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Spatial-Temporal Analysis

An Exploration of the Value

Highlights

The Utilization of MODIS

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Discovering Thoughts, Inventing Future

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# Spatial-Temporal Analysis of Vegetation Dynamics in the Semi Arid Belt of Nigeria

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*Keywords: vegetation index, landsat, image differencing, change detection, degradation, remote sensing.*
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# Spatial-Temporal Analysis of Vegetation Dynamics in the Semi Arid Belt of Nigeria

Gadiga, B. L.[α], Adesina. F. A .[σ] & Orimoogunje. I. O. O.[ρ]

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*Keywords: vegetation index, landsat, image differencing, change detection, degradation, remote sensing.*

## I. Introduction

Vegetation is an important component of the ecosystem that provides habitat for wildlife and maintains the functioning of the ecosystem. However, improper use of this vital natural resource has undermined its integrity in meeting some of its objectives. Hence, there is the need to monitor and manage this natural resource for the benefit of the present and future generations. Remote sensing technique has been used in monitoring land cover change and in managing biological resources such as in forest management. This is mostly done using Vegetation index as a surrogate for vegetation greenness. Remote sensing is the technique of acquiring information without direct contact with the object. It consists of the interaction of measurements of electromagnetic energy reflected from or emitted by a target from a vantage point that is distance from the target (Mather, 1999). Understanding and interpretation of electromagnetic energy that the earth surface reflects or emits enables earth observation by remote sensing.

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This is because diverse objects on the earth surface behave differently in their reflectance and emission characteristics thereby making it possible to measure and analyze the various materials on the earth surface. The information received by remote sensing platforms are digital in nature, this has made it feasible to manipulate the acquired information using computer systems.

Remotely sensed images are acquired from different region of the electromagnetic spectrum which ranges from ultra violet to radio waves. The ones frequently used in land cover studies are those from visible to the thermal infrared spectrum. Landsat TM, and ETM+ images are the commonly used remotely sensed imageries that span from the visible to the thermal region of the electromagnetic spectrum. The different spectral signatures of the earth surface materials have allow application in different fields of environmental studies like vegetation, soil, hydrology and geology. Remote sensing and GIS have provided new tools for advanced ecosystem management. The acquisition of remotely sensed data facilitates the synoptic analyses of earth-system function, patterning, and change at local, regional, and global scales over time; such data also provide a link between intensive, localized ecological research at the regional, national, and international for conservation and management of biological diversity. Geoinformation which embraces the technology of Remote Sensing, Global Positioning Systems (GPS) and Geographic Information Systems (GIS) has been used in various studies in the earth sciences to explain the processes taking place on the earth surface.

Change detection has been used in the process of identifying differences in the state of an object or phenomenon over time. Timely and accurate change detection of Earth's surface features provide the foundation for better understanding of the relationships and interactions between human and natural phenomena towards the management of resources (Lu, et al. 2004). In general, change detection involves the application of multi-temporal datasets to quantitatively analyze the temporal effects of the phenomenon. Because of the advantages of repetitive data acquisition, its synoptic view, and digital format makes it suitable for computer processing. Remotely sensed data has become the major data source for different change detection applications.



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Analysis of vegetation and detection of changes in vegetation pattern are keys to natural resources assessment and monitoring. Green vegetation has a distinct interaction with energy in the visible and near-infrared regions of the electromagnetic spectrum. In the visible region, plant pigments (chlorophyll) cause strong absorption of energy, primarily for the purpose of photosynthesis. The absorption peaks at the red and blue area of the visible spectrum, thus leading to the typical green appearance of most leaves. In the near-infrared however, a very different behavior occurs, energy in this region is not used in photosynthesis, hence, it is strongly scattered by the internal structure of leaves, leading to a very high reflectance. It is this disparity between visible and infrared regions of the electromagnetic spectrum that has been used in remote sensing to develop quantitative indices of vegetation condition. There are many types of vegetation indices in use today. The ones used in this study are; Normalized Difference Vegetation Index (NDVI), Green Vegetation Index (GVI), Perpendicular Vegetation Index (PVI), Transformed Soil Adjusted Vegetation Index (TSAVI) and Weighted Difference Vegetation Index (WDVI). These vegetation indices were chosen partly due to their different behavior to soil background reflectance (Eastman, 2009). This study therefore, assesses the application of the common vegetation indices used in the study of arid land vegetation. This is in order to determine the factors influencing dynamics of vegetation cover in the area.

## II. Study Area

The study area is located between latitude $12^0$ 58' N and $13^0$ 07' N, and longitude $10^0$ 12' E and $10^0$ 17' E (Figure 1). The area is found in Garanda which forms part of Michina Local Government Area of Yobe State. It is a part of the Sahelian region of Nigeria where desertification is threatening the ecology and livelihood of the inhabitants of the area (UNESCO, 2000; UNDP, 2009; Orounye, 2009). Yobe State is bordered to the North by Niger republic, to the East by Borno State, to the West by Jigawa and Bauchi States and to the South by Gombe and Borno States. It has a land area of 47,153 sq. km and a population of 2.7 million. Yobe State like other parts of the Sahel savanna has clearly defined wet and dry season largely determined by the properties and movement of the Inter-tropical Convergence Zone (ITCZ). Temperatures are generally high throughout the year, although there are significant variabilities. The highest air temperatures are normally in April before the onset of the rains and the minimum in December during the harmattan. The area has a mean maximum of 40.60 C and a mean minimum of 12.80C (Oguntoyinbo, 1983). The movement of the ITD controls the durations and amounts of rainfall received in most parts of West Africa including the study area. The state in general receives between 250 - 500 mm of rainfall in the northern parts lasting for three months and up to 1000 mm in the southern parts spread over 3 to 6 months (Oruonye, 2009). The main drainage system in the study area is the Komadugu-Yobe river systems. The system stretches from areas south of Kano State into the Lake Chad basin the largest inland water body located at the northeast corner of Borno State.

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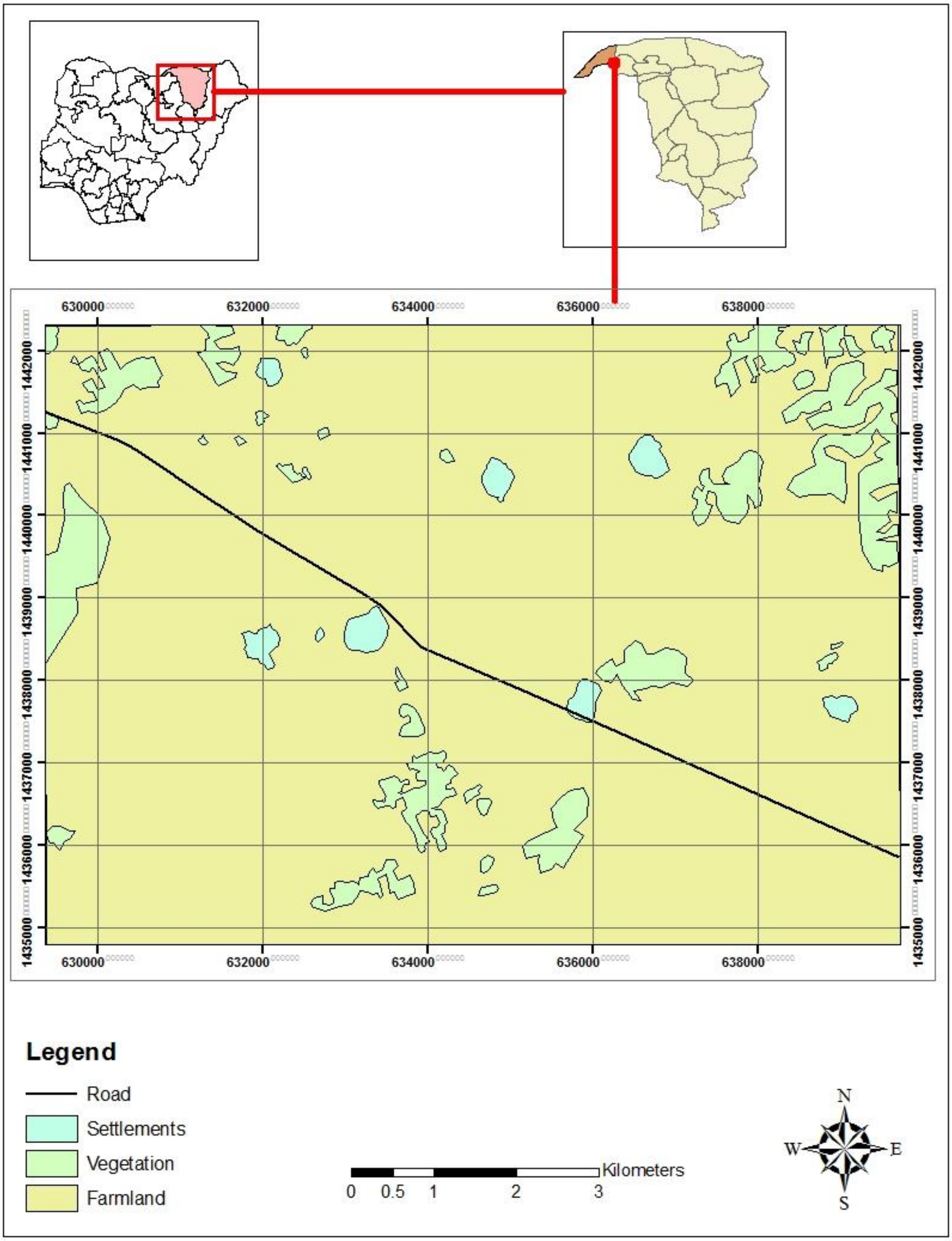


*Figure 1:* Map of the study Area

## III. Material and Methods

Satellite imageries were used to generate basic data on the vegetation cover using different vegetation indices. The data and procedures used for this study are described in the sections below.

### *a) Satellite Imagery*

A variety of remotely sensed images of the sites were acquired for the study. These include Landsat MSS of 1972, Landsat TM of 1986, Landsat ETM+ of 2000 and 2005, and ASTER of 2007. The images were so selected in part because they were taken in the same season of the year. This was to remove the effect of



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seasonal variation in vegetation cover (e.g. Pu et al., 2008). Pheneology difference in particular is controlled for in this way (Lu, et al., 2004; Mas, 1999; Singh, 1989). The satellite images selected ranges from low (Landsat MSS 80m) to medium spatial resolution, (TM (30m), ETM+ (30m) and ASTER (15m).

The four sets of the Landsat images were acquired from Global Land Cover Facility website (http://glcfapp. umiacs.umd.edu:8080/esdi/index.jsp) and from Earth Resources Observation and Science Center (EROS). Landsat MSS of 1972 and Landsat TM of 1986 were acquired from Global Land Cover Facility while Landsat ETM+ of 2000 and 2005 were acquired from EROS. The ASTER image was acquired through partnership with ITC Netherlands. Table 1 shows the detail characteristics of the images used for the image analysis.

*Table 1 :* Spatial and Spectral Characteristics of LandSat (MSS, TM and ETM+) and ASTER Images

| Spatial Resolution | | | Spectral Resolution | | Date of Acquisition | |
|---|---|---|---|---|---|---|
| Band | MSS | ASTER | MSS | ASTER | MSS | ASTER |
| 1 (Green) | 80 m | 15 m | 0.5-0.6 μm | 0.52-0.62 μm | 04/11/1972 | 03/11/2007 |
| 2 (Red) | 80 m | 15m | 0.6-0.7 μm | 0.63-0.69 μm | | |
| 3 (Near IR) | 80 m | 15 m | 0.7-0.8 μm | 0.76-0.90 μm | | |
| 4 (Near IR) | 80 m | | 0.8-1.1 μm | | | |
| | TM | ETM+ | TM | ETM+ | TM | ETM+ |
| 1 (Blue) | 30 m | 30 m | 0.45-0.52 μm | 0.45-0.52 μm | 09/10/1986 | 06/11/2000 |
| | | | | | | 06/11/2005 |
| 2 (Green) | 30 m | 30 m | 0.52-0.60 μm | 0.53-0.61 μm | | |
| 3 (Red) | 30 m | 30 m | 0.63-0.69 μm | 0.63-0.69 μm | | |
| 4 (Near IR) | 30 m | 30 m | 0.76-0.90 μm | 0.78-0.90 μm | | |
| 5 (Middle IR) | 30 m | 30 m | 1.55-1.75 μm | 1.55-1.75 μm | | |
| 6 (Thermal IR) | 120 m | 60 m | 10.4-12.5 μm | 10.4-12.5 μm | | |
| 7 (Middle IR) | 30 m | 30 m | 2.08-2.35μm | 2.09-2.35 μm | | |
| 8 (Panchromatic) | | 15 m | | 0.52-0.90 μm | | |

*Source: USGS Website*

*b) Preparing Images For Analyses*

The acquired images were first resampled and image regression performed on them before getting the images sub-mapped in order to extract the Area of Interest (AOI) for further analyses. These operations were performed so as to correct geometric and radiometric distortions as a result of satellite sensor differences or errors, atmospheric attenuations and to properly align multi-date imageries that were used in the study (Lu, et al., 2004; Pu, et al., 2008; Eastman, 2009). The resampled images were co-registered into the same coordinate system as suggested by some authors (Washington-Allen, et al., 1998; Pu, et al., 2008).

*c) Creation of Vegetation Indices*

On the corrected images, Vegetation Indices (VIs) were calculated to determine the biomass before change detection was carryout. All the vegetation indices used in this study are the ones that have been corrected for soil background reflectance except the Normalized Difference Vegetation Index (NDVI). IDRISI Taiga software was used in creating all the vegetation indices used in this study.



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In the creation of PVI, TSAVI and WDVI images, soil line was required. Soil line represents a linear equation that describes the relation between reflectance values in the red and near infrared bands for bare soil pixels. In other words, the pixels that fall far from the soil line due to high reflectance value in the near infrared band are assumed to be vegetation while the pixels that fall far from the soil line due to high reflectance value in the red band are assumed to be water. Soil line is typically the signature of soils in the red and near infrared bi-spectral plot. A regression analysis was carried out to relate the soil line between NIR and RED bands (Eastman, 2009).

*d) Image Regression Differencing*

'Image regression differencing' is a form of image differencing that involves the regression of the two images before differencing operation is applied. The advantage of this operation over the conventional method of image differencing is that it corrects sensor difference and errors between the two dates. In carrying out 'image regression differencing' of the vegetation

indices, the earlier images in the series were used as independent variable and the later images as dependent variable in the regression analysis. For example the Landsat MSS image of 1972 was used as the independent variable and the later Landsat TM image of 1986 as dependent variable. Intercept and the slope of the regression were used to adjust the earlier image in order to have comparable characteristics with later image. The equation for adjusting the earlier image is given as;

Adjusted Image = (earlier image*slope) + intercept (1)

After adjusting the earlier image, differencing of the images was carried out to get a difference image.

In order to avoid the confusion associated with identifying areas of change (decrease or increase) in a difference image, 'thresholding' was applied (Eastman, 2009; Wojtek, 2007). With 'threshold' one can establish a lower and upper limit to a normal variation beyond which it is considered that true change has occurred. Histogram was used to establish the threshold limits of the normal variation. A normal distribution has a bell-shaped curve with a single peak and symmetrical tails that fall off in a convex fashion on either side (Figure 2). In a normal distribution, the standard deviation (SD) measures the characteristic dispersion of values away from the mean (Wojtek, 2007). Therefore, values that were within plus or minus SD from the mean are areas where change is not expected to take place (Eastman, 2009). This implies that any values beyond the SD values mentioned above are considered as change in the difference image. In this study, +/- SD was adopted.



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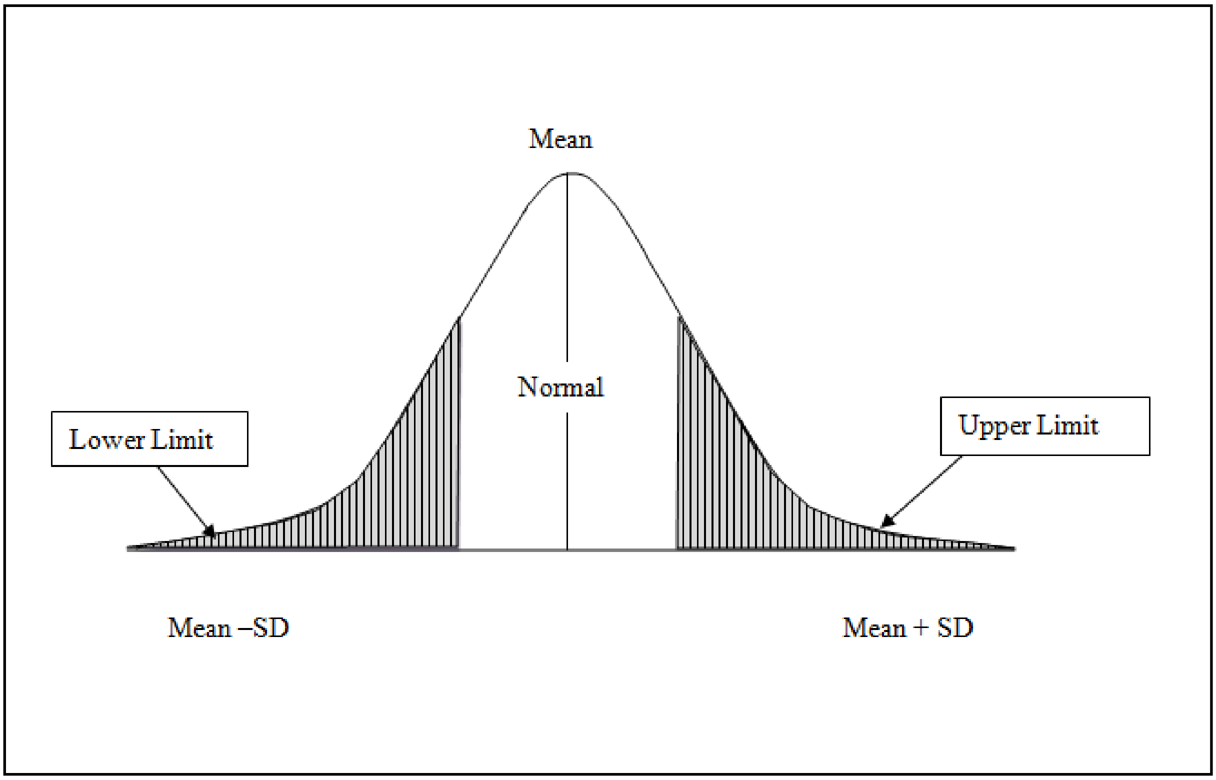


*Figure 2 :* Illustration of the Thresholds used in the Analysis

Correlation between changes in NDVI, PVI, TSVI, WDVI and GVI images over the period under study and rainfall variability within the same period was carried out in order to determine the relationship between vegetation indices and rainfall in the area (Bonan et al. 2002; Anyamba and Tucker, 2005). The rainfall data were those of Nguru located at Latitude 12052/ N and Longitude 10027/ E which was collected from Nigerian Meteorological Agency (NIMET). The Nguru weather station is located 28 km southeast of the study area. The rainfall data were monthly rainfall records but were added up to obtain annual total for each of the five years.

