

# Digital Image Processing

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**Abstract:** This paper describes the basic technological aspects of Digital Image Processing with special reference to satellite image processing. Basically, all satellite image processing operations can be grouped into three categories: Image Rectification and Restoration, Enhancement and Information Extraction. The former deals with initial processing of raw image data to correct for geometric distortion, to calibrate the data radiometrically and to eliminate noise present in the data. The enhancement procedures are applied to image data in order to effectively display the data for subsequent visual interpretation. It involves techniques for increasing the visual distinction between features in a scene. The objective of the information extraction operations is to replace visual analysis of the image data with quantitative techniques for automating the identification of features in a scene. This involves the analysis of multispectral image data and the application of statistically based decision rules for determining the land cover identity of each pixel in an image. The intent of classification process is to categorize all pixels in a digital image into one of several land cover classes or themes. This classified data may be used to produce thematic maps of the land cover present in an image.

**Keywords:** Digital Image, Image Rectification, Image Restoration, Image Enhancement, Information Extraction.

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## 1. INTRODUCTION

Image enhancement processes consist of a collection of techniques that seek to improve the visual appearance of an image or to convert the image to a form better suited for further analysis. The purpose of image enhancement methods is to process an acquired image for better contrast and visibility of features of interest for visual examination as well as subsequent computer-aided analysis and diagnosis. When pictures are converted from one form to another by processes such as imaging, scanning, or transmitting, the quality of the output image may be inferior to that of the original input picture. There is thus a need to improve the quality of such images, so that the output image is visually more pleasing to human observers from a subjective point of view. To perform this task, it is important to increase the dynamic range of the chosen features in the image, which is essentially the process of image enhancement.

A routine image processing analysis was basically performed on a specific image notably band 1, band 2 and band 3 to carry out a single pixel operation and neighborhood operations on them. An Image processing operation was specifically performed on Landsat band 1 and an explanation was adequately written vividly to illustrate the processes carried out on the band. References were also made to other bands but not to detail as against band 1.

However, the Image processing operation performed on the images is Image enhancement which is a low level operation and entails Contrast Stretching, Digital Filtering Composite, Pan sharpening, sobel edge detector, Laplacian edge filter and Filtering.

## 2. IMAGE ENHANCEMENT

Image Enhancement is actually concerned with the modification of an image to make it more visible and more interpretable to the user of the image. Regardless of the extent of the digital intervention, visual analysis invariably plays a prominent role in any sphere of remote sensing. Before using any data in a GIS environment, the data or Map need to be georeferenced. It is the process of giving a cartographic material such as a digital satellite imagery, aerial photograph,

Map, or statistical data a real world coordinate system and map projection. Georeferencing operation was done on both satellite imagery and Topographical Map. This involves assigning map coordinates to its spatial location.

ArcGIS software was used to georeference the Topographical Map of Koton Karifi South West, Sheet 227 S.W, Nigeria. The scale of the map georeferenced is 1:50,000. The satellite imagery map of part of my state was cropped out from the Google Earth Pro 4.2 of relatively one square kilometer in dimension and georeferenced accordingly.

Moreover, four points were chosen both on the Topographical map and the satellite imagery for easy georeferencing and this is commonly achieved using a coordinate system.

### OBJECTIVES:

The objectives of this study are;

- To Perform a low level image processing operation on selected Landsat Imageries (Band 1, 2, 3 and others) using notable image processing softwares like **Idrisi 15**, **Envi 4.3** and **Ilwis 3.7**.
- To georeference a topographical Map and a Satellite imagery of the area covered using **ArcGIS 9.3** or **AutoCAD 2009** softwares.

