, which is chief part and a rise feature in study. The new generation of images covering the study area is illustrated in Fig 3. Additionally, it is cover content some of terra, elevation, vegetation, soil, urban, and water in study area, assistant good resulted spectral reflectance of bands. Use pairs satellite image had been used in different times, Landsat-5 Thematic Mapper (TM) 1986, and Landsat-7 Enhanced Thematic Mapper Plus (ETM+) 2003, three band (RGB) used. Study area is lies in (4033173.6E- 4006910.85E) latitude and (324093.597N-347150.097N) longitude, projection coordinate system is WGS_1984_UTM_Zone_38N, measure unite is meters.

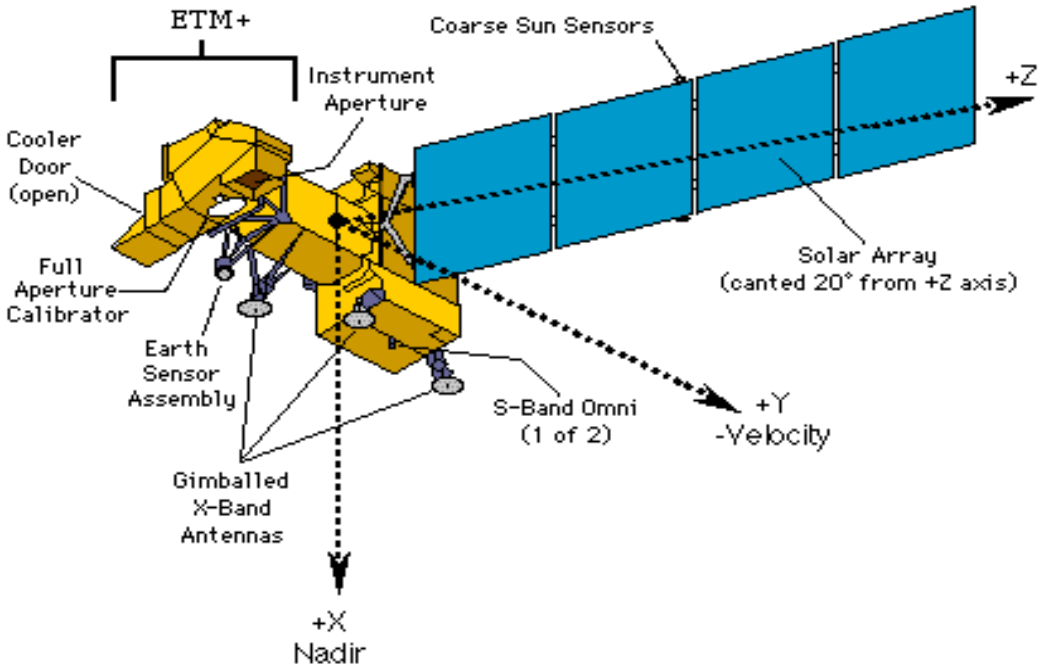
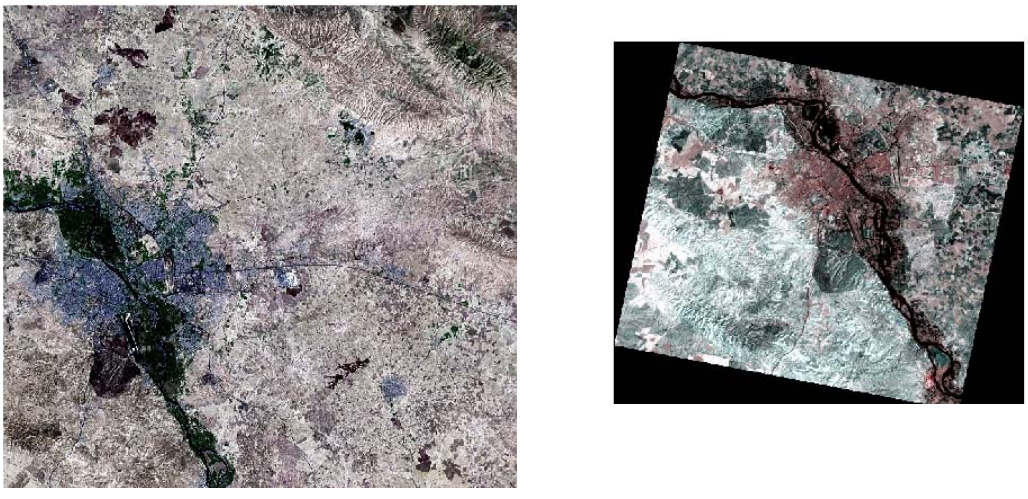


Fig 1: The Landsat ETM+ 7 satellite system.



a b

Fig 2: Source image, (a) Landsat 7 ETM+, (b) Landsat 5 TM.