## IV. Results and Discussions

The result of NDVI differencing between 1972 and 1986 shown in Table 2 reveals that the areas without vegetation in 1972 have witnessed an increase (regeneration) in area of vegetation cover by 1720.59 hectares while areas with vegetation have experienced decrease (degradation) in vegetation cover by 1705.40 hectares. This means that the areas with vegetation in 1972 have increase than decrease between the two periods with a difference of 15.19 hectares. Areas that did not witness any change in vegetation cover (No change) represent 7190.69 hectares.

*Table 2 :* Vegetation change detection of the study area between 1972 and 1986

| Vegetation Index | Area measured in Hectare | | | |
|---|---|---|---|---|
| | No change (0) | Decrease (1) | Increase (2) | Difference |
| NDVI | 7190.69 | 1705.40 | 1720.59 | 15.19 |
| GVI | 7278.57 | 1662.66 | 1675.43 | 12.77 |
| $PVI_3$ | 8100.81 | 1241.93 | 1273.93 | 32 |
| $TSAVI_2$ | 7316.10 | 1667.31 | 1633.27 | -34.04 |
| WDVI | 9780.46 | 317.35 | 518.87 | 201.52 |

All the other vegetation indices studied, show increase in vegetation cover than decrease between the year 1972 and 1986, even though there was slight decrease in rainfall from 247.6 to 240.5 mm between 1972 and 1986 respectively (Figure 3). Only TSAVI showed a result that closely reflects the status of vegetation cover in the period. This is base on the premise that rainfall is a determinant of vegetation development in the area (Anyamba and Tucker, 2005; Fabricante et al. 2009). NDVI shows the highest increase than decrease in area of vegetation compared with all the other vegetation indices followed by GVI with an increase in area of vegetation cover amounting to 1675.43 hectares and decrease to 1662.66 hectares.

PVI shows an increase in vegetation by 1273.93 hectares and decrease by 1241.93 hectares while WDVI shows the lowest increase in terms of vegetation cover

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(518.87 hectares) and a decrease of 317.35 hectares. TSAVI shows an increase of 1633.27 and a decrease of 1667.31 hectares in area of vegetation cover. Though the difference in the changes witnessed between increase in vegetation and decrease in vegetation was not so pronounced, but the increase in vegetation cover might be attributed to slight increase in rainfall in the years preceding 1986 and probably as a result of abandonment of farmlands by the migration of people out of the area due to frequent droughts witnessed in the period (1972 and 1986).

The correlation between rainfall and the vegetation indices is presented in Table 3. The results show that there is significant relationship between rainfall and NDVI at the 95 percent (p=0.05) level of significance while the other vegetation indices show no significant relationships in the period spanning 1972 and 2007 in the area. Although most of the results of the Pearson Correlation show no significant relationship existing between vegetation indices and rainfall, there is a strong negative linear relationship existing between the variables.

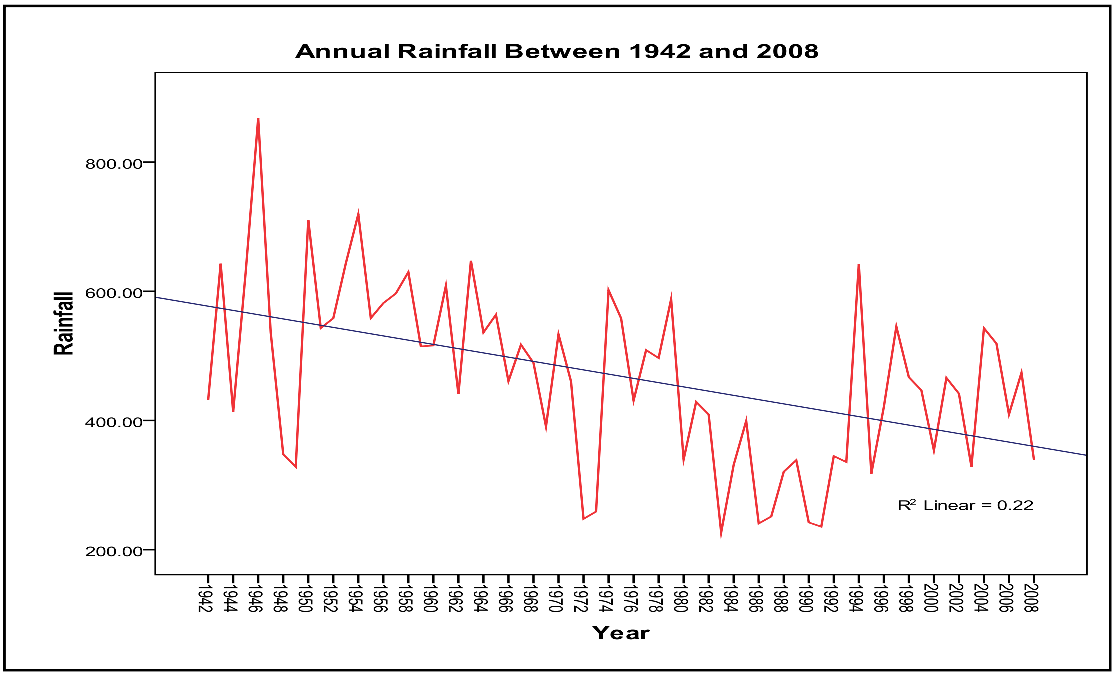


*Figure 3 :* Rainfall of the study area between 1942 and 2008

NDVI, GVI and TSAVI are the ones with strong negative correlations - r = -0.92, -0.75 and -0.77 - with rainfall while PVI and WDVI have weak linear relationship with rainfall. (r = 0.15 and 0.29). This means that there was decrease in vegetation cover in the area in spite of increase in rainfall between 1972 and 2007. It thus appears that other factors other than rainfall might have influenced the development of vegetation cover in the area.

*Table 3 :* Relationship Rainfall and Vegetation Indices

| Vegetation Index | NDVI | GVI | PVI | TSAVI | WDVI | Rainfall |
|---|---|---|---|---|---|---|
| NDVI | 1 | | | | | |
| GVI | 0.565 | 1 | | | | |
| | 0.217 | | | | | |
| PVI | -0.509 | -0.003 | 1 | | | |
| | 0.245 | 0.499 | | | | |
| TSAVI | 0.552 | 0.994** | 0.093 | 1 | | |
| | 0.224 | 0.003 | 0.454 | | | |
| WDVI | -0.223 | 0.299 | -0.361 | 0.210 | 1 | |
| | 0.388 | 0.351 | 0.320 | 0.395 | | |
| Rainfall | -0.919* | -0.752 | 0.155 | -0.770 | 0.288 | 1 |
| | 0.040 | 0.124 | 0.423 | 0.115 | 0.356 | |

*. Correlation is significant at the 0.05 level (1-tailed).
**. Correlation is significant at the 0.01 level (1-tailed).



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The result from the image differencing of the study area between 1986 and 2000 with respect to the vegetation indices show that NDVI, TSAVI and WDVI indicated greater degradation in vegetation cover than regeneration between 1986 and 2000 while GVI and PVI show more increase than decrease in vegetation cover (Table 4). The rainfall record shows that there was more rainfall in 2000 (353.8 mm) than in 1986 (240.5 mm). Thus, if rainfall had been the major determinant of vegetation development in the area (Anyamba and Tucker, 2005) then the change detection result should have shown greater increase than decrease in vegetation cover. However, reverse was the case as most of the vegetation indices gave a contrary result. This result therefore supports the earlier assertion that other factors especially human activities might have played a major role in the development of vegetation in the area within that period.

*Table 4 :* Vegetation Cover change in the study area between 1986 and 2000

| Vegetation Index | Area measured in Hectare | | | |
|---|---|---|---|---|
| | No change (0) | Decrease (1) | Increase (2) | Difference |
| NDVI | 7581.05 | 1549.61 | 1486.01 | -63.6 |
| GVI | 7297.58 | 1654.80 | 1664.30 | 9.5 |
| $PVI_3$ | 5265.09 | 2652.16 | 2699.43 | 47.27 |
| $TSAVI_2$ | 7237.15 | 1721.40 | 1658.13 | -63.27 |
| WDVI | 9750.09 | 450.96 | 415.63 | -35.33 |

The result of vegetation change detection between 2000 and 2005 is presented in Table 5. The values for NDVI indicate greater increase in area of vegetation degraded (1451.73 hectares) than in area of vegetation restoration or increase (1423.63 hectares) in spite of the increase in rainfall by up to 47.6 percent in 2005. GVI and TSAVI on the other hand indicated greater increase (regeneration) in area of vegetation cover (1338.91 and 1151.12 hectares) than decrease (degradation) in vegetation cover (1151.99 and 1147.63 hectares respectively).

*Table 5 :* Vegetation change detection of the study area between 2000 and 2005

| Vegetation Index | Area measured in Hectare | | | |
|---|---|---|---|---|
| | No change (0) | Decrease (1) | Increase (2) | Difference |
| NDVI | 7741.31 | 1451.73 | 1423.63 | -28.1 |
| GVI | 8124.77 | 1152.99 | 1338.91 | 185.92 |
| $PVI_3$ | 6847.59 | 1891.49 | 1877.60 | -13.89 |
| $TSAVI_2$ | 8317.93 | 1147.63 | 1151.12 | 3.49 |
| WDVI | 9500.89 | 788.61 | 327.17 | -461.44 |

Therefore, GVI and TSAVI show greater relationships with rainfall in the area during the period between 2000 and 2005 compared with the other indices. The relationships might also be as a result of the reflectance interaction with the soil background during the period. In line with above result of the NDVI, PVI and WDVI show higher degradation in vegetation cover (1891.49 and 788.61 hectares respectively) than regeneration (1877.60 and 327.17 hectares respectively).

Table 6 shows the results of vegetation cover change between 2005 and 2007. Three of the vegetation indices: NDV, PVI and TSAVI indicated greater degradation in area of vegetation cover than regeneration. The sizes of the degradation areas for the three indices are 1474.72, 1603.79 and 1634.33 hectares respectively, while the area sizes of vegetation cover regeneration are 1449.38, 1575.36 and 1597.94 hectares respectively.

The other two indices i.e. GVI and WDVI show increase in area of vegetation cover. The area sizes of the regenerated areas cover 1619.71 and 1597.94 hectares compared with areas of degradation which are 1532.23 and 1585.67 hectares respectively. In year 2007, there was a decrease in rainfall by about 8.7 percent from that of 2005. The decrease in rainfall would normally be expected to affect vegetation development. However, the magnitude of decrease does not appear large enough to have brought about the observed change. The human use of the environment remains a strong factor in the whole process vegetation dynamics in the study area.

*Table 6 :* Vegetation change detection of the study area between 2005 and 2007

| Vegetation Index | Area measured in Hectare | | | |
|---|---|---|---|---|
| | No change (0) | Decrease (1) | Increase (2) | Difference |
| NDVI | 7692.58 | 1474.72 | 1449.38 | -25.34 |
| GVI | 7464.74 | 1532.23 | 1619.71 | 87.48 |
| $PVI_3$ | 7437.53 | 1603.79 | 1575.36 | -28.43 |
| $TSAVI_2$ | 7452.80 | 1634.33 | 1529.55 | -104.78 |
| WDVI | 7433.06 | 1585.67 | 1597.94 | 12.27 |

The image differencing change detection shows variations in the biomass content of the area when compared with rainfall data in the periods under review. Thus the results show that rainfall is not the only determinant of vegetation development in the area as was seen from the pattern of vegetation dynamics earlier presented. Fragmentations of the landscape was seen all over the areas which suggests that human activities have to be taken seriously if any conservation project is to succeed in the area. Giving the importance of trees in maintaing balance in the ecological systems,

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more efforts is required in establishing and properly managing parks and forest reserves in the area. This is in order to fight the encroaching desert and mitigate the impact of climate change. Trees are also known to sequester CO2 in the atmosphere therefore their establishment will also mean reducing the effcts of global warming. UNDP, (2009) suggested that about 20 percent of an area is required to be conserved in order to maintain and improve the ecological and social welbeing of a region.

## V. Conclusion

The results on vegetation change detection using vegetation indices (VIs) show limited relationships between vegetation indices and rainfall in the study area, whereas studies on the relationships between rainfall and vegetation change at regional scale show that there is high correlation existing between them (Anyamba and Tucker, 2005; Fabricante et al. 2009). This therefore shows that anthropogenic rather than natural factors (e.g. rainfall) have more influence on the vegetation of the area at a local scale. In other words, the human activities in the area are responsible for the degradation of the environment. This therefore calls for concerted efforts in educating the dwellers of such fragile ecosystem on the consequences of devegetation on their environment. The regression differencing method of change detection proved to be good in discriminating changes in vegetation cover (trees, shrubs and grasses). The advantage of this method of change detection is that it can be used to detect “hot spots” where vegetation cover degradation is actively taking place so as to arrest the trend before it goes out of hand. This will help in the achievement of sustainable plan and in management of the dwindling ecological resources especially in arid environment.

## VI. Acknowledgement

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## References Références Referencias

1. Anyamba A. and C.J. Tucker, 2005. Analysis of Sahelian vegetation dynamics using NOAA-AVHRR NDVI data from 1981–2003. Journal of Arid Environments 63: 596–614.
2. Bonan, Gordon B., Keith W. Oleson, Mariana Vertenstein, Samuel Levis, Xubin Zeng, Yongjiu Dai, Robert E. Dickinson, Zong-Liang Yang, 2002: The Land Surface Climatology of the Community Land Model Coupled to the NCAR Community Climate Model. Journal of Climate 15: 3123–3149.
3. Eastman, J. R., 2009. IDRISI Taiga Guide to GIS and Image Processing. Worcenter, MA USA, Clark Labs, Clark University.
4. Fabricante I., Oesterheld M. and Paruelo J. M., 2009. Annual and seasonal variation of NDVI explained by current and previous precipitation across Northern Patagonia. Journal of Arid Environment 73: 745–753.
5. Lu, D., Mausel, P., Brondízio, E. and Moran, E. 2004 'Change detection techniques'. International Journal of Remote Sensing 25: 2365 — 2401.
6. Mas, J. F. 1999. Monitoring land-cover changes: a comparison of change detection Techniques. International Journal of Remote Sensing 20: 139- 152.
7. Oguntoyinbo, J. S., 1983. Climate. In (eds) Oguntoyinbo, J. S., Areola, O. O. and Filani, M. A geography of Nigerian development. (Second edition). Ibadan, Heinemann Educational Books.
8. Oruonye, E. D. 2009. Geographical aspects of Yobe State, Nigeria. Jos, Fab Education Books.
9. Pu, R., Gong, P., Tian, Y., Miao, X., Carruthers, R. I. and Anderson, G. L. 2008. Using classification and NDVI differencing methods for monitoring sparse vegetation coverage: a case study of saltcedar in Nevada, USA. International Journal of Remote Sensing 29: 3987–4011.
10. Singh, A., 1989, Digital change detection techniques using remotely-sensed data. International Journal of Remote Sensing 10: 989–1003.
11. UNDP, 2009. Climate Change in African Drylands: Adaptive Livelihood Options.
12. UNDP-UNEP-UNCCD papers (May, 2009) retrieved from www.undp.org/drylands UNEP. 2008. “Africa: Atlas of Our Changing Environment.” Division of Early Warning and Assessment (DEWA) United Nations Environment Programme (UNEP) P.O. Box 30552, Nairobi 00100, Kenya.
13. Washington-Allen, R. A., Ramsey, R. D., Norton, B. E., and West, N. E. 1998. Change detection of the effect of severe drought on subsistence agropastoral communities on the Bolivian Altiplano. International Journal of Remote Sensing 19: 1319- 1333.
14. Wojtek J. Krzanowski, 2007. Statistical Principles and Techniques in Scientific and Social Investigations. New York, Oxford University Press.



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# Environment Management in Mining Areas (A Study of Raniganj and Jharia Coal Field in India)

By Dr. Sribas Goswami
*Serampore College, India*

*Abstract-* Coal mining practices in India have a long history. On a commercial scale mainly British companies started it in India. From its very first day exploitation of coal reserve started and it resulted into the environmental degradation through various ways. It is a topic of research importance because now a day the environmental problem is a burning global issue. Now a day if one observes any coal-mining project in India the truth aforesaid will automatically reveal. There is destruction of vegetation, soil resource, water resource; underground resource and great intensity of various pollutions have been observed. In short an inhuman treatment is meted out to the environment by modern civilization. The Raniganj Coal Field of Eastern Coal Field Ltd. and Jharia coalfield of BCCL are not an exception in this regard. Eminent Research scholars have done many research works in India regarding coalfield. But here the author wants to emphasize the environmental impact of the Raniganj and Jharia coal mining projects through this research work. Though coal is an essential resource but protection of environment is not less important. The author wants to disclose all the environmental impact of coal mining projects with its possible preventive measures. So the environmental impacts of coal mining projects are immense which will also help understand the development of Raniganj and Jharia coalmines.

*Keywords:* *coal mines, eco friendly environment, bio-restoration, a-forestation, combustion.*

*GJHSS-B Classification :* *FOR Code: 961007*

ENVIRONMENT MANAGEMENT IN MINING AREAS A STUDY OF RANIGANJ AND JHARIA COAL FIELD IN INDIA

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## I. History of Coal Mining in India

Coal mining on a commercial scale was started in India mainly by British Companies. Mining practices adopted were based naturally on the experience of mining engineers. As large capacity excavation equipment was not developed, even shallow thick seam deposits were mined by underground bored and pillar method. This has lead to huge loss of coal and problems of fire. A large part of good quality of coal reserve in standing on pillars and its liquidation does not appear in sight.

Today the obvious choice for most of such areas would have been opencast mining, had it not been developed by underground methods. With the availability of large sized excavation equipment,moving during the construction of dams. Many of the experts of opencast mining in India had worked on such dam construction projects. A large part of the HEMM (Heavy earth moving machinery) had come from U.S.A., which even now leads in the manufacture of HEMM. A responsible manufacturing base of HEMM has been established in India. The mining practices followed today have been influenced by this historical fact to a considerable extent. NCDC (National Coal Development Corporation), a public sector company, formed in 1956, sought collaborations with Polish and Russian mining institutes. This led to the development of a few underground shaft mines with mining methods practices in the aforesaid countries. With the rapidly increasing demand of power grade coal, high capacity fully mechanized opencast mining commenced large inferior grade thick shallow coal deposits had been ignored altogether in the past, as earlier the demand was mainly for the superior grade of coal.