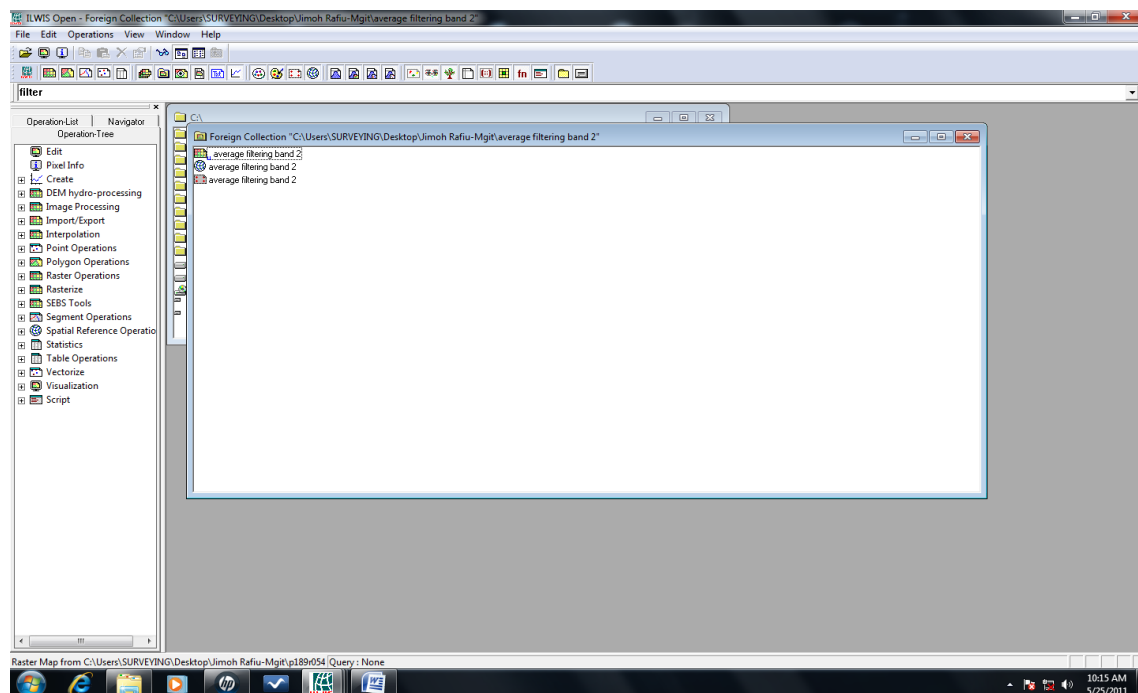
### DATA REQUIREMENTS:

Data requirements include;

- Landsat Satellite imagery cropped from Google Earth and a Topographical Map of koton karifi sheet 227. The Topographical Map used were gotten from the Department of Surveying and Geoinformatics, Remote sensing Laboratory while the satellite imagery was gotten from Google Earth website.

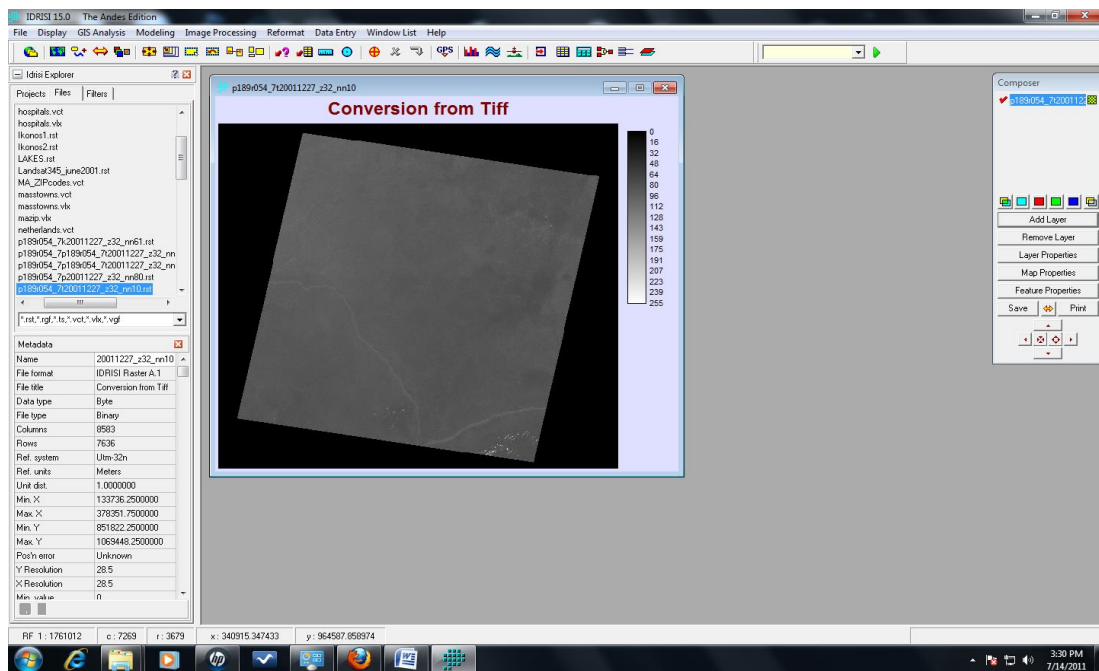
### PROCEDURAL APPROACH USED FOR THE IMAGE PROCESSING OPERATION USING ILWIS 3.7 SOFTWARE, IDRIS 15.0 AND ENVI 4.3 IMAGE PROCESSING SOFTWARE:

