USING THE BAND RATIO CLASSIFICATION METHOD TO DETECT THE REGIONS THAT NEED TO REMOVE SEDIMENTATION IN TIGRIS RIVER

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Abstract
LandSat Satellite ETM+ image have been analyzed to detect the different depths of regions inside the Tigris river in order to detect the regions that need to remove sedimentation in Baghdad in Iraq Country. The scene consisted of six bands (without the thermal band),It was captured in March ٢٠٠١. The variance in depth is determined by applying the rationing technique on the bands ٣ and ٥.GIS ٩.١ program is used to apply the rationing technique and determined the results.

استخدام طريقة تصنيف نسبية الحزمة للكشف عن المناطق التي بحاجة لإزالة الترسبات في نهر دجلة

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المستخلص
تم تحليل صورة الساتل (Landsat-٧) للمتحسس ETM+ للكشف عن أعماق مختلفة من نهر دجلة، لغرض الكشف عن المناطق التي تحتاج الى ازالات الترسبات في بغداد في العراق. يحتوي المشهد على ستة حزم (بدون الحزمة الحرارية)، تم التقاطه في آذار ٢٠٠١. الاختلاف في العمق قد تم أستحصاله من خلال تطبيق تقنية النسبة على الحزمتين الثالثة والخامسة. تم إستخدام برنامج ٩.١ GIS لتطبيق نظريـة النسـبة وأستحصال النتائج.

١. Introduction:

Remote sensing is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation [١].

Remote sensors usually record electromagnetic radiation (EMR) which travels at a velocity of ٣×١٠^٨ ms-^١ from the source, directly through the vacuum of space or indirectly by reflection or reradiation to the sensor. As such, EMR represents a High-speed communications link between the sensor and remotely located phenomena [٢].

Landuse and Landcover studies have become important in recent years due to explosive growth in the population and economy. As growth continues, the landscape is altered in dramatic ways [٣].

Whether for irrigation, power generation, drinking, manufacturing, or recreation, water is one of our most critical resources. Visual image interpretation can be used in a variety of ways to help monitor the quality, quantity, and geographic distribution of this resource. In general, most of the sunlight that enters a clear water body is absorbed within about ٢m of the surface. The degree of absorption is highly dependent on wavelength. Near-infrared wavelengths are absorbed in only a few tenths of centimeters of water, resulting in very dark image tones of even shallow water bodies on near-infrared images. Absorption in the visible portion of the spectrum varies quite dramatically with the characteristics of the water body under study. From the standpoint of the imaging of bottom details through clear water, the best light penetration is achieved between the wavelengths of ٠.٤٨ and ٠.٦٠ µm. Penetration of up to about ٢٠ m in clear, calm ocean water has been reported in this wavelength band. Although blue wavelengths penetrate well, they are extensively scattered and an "underwater haze" results. Red wavelengths penetrate only a few meters [١].

Ratio images are enhancement resulting from the division of digital number values in one spectral band by the corresponding values in another band. A major advantage of ratio images is that they convey the spectral or color characteristics of image features, regard less of variations in scene illumination conditions. Radioed images are often useful for discriminating subtle spectral variations in a scene that are masked by the brightness variations in images from individual spectral bands or in standard color composites. Obviously, the utility of any given spectral ratio depends upon the particular reflectance characteristics of the features involved and the application at hand. The form and number of ratio combination a available to the image analyst also varies depending upon the source of the digital data. The number of possible ratios that can be developed from n bands of data is n(n-١). Thus for the six nonthermal bands of Landsat TM or ETM+ data there are ٦(٦-١), or ٣٠, possible combinations. The manner in which ratios are computed and displayed will also greatly influence the information content of a ratio image. For, example, the ratio between two raw DNs for a pixel will normally be quite different from that between two radiance values computed for the same pixel. The reason for this is that the detector response curves for the two channels will normally have different offsets, which are additive effects on the data. (This situation is akin to the differences one would obtain by rationing two temperatures using the Fahrenheit scale versus the Celsius scale). Some trial and error may be necessary before the analyst can determine which form of ratio works best for a particular application [٤].