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## II. Eco-Friendly Coal Mining in Raniganj and Jharia

Towards the beginning of the earth's history the four spheres on the globe, i.e. the lithosphere (the land), hydrosphere (the water regime), atmosphere and biosphere (the plants and animals) had been set by the nature in a balanced state to live irresponsible harmony with each other. The system had thus been in the state of a simple balance in which any action in one part would result into an equal and opposite reaction in the system itself. Three among these four spheres, namely lithosphere, hydrosphere and biosphere together from the "ecosystem", the result of juxtaposition of land, water, forest, men and animal (biosphere). Any damage to any component of this result in damage to ecosystem, the counter-effect of which to the same system may not always be very acceptable or comfortable to men, as men is a part of this same system. Because of this fact all industrial activities should be planned and executed in such manner that the natural ecosystem is damaged to a minimum extent.

Coal Mining is a development activity, which is bound to damage the natural ecosystem by all its activities direct and ancillary, starting from land acquisition to coal beneficiation and use of the products; but it cannot be avoided be avoided because it required development. Hence it is the time of "Eco-friendly Coal Mining".

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## III. Damage to Ecosystem by Coal Mining

Damage to ecosystem by coal mining starts immediately after land acquisition, when pre-mining land-uses start shifting. This may require shifting of habitations to new sites, which may require damage to greenery at the new site. Further, to replace a cultivation or horticultural land may require cutting greeneries which were existing at the new site. Regarding forest-lands to be disturbed by mining, "compensatory a forestation" is an essential activity but to view from the stand-point of ecology, "no forest can be compensated in a year or two", as forests the sum total of ecological, and biological parameters. What can be done is, only "compensatory plantation". Saplings of selected forest species planted in the name of "compensatory a forestation" can only form, at best, a dense population of plants which will take a considerable number of years to from a real forest. Over and above such direct damage to ecosystem after land acquisition, greeneries and surface water bodies may gate damaged by direct excavation (at the quarry sites) the OB dumping (at the OB dumping sites) causing a direct damage to ecosystem.

Any excavation, be it at the mining site or at the site for rehabilitation of the population to be shifted, opens a source of severe erosion and hence damage to land and surface water bodies by situation. Further, to facilitate excavation below water table it needs pumping out of ground water which damages ground water resource of the region. This results in chances of damage to greenery.

After excavation the coal needs haulage, storage, transportation and beneficiation before it is used. Throughout the total process coal-dust spreads over the surrounding land and greeneries. This damages greenery growth and specially sprouting of fresh leaves.

Damage to greenery results in more barren land, more erosion, and loss of surface water bodies by siltation, hence decrease in irrigation potential of the region which triggers the cycle of land degradation. This total process, once started, works through number of "do-loops" in accelerated speed resulting into more damage as detailed in figure given below. The ultimate effect is damage to ecosystem which is exhibited in the regions land-cover and land-use pattern. Studies from Jharia and Raniganj coalfield corroborate this fact.

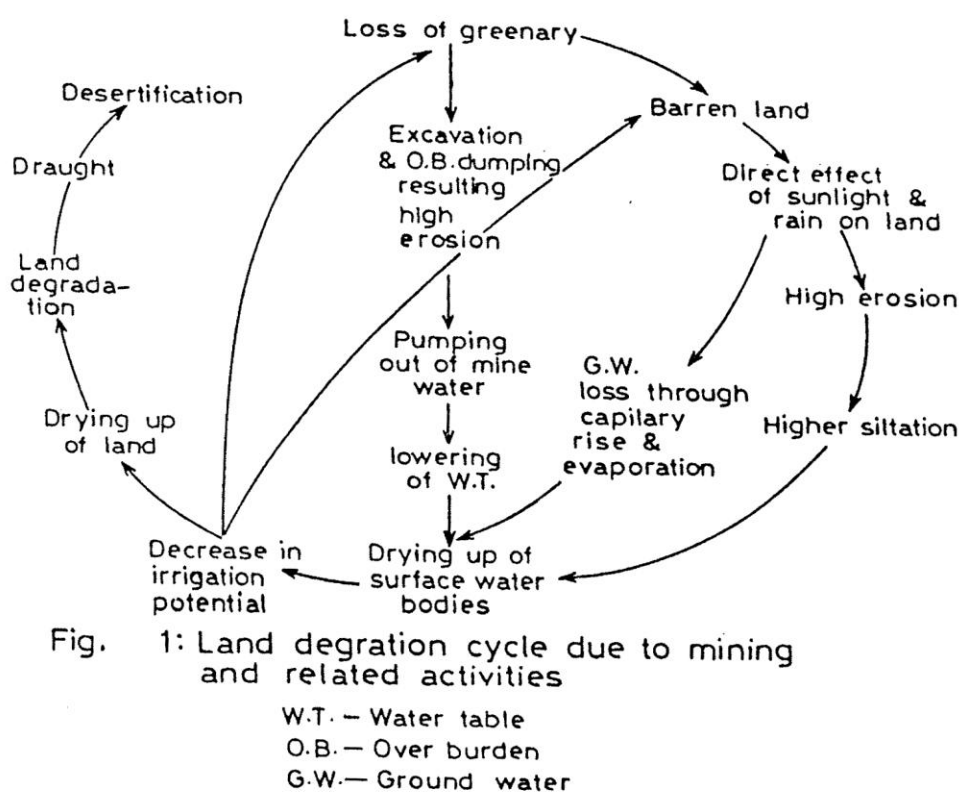


*Figure1 :* Main Issues for Eco-friendly coal mining

The parties to the Climate Convention have already committed to promote and cooperate in the development, application, and diffusion including transfer of technology to reduce and control greenhouse gas emission. As per the President of the World Resources Institute, Washington, "if countries who sign the treaty put in place the requisite policies and action, the world will be set on a new course, one which is less

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dependent on fossil fuels, less polluting and less a threat to human health." The industrialized countries have to play a major role in this endeavor in the light of the fact that 20% of the world population in these countries is responsible for 90% of the global carbon emission that has been carbon emission that has been released into the atmosphere since the industrial revolution. They should help the developing countries introducing cost effective emission control measures and efficient technology for clean power generation. This will help reduce the threat of global warming which is likely to cause 1 to 3.5 degree centigrade rise in earth temperature within next century. It may be of interest to note that this may cause more rapid change in the climate than has occurred for the last 10,000 years. The life cycle of coal starting from exploration to mining, beneficiations and combustion has damaging impact over environment and ecology. The issue is mainly to take account of the global efforts and add its humble contribution in the following areas:

## IV. Mining

The mining of already developed, caved or partially worked coal seams in many coalfields has advanced mixing and hence clean coal is the casualty with the underground and surface mining. Reduction of ash content will minimize the load over the transport system which is to be carried to remote areas. Eco-friendly mining with subsidence control and protection of fields, farms and forest need in-depth R&D effort. Waste management may be integrated for surface protection and support for selective thick seam mining. Following dimensions of mining technology are needed in the interest of eco-friendly coal mining:

- Horizon control during mining underground to avoid dilution of roof floor.
- Selective mining technology of desired quality coal by leaving the bands underground
- Ways and means to control the dilution of coal quality at the loading point, railway siding and dump site.
- Backfilling of waste material sorted, picked or segregated in the voids created during mining
- Methane drainage and utilization to minimize release to the environment.
- Control of mine fire and oxidation of coal to minimize carbon dioxide release to the atmosphere.

## V. Transport

- Scope of encapsulated transport of coal to pit top bankers of nearly build consumers.
- Scope of inland water channel transport of coal-rivers like Brahmputra, Ganga, Godavari, etc.
- Transport of coal from mine site to the loading points by artificial canals or water channels.
- Scope of coastal shipment of coal to enter remotely located coastal consumers.
- Railway transfer pits-handling plants at main dump sites to minimize pollution level.
- The road transport restricted to sealed containers, on well maintained roads of heavy duty and dedicated lining.
- Location of power units close to the pit top with water channel transport.

## VI. Combustion

- Evaluation of residual life and modernization of the inefficient power plants.
- Adopting state of art technology for upcoming power plants for energy efficiency.
- State of art technology for greenhouse gas emission control.
- Scope of locating power plants close to the mine site or nearest locale to the production.
- Efficient management of fly ash and bottom ash including underground packing.
- Development of efficient national power grid for power traction rather than coal transport.

## VII. Environment

- Protection of land, water, atmosphere and bio-diversity during mining
- Reduction in vehicular emission, pollution and particulate load
- Adoption of the state of art technology for pollution control in mining, transport & combustion
- Reclamation of mine site for landscaping, green cover and aforestation
- Rehabilitation and resettlement of flora, fauna & displaced population

Environment and ecology of the earth has been disturbed with the increasing use of fuel; particularly coal produced over the last centuries by the developed world. This has taken the global up to the verge of ozone hole formation and global warming. The developing world has joined the race and if adequate precaution is not taken, the globe will suffer irreparable loss and every creature of the earth will have to bear the brunt of it. The global fraternity has to open to ensure better environment and ecology of the mother earth to keep it safe for our posterity and maintaining sustainable uniform growth of the present populace.

This needs sharing of knowledge, technology and resources by the developed world so as to maintain the rate of progress in the under developed nations. Energy is being the prime mover; especially coal playing important role requires special attention in terms of clean coal initiatives as this is going to be the main source of commercial energy of tomorrow in some of the developing nations. The developing the sate of art



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technology in mining, transportation, beneficiation and combustion to save our common heritage.

## VIII. Impact of Coal mining on Human Health

Coal mining operations have resulted in environmental degradation, ecological changes and are associated with health and safety of mine workers. The environmental hazards are dangerous for the mining community as they aggravate the problem of ill-health. Majority of the children suffer from moderate malnutrition and are found to have vitamin and iron deficiencies in particular. Mining communities, who have inferior access to balanced diet, easily falls pray to the chain of malnutrition, poor health and weakness which are prone to diseases. Polluted environment further aggravates the situation. Clean coal technologies are definition an answer to the above mentioned problems. However, it is very doubtful that such mining condition because of their high cost, high level of pollution etc. As scholar stated "falling into the trap of opting for technologies which are not sustainable within our means."

## IX. Health Technology

A new technology to combat environment stresses on the working personnel associated with coal mining can be betterment of their health by gainfully using the knowledge of proper nutrition and balanced diet. A large section of the population in and around the coal mining area in Damodar Basin suffers from chronic water borne diseases. Miners develop intestinal parasitic infection, anemia, skin diseases, tuberculosis; they also succumb to diarrhea, weight loss and are subjected to respiratory infection. The transition of the natural environment which has resulted in worsening of the situation can be tackled effectively with the help of health technology.

Health is the key to all progress, whether for the individual or for the society. Overall social and economic development of a country depends on the health of its workers. To achieve good health better identification and improvement in nutritional status is necessary. The quality of nutrition affects the well-being and immune capabilities of a person.

A personal survey was conducted in two different coal-belt areas of Damodar River Basin. From hospital records and general survey it was found that people suffering from gastrointestinal diseases were high in both the areas due to water pollution and unhygienic conditions. People suffered from respiratory diseases as a result of air pollution in both areas. Besides the above mentioned two types of diseases, it was observed that due to nutritional deficiencies anemia, skin diseases were commonly found among the mining population. But what is noteworthy is that, people living in unhygienic conditions and suffering form nutritional deficiencies and its effects is higher in one area in comparison to the other as observed in Table 5.4.. Consciousness regarding proper nutrition, health and hygiene helped the people of one region to reduce nutritional deficiencies.

Salient points of health technology proposed for coal mining community is briefly discussed below. Solid foundation must be laid early to lead a healthy life. Individual responsibility and self help must be of prime importance. Thus the emphasis has shifted from 'Health care for the people' to 'Health care by the people'. Food taken must be simple tasty, nutritious, variable and balanced. An individual's nutrition is linked with his health and development during childhood years. Thus children must be well-fed with suffer from polluted environment linked diseases. Grain-based diet can also have more nutritive value than meat-based diet. Flexibility and opportunism in diet are valuable. Drinking water must be clean. Simple rules of personal cleanliness must be observed and basic elements of health education must be followed.

Health education about simple sanitary practices and checking of unhealthy dirty habits such as spitting, buying and selling of food exposed to flies and dust etc. must be checked. Diarrhea, weight loss, anemia, dermatitis can be checked by ensuring proper nutrition sanitation. Consumption of clean water will check diseases such as typhoid, cholera, dysentery. It is also necessary to see that a habitat is also necessary to see that a habitat is not over congested. Primary health care is the prerequisite of health technology and so periodical health check up must be done. Mind free form tension but constantly engaged provides food for happy and healthy life. Yoga, hygiene has a key role to play in maintaining proper health.

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*Table 1 :* Morbidity Pattern of Worker's Community in Coal Mines (2008-2010) Raniganj Coalfild and Jharia Coalfield

| Type of Diseases | No. of patient | % | No. of Patient | % |
|---|---|---|---|---|
| Gastrointestinal disorder | 4076 | 19.32 | 4289 | 21.52 |
| Respiratory disease | 3224 | 15.28 | 3384 | 16.98 |
| Ear disease | 629 | 2.98 | 622 | 3.12 |
| Skin disease | 475 | 2.25 | 702 | 3.52 |
| Joint Pain | 460 | 2.18 | 494 | 2.48 |
| Fever (Malaria, Filaria etc.) | 3051 | 14.46 | 3113 | 15.62 |
| Anemia | 4365 | 20.69 | 4461 | 22.38 |
| Injury | 1401 | 6.64 | 861 | 4.32 |
| Cardiovascular diseases | 722 | 3.42 | 630 | 3.16 |
| Other ailments | 2696 | 12.78 | 1375 | 6.90 |
| Toatal | 21099 | 100.00 | 19931 | 100.00 |

*Source : Personal survey-2010*

*Table 2 :* Calorie Consumption of Coal Miners' Community

| Type of work | Calorie Require-ment | Coal Mine No.1 Calorie consu-mption | calorie defici-ency % | Excess % | Coal Mine No. 2 Calorie Consu-mption | deficiency % | Excess % | Calori Consu-mption | Average Defici-ency % |
|---|---|---|---|---|---|---|---|---|---|
| MAN | | | | | | | | | |
| Heavy work | 3900 | 3540 | 9.23 | - | 3860 | 1.03 | - | 3700 | 5.13 |
| Mod. Work | 2800 | 2650 | 5.36 | - | 2890 | - | 3.21 | 2770 | 1.07 |
| Sed. Work | 2400 | 2210 | 7.92 | - | 2410 | - | 0.42 | 2310 | 3.75 |
| WOMAN | | | | | | | | | |
| Heavy work | 3000 | 2630 | 12.33 | - | 2890 | 3.67 | - | 2760 | 8.00 |
| Mod. Work | 2200 | 1990 | 9.55 | - | 2170 | 1.36 | - | 2080 | 5.45 |
| Sed. Work | 1900 | 1770 | 6.84 | - | 1930 | - | 1.58 | 1850 | 2.63 |
| ADOLESCENT | | | | | | | | | |
| 10-12 Years | 2100 | 1550 | 26.19 | - | 1690 | 19.52 | - | 1620 | 22.86 |
| 7-9 years | 1800 | 1330 | 26.11 | - | 1450 | 19.44 | - | 1390 | 22.78 |
| 4-6 years | 1500 | 1080 | 28.00 | - | 1220 | 18.66 | - | 1150 | 23.33 |
| 1-3 years | 1200 | 830 | 30.83 | - | 960 | 20.00 | - | 895 | 25.42 |

*Source : Personal survey-2010*

Special attention has to be paid to women and children. Health technology emphasizes on health status and education. Today man is armed with sufficient knowledge of balanced diet to achieve all around progress.

Besides good food several other factors also help to lead a healthy life. It is observed that in coal mining area where pollution level is high people with simple fares, frugal habits and having contented mind have better longevity.

Health technologies which are relatively an inexpensive technology and are well within our means serve as a simple guide to healthy living. Health care program combining and coordinating the needs of both curative and preventive medicine, knowledge of balanced diet are the prerequisites of the people residing in coal mining region for sustaining healthy and vigorous life. To draw utmost benefit from health technology information must be transferred by proper motivation through training education and feedback.

## X. Process of Environmental Rehabilitation in Opencast Mines

Coal is the major primary source of energy and has a share of about 60% in the National energy scenario. Besides, the coal is also used by the steel and other base manufacturing industries. It is rather ironical that the power grade coal, the prime source of energy is deposited in the forest areas. This immediately brings



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direct confrontation of coal exploitation with environment.

The perspective plan of the production programme drawn for the VIII & IX Plan and 2007-08 period is given below:

*Table 3 :* Technology-Wise Coal Production Programme From Indian Mines

| | 1992-93 | 1993-94 | 1994-95 | 1995-96 | VIII plan 1996-97 | IX Plan 2001-02 | 2007-08 |
|---|---|---|---|---|---|---|---|
| Opencast | 168.33 | 177.33 | 190.60 | 199.84 | 210.82 | 274.45 | 403.74 |
| Underground | 68.76 | 71.78 | 74.98 | 79.79 | 82.39 | 95.58 | 43.96 |
| Total | 237.09 | 249.51 | 265.58 | 279.63 | 293.21 | 370.03 | 447.00 |

*Sources : CMPDI Survey Report, 2010.*

Though the above figures are rather indicative, the growth of opencast production in absolute terms will need opening of big new mines. This will in turn, have confrontation with the environment and will need effective rehabilitation measures for their environmental restoration.

The opencast mines generally affect most of the environmental attributes. However the major concerned descriptors of the environment being affected are land, water, air, flora and fauna.

The environment in an opencast mine in post-mining phase is as important as or rather more important than the operational phase. The importance of post-mining environment can be comprehended since the post-mining scenario become everlasting unless properly rehabilitated. The rehabilitation of the mined out areas and the OB or reject dumps assume special significance in the rehabilitation efforts in the post-operational period.

## XI. Environment Impacts of Opencast Mines (Operational Stage)

Before going to the post mining stage, the environmental impacts of the operational stage can briefly be discussed.

### *a) Air*

The air in the opencast mine including its surrounding zone is affected due to various mining operations. If effective dust suppression measures are not taken the air quality deterioration in the operational stage of an opencast mine may become appreciable. However, for environment, health and operational efficacy the dust suppression is taken care by the mine management.

### *b) Water*

The natural water system in the project area as well as its surrounding zone is affected due to various reasons like mine water discharge, erosion from dump etc.

### *c) Land*

The impact on land in the operational phase is direct and visible. The mined-out area, the overburden or reject dumps, the infrastructural built-up area all affect the land during the operational stage. Unless proper reclamation is possible by backfilling, the land impacts during the operational stage remain visible and glaring. Most of the land management can be done only in the post-mining stage. However, at present thrust is for concurrent or early backfilling and physical reclamation of the mined areas or OB dumps during the operational phase itself.