In this paper, only Band 1 imagery was subjected to image processing analysis and reported accordingly, other bands were also done but not explained.



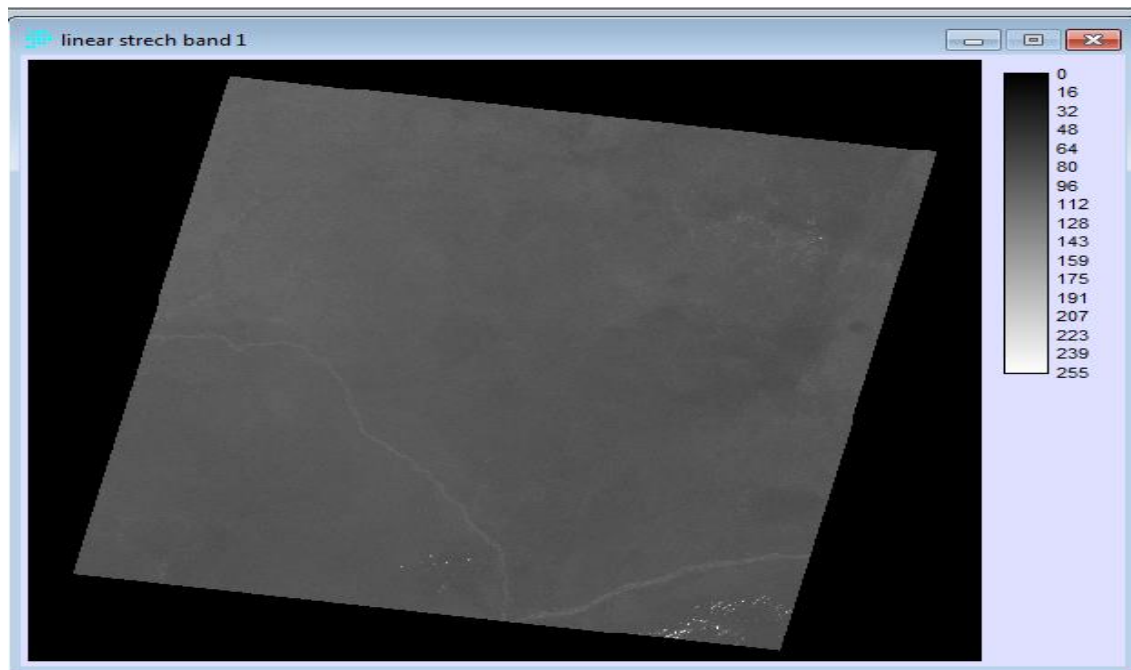
**Fig. 1: Ilwis environment for importing images.**

Images were imported from the file menu on the ilwis environment to commence image processing operation on the specified image. For image to be imported into the environment, it must have been downloaded from a source and saved on the desktop.