It should also be noted that ratios can "blow up" mathematically (become equal to infinity) if the band in the denominator has a DN of zero. At the same time, ratios less than ١ are common and rounding to integer values will compress much of the ratio data into gray level ٠ or ١. Hence, it is important to scale the results of ratio computations somehow and relate them to the display device used.

One means of doing this is to employ an algorithm of the form

$$DN' = R\tan^{-1}\left(\frac{DN_x}{DN_Y}\right) \qquad \text{............١}$$

DN' = Digital number in ratio image

R= Scaling factor to place ratio data in appropriate integer range

$\tan^{-1}\left(\frac{DN_x}{DN_Y}\right)$ ≡ Angle (in radians) whose tangent is the ratio of the digital numbers in Bands X and Y; if DNY equals ٠, this angle is set to ٩٠o.

In the above equation the angle whose tangent is equal to the ratio of the two bands can range from ٠oto ٩٠o, or from ٠ to approximately ١.٥٧١ rad. Therefore, DN/ can range from ٠ to approximately ١.٥٧١R. If an ٨-bit display is used, R is typically chosen to be ١٦٢.٣, and DN/ can then rang from ٠ to ٢٥٥ [١].

Water Bodies generally reflect high in the visible spectrum; however, clearer water has less reflectance than turbid water. In the Near IR and Mid-IR regions water increasingly absorbs the light making it darker. This is dependent upon water depth and wavelength. Increasing amounts of dissolved inorganic materials in water bodies tend to shift the peak of visible reflectance toward the red region from the green region (clearer water) of the spectrum. The ratio band٣/band٥ enhanced turbid water. This ratio is useful for observing differences in water turbidity [٤].

٢. The Studied Area and Data Forms:

The Tigris River is one of the Twin Rivers in Iraq, which is one of the reasons for the development of the great civilization in Mesopotamia. Both the Tigris and the Euphrates are Trans Boundary Rivers, originating in

Turkey. Before their confluence, the Euphrates flows for about ١٠٠٠ km and the Tigris for about ١٣٠٠ km within the territory of Iraq [٥].

Approximately ٣٠% ٠f Iraq is composed of the alluvial plain formed by the combined deltas of the Tigris and Euphrates Rivers. This region begins north of Baghdad and extends south to the Gulf Coast bordering Iran. The once extensive wetlands of the region have been decimated by damming and diversions of the Euphrates River in Turkey and Syria. The plain begins near Samarra and Ramadi, ending near the Gulf Coast after covering a distance of approximately ٦٠٠ km long and ٢٠٠ km wide. From Baghdad the basin tilts to the southeast to the City of Hilla, which is situated on the eastern bank of the Euphrates River, in an area that is also a part of the alluvial plain. Southeastern Iraq also has remnants of Mesopotamian marsh low-lying plains and complex interconnected shallow freshwater lakes and canals. The Tigris and Euphrates Rivers flood this area seasonally during month of March through May. The City of Basrah is located in this area. [٦].

The Tigris River originates in the Toros mountains of southeastern Turkey, it passes through Turkey, Syria, and Iraq. The Tigris ends at Shatt Al-Arab. Its total length in Iraq is ١٤١٨Km. The part of the Tigris River that passes through Baghdad is about ٥٠Km long. The River passes through many cities in Iraq receiving their wastes along its passage. Baghdad, with its several million people is considered to be the most populated and industrialized city in Iraq. The majority of its municipal and industrial wastes are discharged directly into the river without any treatment. Total turbidity were increased when the river passed through Baghdad [٥].

The River Tigris drains a basin of ١٣٤ ٠٠٠km^{٢} above the city of Baghdad. The mean annual discharge of the Tigris at Baghdad gauging station is ١١٤٠ m^{٣}/s. Estimates of sediment load which rely mainly on measurements of suspended sediment indicate that an average of ٤.٦ million tones of sediment were transported annually during the period ١٩٦٩-١٩٧٥. This implies that the average sediment yield from the basin above Baghdad approximates ٣٤.٣١ km"٢ year"١ [٧].