### *d) Flora and Fauna*

The flora and fauna in the forest areas face the direct impact of the mining operation. The diversion of forest land for the mines and OB dumps clearly affect the floral system in the area. The fauna in the area normally migrate because most of the coal mines in the forest area are surrounded by contiguous forests.

## XII. Environmental Impacts of Open cast Mines (Post-Mining Stage)

The following are the impacts on the environmental descriptors in the post-mining stage as can be envisaged at present.

### *a) Air*

After closure of the mining operation the activities causing air pollution are minimized. The activities of reclamation and rehabilitation of the areas may generate just a meager quantity of dust. This is not likely to have any impact on the ambient air quality.

### *b) Water*

The impact on water quality after the closure of the mining operation will also get reduced appreciably. The pumping of the mine water is likely to the mine water is likely to stop due to reduced activities. The quality of mine water, even if pumping is continued for some reason will be always within the acceptable limits. The pollution due to waste dumps will also slowly reduce with improved vegetative cover on these waste dumps. The problem of acidity or alkalinity will also appreciable reduces with no exposure of fresh rock surfaces in the mined area. It is therefore stated that rehabilitation of the dumps is a must for controlling the water pollution.



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*c) Land*

Land is a major problem even in the post-mining stage. The following land uses will result upon completion of the mineral extraction.

i. Mined-out area (voids)
ii. Internal dump areas
iii. External dump areas
iv. Infrastructural areas
v. Residential areas.

Out of the above, the residential areas may be suitable developed so that aesthetically and also environmentally they remain acceptable. However, other four post-mining land uses need proper rehabilitation so that they match with the ambient scenario and are acceptable to the society as a whole.

*d) Flora and Fauna*

The impact on flora and fauna after completion of the mining operation would remain insignificant. However, a possible impact can always be envisaged with proper planning of the land use and proper harvesting of the water and soil resources within or near the project area. The proper rehabilitation of the mining areas and rational utilization of water and soil resources will help to enrich the growth of flora and thereby advent of the migration fauna. This could be useful post-mining scenario.

## XIII. Rehabilitation Measures

*a) Land*

Land is a limited resource under the prevailing circumstance. It can be called a depleting resource. There is continued denudation of the top soil rendering the useful land as waste land. The waste land can be regenerated but the geological process of the top soil rendering the useful land as waste land. The waste land can be regeneration by us may not be effective. Therefore land can be treated as a depleting resource.

The population density of our country is galloping in each decade. The rate of increase has already caused concern and therefore there is pressure on the conservation of good land and regeneration of the waste land. This establishes that rehabilitation of the mining areas is a national priority and has to be taken up in concerted way with required steps.

The following are the different post-mining land use scenario. These are:

i. Mined out and internal dump areas
ii. Internal and External OB dumps.
iii. Infrastructural areas and residential areas.

The rehabilitation measure for each of the above scenario is discussed below:

*b) Mined-Out Areas*

The different in the post-mining stage can be envisaged as follows.

- Complete void
- Partial void
- Completely backfilled

In situations where the underlying seams are yet to be worked or the waste generated by the mine has been used for some very useful purposes, this situation of the complete void is envisaged. This is normally a rare situation. Normally partial void situation in the mined-out areas are a common feature. This situation arises as voids left over the last years of the mine life cannot be backfilled without re-handling, or bringing waste from the other operational mines. The partial void situation presents a suitable scenario for effective rehabilitation. The situation of the completely backfilled area is again quite rare but this may arise due to some safety reasons of not allowing the water bodies in the abandoned mine.

## XIV. Rehabilitation of Complete Voids

In the coalfield situation where water is a scarce resource the complete void scenario presents an opportunity for water harvesting and conservation. If the mine is isolated from the workings in the neighborhoods, the void can be ideally suited for being developed into ponds. The different uses of the water can be for supporting the life in the vicinity, as a water resource the inhabitants, development of fisheries, development of picnic sites and it will also act as moderator of heat and temperature in the ambient area. For developing fisheries and scenic sites a scheme need be drawn and suitable modifications in and around the mine voids will be affected.

## XV. Partial Voids

This is a common situation arising in the opencast mining. Normal practice for a useful post-mining land use is to develop the haul road in the mine on one of the flanks. The backfilling is systematically carried out from the other end of the quarry. The backfilled areas are so fro filed that the dump level at the quarry edge matches the height of it he external dumps if disposed near the quarry edge in the blasting zone. This situation normally creates small water body at the dip side and along the haul road maintained at one of the flanks.

This situation can be used again for water harvesting and developing a scenic spot and also fisheries in the water bodies. The backfilled area of the mine can be developed for afforestaion or as pasture land. The physical rehabilitation of the backfilled area will not be complicated in the instance case. With water availability within the area being reclaimed, the aforestation over the backfilled area will be a good land use. It can be developed into a suitable picnic spot.



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## XVI. Completely Filled Areas

This situation allows the mining authority to productive uses of the reclaimed area. After proper physical reclamation by dozers and graders a layer of soil will be spread over. The soil will be treated with suitable modification agents for generation of micro biota. As the soil conservation can be feasible in this situation, the land can be generated to support even agriculture. The afforestation and the pasture land development will always be possible in these circumstances. The filled-in areas will be reclaimed physically so as to match with the ambient landscape. After the bio reclamation, the re habited area will be in complete harmony with the local scenario.

## XVII. Ob Dumps

Reclamation of OB dumps is one of the most challenging areas in the Environment Management of opencast mines. The physical reclamation of the dumps need making the slope area mild enough (30 degree gradient) for supporting the attempt of water and soil conservation. In difficult conditions small benches at intervals of 3 m or so may be developed.

The development of the OB dumps can be programmed in 2 different ways:

- Building the peripheral area for immediate bio restoration.
- Building the dumps in complete totality before bio-reclamations done.

The first choice is more scientific and if implemented will give good results. In systematic mining conditions, this choice must be adhered to. The development of the peripheral first bench is required to be done. The peripheral development of subsequent bench is not bringing out the same advantage. Once the peripheral area of the first bench is physically and biologically reclaimed, the dumping in the first bench can be continued without any adverse impact of situation and soil or water conservation. The second bench can be developed with complete filling from one end with the beam width between the benches needing to be kept only up to 30 m on the top of the first bench onwards. The silt load from the second and third benches will be caught by the bio-reclaimed area of the first bench and will not be allowed to enter the natural water benches also. The physical reclamation of the OB benches by toe walls, proper beam widths, mild slopes (30 degrees) and adequate bunds at the top of the OB dumps will be completed with.

## XVIII. Bio-Restoration of The Dump Area (Both Internal and External)

The broad objectives of bio-restoration of the dumps are

a) Ecological restoration
b) Soil and water conservation
c) Preventing air and water from entering the layers of coal seams
d) Providing effective coverage to the mine area so that the pumping needs of the mine area is reduced
e) Bring improvement in the aesthetics of the area and moderate the ambient temperature
f) Providing fodder and fuel for the local population
g) To support economic activities of the area by providing timber, fruits and other raw materials.

## XIX. Principles of Mine Restoration

*a) Physical Reclamation*

i. The hydrology after reclamation should be as close to the original as possible.
ii. The dump slope should be stable (nearly 30 degrees), the flat portion of the dump top should slope inward.
iii. The dumps should be developed with due considerations of spontaneous heating.
iv. The sediment control measures should be developed to ensure soil conservation on the dumps.
v. The precipitation drainage and internal seepage should be properly taken care of.

*b) Biological Reclamationl*

i. Protection and reuse of top soil is an important activity
ii. Dust in the ambient air to be reduced.
iii. Choice of succession of plantation-grass, legumes and trees to be decided.
iv. Choice of species of grass, legumes and trees to be finalized based on the ambient air, water and soil quality.
v. Nursery development for sapling to be ensured
vi. Study and application of micro organisms to be ensured.
vii. Suitability of fertilizers and manures to be decided.
viii. Lab facilities for evaluation of air, water and soil to be developed
ix. After care of pants to be ensured.

## XX. Role of Micro-Organism in Reclamation Process

Mine spoil and mined land lack microbial activity as it is devoid of organic matter. Microbial processes such as humification, soil aggregation and nitrogen & carbon cycling are essential in establishing productivity in mine spoil. The restoration of spoil and mined land should be evaluated not only on above ground biomass, but also on the degree of development of functional microbial population resembling those in undisturbed soil, namely, Bacteria, fungi, Actinomycetes, Rhizobium, Azatobacter etc. which play

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an important role in biological reclamation. Microbial processes are so important to ecosystem recovery that the activity of micro-organisms can be used as an index of the progress of spoil restoration in mine land reclamation.

Micro-organisms are prolific producer of vitamins, amino acids and other growth regulation substances. Many soil bacteria and fungi syntheria and fungi synthesize compounds that provoke a growth in plant tissue. Some produces chormone-indol actic acid (IAA) and gibberlicacid which control plant growth, while others produce vitamins. Rhizopheric micro-organisms are differently credited with promoting increased rate of seed germination. Some micro-organism serves as bio-fertilizers and provides stability to plants to respond to stress and to promote growth of pant on mine spoil.

## XXI. Some Success Stories of Rcf and Jcf

GHANSHYAM COLLIERY (ECL, WEST BENGAL): This colliery in Raniganj Coalfields has opencast mined-out area and overburden dumps. Some of the mined-out areas were backfilled and a large operation was left for water storage. The quarries are on both side of GT road. On the north side the water pond has been developed and the backfilled area has been densely planted. On the south side plantation on overburden dumps have survived for more than 6 years and now give a good aesthetic view.

KATRAS O.C.P (BCCL, JHARKHAND): In this project large area of overburden dumps have been reclaimed by plantation on the east side of the mine up to the railway track. The plantation consists of the following species:

a. Dalbergia sisoo
b. Acacia nilotica
c. Acacia auriculiformis

These plantations are surviving for the last five years and some grass is also growing on this over burdens. This gives good picture of biological reclamation of the OB dumps. It may, however, be noted that the initial OB on the eastern side was having some top soil mixed with it. It was not as refractory as the present OB dumps on the quarry.

## XXII. Conclusion

In the forgoing discussion we have discussed broad aspects of mined and reclamation along with the ecological restoration. The key to the success is perseverance with the improvement of vegetation cover. The main support to this key is meticulous planning of the OB dumping in proper horizon and strict adherence to the sectional dumping. Preservation of the top soil and its timely reuse are other key areas to achieve fast environmental rehabilitation. The success stories discussed indicate that both in backfilled areas as well as overburden dumps sincere efforts will pay. It is concluded by saying that rehabilitation of the mined-out areas needs care at all the stages and for an encouraging result the awareness at the project and at the area level has to be generated. Once convinced of the good results of the efforts the operational people will involve whole-heartedly and the success of the rehabilitation measures can be ensured.

Opencast mining in the Raniganj and Jharia region has created deep depression and massive flat-topped overburden dumps of sandstone and carbonaceous shales. These rocky materials have very little organic matter and need to undergo special treatment before they can be reclaimed and revegetated. Open cast mines have now become the largest agent for destroying and dereliction of land in Raniganj and Jharia coal belt. According to CMPDIL report (2010) approximately 55.5 Sq. Km. of land has become abandoned due to active surface and underground mining the land excavated in such mines is lost forever to the local community, stagnant waters of exhausted depressions either become a source of malaria or the water quickly dries up in summer and have little resource value. The dumps are regular death traps for local children who haunt the sites in search of leftover coal. The opencast mines have led to alternations in geomorphological, hydrological and biotic processes both at the local and the regional level, leading to the disruption in ecosystem development.

Rarnganj and Jharia coal mining region plays an important role in countries overall development. This region has well developed transport and communication and rich in mineral resources. This famous coal bearing region has got very well scope for large industrial development along with other developments of agriculture, livestock, forest, water and other minerals. An integrated approach is very necessary for a sustainable development in this region.

It is thus clear that coal mining leads to environmental damage, while economic development and self-reliance call for the increased mining activities of the available mineral resources. Though there is no alternative to the site of mining operations, options as to the location and technology of processing, adaptation of eco-friendly coal mining process and a forestation in the mining site etc. can really minimize that damage to the environment.

## References Références Referencias


1. Agarwal.A and Narain.S. (1991), " Global warming in an unequal World" International Sustainable Development. Vol.1. Oct. pp. 98-104.
2. Bagchi. A and Gupta, R.N. (1990), "Surface blasting and its impact on environment", Workshop on Environmental Management of Mining Operations, Varanasi, pp.262 -279.




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3. Biswas, A.K and Agarwal, S.B.C. (1992). "Environmental Impact Assessment for Developing countries": Butterworth aeinemann Ltd. Oxford, pp.249
4. Bose, A.K.and Singh, B. ( 1989). "Environmental Problem in coal Mining areas, Impact assessment and Management strategies- case study in India": vol-4, pp.243
5. Ghose, K. M. (2004). "Effect of opencast mining on soil fertility" Centre of mining environment, I.S.M, Dhanbad, India.
6. Saxena N.C., Singh, G. and Ghosh, R. (2000). "Environment Management in mining areas", Centre of mining environment, I.S.M., Dhanbad, India.
7. Rao, D.N. (1971). "Air pollution and plant life": Department of Environment, London.
8. Singh, G. (2005). "Water sustainability through augmentation of underground pumped out water for portable purpose from coalmines of Eastern India": Indian School of Mines, Dhanbad. India.
9. Walsh, Fiona and Wood C. (1991). "The Environmental Assessment of opencast coal mines": Occasional Paper 28, Department of Planning and Landscape, University of Manchester, U.K
10. Wathern, P. (1988). "An introductory guide to EIA in: Environmental impacts assessments (2nd ed.), London, U.K, pp.3-28



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# The Utilization of MODIS and Landsat TM/ETM+ for Cotton Fractional Yield Estimation in Burewala

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*Abstract-* Estimates of crop yield are desirable for managing agricultural lands. Remote sensing is the one technology that can give an unbiased view of large areas, with spatially explicit information distribution and time repetition, and has thus been widely used to estimate crop yield and offers great potential for monitoring production, yet the uncertainties associated with large-scale crop yield estimates are rarely addressed. In this study, we tried to estimate cotton cropped area using the supervised classification; planting dates for 11 years (1998 to 2009) of Landsat imagery, and fractional yield using MODIS (Terra) the normalized difference vegetation index (NDVI), and enhanced vegetation index (EVI) in an intensive agricultural region of Burewala, Punjab province of Pakistan. Vegetation indices are widely used for assessing and monitoring ecological variables such as vegetation cover and above-ground biomass. Monitoring the spatial distribution of cotton yield helps identifying sites with yield constraints. The newly available satellite images from the MODIS sensor provide enhanced atmospheric correction, cloud detection, improved geo-referencing, comprehensive data quality control and the enhanced ability to monitor vegetation development. The high temporal resolution of the MODIS datasets can provide an efficient and consistent way for biomass and fractional yield monitoring and assessment. The reflected radiation provides an indication of the type and density of canopy. The condition, distribution, structure and the development of the vegetation through the phenological stages can affect the relation between yield and NDVI. The high spatial resolution Landsat images were applied to extract the area under cotton cultivation within the landscape and to determine the cotton fraction among other land uses within the coarse spatial resolution MODIS pixels.

*Keywords:* *Crop yield, EVI, cotton fraction, Landsat, MODIS dataset, NDVI, remote sensing.*

*GJHSS-B Classification :* *FOR Code: 059999*

THE UTILIZATION OF MODIS AND LANDSAT TMETM+ FOR COTTON FRACTIONAL YIELD ESTIMATION IN BUREWALA

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# The Utilization of MODIS and Landsat TM/ETM+ for Cotton Fractional Yield Estimation in Burewala

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*Abstract-* Estimates of crop yield are desirable for managing agricultural lands. Remote sensing is the one technology that can give an unbiased view of large areas, with spatially explicit information distribution and time repetition, and has thus been widely used to estimate crop yield and offers great potential for monitoring production, yet the uncertainties associated with large-scale crop yield estimates are rarely addressed. In this study, we tried to estimate cotton cropped area using the supervised classification; planting dates for 11 years (1998 to 2009) of Landsat imagery, and fractional yield using MODIS (Terra) the normalized difference vegetation index (NDVI), and enhanced vegetation index (EVI) in an intensive agricultural region of Burewala, Punjab province of Pakistan. Vegetation indices are widely used for assessing and monitoring ecological variables such as vegetation cover and above-ground biomass. Monitoring the spatial distribution of cotton yield helps identifying sites with yield constraints. The newly available satellite images from the MODIS sensor provide enhanced atmospheric correction, cloud detection, improved geo-referencing, comprehensive data quality control and the enhanced ability to monitor vegetation development. The high temporal resolution of the MODIS datasets can provide an efficient and consistent way for biomass and fractional yield monitoring and assessment. The reflected radiation provides an indication of the type and density of canopy. The condition, distribution, structure and the development of the vegetation through the phenological stages can affect the relation between yield and NDVI. The high spatial resolution Landsat images were applied to extract the area under cotton cultivation within the landscape and to determine the cotton fraction among other land uses within the coarse spatial resolution MODIS pixels.

*Keywords: Crop yield, EVI, cotton fraction, Landsat, MODIS dataset, NDVI, remote sensing.*

## I. Introduction

The high temporal resolution of the MODIS datasets can provide an efficient and consistent way for biomass and yield monitoring (Dalezios et al., 2001; Alexandridis and Chemin, 2002). Increased knowledge about the spatial distribution of cotton yield (Shi et al., 2007) in Burewala, Punjab province of Pakistan, supports the optimal provision of resources (Macdonald and Hall, 1980; Hutchinson, 1991; Lobell et al., 2003; Hongo and Niwa, 2012).

Remote sensing imagery offers unique possibilities for spatial and temporal characterization of the changes. The basic requirement is the availability of different dates of imagery which permit continuous monitoring of change and environmental developments over time (Lu et al., 2004; Nasr and Helmy, 2009; Ahmad, 2012d). Long-term observations of remotely sensed vegetation dynamics have held an increasingly prominent role in the study of terrestrial ecology (Budde et al., 2004; Prasad et al., 2007; Ouyang et al., 2012; Ahmad, 2012). A major limitation of such studies is the limited availability of sufficiently consistent data derived from long-term remote sensing (Ouyang et al., 2012; Ahmad, 2012). The benefit obtained from a remote sensing sensor, thereby, largely depends on its spectral resolution (Jensen, 2005; Ahmad, 2012), which determines the sensor's capability to resolve spectral features of land surfaces (Fontana, 2009; Ahmad, 2012). One of the key factors in assessing vegetation dynamics and its response to climate change is the ability to make frequent and consistent observations (Thomas and Leason, 2005; Ouyang et al., 2012; Ahmad, 2012). Photosynthetically active vegetation is characterized by very low reflectance values (Jensen, 2005; Ahmad, 2012a) in the red part of the electromagnetic spectrum due to the absorption of solar radiation by the leaf pigments involved in photosynthesis (Lillesand et al., 2004; Ahmad, 2012a), and by increased reflectance in the near infrared portion of the spectrum due to reflection of incoming solar radiation at the leaf internal structures (Gitelson and Merzlyak, 1996; Fontana, 2009; Ahmad, 2012a). With regard to the monitoring of terrestrial vegetation, the Normalized Difference Vegetation Index (Rouse et al., 1973; Tucker, 1979; Ahmad, 2012a) is the most commonly used index and serves as a measure of photosynthetic activity within a certain area (Fontana, 2009; Ahmad, 2012a).