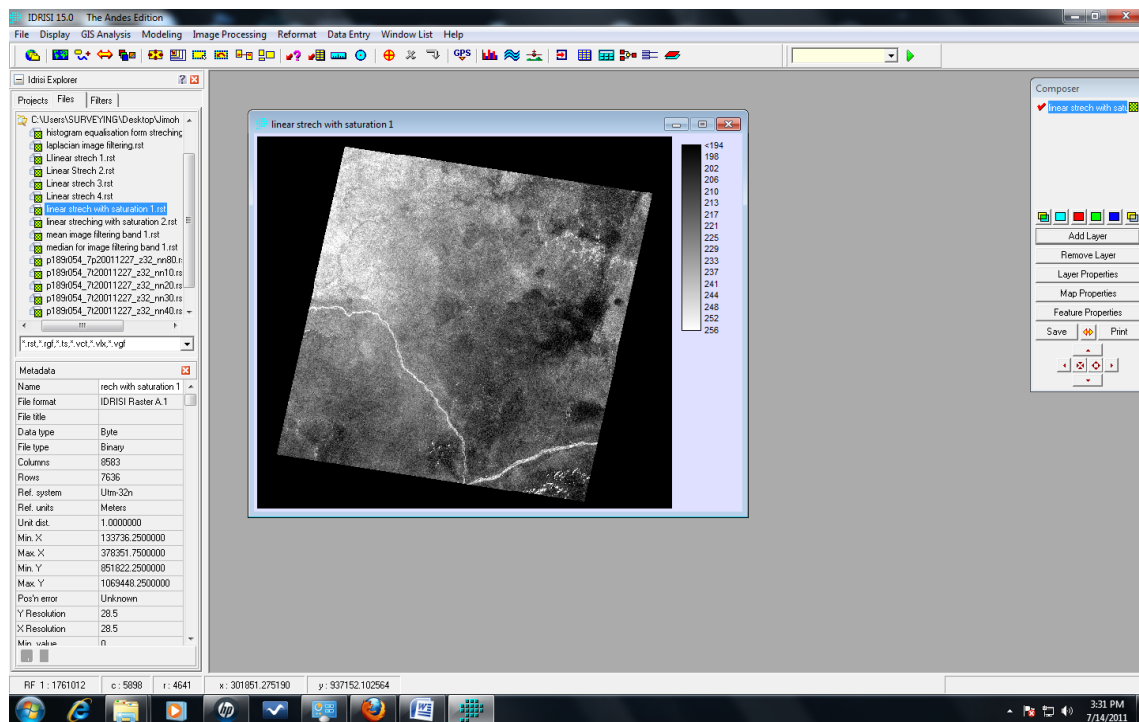
**Fig. 2: The converted band 1 imagery form tiff format**

The Band 1 Landsat Imagery acquired in 2001 was converted to tiff, a format that the Idrisi 15.0 software will understand. This conversion is necessary before commencement of any image processing especially when the software does not recognize the initial format of the image being envisaged for processing.



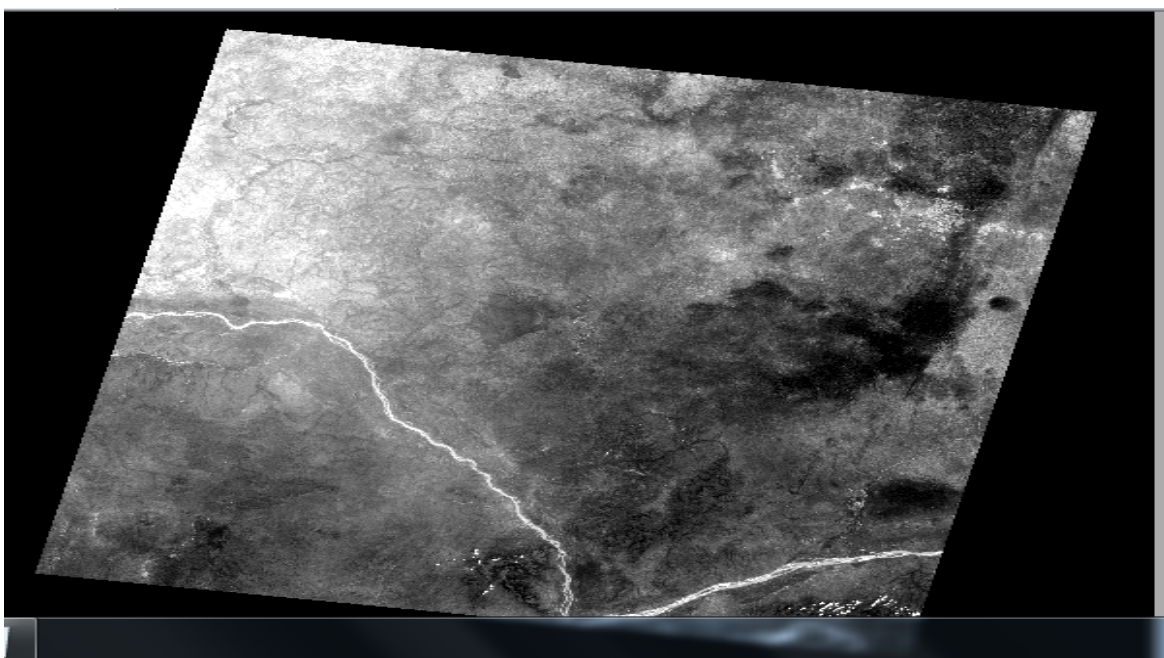
**Fig. 3: The linear stretch operation on band 1 imagery**