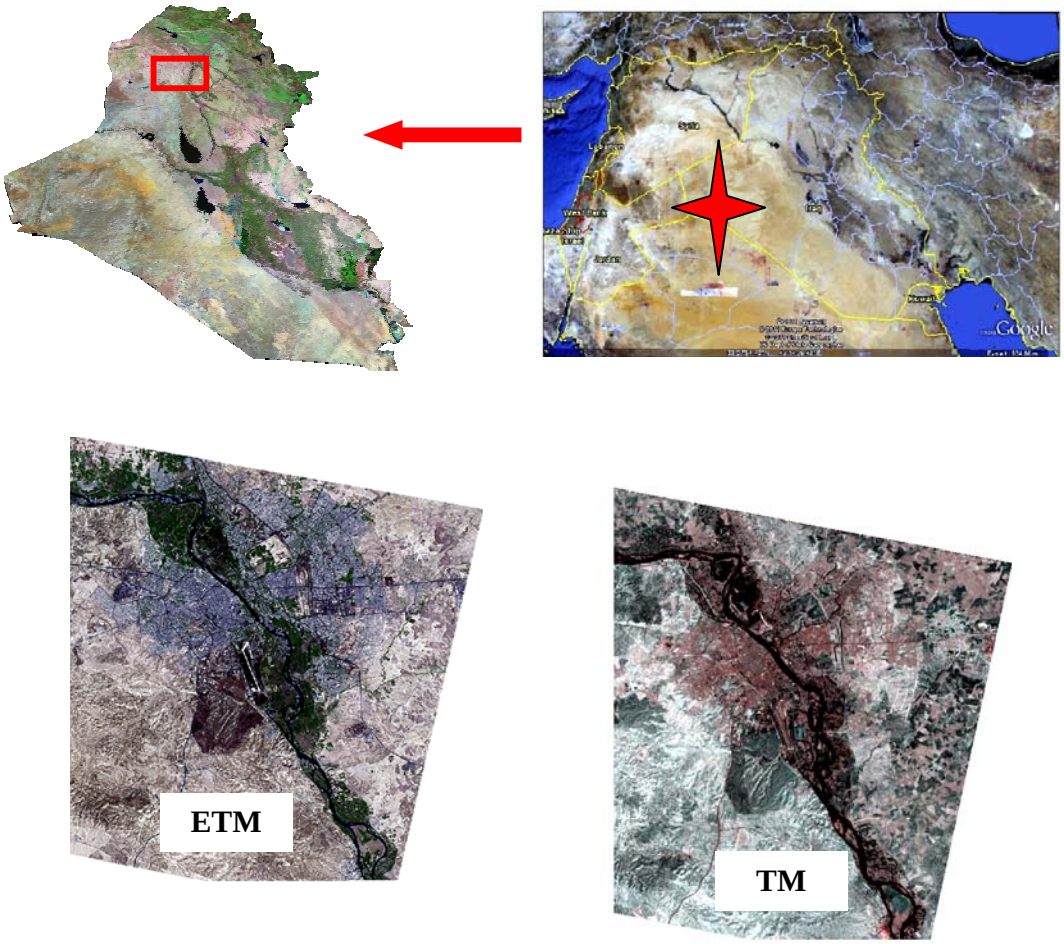


Fig 3: Represent the study area. Illustration satellite images of Mosul location are using enhancement thematic mapper ETM+ and thematic mapper TM (RGB).