The deposition of sediment along the reach of the River Tigris within Baghdad city causes a decrease in concentrations and diminishes the short periodicity cycles downstream [٨].

Satellite image captured from Landsat-٧ (ETM+) in march (٢٠٠١) illustrated in (fig. ١). The third and the fifth bands were used with wavelengths (٠.٦٣-٠.٦٩) and (١.٥٥-١.٧٥) Micrometer respectively with pixel size (٢٨.٥ × ٢٨.٥) m and image size (٢٠٥٤ × ١٩١٥) Pixels.

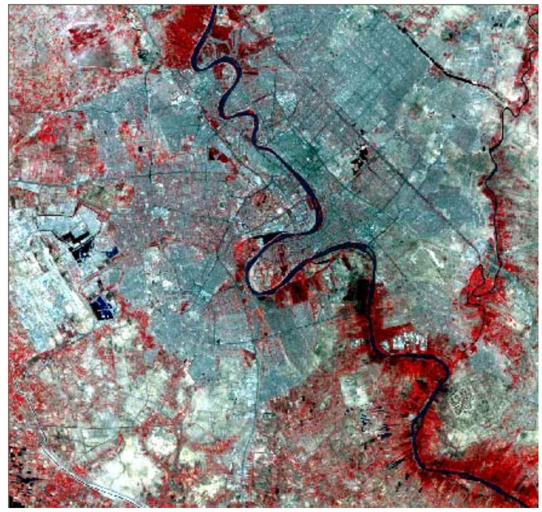


Fig. ١: Baghdad image acquired on; March (٢٠٠٧).

The band ratio Methodology:

Band ratio method has been applied on the multispectral remotely sensed image to detect different depths in image water area (Tigris River).

١. Perform image ratioing technique, by ratioing band٣/band٥, to produce image with differentiated water areas.

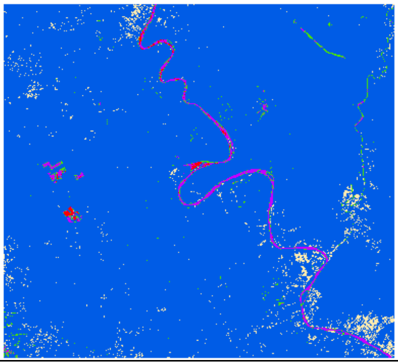
٢. Perform normalization technique (i.e. Using Unique Values Criterion) on the rationing image to produce different water classes (three water classes) in the image.

٣. Perform raster to polygon process for each class of water (shallow, average depth and deep water) to select the pixels that turned to Tigris River only from other water areas pixels in the image.

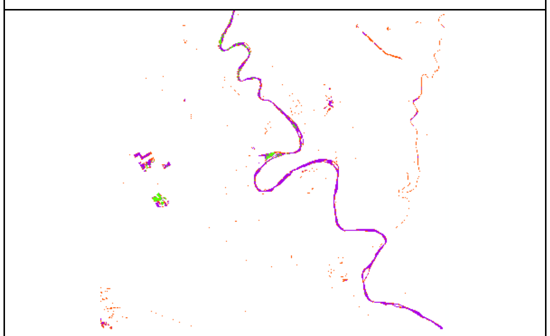
٤. The pixels of water outside the river were selected and removed then the areas of classes were calculated.

٥. The area of each class was calculated.

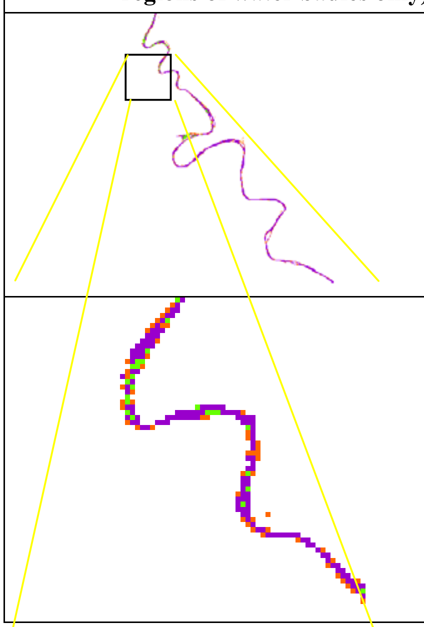
(Figure ٢) demonstrates the operational steps involved in this method, while Tables- (٣ and ٤) represents the number of points and the percentage of classes areas obtained by implementing the band ratio method**.**



(a)Ratio of band٣/band٥ of baghdad scene



(b)Ratio of band٣/band٥ of baghdad scene(the regions of water badies only)



(c)Raster to polygon resulted image

Fig. ٢: Illustrating the processes involvedby the band ratio classification method.