The Linear stretch operation was performed on band 1 imagery and the essence is to make the imagery more meaningful to the understanding of the interpreter. The imagery contains an alternation of slightly white and parches of white colour. On the imagery, the feature that is seen is a river channel. Comparing the Linear stretch operation with linear stretch (saturation) in Fig. 4 below, it is clearly seen that the feature is more pronounced clearly and other features that were not seen were well seen. This is a contrast stretching operation and the idea behind contrast stretching is to increase the dynamic range of the gray levels in the image being processed. Contrast enhancement involves changing the original values so that more of the available range is used, thereby increasing the contrast between targets and their backgrounds.



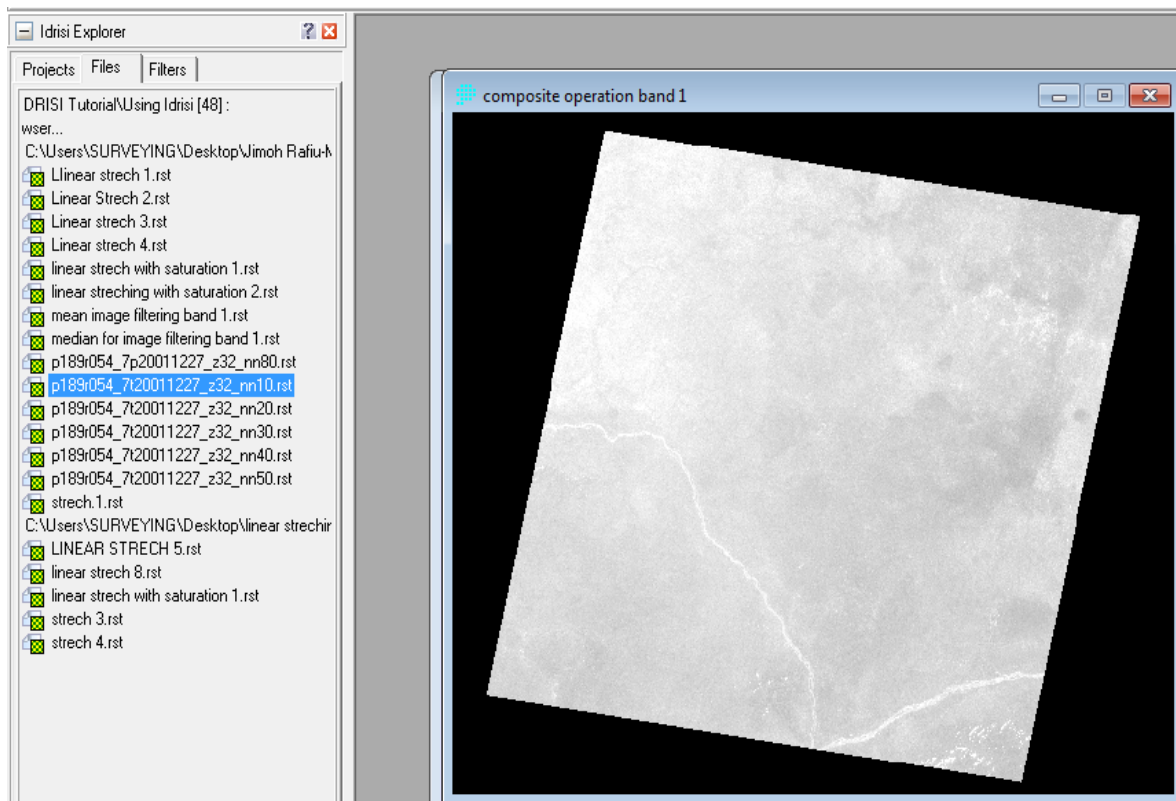
**Fig. 4: Linear stretching operation with saturation on band 1**