The Spectral Band Difference Impact Factor

Many impact factor had been effected on spectral band of landsate ETM+ and TM, see [1,7,8]. The solar-reflective spectral bands of the Landsat-5 TM and Landsat-7 ETM+ sensors. Scenes that had undergone radiometric and geometric correction as opposed to the raw data used in the present work. Geometrically, the Landsat-7 and Landsat-5 sensors differ in their along-track and across-track pixel sampling. Due to wearing of the bumpers used by the Landsat-5 TM scanning mirror, along-track gaps between scans are longer than they are for Landsat-7 ETM+. For the same reason and because the ETM+ scan time is slightly longer than the specification, there are also across-track differences in the ground coverage. In addition, see (fig 3). Sight mismatches will arise in the imagery because of the altitude difference. In particular, there is variation in the ETM+ scanning pattern and its effect on the scan line corrector due to the lower-than nominal orbit during the tandem configuration time period. These considerations make it very difficult to establish sufficient geometric control to facilitate radiometric comparisons on a point-by-point and/or detector-by-detector basis. Therefore, analysis approaches have been developing to make use of image statistics based on large areas in common between the image pairs. In spectral band, the image-quantized level (in counts) haves been related to top-of-atmosphere (TOA), (solar zenith angle, and the Earth–Sun distance). Bidirectional reflectance factor (BRF) effected due to differences in illumination and observation angles see (table 1).
The effects these spectral band differences have on measured TOA reflectance depend on spectral

variations in the exo-atmospheric solar illumination, the atmospheric transmittance, and the surface reflectance. Because surface spectral reflectance and atmospheric aerosol optical depth data. These data were used as inputs to a radiative transfer code to compute the TOA reflectance in corresponding solar reflective ETM+ and TM band, show. The magnitude of the spectral band difference effect for a variety of surface cover types, (vegetation, sand, rock, water, snow, aerosol, forests …etc). Aerosol scattering varies slowly with wavelength and lower aerosol optical depths allow the stronger wavelength dependence of molecular (Ray Leigh) scattering to increase slightly the spectral band difference effect, table 2.

Table 1: Characteristics of ETM+ and TM sensors.

Satellite Sensor	Spectral Band No	Landsat 2003/1985	Wavelength (μm)	Pixel depth (Pit)	Resolution (M)
ETM+	Band 1	7	0.45 - 0.515	16	14.25
ETM+	Band 2	7	0.525 - 0.605	16	14.25
ETM+	Band 3	7	0.63 - 0.690	16	14.25
TM	Band 1	5	0.45 - 0.52	16	28.5
TM	Band 2	5	0.525 -0.605	16	28.5
TM	Band 3	5	0.63 – 0.69	16	28.5

Table 2: Mean (μ) and standard deviation (σ) of satellite ETM+ and TM sensor in moment token the scene.

Satellite Sensor	Spectral Band No	Description	Mean (μ)	Standard Deviation (σ)	Maxim	Minim
ETM+ 7	Band 1	Blue	125.0019	70.33904	255	0
ETM+ 7	Band 2	Green	119.9300	68.47717	255	0
ETM+ 7	Band 3	Red	124.1920	69.21726	255	0
TM 4-5	Band 1	Blue	133.5424	65.90135	255	0
TM 4-5	Band 2	Green	136.7269	65.79943	255	0
TM 4-5	Band 3	Red	136.8419	66.10087	255	0

Statistics process and analysis

Most of all process and analysis image satellite depended on pixel, which is smallest unit in image satellite, and the cell include summation of pixels, which allowed image processing and determined to find statistics on all cell, neighbor cell, zonal include cell, and histogram. In this study is assuming statistics of cell and finding difference standard deviations and means for satellite ETM+ 7 and satellite TM 5 imagery. This study represents, determination has work area and clipping data frame from source imagery, see fig 4.