Los et al. (1994) and Sellers et al. (1996) were the first to derive land surface parameters with realistic seasonal and spatial variations for the globe from NDVI data collected by the AVHRR satellite (Los et al., 2000;

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Ahmad, 2012a). Estimation of land surface vegetation parameters from satellite is based on the spectral properties of vegetation; vegetation strongly absorbs visible light, using the energy for photosynthesis, and strongly reflects near-infrared (NIR) radiation (Rouse et al., 1973; Los, 1998; Los et al., 2000; Ahmad, 2012a; Ahmad, 2012b). Changes in vegetation spectral response caused by phenology can conceal the longer term changes in the landscape (Hobbs, 1989; Lambin, 1996; Dennison and Roberts, 2003; Ahmad, 2012d). Multi-temporal data that captures these spectral differences can improve reparability of vegetation types over classifications based on single date imagery (DeFries et al., 1995; Ahmad, 2012d).

The Moderate Resolution Imaging Spectroradiometer (MODIS) is a key instrument onboard the Terra satellite platform (Huete et al., 2006; Carrão et al., 2008; Ahmad, 2012c). Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning (Salomonson and Toll, 1991; GSFC/NASA, 2003; Huete, 2005; Ahmad, 2012c). There are now over 13 years of MODIS Terra data (first image, February 24, 2000), available producing high quality scientific products with calibration specifications of 2% reflectance and 5% radiance and geolocation of 50 m (Huete, 2005; Ahmad, 2012c).

The MODIS sensor has 36 spectral bands extending from the visible to the thermal infrared wavelengths [between 0.405 and 14.385 μm] (Running et al., 1994; Zhan et al., 2000). The MODIS land bands have a heritage related to the Landsat TM, with additional spectral capabilities added in the short-wave and long-wave infrared (Justice et al., 1998; Jin and Sader, 2005). Several researchers have used MODIS to detect changes in land cover (Zhan et al., 2000; 2002; Roy et al., 2002; Korontzi et al., 2004; Jin and Sader, 2005).

A remote sensing sensor is a key device that captures data about an object or scene remotely. Since objects have their unique spectral features, they can be identified from remote sensing imagery according to their unique spectral characteristics (Xie, 2008; Ahmad, 2013). A good case in vegetation mapping using remote sensing technology is the spectral radiances in the red and near-infrared (NIR) regions, in addition to others. The radiances in these regions could be incorporated into the spectral vegetation indices (VI) that are directly related to the intercepted fraction of photosynthetically active radiation (Asrar et al., 1984; Galio et al., 1985; Xie, 2008; Ahmad, 2013). Such evaluations often require the use of vegetation indices calculated from archived satellite data.

The NDVI is chlorophyll sensitive; the EVI (Liu and Huete, 1995; Justice et al., 1998; Huete et al., 1999) is more responsive to canopy structural variations, including canopy type, plant physiognomy and canopy architecture (Gao et al., 2000; Huete et al., 2002). The two VIs complement each other in global vegetation studies and improve upon the detection of vegetation changes and extraction of canopy biophysical parameters (Huete et al., 1999; 2002).

The NDVI can be a useful tool to couple climate and vegetation distribution and performance at large spatial and temporal scales (Pettorelli et al., 2005; Aguilar et al., 2012; Ahmad, 2012; Ahmad, 2013a) because vegetation vigor and productivity are related to temperature-precipitation and evapotranspiration. The NDVI serves as a surrogate measure of these factors at the landscape scale (Wang et al., 2003; Groeneveld and Baugh, 2007; Aguilar et al., 2012; Ahmad, 2012; Ahmad, 2013a). The NDVI product works optimally with cloud filtering, radiometric calibration, precise geolocation, and a snow mask. In addition, the product performs best using top-of-canopy reflectance inputs, corrected for atmospheric ozone, molecular scattering, aerosol, and water vapour (Huete et al., 2006; Ahmad, 2012; Ahmad, 2013a).

Accurate evaluation of vegetation response across multiple-year time scales is crucial for analyses of global change (Running and Nemani, 1991; Sellers et al., 1994; Stow, 1995; Justice et al., 1998; Fensholt, 2004; Baugh and Groeneveld, 2006; Ahmad, 2012e), effects of human activities (Moran et al., 1997; Milich and Weiss 2000; Thiam, 2003; Baugh and Groeneveld, 2006; Ahmad, 2012e) and ecological relationships (Baret and Guyot, 1991; Asrar et al., 1992; Begue, 1993; Epiphanio and Huete, 1995; Gillies et al., 1997; Baugh and Groeneveld, 2006; Ahmad, 2012e).

### *a) Study Area*

Burewala (Figure 1) lies in the Punjab province of Pakistan from 29° 52' 28" to 30° 22' 12" North latitude and 72° 30' 04" to 72° 59' 35" East longitude.

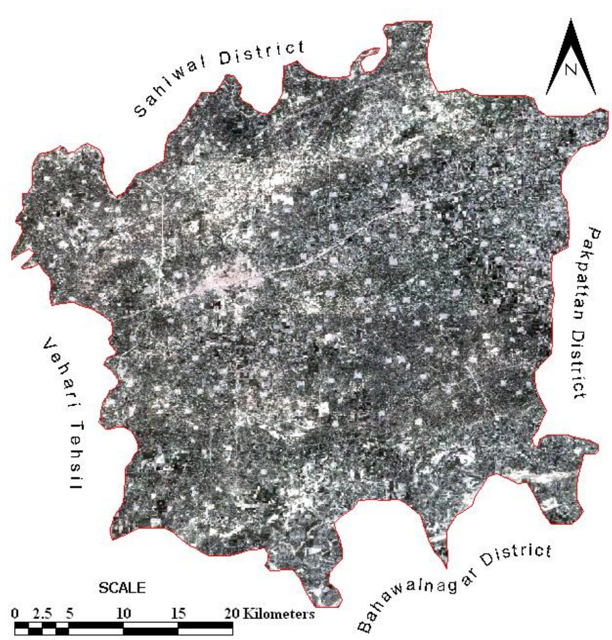


*Figure 1 :* Burewala - Landsat TM 2nd August, 2009 image

*Source: http://glovis.usgs.gov/*

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## II. Research Design and Methods

In this research paper four Landsat TM/ETM+ scenes of 20th August, 1998; 15th August, 1999; 20th August, 2001 and 2nd August, 2009 (path 150; row 39) were used to detect and recognize the cotton-pixels and cotton cropped areas in Burewala. These vital steps are: image registration and image enhancement as discussed by Macleod and Congalton (1998), Mahmoodzadeh (2007) and Al-Awadhi et al., 2011. These scenes were corrected and geo-referenced using projection UTM, zone 43 and datum WGS 84. The Landsat has a long history of dataset, it is very helpful to map long-term vegetation cover and study the spatio-temporal vegetation changes (Schroeder et al., 2006; Xie, 2008; Ahmad, 2012d).

Radiometric enhancement is performed to produce a homogenous radiometric set of data (Richard et al., 2005; Ahmad, 2012d). So that, false changes are not introduced by factors such as: modification of the spectral distribution due to atmospheric conditions, different path radiance and seen angle variation (Ulbricht and Heckendorf, 1998; Ahmad, 2012d). Ideally, all images would be calibrated to standard reflectance units (Nasr and Helmy, 2009; Ahmad, 2012d). However, when comparing images to detect change, it is sufficient to convert raw digital counts to be consistent with a chosen reference image (Symeonakis et al., 2006; Ahmad, 2012d). Histograms equalization and histogram matching were generated in order to identify the suitable contrast stretching level to optimize the balance (Singh, 1989; Ahmad, 2012d) for Landsat TM/ETM+ images. Landsat TM/ETM+ different bands have used in order to estimate the vegetation quantities parameter based on vegetation indices (Ahmad, 2012e). While all dimensions of remotely sensed data are relevant, for practical purposes it is the temporal information that has been most useful for monitoring of major crop types with remote sensing (Smith and Ramey, 1982; Badhwar, 1984; Hall and Badhwar, 1987; Price et al., 1997; Wardlow et al., 2007; Singh, 2012).

The MODIS (Terra) NDVI/EVI (MOD13A1) data products for research area were acquired, in this case data were downloaded from the Land Processes Distributed Active Archive Center (LPDAAC). Tile number covering this area is h24v05, reprojected from the Integerized Sinusoidal projection to a Geographic Lat/Lon projection, and Datum WGS84 (GSFC/NASA, 2003; Ahmad, 2012; 2012d). A gapless time series of MODIS (Terra) NDVI/EVI composite raster data from February, 2000 to February, 2013 with a spatial resolution of 500 m (Table 1) was utilized for calculation of the cotton fractional yield (Figure 2). The datasets provide frequent information at the spatial scale at which the majority of human-driven land cover changes occur (Townshend and Justice, 1988; Verbesselt et al., 2010; Ahmad, 2012). MODIS products are designed to provide consistent spatial and temporal comparisons between different global vegetation conditions that can be used to monitor photosynthetic activity and forecast crop yields (Vazifedoust et al., 2009; Cheng and Wu, 2011). Details documenting the MODIS (Terra) NDVI/EVI compositing process and Quality Assessment Science Data Sets can be found at NASA's MODIS web site (MODIS, 1999; USGS, 2008).

*Table 1:* MODIS (Terra) Bands used in this research study

| | |
|---|---|
| Bandwidth specifications (nm) | Band 3: 459-479 |
| | Band 4: 545-565 |
| | Band 5: 1230-1250 |
| | Band 6: 1628-1652 |
| | Band 7: 2105-2155 |
| Spatial resolution (m) | 500 |
| Radiometric resolution (bits) | 12 |
| Time window | 16-days |

Earth location data is available at sub-pixel accuracy. This extraordinary geolocation accuracy is achieved due to several reasons (Wolfe et al., 1995; 2002; Fontana, 2009; Ahmad, 2012): First, the spacecrafts carrying MODIS are very stable and provide highly precise external orientation knowledge. Second, the MODIS instrument was designed to give precise interior orientation knowledge (Khlopenkov and Trishchenko, 2008; Fontana, 2009; Ahmad, 2012). Third, an accurate global DEM (Logan, 1999; Fontana, 2009; Ahmad, 2012) is used to model and remove relief-induced distortions. Fourth, a global set of GCPs based on Landsat imagery served to determine biases in the sensor orientation, which were finally used to improve geolocation processing (Ackerman et al., 1998; 2006; Fontana, 2009; Ahmad, 2012).

The NDVI is successful as a vegetation measure is that it is sufficiently stable to permit meaningful comparisons of seasonal and inter-annual changes in vegetation growth and activity (Choudhury, 1987; Jakubauskas et al., 2002; Chen et al., 2006; Zoran and Stefan, 2006; Nicandrou, 2010; Ahmad, 2012; Ahmad, 2012d; 2012e). The strength of the NDVI is in its ratioing concept (Moran et al., 1992; Ahmad, 2012),


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which reduces many forms of multiplicative noise (illumination differences, cloud shadows, atmospheric attenuation, and certain topographic variations) present in multiple bands (Chen et al., 2002; Nicandrou, 2010; Ahmad, 2012; Ahmad, 2012d).

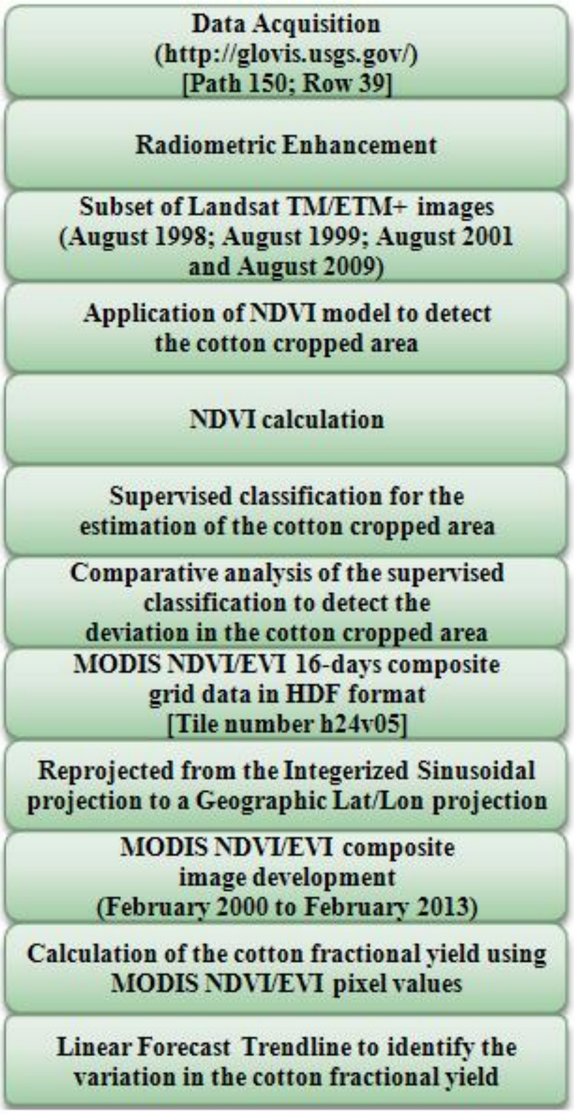


*Figure 2 :* Scheme for research design and methods

The NDVI,spectral vegetation index which measures soil and vegetation moisture (Singh, 1989; Lyon et al., 1998; Mambo and Archer, 2007; Ahmad, 2013a), has been widely used for environmental change monitoring (Young, 1998; Lillesand and Kiefer, 2000; Eastman, 2003; Lillesand et al., 2004; Mambo and Archer, 2007; Ahmad, 2013a). The index can be used to identify areas showing distressed or degraded vegetation, leading to identification of possible degraded areas (Barrow, 1991; Booth et al., 1994; Mambo and Archer, 2007; Ahmad, 2013a). The NDVI captures the marked contrast between the strong absorptance in the visible wavelengths and strong reflectance in the near-infrared wavelengths which uniquely characterize the presence of photosynthetically active vegetation (Tucker, 1979; Wessels et al., 2004; Ahmad, 2013a). The NDVI is an indicator of vegetation health, because degradation of ecosystem vegetation, or a decrease in green, would be reflected in a decrease in NDVI value (Meneses-Tovar, 2011; Ahmad, 2013a).

The NDVI is highly correlated with vegetation parameters such as green leaf biomass and green leaf area (Justice et al., 1985; Ahmad, 2013a), and it also is directly related to plant vigor, density, and growth conditions (Holben, 1986; Ahmad, 2013a), now it is widely accepted as a primary tool for monitoring land degradation (Huang et al., 2010; Ahmad, 2013a). In arid and semi-arid lands, seasonal sums of multi-temporal NDVI are strongly correlated with vegetation production (Prince and Tucker, 1986; Prince, 1991; Nicholson and Farrar, 1994; Nicholson et al., 1998; Wessels et al., 2004; Ahmad, 2013a).

The NDVI values range from -1 to +1; because of high reflectance in the NIR portion of the EMS, healthy vegetation is represented by high NDVI values between 0.1 and 1 (Liu and Huete, 1995; USGS, 2008; 2010; Ahmad, 2012). Conversely, non-vegetated surfaces such as water bodies yield negative values of NDVI because of the electromagnetic absorption property of water. Bare soil areas represent NDVI values which are closest to 0 due to high reflectance in both the visible and NIR portions of the EMS (Townshend, 1992; Ahmad, 2012). The NDVI is related to the absorption of photosynthetically active radiation and basically measures the photosynthetic capability of leaves, which is related to vegetative canopy resistance and water vapour transfer (Wan, 2003; Rahman et al., 2004; Ahmad, 2012; 2012d).

The NDVI is the most commonly used index of greenness derived from multispectral remote sensing data (USGS, 2010; Ahmad, 2013a), and is used in several studies on vegetation, since it has been proven to be positively correlated with density of green matter (Townshend et al., 1991; Huete et al., 1997; Huete et al., 2002; Debien et al., 2010; Ahmad, 2012a; 2012d; Zaeen, 2012; Ahmad, 2013a). The NDVI provides useful information for detecting and interpreting vegetation land cover it has been widely used in remote sensing studies (Dorman and Sellers, 1989; Myneni and Asrar, 1994; Gao, 1996; Sesnie et al., 2008; Karaburun, 2010; Ahmad, 2012b; Ahmad, 2013a).

The EVI is an 'optimized index' designed to enhance the vegetation signal with improved sensitivity in high biomass regions and improved vegetation monitoring through a de-coupling of the canopy background signal and a reduction in atmosphere influences (Liu and Huete, 1995; Justice et al., 1998; Huete et al., 1999; Ahmad, 2012e), and minimizes canopy-soil and aerosol variations and improves sensitivity over dense vegetation conditions (Qi et al., 1994; Ahmad, 2012c). The two products more effectively characterize a global range of vegetation states and

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processes, and improve upon the extraction of canopy biophysical parameters (Jiang et al., 2008; Ahmad, 2012c).

ERDAS imagine 2013 and ArcGIS 10 software were used for application of NDVI model to detect the cotton cropped area and calculation for Landsat TM/ETM+ images (path 150; row 39) of 20th August, 1998; 15th August, 1999; 20th August, 2001 and 2nd August, 2009 respectively. The supervised classification was applied upon the images for the estimation of the cotton cropped area. Further, comparative analysis was carried out upon supervised classification to detect the deviation in the cotton cropped area in Burewala. Calculation of the cotton fractional yield using MODIS (Terra) NDVI/EVI pixel values of the selected villages; Chak 44/KB, Chak 305/EB, Chak 487/EB and Chak 529/EB of Burewala was carried out and linear forecast trendline was plotted to identify the variations in the cotton fractional yield dataset of Chak 44/KB from February 2000 to February 2013. Standard multispectral image processing techniques were generally developed to classify multispectral images into broad categories of surface condition (Shippert, 2004; Ahmad, 2012f). ERDAS imagine (ERDAS Imagine, Inc., 2010) and ENVI tools, applicable to a variety of applications, distinguish and identify the unique resource information present in the scene and map them throughout the image (Research System, Inc., 2004).