The imagery envisages a clearer feature than when it was only subjected to linear stretch without saturation as shown figure 4 above. This image was subjected to linear stretch with saturation to better enhance the image for better interpretation. The gray level value of the imagery is from 194 to 256. The image has a defined column and row with a specific resolution.

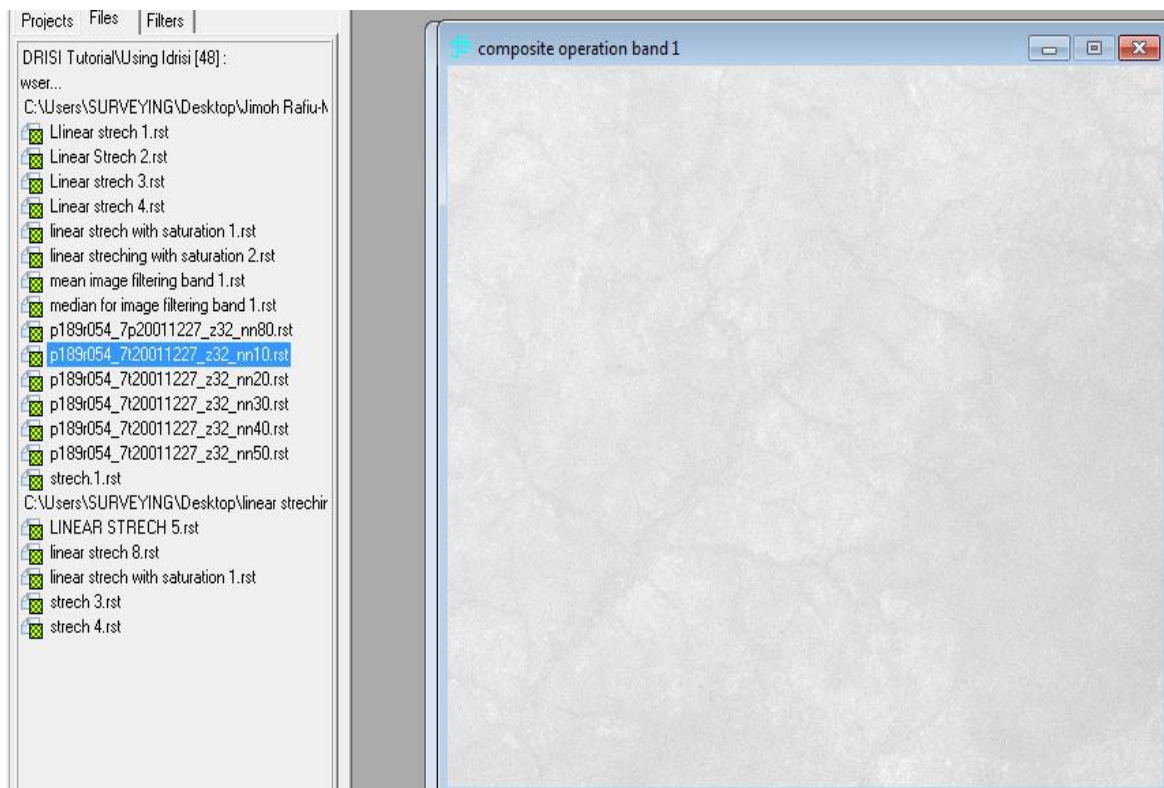


**Fig. 5: Average filtering operation from ILWIS environment on band 1**

The Average filtering operation was performed on band 1 imagery. This is to smoothen the appearance of the imagery in terms of feature enhancement. It is a low pass filtering process designed to emphasize larger homogeneous areas of similar tone and reduce the smaller detail in the image. Low pass filtering involves the elimination of the high frequency components in the image. It results in blurring of the image and thus a reduction in sharp transitions associated with the noise.