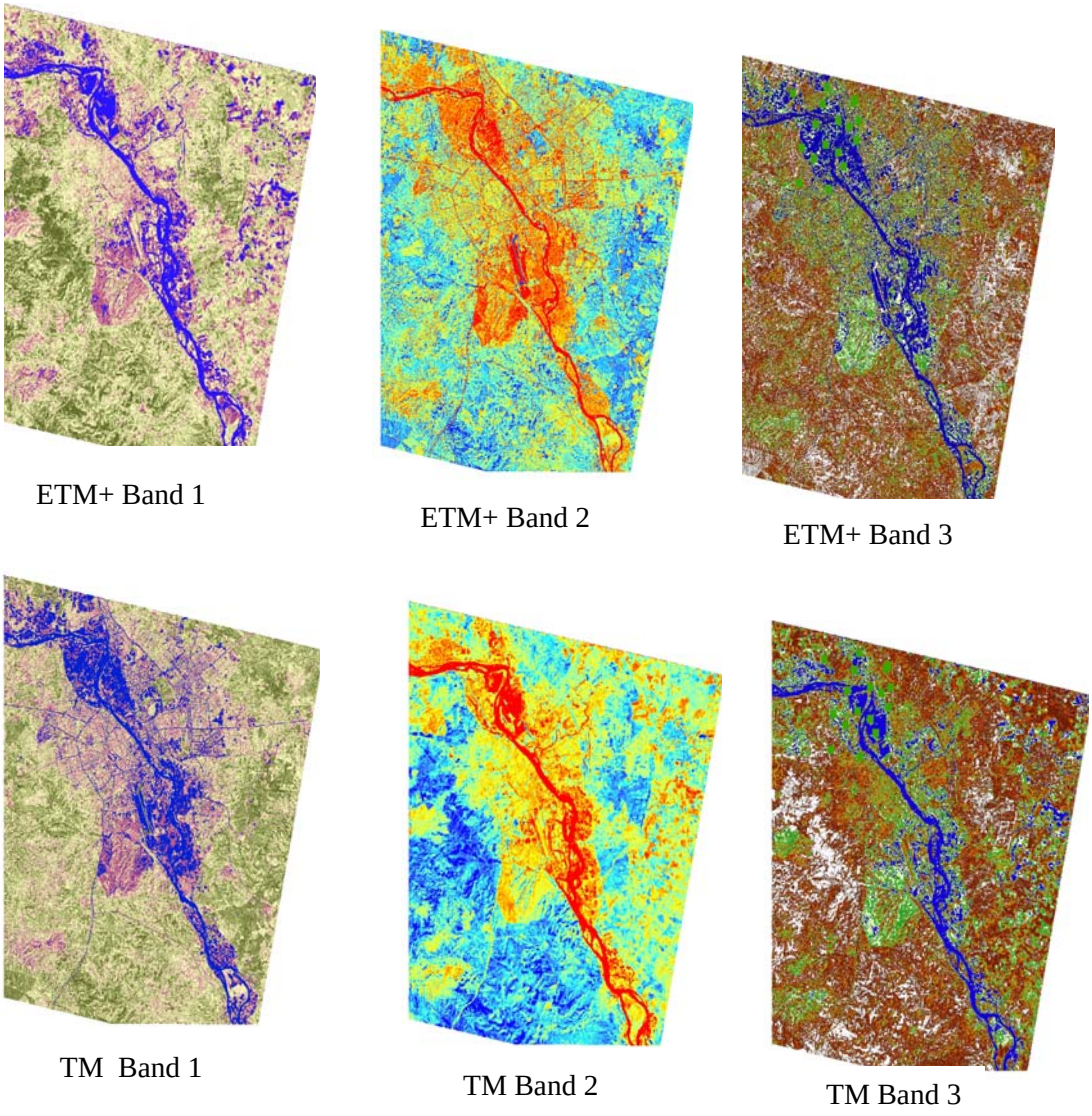


Fig 4: cell statistics of satellite images for ETM+ Band 1,2,3 and TM Band 1,2 and 3.

In addition, classify the bands to see rise feature and use the data characteristics in each band for comparison, shown in figs 5 and 6. Several data attributes are to find difference of bands, and compare between Landsat-7 ETM+ and Landsat-5 TM. Geodetic or georefrence accuracy refers to the absolute accuracy of projected pixel locations within the image, using the universal coordinates system provided by the ground processing system.

Radiometric information content specifies the amount of information (Data) used to represent the land surface in any given image or image subset.