## III. Results

Figure 3, 4, 5 and 6 (Table 2) shows classified NDVI for Landsat TM/ETM+ scenes of 20th August, 1998; 15th August, 1999; 20th August, 2001 and 2nd August, 2009 respectively. The NDVI model was applied upon the Landsat TM/ETM+ using ERDAS imagine 2013 software while ArcGIS 10 was used for NDVI calculation. Further, ArcGIS symbology tool was used to develop NDVI classes and recognize the cotton cropped areas in Burewala. The NDVI is an effective vegetation measure since it is sufficiently stable to permit meaningful comparisons between seasonal and interannual changes in vegetation growth and activity (Cheng and Wu, 2011). This is because it can reduce different forms of multiplicative noise present in multiple bands (Myneni et al., 1995; Cheng and Wu, 2011). The significance of NDVI index may vary according to habitat type (Pettorelli et al., 2005; Hamel et al., 2009; Ahmad, 2013a). Vegetation indices may employ simple ratios of any two single wavelength combinations. These ratios were found to be fairly effective in normalizing the effect of reflectance variation in soil background (Colwell, 1973; Cheng and Wu, 2011).

Remote sensing data provides systematically high-quality spatial and temporal information about land surface features, including behaviour of agricultural crops and cumulative environmental impacts on crop growing conditions (Liu and Kogan, 2002). Remote sensing techniques have been employed to estimate various plant parameters (Wiegant et al., 1979; Price, 1995; Mirik et al., 2007; Cheng and Wu, 2011) and crop yield (Cheng et al., 2004; Cheng, 2006; Cheng and Wu, 2011). Remote sensing provides quantitative information on agricultural crops instantaneously and nondestructively (Clevers, 1988; Mirik et al., 2006; Cheng and Wu, 2011), and the spatial and temporal distributions of crop production offer valuable information for agricultural management and biogeochemical modeling efforts (Lobell et al., 2003; Sönmez and Sarı, 2006; Cheng and Wu, 2011).



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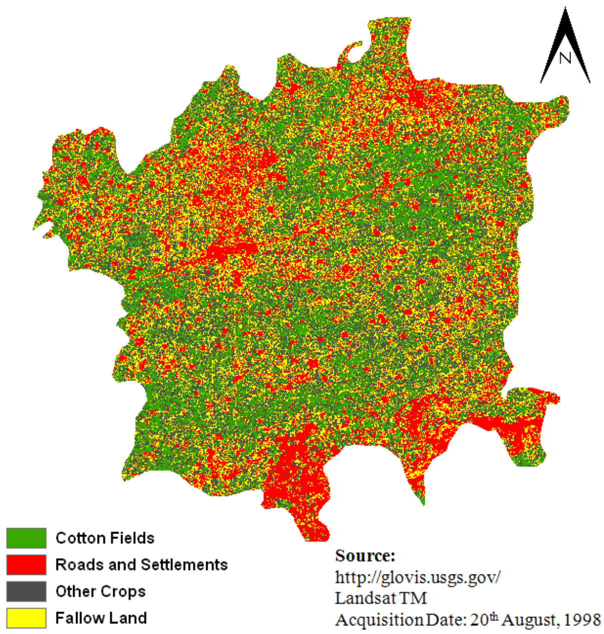


*Figure 3 :* Classified NDVI 1998, Burewala

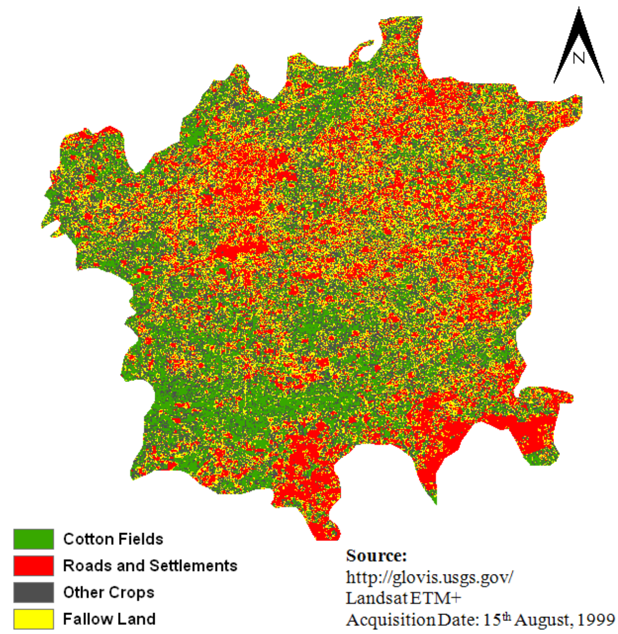


*Figure 4 :* Classified NDVI 1999, Burewala

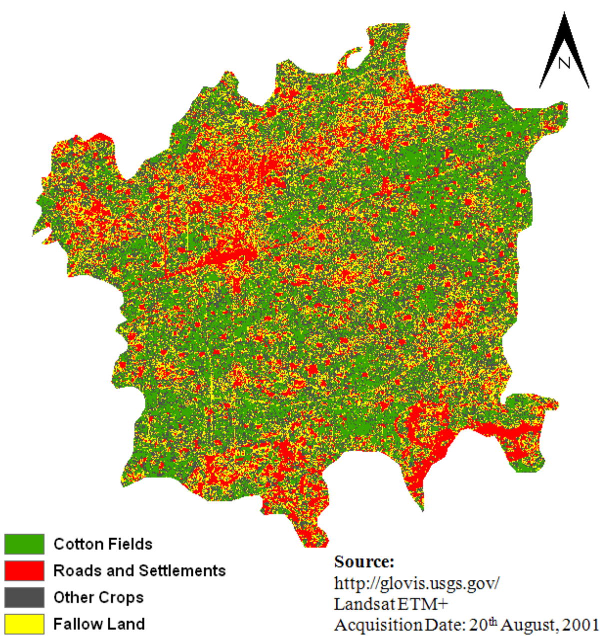


*Figure 5 :* Classified NDVI 2001, Burewala

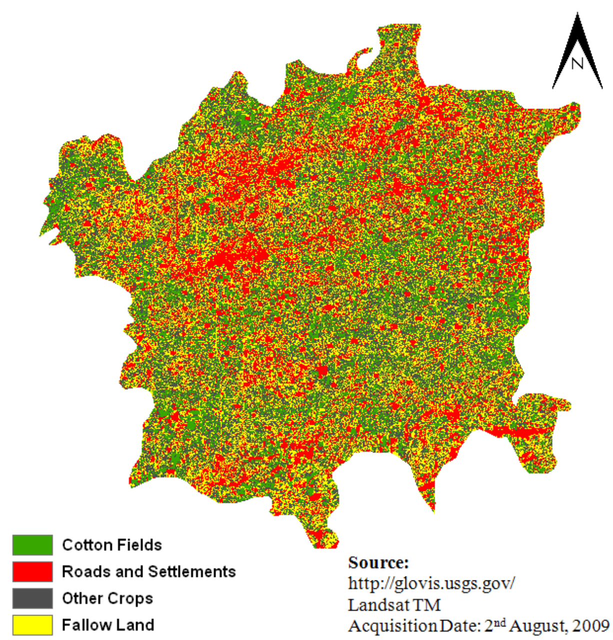


*Figure 6 :* Classified NDVI 2009, Burewala

*Table 2 :* NDVI values of Landsat images

| Image Acquisition Date | Maximum NDVI | Minimum NDVI | Mean NDVI | Standard Deviation |
|---|---|---|---|---|
| 20th August, 1998 (Landsat TM) | 0.61 | -0.19 | 0.23 | 0.13 |
| 15th August, 1999 (Landsat ETM+) | 0.51 | -0.26 | 0.11 | 0.12 |
| 20th August, 2001 (Landsat ETM+) | 0.56 | -0.24 | 0.21 | 0.14 |
| 2nd August, 2009 (Landsat TM) | 0.54 | -0.15 | 0.20 | 0.11 |

The NDVI (Sellers, 1985) as an indicator of vivid green vegetation and as a descriptor of ecosystem functions has proved to be very valuable for assessing ecological responses to environmental changes (Pettorelli et al., 2005; Alcaraz-Segura et al., 2009; Höpfner and Scherer, 2011; Ahmad, 2012a). The NDVI can be used not only for accurate description of vegetation classification and vegetation phenology (Tucker et al., 1982; Tarpley et al., 1984; Justice et al., 1985; Lloyd, 1990; Singh et al., 2003; Los et al., 2005;

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Ahmad, 2013a) but also effective for monitoring rainfall and drought, estimating net primary production of vegetation, crop growth conditions and crop yields, detecting weather impacts and other events important for agriculture and ecology (Kogan, 1987; Dabrowska-Zielinska et al., 2002; Singh et al., 2003; Chris and Molly, 2006; Baldi et al., 2008; Glenn et al., 2008; Ahmad, 2012b; Ahmad, 2013a).

Figure 7, 8, 9 and 10 shows the supervised classification for Landsat TM/ETM+ scenes of 20th August, 1998; 15th August, 1999; 20th August, 2001 and 2nd August, 2009 respectively. The supervised classification was applied upon the Landsat TM/ETM+ using ERDAS imagine 2013 software to detect cotton cropped areas in Burewala. The approach supervised classification which is part of post classification comparison method or direct classification method. This approach is based on the natural groupings of the spectral properties of the pixels which are usually selected by the RS software without any influence from the users (Al-Awadhi et al., 2011).

Figure 7 shows the supervised classification for Landsat TM image of 20th August, 1998. The findings showed that the cotton fields were 591.44 km$^2$ (47.77%), roads and settlements 402.34 km$^2$ (32.50%), and other crops 206.06 km$^2$ (16.65%) while the fallow land was 38.13 km$^2$ (3.08%). The accuracy assessment is given in Table 3.

Figure 8 shows the supervised classification for Landsat ETM+ image of 15th August, 1999. The findings showed that the cotton fields were 528.38 km$^2$ (42.68%), roads and settlements 404.55 km$^2$ (32.68%), and other crops 257.13 km$^2$ (20.77%) while the fallow land was 47.91 km$^2$ (3.87%). The accuracy assessment is given in Table 3.

Soil compaction negatively affects crop growth characteristics (Lowery and Schuler, 1991; Kulkarni and Bajwa, 2005), yield (Johnson et al., 1990; Kulkarni and Bajwa, 2005), and root development and distribution (Taylor and Gardener, 1963; Unger and Kaspar, 1994; Kulkarni and Bajwa, 2005). However, bare soil reflectance may be affected by the impact of tillage practices and moisture content (Barnes et al., 1996; Kulkarni and Bajwa, 2005). The wavelengths detected as responsive to soil compaction were close to each other, they may had similar information about the vegetation vigor. In the red portion of spectrum the wavelengths ranged from 620 to 700 nm (Thenkabail et al., 2000; Kulkarni and Bajwa, 2005). In this region of visible spectrum, a mixed spectral signature was produced from cotton bolls and the yellow and brownish green leaves. Some exposure of cotton stems as leaves had fallen and more soil exposure caused the mixed signature (Rosenthal and Gerik, 1991; Kulkarni and Bajwa, 2005).

Figure 9 shows the supervised classification for Landsat ETM+ image of 20th August, 2001. The findings showed that the cotton fields were 702.61 km$^2$ (56.76%), roads and settlements 319.58 km$^2$ (25.81%), and other crops 175.56 km$^2$ (14.18%) while the fallow land was 40.22 km$^2$ (3.25%). The accuracy assessment is given in Table 3.

Figure 10 shows the supervised classification for Landsat TM image of 2nd August, 2009. The findings showed that the cotton fields were 494.11 km$^2$ (39.91%), roads and settlements 509.13 km$^2$ (41.13%), and other crops 213.58 km$^2$ (17.25%) while the fallow land was 21.15 km$^2$ (1.71%). The accuracy assessment is given in Table 3.

Figure 11 shows the comparative analysis of the supervised classification for Landsat TM/ETM+ scenes of 20th August, 1998; 15th August, 1999; 20th August, 2001 and 2nd August, 2009 respectively. The findings showed that the area of the cotton fields decreased from 591.44 km$^2$ (47.77%) on 20th August, 1998 to 494.11 km$^2$ (39.91%) on 2nd August, 2009 (Table 3).

Remote sensing provides a viable source of data from which updated land-cover information can be extracted efficiently and cheaply in order to invent and monitor these changes effectively (Mas, 1999; Ahmad, 2013a).



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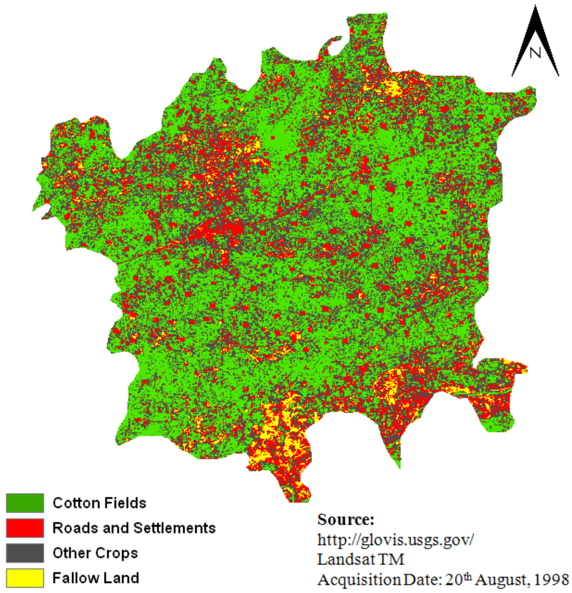


*Figure 7 :* Supervised Classification 1998, Burewala

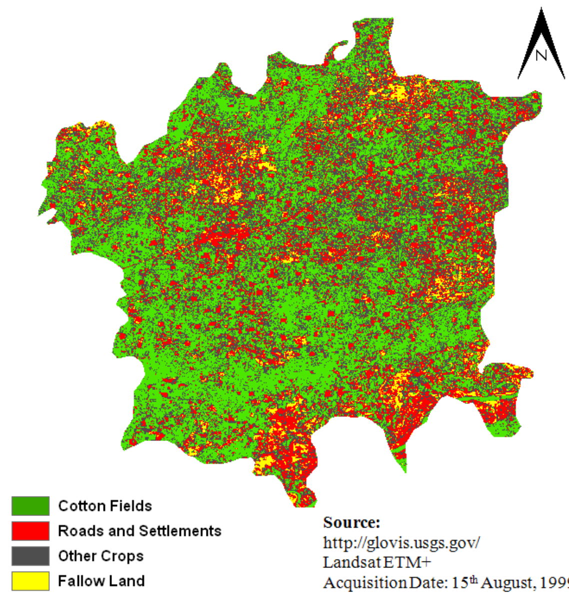


*Figure 8 :* Supervised Classification 1999, Burewala

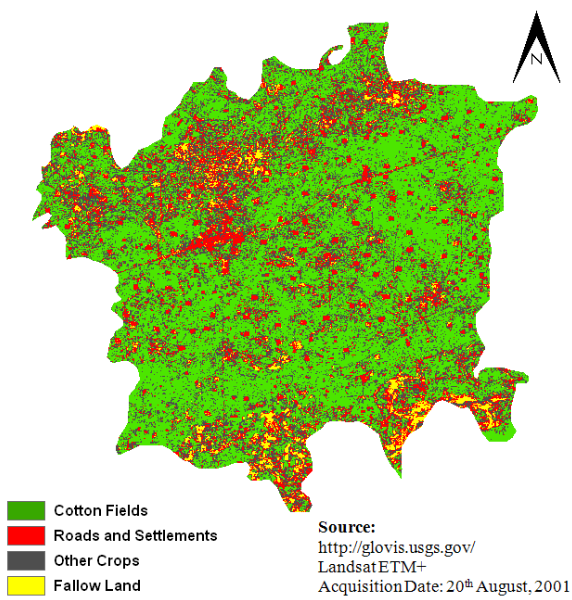


*Figure 9 :* Supervised Classification 2001, Burewala

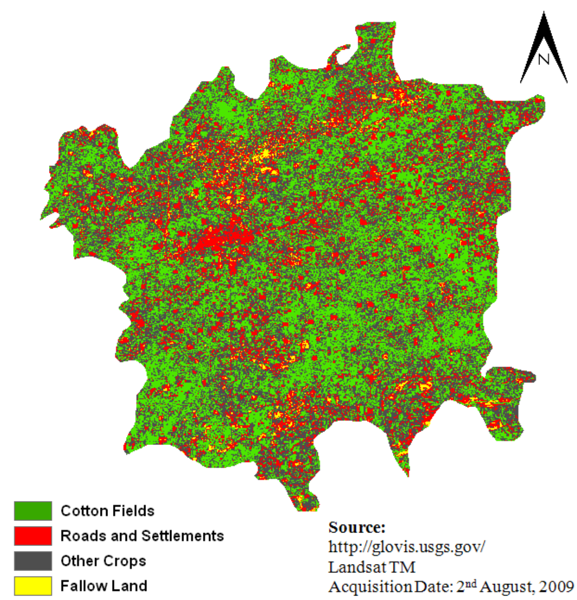


*Figure 10 :* Supervised Classification 2009, Burewala

*Table 3 :* Supervised Classification of Landsat TM/ETM+ images

| Image Acquisition Date | Classes | Area ($km^2$) | Area (%) | Accuracy Assessment (%) |
|---|---|---|---|---|
| 20th August, 1998 (Landsat TM) | Cotton Fields | 591.44 | 47.77 | 86.13 |
| | Roads and Settlements | 402.34 | 32.50 | 89.62 |
| | Other Crops | 206.06 | 16.65 | 85.47 |
| | Fallow Land | 38.13 | 3.08 | 88.75 |
| | SUM | 1237.97 | 100 | - |
| 15th August, 1999 (Landsat ETM+) | Cotton Fields | 528.38 | 42.68 | 87.38 |
| | Roads and Settlements | 404.55 | 32.68 | 92.35 |
| | Other Crops | 257.13 | 20.77 | 92.15 |
| | Fallow Land | 47.91 | 3.87 | 85.44 |
| | SUM | 1237.97 | 100 | - |

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| | | | | |
|---|---|---|---|---|
| 20th August, 2001 (Landsat ETM+) | Cotton Fields | 702.61 | 56.76 | 85.47 |
| | Roads and Settlements | 319.58 | 25.81 | 85.77 |
| | Other Crops | 175.56 | 14.18 | 85.16 |
| | Fallow Land | 40.22 | 3.25 | 90.15 |
| | SUM | 1237.97 | 100 | - |
| 2nd August, 2009 (Landsat TM) | Cotton Fields | 494.11 | 39.91 | 92.18 |
| | Roads and Settlements | 509.13 | 41.13 | 89.34 |
| | Other Crops | 213.58 | 17.25 | 88.32 |
| | Fallow Land | 21.15 | 1.71 | 85.47 |
| | SUM | 1237.97 | 100 | - |