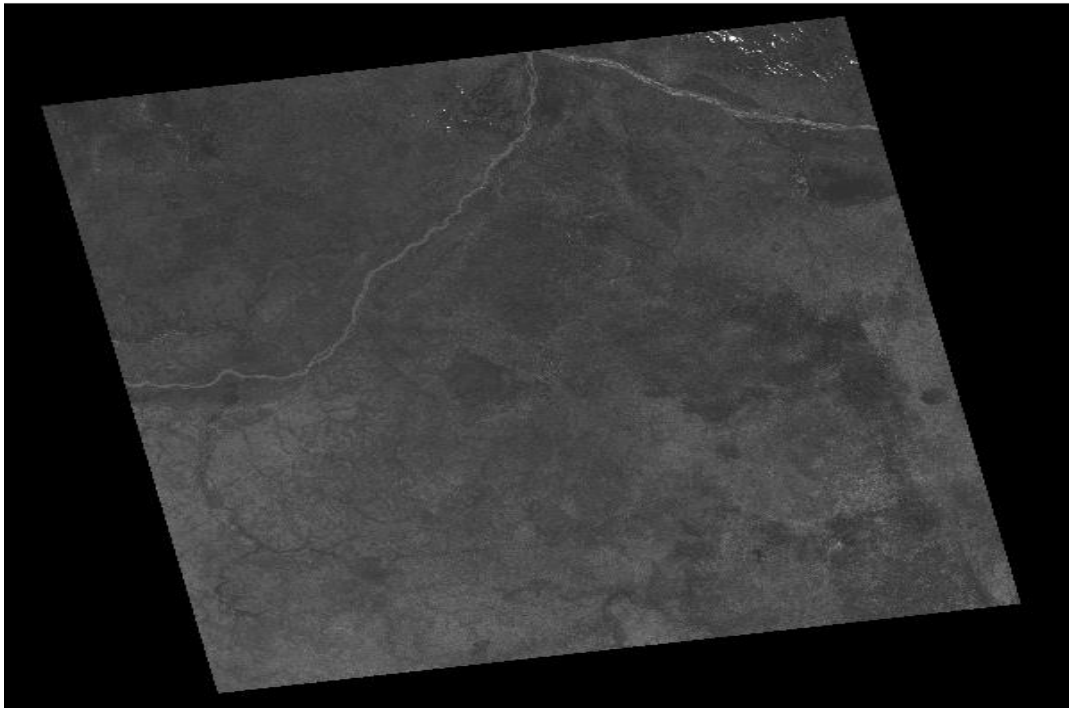


**Fig.6: Composite Operation by combining band 1, band 2, and band 3 images together to give an image.**



**Fig.7: Clear resolution of composite operation by combining band 1, band 2, and band 3 images together to give an image**

The product of the images gives clearer features which looks more interpretable to even a lay man. On the image, there is alternation of white colours which make the image more visible. The feature seen is drainage pattern possibly a river course having different branches or tributaries.