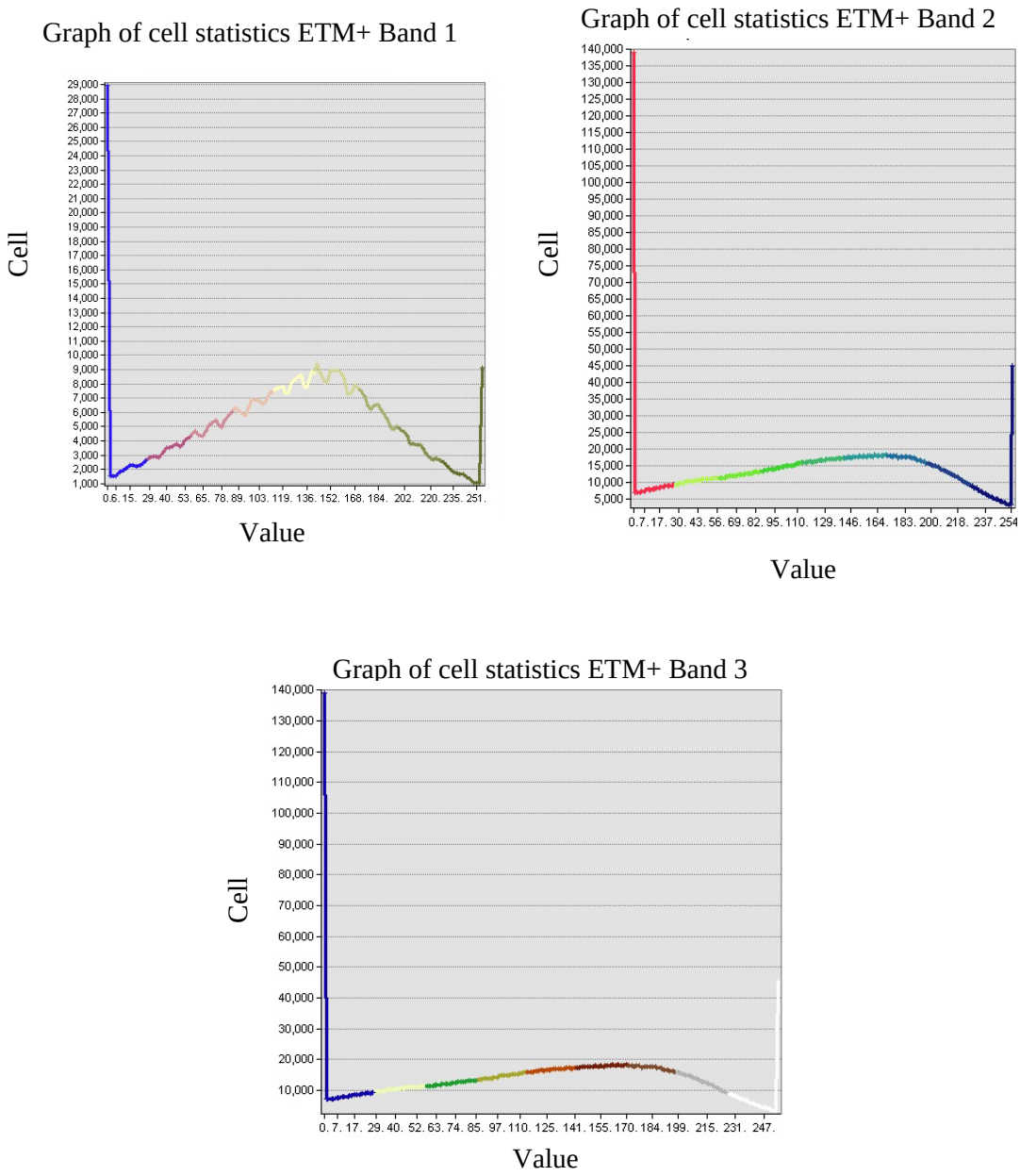


Fig 5: Graph illustration of cell statistics value per cell number for ETM+ Band 1,2 and ,3.