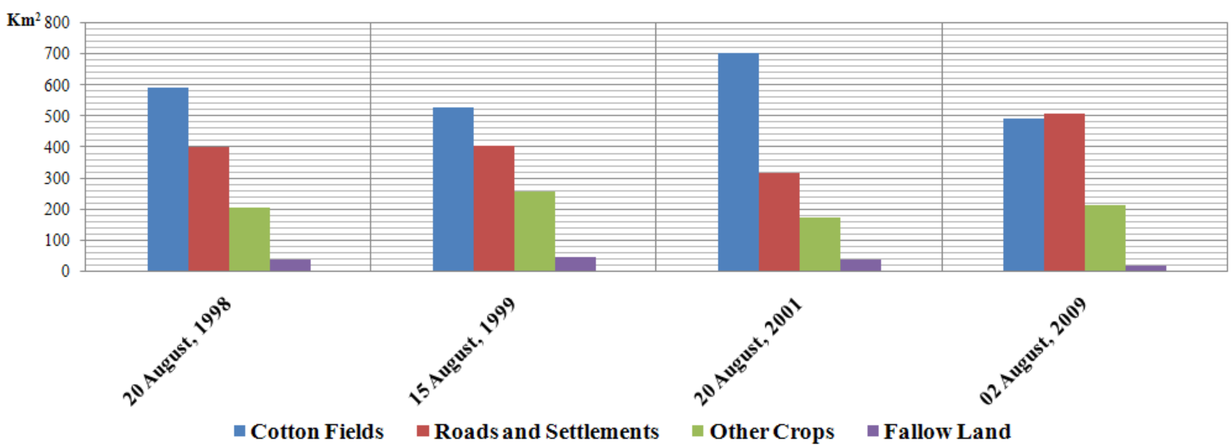


*Figure 11 :* Comparative Analysis of Supervised Classification of Landsat TM/ETM+ Images

Figure 12 shows NDVI/EVI phenological profile for Chak 44/KB; Figure 13 shows NDVI/EVI phenological profile for Chak 305/EB; Figure 14 shows NDVI/EVI phenological profile for Chak 487/EB and Figure 15 shows NDVI/EVI phenological profile for Chak 529/EB, Burewala, Punjab province, Pakistan. The NDVI/EVI pixel values were used to calculate fractional yield (Shinners and Binversie, 2007) from February 2000 to February 2013. The NDVI pixel values showed theoretical yield and EVI pixel values showed actual yield (Table 4). Further, linear forecast trendline was plotted upon the fractional yield dataset of Chak 44/KB to investigate the general trend during the entire period (Figure 16). The linear forecast trendline showed that fractional yield at Chak 44/KB was decreasing. The tendency of decreasing in the fractional yield from February 2000 to December 2004 was low and the tendency from January 2005 to February 2013 was high.

Vegetation phenology refers to the relationship between climate and periodic development of photosynthetic biomass (Ahl et al., 2006; Ahmad, 2012a). Satellite monitoring of vegetation phenology has often made use of a vegetation index such as NDVI because it is related to the amount of green leaf biomass (Lillesand and Kiefer, 2000; Beurs and Henebry, 2004; Ahl et al., 2006; Ahmad, 2012a). The potential solution to provide more frequent high resolution surface observations is to fuse Landsat observations with data from other remote sensing systems, such as MODIS (Singh, 2012). The MODIS NDVI datasets provides unique opportunities for monitoring terrestrial vegetation conditions at regional and global scales (Yang et al., 1997; Piao et al., 2006; Ahmad, 2012), and has widely been used in research areas of net primary production (Potter et al., 1993; Paruelo et al., 1997; Piao et al., 2006; Ahmad, 2012), vegetation coverage (Tucker et al., 1991; Myneni et al., 1997; Los et al., 2001; Zhou et al., 2001; Piao et al., 2003; Piao et al., 2006; Ahmad, 2012), biomass (Myneni et al., 2001; Dong et al., 2003; Piao et al., 2006), and phenology (Reed et al., 1994; Moulin et al., 1997; Piao et al., 2006; Ahmad, 2012).



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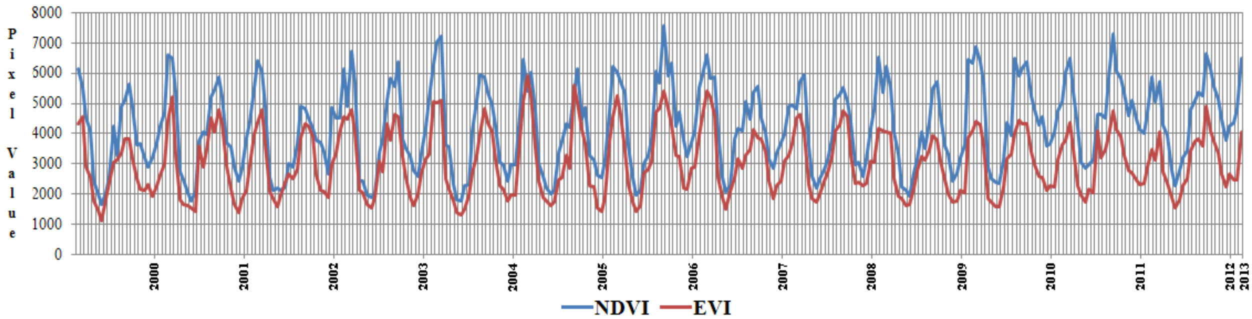


*Figure 12 :* NDVI/EVI phenological profile for Chak 44/KB *Processed by the author*

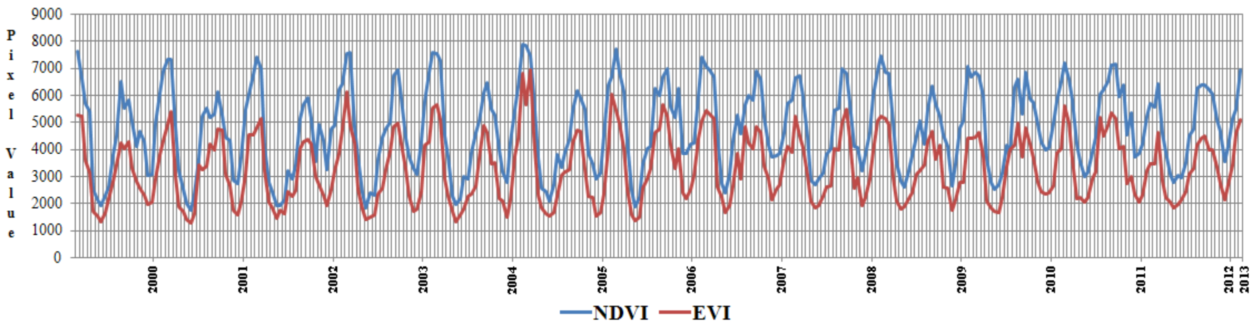


*Figure 13 :* NDVI/EVI phenological profile for Chak 305/EB *Processed by the author*

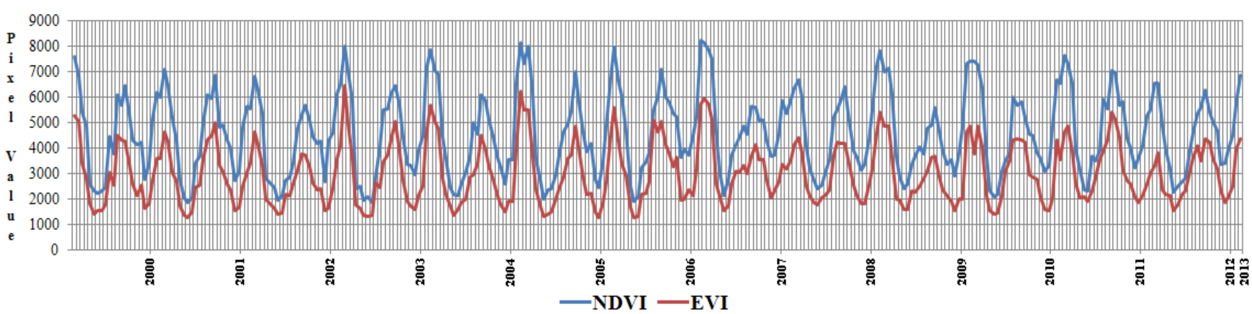


*Figure 14 :* NDVI/EVI phenological profile for Chak 487/EB *Processed by the author*

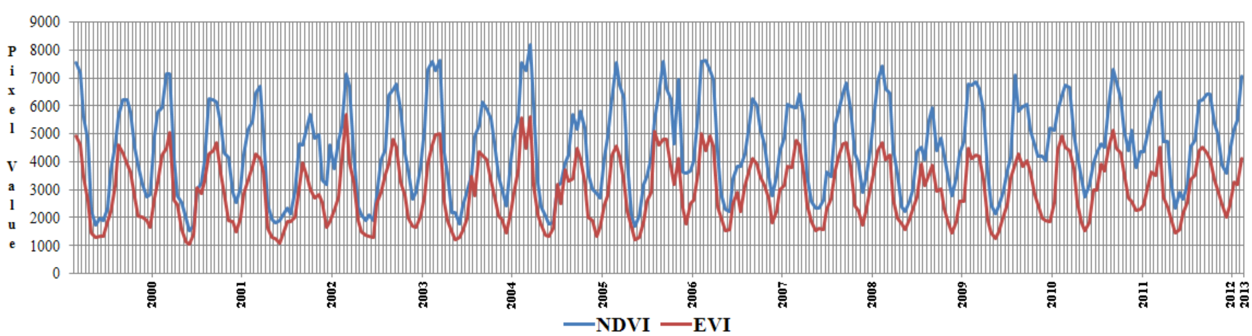


*Figure 15 :* NDVI/EVI phenological profile for Chak 529/EB *Processed by the author*

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*Table 4 :* MODIS (Terra) EVI/NDVI and Fractional Yield dataset of Chak 44/KB

| Image Acquisition (Month/Year) | EVI Pixel Value | NDVI Pixel Value | Fractional Yield (%) | Image Acquisition (Month/Year) | EVI Pixel Value | NDVI Pixel Value | Fractional Yield (%) |
|---|---|---|---|---|---|---|---|
| Feb. 2000 | 4320 | 6127 | 70.51 | Feb. 2007 | 5409 | 6605 | 81.89 |
| May 2000 | 1108 | 1664 | 66.59 | May 2007 | 2055 | 2288 | 89.82 |
| Aug. 2000 | 3826 | 5102 | 74.99 | Aug. 2007 | 4122 | 5381 | 76.6 |
| Nov. 2000 | 2104 | 3222 | 65.3 | Nov. 2007 | 1845 | 2858 | 64.56 |
| Feb. 2001 | 4419 | 6595 | 67.01 | Feb. 2008 | 4498 | 4819 | 93.34 |
| May 2001 | 1520 | 1771 | 85.83 | May 2008 | 1987 | 2501 | 79.45 |
| Aug. 2001 | 4051 | 5442 | 74.44 | Aug. 2008 | 4733 | 5528 | 85.62 |
| Nov. 2001 | 1647 | 2898 | 56.83 | Nov. 2008 | 2267 | 2602 | 87.13 |
| Feb. 2002 | 4360 | 6397 | 68.16 | Feb. 2009 | 4049 | 6222 | 65.08 |
| May 2002 | 1958 | 2110 | 92.8 | May 2009 | 1665 | 1923 | 86.58 |
| Aug. 2002 | 4305 | 4834 | 89.06 | Aug. 2009 | 3923 | 5463 | 71.81 |
| Nov. 2002 | 2076 | 3414 | 60.81 | Nov. 2009 | 1709 | 2434 | 70.21 |
| Feb. 2003 | 4447 | 4902 | 90.72 | Feb. 2010 | 4404 | 6864 | 64.16 |
| May 2003 | 1537 | 1879 | 81.8 | May 2010 | 1559 | 2345 | 66.48 |
| Aug. 2003 | 4623 | 5571 | 82.98 | Aug. 2010 | 4327 | 6165 | 70.19 |
| Nov. 2003 | 1615 | 2783 | 58.03 | Nov. 2010 | 2554 | 4549 | 56.14 |
| Feb. 2004 | 4986 | 7037 | 70.85 | Feb. 2011 | 3778 | 6040 | 62.55 |
| May 2004 | 1294 | 1795 | 72.09 | May 2011 | 2164 | 2983 | 72.54 |
| Aug. 2004 | 4820 | 5857 | 82.29 | Aug. 2011 | 4740 | 7275 | 65.15 |
| Nov. 2004 | 2148 | 2983 | 72.01 | Nov. 2011 | 2679 | 5094 | 52.59 |
| Feb. 2005 | 5892 | 5400 | 109.11 | Feb. 2012 | 3102 | 5055 | 61.36 |
| May 2005 | 1598 | 1994 | 80.14 | May 2012 | 1785 | 2768 | 64.49 |
| Aug. 2005 | 5599 | 5380 | 104.07 | Aug. 2012 | 3564 | 5251 | 67.87 |
| Nov. 2005 | 2242 | 3144 | 71.31 | Nov. 2012 | 2639 | 4480 | 58.91 |
| Feb. 2006 | 5230 | 6031 | 86.72 | Feb. 2013 | 4059 | 6476 | 62.68 |
| May 2006 | 1607 | 2145 | 74.92 | | | | |
| Aug. 2006 | 5379 | 7564 | 71.11 | | | | |
| Nov. 2006 | 2173 | 3766 | 57.7 | | | | |

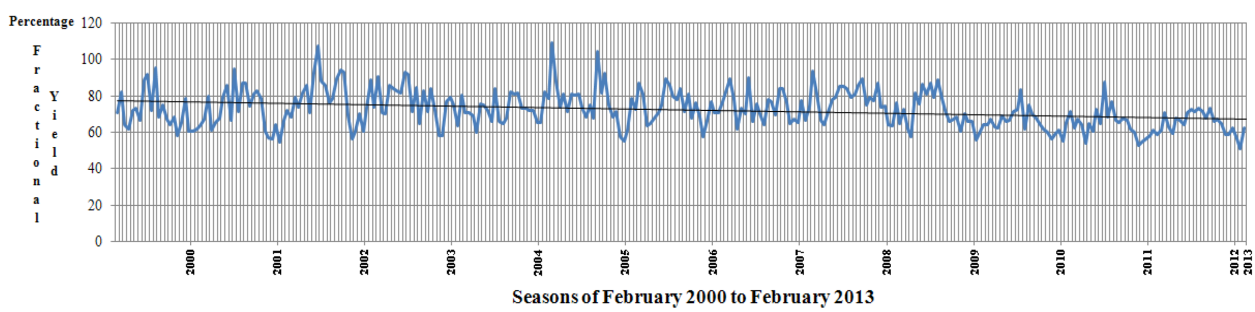


*Figure 16 :* Linear forecast trendline for the dataset of Chak 44/KB *Processed by the author*

## IV. Discussion and Conclusions

As the use of space and computer technology developed, humankind has a great advantage to produce this much important research projects with the help of technology in an easier, more accurate way within less time than of other ways. As a result, all these can have a very effective role in helping the country to increase the amount and the quality of agricultural products (Akkartala et al., 2004; Ahmad, 2012; Ahmad, 2012e). With the continuous development of computer network, space technology and remote sensing, demand on automated, real-time and in-orbit processing become more urgent than ever before for change detection (Mouat et al., 1993; Ahmad, 2012d). To achieve this, the challenges to the technology include the full automation for image registration, image matching, feature extraction, image interpretation, image fusion, data-cleaning, image classification, and data mining and knowledge discovery from GIS database (Liu and Zhou, 2004; Jianya et al., 2008; Ahmad, 2012d). The vegetation indices incorporate a ratio of NIR and red bands, with NDVI being the most frequently used because of its simplicity and robustness. Even so, this index performed relatively poorly for comparison



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across our multiple year dataset (Baugh and Groeneveld, 2006).

The NDVI exhibits scaling problems, asymptotic signals over high biomass conditions, and is very sensitive to canopy background variations with NDVI values particularly high with darker canopy backgrounds (Vermote and Vermeulen, 1999; Vermote et al., 2002; Ahmad, 2012b).

RS data can be used to evaluate model performance (Kite and Droogers, 2000; Vazifedoust et al., 2009), or to initialize, drive, update or re-calibrate models (Droogers and Bastiaanssen, 2002; Vazifedoust et al., 2009). When the error between model results and data is low, RS-based initialization of models would, in principle, be sufficient to provide spatially distributed information (Vazifedoust et al., 2009).

Roth (2002) studied the effect of water stress and soil compaction on cotton canopy and showed that canopy reflectance is affected by water stress and canopy reflectance changes were greatest at 555 nm in the green band, 670 nm in the red band and 760 nm in the near infrared band (Kulkarni and Bajwa, 2005). The NDVI can more accurately represent the yield when using higher spatial and temporal resolution satellite data (Li et al., 2007) and the pixel-based modeling revealed a general spatial trend of higher cotton yield (Ruecker et al., 2007).

The methodology presented in this research paper has several desirable properties. Since it treats each pixel individually without setting thresholds or empirical constants, the method is globally applicable (Vermote and Vermeulen, 1999; Vermote et al., 2002; Ahmad, 2012c). The overall accuracy of the results exceeded 85%, the level that the US Geological Survey (Anderson et al., 1976; Sader et al., 2001; Ahmad, 2013a) uses as a threshold to define acceptability (Sader et al., 2001; Ahmad, 2013a). This study also identified several data acquisitions and processing issues that warrant further investigation. Studies are under way to assess the importance of coordinating and timing field data collection and image acquisition dates as a means of improving the strength of the relationships between image and land condition trend analysis (Senseman et al., 1996; Ahmad, 2012e) ground-truth data.