Table١: the number of points and percentages area of each class of water body, using band ratio classification method

Classes of water body in Baghdad scene				
Class color	The depth of water name	Number of class points (pixels)	Class Area ($m^٢$)	Percentages area of the class
Red	Shallow	٧٩١٨	٦٤٣١٣٩٥.٥	٣٤.٤٧%
Violate	Average depth	١٢٩٧٤	١٠٥٣٨١٣١.٥	٥٦.٤٨%
Green	Deep	٢٠٨٠	١٦٨٩٤٨٠	٩.٠٥%
	SUM	٢٢٩٧٢	١٨٦٥٩٠٠٧	

Table ٢: the number of points and percentages area of each class of Tigris water body, using band ratio classification method.

Classes of Tigris water body in Baghdad scene				
Class	The depth of water name	Numbor of class points (pixels)	Class Area ($m^٢$)	Percentages area of the class
Red	Shallow	٣٠٤٨	٢٤٧٥٧٣٨	١٩.٨٩٦%
Violate	Average depth	١٠٨٤٧	٨٨١٠٤٧٥.٧٥	٧٠.٨%
Green	Deep	١٤٢٥	١١٥٧٤٥٦.٢٥	٩.٣%
	SUM	١٥٣٢٠	١٢٤٤٣٦٧٠	

Results and Discussion:

After the band ratio classification technique had applied, visually interpretation process applied to give identification for classes of water bodies' area for the scene (Tigris river depths in Baghdad). Then for each class of water bodies, the pixels outside the river were removed by using raster to vector process and the summation of the pixels inside the river were calculated. By using this technique the boundaries of Tigris River could be studied to detect the long shallow regions pixels that need to remove sedimentation.

References

١. Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman ٢٠٠٧ .Remote Sensing and Image Interpretation. Sixth Edition, John Wiley & Sons, Inc. printed in the United States of America, p.١, p.٢٥٢, p.٥٢٤.

٢. John R. Jensoun, ١٩٨٦ .*introductory Digital Image Processing*. Prentice-Hall A.Division of Simon & Schiter, Inc P. ١.

٣. Kathleen Tucker, ١٩٩٧ .*Change Detection in the Area of Benton and Draffenville*. Murraystate/geo/gsc ٦٤١,

٤. James W. Quinn, ٢٠٠١. Band Combination. (http://web.www.pdx.edu/emch/ipl/bandcombination.html).

٥. S.M. Mutlak, B. M. Salih and S. J. Tawfiq.١٩٧٩ .Quality of Tigris is river passing Through Baghdad for Irrigation. Envir٠ onmental Pollution Research Centre, P. O. Box ٢٣٧١ Alwiyah - Baghdad/Iraq. (Received ٤ June, ١٩٧٩; revised ١٨ September, ١٩٧٩).

٦. United States Army Corps of Engineers Mississippi Valley Division. ٢٠٠٦. Programmatic environmental assessment (PEA) of rural water supply project. P.١٠

٧. Nadhir A. AL-anasri, Sana H. Ali and Arwa S. Taqa. ١٩٧٩. Sediment discharge of the River Tigris at Baghdad (Iraq). The hydrology of areas of low precipitation. (Proceedings of the Canberra Symposium, December ١٩٧٩. IAHS-ISH Publ. no. ١٢٨.

٨. Campbell, B.L., R.J. Loughran, and G.L. Elliott. ١٩٨٨. A method for determining sediment budgets using caesium-١٣٧. International Association of Hydrological Sciences Publication No. ١٧٤.pp.١٧١-١٧٩.