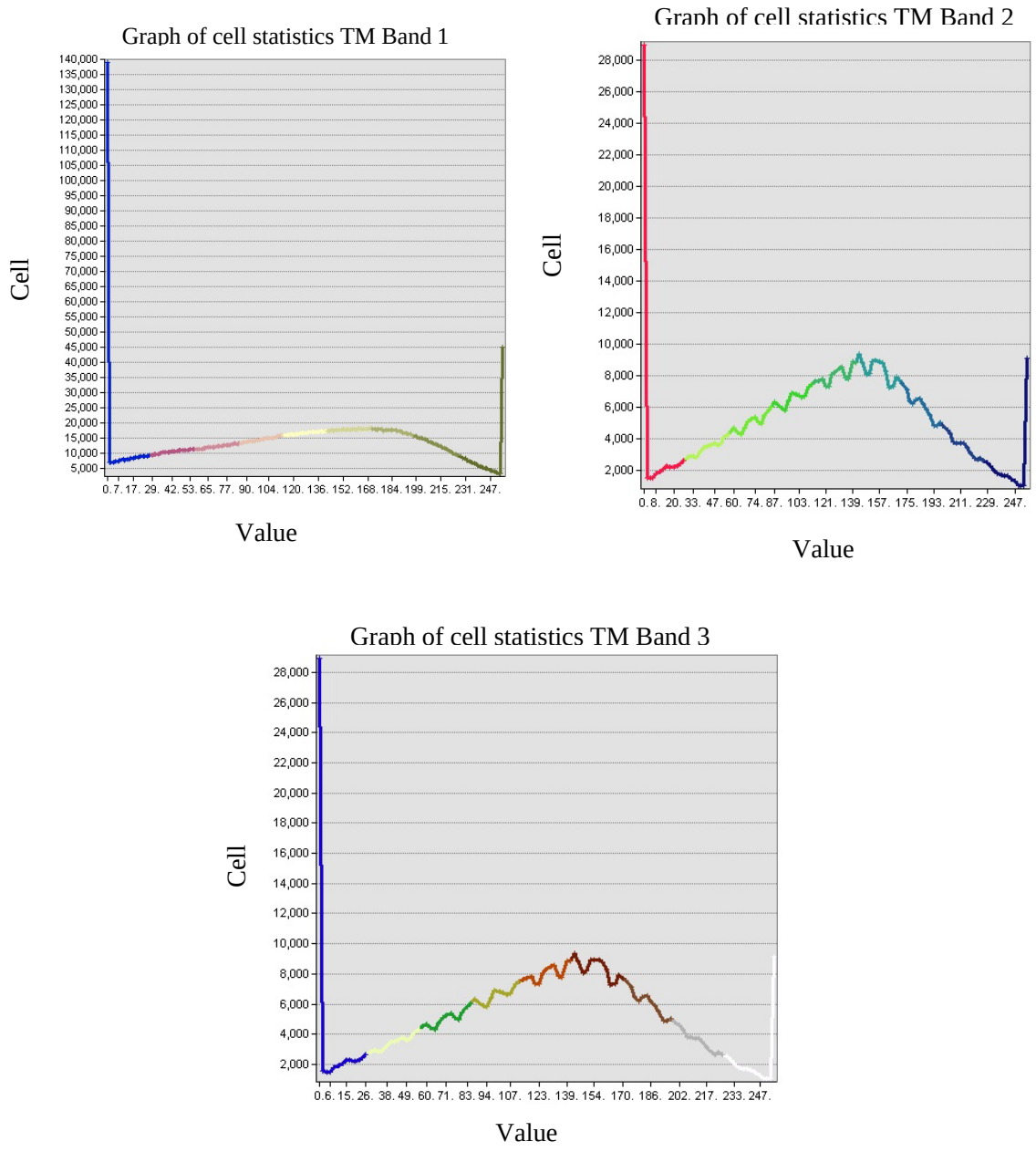


Fig 6: Graph illustration of cell statistics value per cell number for TM Band 1,2 and 3.

Clearly, in this graphics, the difference were between spectral bands in each ETM+ and TM apparent, the largest difference was in band 3 of each satellite, the value of Cell number lie under 20000 in graph for both. Additionally, choose many of point on satellite imagery are randomly representation topology, shown in **(**fig 7**).** Using the same imagery, that is identical ground targets for some to compare Landsat-7 and Landsat-5 data, to examine the difference bands are of these scenes for one region, which involved various many of topology, shown in **(**fig 8.)Briefly, Chosen band 3 in both satellite found wisely difference effect among band 1 and 2.