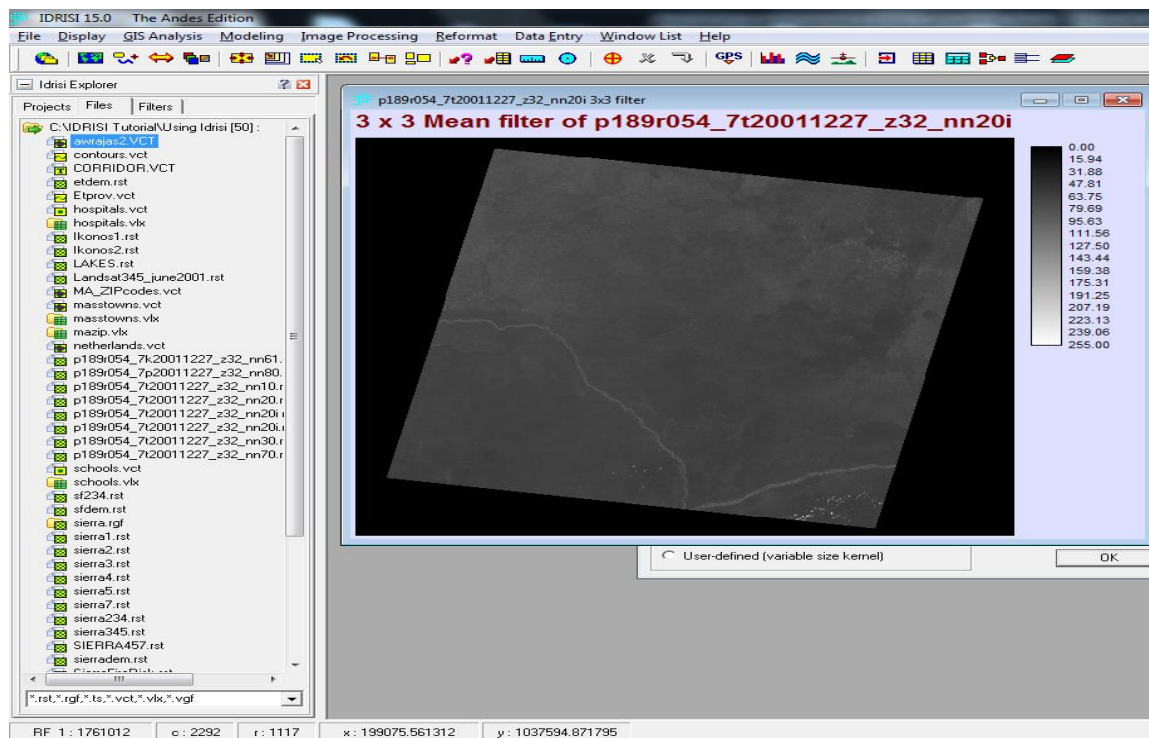
**Fig. 8: Raw Landsat Imagery (converted image) from ILWIS environment on band 2**

The raw imagery of band 2 when it has not been processed, some features on it are not that clear though some can be seen and interpretable. The image as converted to tiff, a language that the surfer will understand. This conversion is necessary before commencement of any image processing especially when the software does not recognize the initial format of the image being envisaged for processing.



**Figure 9: Sobel Edge Detector on Band 2**

The Sobel edge filters is a high pass filter, high pass filters are filters that pass through high frequencies, therefore they stressed on fine details and edges. As compared with band 1 above in Figure 4H, the edge of band 2 image was well defined and the gradient defined accordingly. The gray level values are mathematically correlated given rise to the well-defined edges symbolized by the dots on the imagery.



**Figure 10: Mean filter operation on Band 2**

A mean filter operation was performed on band 2 imagery to know the average concentration of pixels in the imagery. **Tone** refers to the relative brightness or colour of objects in an image. The image is slightly bright as compared band 1. The gray scale level of the mean filter on band 2 is quite different from the mean filter on band 1. The gray level represents the concentration of the average pixel of the imagery.

### 3. CONCLUSION

There is no unique general theory or method for processing all Kinds of images for feature enhancement. Point operations which include contrast stretching, window slicing, histogram modeling are zero memory operations that remap a given input gray level into an output gray level according to a global transformation. These methods have the disadvantage of treating the image globally, not being able to differentiate between several areas of the image that might require different levels of contrast enhancement. Of these techniques, linear contrast stretching and histogram equalization are the most widely used. Linear contrast stretching employs a linear transformation that remaps the gray-levels in a given image to fill the full range of values. Histogram equalization applies transformation to the input image such that the output image will have a uniform histogram (that is, the gray-levels have a relative frequency that is uniformly distributed). Spatial operations include noise smoothing, median filtering, unsharp masking, low-pass, band-pass and high-pass filtering. In this category of methods, spatial operations are performed in local neighborhoods of input pixels, these operations being often convolutions with Finite Impulse Response filters (FIR), called spatial mask. Depending on the intention of the interpreter and the level of visual and technical intelligence of the interpreter, a particular operation can be assign to an image for a particular application and result achieved.

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