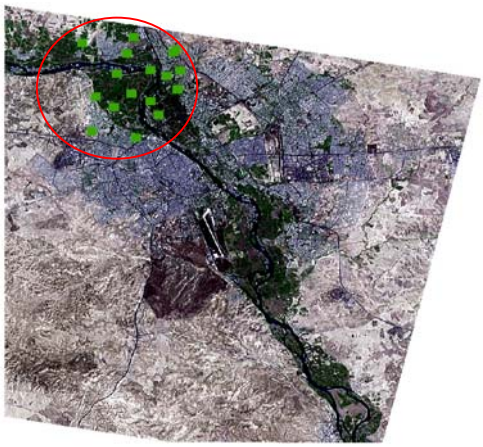
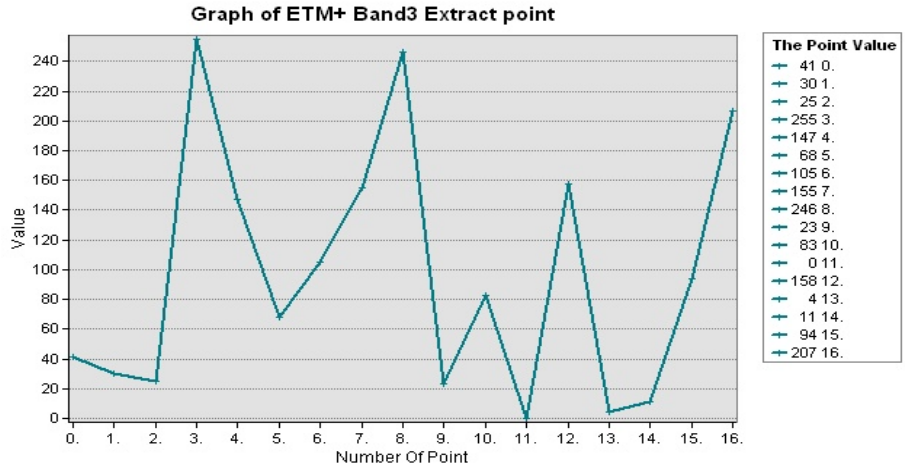
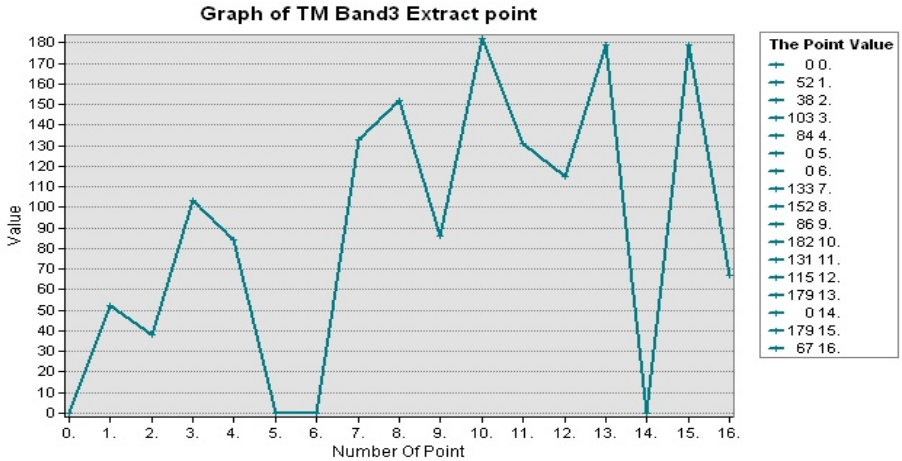


Fig 7: source of satellite image ETM 7 and 16 point choice representation topology location.

A



B



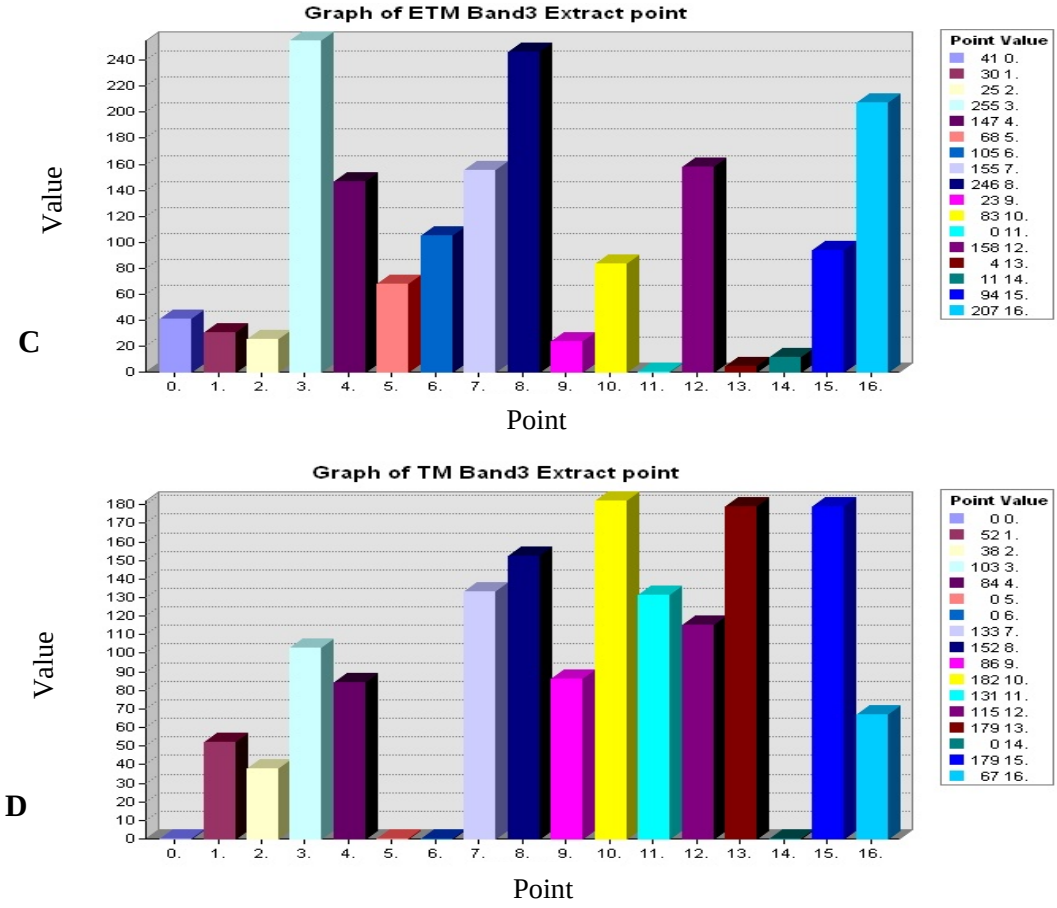


Fig 8: Graph illustration 16 point Value represented topology for cell statistics value per point number, which are A and C representation ETM+ 7, B and C are representation TM 5, that is imagery only Band 3.

Results and Conclusions

The spectral bands difference effects have been finding to be more dependent on the surface reflectance spectrum, that are effect factor main atmospheric and illumination conditions. In particular, targets are represent, thick vegetation, water, sold, rocks and forests. In this study, using three bands of satellite imagery have been (RGB), which found implement sufficient of spectral bands comparison. To be done computation the cell statistics, which is represent smallest unit object in satellite image to include many of pixels. That is best's manner to find difference in spectral bands. Additionally, present many impact factor effect on band, too, nature of scene with involved topology have been effect bands. To be done finding spectrally comparison between ETM+ 7 and TM 5 bands, by spatial analyst in ArcGIS template application on cell statistics in both satellite with same scene and chosen 16 point on satellite image to verify the result, show (table 3). Clearly, satellite ETM+ 7 sensor has ability to read and accuracy precision any point of image. Therefore, this reading has assistance to find phenomena appearance in natural. The excellent radiometric performance of the Landsat-7 ETM+ and provides an update to the Landsat-5 TM calibration in the solar reflective bands. Initial trials of the approach with two different tandem image pairs yielded repeatable results for TM responsively coefficients, for spectral bands 1, 2 and 3**.**

Table 3: Find mean of satellite ETM+ 7 and TM 5 for Value of 16 point location.

Point location number	satellite / Value	ETM+ Mean Band 3	TM Mean Band 3
1	2	6	32
2	0	0	0
3	0	0	0
4	5	115	84
5	6	79	0
6	7	116	0
7	8	135	108
8	9	230	138
9	10	36	61
10	11	134	121
11	12	4	175
12	13	158	115
13	14	9	179
14	15	11	0
15	16	115	0
16	17	207	0

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