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## References Références Referencias

1. Ackerman, S.A., Strabala, K.I., Menzel, W.P., Frey, R.A., Moeller, C.C., Gumley, L.E., Baum, B., Seemann, S.W. and Hong, Z. (2006). Discriminating clear sky from clouds with MODIS, Algorithm theoretical basis document (MOD35). URL: http://modis.gsfc.nasa.gov/ (Accessed on December 14, 2012).
2. Ackerman, S.A., Strabala, K.I., Menzel, W.P., Frey, R.A., Moeller, C.C. and Gumley, L.E. (1998). Discriminating clear sky from clouds with MODIS. Journal of Geophysical Research, Vol. 103(D24), pp.32,141-32,157.
3. Aguilar, C., Zinnert, J.C., Polo, M.J. and Young, D.R. (2012). NDVI as an indicator for changes in water availability to woody vegetation. Ecological Indicators, Vol. 23, pp.290-300.
4. Ahl, D.E., Gower, S.T., Burrows, S.N., Shabanov, N.V., Myneni, R.B. and Knyazikhin, Y. (2006). Monitoring spring canopy phenology of a deciduous broadleaf forest using MODIS. Remote Sensing of Environment, Vol. 104, pp.88-95.
5. Ahmad, F. (2012). Phenologically-tuned MODIS NDVI-based time series (2000-2012) for monitoring of vegetation and climatic change in North-Eastern Punjab, Pakistan. Global Journal of Human Social Science: Geography & Environmental Geo-Sciences, Vol. 12(13), pp.37-54.
6. Ahmad, F. (2012a). NOAA AVHRR NDVI/MODIS NDVI predicts potential to forest resource management in Çatalca district of Turkey. Global Journal of Science Frontier Research: Environment & Earth Sciences, Vol. 12(3), pp.29-46.
7. Ahmad, F. (2012b). NOAA AVHRR satellite data for evaluation of climatic variation and vegetation change in the Punjab Province, Pakistan. Journal of Food, Agriculture & Environment, Vol. 10(2), pp.1298-1307.
8. Ahmad, F. (2012c). Landsat ETM+ and MODIS EVI/NDVI data products for climatic variation and agricultural measurements in Cholistan Desert. Global Journal of Human Social Science: Geography & Environmental Geo-Sciences, Vol. 12(13), pp.1-11.
9. Ahmad, F. (2012d). A review of remote sensing data change detection: Comparison of Faisalabad and Multan Districts, Punjab Province, Pakistan. Journal of Geography and Regional Planning, Vol. 5(9), pp.236-251.

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10. Ahmad, F. (2012e). Spectral vegetation indices performance evaluated for Cholistan Desert. Journal of Geography and Regional Planning, Vol. 5(6), pp.165-172.
11. Ahmad, F. (2012f). Pixel Purity Index algorithm and n-Dimensional Visualization for ETM+ image analysis: A case of District Vehari. Global Journal of Human Social Science: Arts and Humanities, Vol. 12(15), pp.23-32.
12. Ahmad, F. (2013). Detection of change in vegetation cover using multi-spectral and multi-temporal information for District Sargodha. Global Journal of Human Social Sciences: Geography & Environmental Geo-Sciences, Vol. 13(1), pp.17-26.
13. Ahmad, F. (2013a). Land degradation pattern using geo-information technology for Kot Addu, Punjab Province, Pakistan. Global Journal of Human Social Sciences: Geography & Environmental Geo-Sciences, Vol. 13(1), pp.1-16.
14. Akkartala, A., Türüdüa, O. and Erbekb, F.S. (2004). Analysis of changes in vegetation biomass using multitemporal and multisensor satellite data. In: Proceedings of XXXV ISPRS Congress, 12-23 July 2004, Istanbul, Turkey. URL: http://www.isprs.org/proceedings/XXXV/congress/yf/papers/946.pdf. (Accessed on September 17, 2011).
15. Al-Awadhi, T., Al-Shukili, A. and Al-Amri, Q. (2011). The use of remote sensing & geographical information systems to identify vegetation: The case of Dhofar Governorate (Oman). URL: http://www.isprs.org/proceedings/2011/ISRSE-34/211104015Final00239.pdf. (Assessed on September 10, 2011).
16. Alcaraz-Segura, D., Cabello, J., Paruelo, J.M. and Delibes, M. (2009). Use of descriptors of ecosystem functioning for monitoring a national park network: A remote sensing approach. Environmental Management, Vol. 43(1), pp.38-48.
17. Alexandridis, T. and Chemin, Y. (2002). Landsat ETM+, Terra MODIS and NOAA AVHRR: Issues of scale and inter-dependency regarding land parameters. In: Proceedings of 23rd Asian Conference of Remote Sensing, 25-29 November 2002, Kathmandu, Nepal, 6 p. URL: http://www.a-a-r-s.org/acrs/proceeding/ACRS2002/Papers/EOS02-3.htm. (Accessed on September 07, 2013).
18. Anderson, J.R., Hardy, E.E., Roach, J.T. and Whitmer, R.E. (1976). A land use and land cover classification system for use with remote sensor data. US Geological Survey: Professional Paper 964, Washington, DC.
19. Asrar, G., Fuch, M. and Kanemasu, E.T. (1984). Estimating absorbed photosynthetic radiation and leaf area index from spectral reflectance in wheat. Agronomy Journal, Vol. 76, pp.300-306.
20. Asrar, G., Myneni, R.B. and Choudhury, B.J. (1992). Spatial heterogeneity in vegetation canopies and remote sensing of absorbed photosynthetically active radiation: A modeling study. Remote Sensing of Environment, Vol. 41, pp. 85-103.
21. Badhwar, G.B. (1984). Automatic corn-soybean classification using Landsat MSS data. II. Early season crop proportion estimation. Remote Sensing of Environment, Vol. 14(1-3), pp. 31-37.
22. Baldi, G., Nosetto, M.D., Aragón, R., Aversa, F., Paruelo, J.M. and Jobbágy, E.G. (2008). Long-term satellite NDVI datasets: Evaluating their ability to detect ecosystem functional changes in South America. Sensors, Vol. 8, pp. 5397-5425.
23. Baret, F. and Guyot, G. (1991). Potentials and limits of vegetation indices for LAI and APAR assessment. Remote Sensing of Environment, Vol. 35, pp. 161-173.
24. Barnes, E.M., Moran, M.S., Pinter, Jr. P.J. and Clarke, T.R. (1996). Multispectral remote sensing and site-specific agriculture: Examples of current technology and future possibilities. In: Proceedings of the 3rd International Conference on Precision Agriculture, 23-26 June 1996, Minneapolis, Minnesota, USA, pp.843-854.
25. Barrow, C.J. (1991). Land Degradation: Development and breakdown of terrestrial environments. Cambridge University Press, Cambridge, p.295.
26. Baugh, W.M. and Groeneveld, D.P. (2006). Broadband vegetation index performance evaluated for a low-cover environment. International Journal of Remote Sensing, Vol. 27(21), pp. 4715-4730.
27. Begue, A. (1993). Leaf area index, intercepted photosynthetically active radiation, and spectral vegetation indices: A sensitivity analysis for regular-clumped canopies. Remote Sensing of Environment, Vol. 46, pp.45-59.
28. Beurs, de K.M. and Henebry, G.M. (2004). Land surface phenology, climatic variation, and institutional change: Analyzing agricultural land



© 2013 Global Journals Inc. (US)

cover change in Kazakhstan. Remote Sensing of Environment, Vol. 89, pp.497-509.

29. Booth, A., McCullum, J., Mpinga, J. and Mukute, M. (1994). State of the environment in Southern Africa. Southern African Research and Documentation Centre (SARDC), Harare, Zimbabwe. URL: http://rmportal.net/library/ content /frame/opinion3.pdf/at_download/file.(Accessed on January 20, 2013).
30. Budde, M.E., Tappan, G., Rowland, J., Lewis, J. and Tieszen, L.L. (2004). Assessing land cover performance in Senegal, West Africa using 1-km integrated NDVI and local variance analysis. Journal of Arid Environments, Vol. 59 (3), pp. 481-498.
31. Carrão, H., Gonçalves, P. and Caetano, M. (2008). Contribution of multispectral and multitemporal information from MODIS images to land cover classification. Remote Sensing of Environment, Vol. 112(3), pp.986-997.
32. Chen, P.Y., Fedosejevs, G., Tiscareño-LóPez, M. and Arnold, J.G. (2006). Assessment of MODIS-EVI, MODIS-NDVI and VEGETATION-NDVI composite data using agricultural measurements: An example at corn fields in western Mexico. Springer, Netherlands, Environmental Monitoring and Assessment, Vol. 119(1-3), pp.69-82.
33. Chen, P.Y., Srinivasan, R., Fedosejevs, G., Báez-González, A.D. and Gong, P. (2002). Assessment of NDVI composite using merged NOAA-14 and NOAA-15 AVHRR data. Geographic Information Sciences, Vol. 8(1), pp.31-38.
34. Cheng, Q. (2006). Multisensor comparisons for validation of MODIS vegetation indices. Pedosphere, Vol. 16(3), pp.362-370.
35. Cheng, Q. and Wu, X. (2011). Mapping paddy rice yield in Zhejiang Province using MODIS spectral index. Turkish Journal of Agriculture & Forestry, Vol. 35(6), pp.579-589.
36. Cheng, Q., Huang, J.F. and Wang, R.C. (2004). Assessment of rice fields by GIS/GPS-supported classification of MODIS data. Journal of Zhejiang University SCIENCE A: Bioscience & Biotechnology, Vol. 5(4), pp.412-417.
37. Choudhury, B.J. (1987). Relationship between vegetation indices, radiation absorption, and net photosynthesis evaluated by sensitivity analysis. Remote Sensing of Environment, Vol. 22, pp.209-233.
38. Chris, C.F. and Molly, E.B. (2006). Intra-seasonal NDVI change projections in semi-arid Africa. Remote Sensing of Environment, Vol. 101, pp.249-256.
39. Clevers, J.G. (1988). The derivation of a simplified reflectance model for the estimation of leaf area index. Remote Sensing of Environment, Vol. 25, pp.53-69.
40. Colwell, J.E. (1973). Bidirectional spectral reflectance of grass canopies for determination of above ground standing biomass. Ph.D. Dissertation, University of Michigan, USA.
41. Dabrowska-Zielinska, K., Kogan, F., Ciolkosz, A., Gruszczynska, M. and Kowalik, W. (2002). Modelling of crop growth conditions and crop yield in Poland using AVHRR-based indices. International Journal of Remote Sensing, Vol. 23, pp.1109-1123.
42. Dalezios, N.R., Domenikiotis, C., Loukas, A., Tzortzios, S.T. and Kalaitzidis, C. (2001). Cotton yield estimation based on NOAA/AVHRR produced NDVI. Physics and Chemistry of the Earth, Part B: Hydrology, Oceans and Atmosphere, Vol. 26(3), pp.247-251.
43. Debien, A., Neerinckx, S., Kimaro, D. and Gulinck, H. (2010). Influence of satellite-derived rainfall patterns on plague occurrence in northeast Tanzania. International Journal of Health Geographics, Vol. 9, pp.1-10.
44. DeFries, R.S., Hansen, M.C. and Townshend, J.R.G. (1995). Global discrimination of land cover types from metrics derived from AVHRR pathfinder data. Remote Sensing of Environment, Vol. 54(3), pp.209-222.
45. Dennison, P.E. and Roberts, D.A. (2003). The effects of vegetation phenology on endmember selection and species mapping in southern California chaparral. Remote Sensing of Environment, Vol. 87(2-3), pp.123-135.
46. Dong, J., Kaufmann, R.K., Myneni, R.B., Tucker, C.J., Kauppi, P.E., Liski, J., Buermann, W., Alexeyev, V. and Hughes, M.K. (2003). Remote sensing estimates of boreal and temperate forest woody biomass, carbon pools, sources and sinks. Remote Sensing of Environment, Vol. 84, pp. 393-410.
47. Dorman, J.L. and Sellers, P.J. (1989). A Global climatology of albedo, roughness length and stomatal resistance for atmospheric general



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circulation models as represented by the simple biosphere model (SiB). Journal of Applied Meteorology, Vol. 28, pp.833-855.

48. Droogers, P. and Bastiaanssen, W.G.M. (2002). Irrigation performance using hydrological and remote sensing modelling. Journal of Irrigation and Drainage Engineering, Vol. 128, pp.111-118.
49. Eastman, J.R. (2003). Idrisi Kilimanjaro: Guide to GIS and Image Processing. Clark Labs, Clark University, Worcester, MA. URL: http://www.gis.unbc.ca/help/software/idrisi/kilimanjaro_manual.pdf. (Accessed on January 20, 2013).
50. Epiphanio, J.C.N. and Huete, A.R. (1995). Dependence of NDVI and SAVI on sun/sensor geometry and its effect on fPAR relationships in Alfalfa. Remote Sensing of Environment, Vol. 51, pp. 351-360.
51. ERDAS Imagine, Inc. (2010). Professional Tour Guides. URL: http://geospatial.intergraph.com/products/ERDASIMAGINE/ERDASIMAGINE/Downloads.aspx. (Accessed on February 18, 2013).
52. Fensholt, R. (2004). Earth observation of vegetation status in the Sahelian and Sudanian West Africa: Comparison of Terra MODIS and NOAA AVHRR satellite data. International Journal of Remote Sensing, Vol. 10, pp.1641-1659.
53. Fontana, F.M.A. (2009). From single pixel to continental scale: using AVHRR and MODIS to study land surface parameters in mountain regions. Ph.D. dissertation, Institute of Geography, University of Bern, Switzerland. URL: http://www.climatestudies.unibe.ch/students/theses/phd/31.pdf. (Accessed on October 15, 2012).
54. Galio, K.P., Daughtry, C.S.T. and Bauer, M.E. (1985). Spectral estimation of absorbed photosynthetically active radiation in corn canopies. Agronomy Journal, Vol. 78, pp.752-756.
55. Gao, B-C. (1996). NDWI - A normalized difference water index for remote sensing of vegetation liquid water from space. Remote Sensing of Environment, Vol. 58(3), pp.257-266.
56. Gao, X., Huete, A.R., Ni, W. and Miura, T. (2000). Optical–biophysical relationships of vegetation spectra without background contamination. Remote Sensing of Environment, Vol. 74(3), pp. 609-620.
57. Gillies, R.R., Carlson, T.N., Cui, J., Kustas, W.O. and Humes, K.S. (1997). A verification of the 'triangle' method for obtaining surface soil water content and energy fluxes from remote measurements of the Normalized Difference Vegetation Index (NDVI) and surface radiant temperature. International Journal of Remote Sensing, Vol. 18, pp.3145-3166.
58. Gitelson, A.A. and Merzlyak, M.N. (1996). Signature analysis of leaf reflectance spectra: Algorithm development for remote sensing of chlorophyll. Journal of Plant Physiology, Vol. 148, pp.494-500.
59. Glenn, E.P., Huete, A.R., Nagler, P.L. and Nelson, S.G. (2008). Relationship between remotely-sensed vegetation indices, canopy attributes and plant physiological processes: What vegetation indices can and cannot tell us about the landscape. Sensors, Vol. 8, pp.2136-2160.
60. Groeneveld, D.P. and Baugh, W.M. (2007). Correcting satellite data to detect vegetation signal for eco-hydrologic analyses. Journal of Hydrology, Vol. 344(1-2), pp.135-145.
61. GSFC/NASA (2003). MODIS technical specifications. URL: http://modis.gsfc.nasa.gov/about/specs.html. (Accessed on September 05, 2011).
62. Hall, F.G. and Badhwar, G.D. (1987). Signature-extendable technology: Global space-based crop recognition. IEEE Transactions on Geoscience and Remote Sensing, Vol. GE-25(1), pp.93-103.
63. Hamel, S., Garel, M., Festa-Bianchet, M., Gaillard, J-M. and Côté, S.D. (2009). Spring Normalized Difference Vegetation Index (NDVI) predicts annual variation in timing of peak faecal crude protein in mountain ungulates. Journal of Applied Ecology, Vol. 46(3), pp. 582-589.
64. Hobbs, R.J. (1989). Remote sensing of spatial and temporal dynamics of vegetation. In: Hobbs, R.J. and Mooney, H.A. (Eds.), Remote Sensing of Biosphere Functioning, Springer-Verlag, New York, pp.203-219.
65. Holben, B. (1986). Characteristics of maximum-value composite images from temporal AVHRR data. International Journal of Remote Sensing, Vol. 7, pp.1417-1434.
66. Hongo, C. and Niwa, K. (2012). Yield prediction of sugar beet through combined use of satellite data and meteorological data. Journal of Agricultural Science, Vol. 4(4), p.251-261.
67. Höpfner, C. and Scherer, D. (2011). Analysis of vegetation and land cover dynamics in north-western Morocco during the last decade using MODIS NDVI time series data. Biogeosciences, Vol. 8, pp.3359-3373.



© 2013 Global Journals Inc. (US)

68. Huang, Q., Li, M., Chen, C., Mao, K., Chen, Z., Li, F. and Chen, D. (2010). Assessment of land degradation in Guizhou province, Southwest China using AVHRR/NDVI and MODIS/NDVI data. 18th International Conference on Geoinformatics, 18-20 June 2010, Beijing, pp.1-5. doi: 10.1109/GEOINFORMATICS.2010.5568119
69. Huete, A.R. (2005). Global variability of terrestrial surface properties derived from MODIS visible to thermal-infrared measurements. In: Proceedings of IGARSS 05 Geoscience and Remote Sensing Symposium, 25-29 July 2005. URL: http://ieeexplore.ieee.org/iel5/10226/32601/01526782.pdf. (Accessed on September 05, 2011).
70. Huete, A.R., Didan, K., Miura, T., Rodriguez, E.P., Gao, X. and Ferreira, L.G. (2002). Overview of the radiometric and biophysical performance of the MODIS vegetation indices. Remote Sensing of Environment, Vol. 83(1-2), pp.195-213.
71. Huete, A.R., Didan, K., Shimabukuro, Y.E., Ratana, P., Saleska, S.R., Hutyra, L.R., Yang, W., Nemani, R.R. and Myneni, R. (2006). Amazon rainforests green-up with sunlight in dry season. Geophysical Research Letters, 33(L06405), 4 p.
72. Huete, A.R., Justice, C.O. and Leeuwen, van W. (1999). MODIS vegetation index (MOD 13) algorithm theoretical basis document version 3. URL: http://modis.gsfc.nasa.gov/data/atbd/atbd_mod13.pdf. (Accessed on September 17, 2011).
73. Huete, A.R., Liu, H.Q., Batchily, K. and Leeuwen, van W. (1997). A comparison of vegetation indices over a global set of TM images for EOS-MODIS. Remote Sensing of Environment, Vol. 59, pp. 440-451.
74. Hutchinson, C.F. (1991). Uses of satellite data for famine early warning in sub-Saharan Africa. International Journal of Remote Sensing, Vol. 12, pp.1405-1421.
75. Jakubauskas, M.E., David, R. and Kastens, J.H. (2002). Crop identification using harmonic analysis of time-series AVHRR NDVI data. Computers and Electronics in Agriculture, Vol. 37(1-3), pp.127-139.
76. Jensen, J.R. (2005). Introductory digital image processing: A remote sensing perspective. 3rd Edition, Englewood Cliffs, New Jersey, Prentice-Hall, pp.34-67.
77. Jiang, Z., Huete, A.R., Didan, K. and Miura, T. (2008). Development of a two-band Enhanced Vegetation Index without a blue band. Remote Sensing of Environment, Vol. 112(10), pp.3833-3845.
78. Jianya, G., Haigang, S., Guorui, Ma. and Qiming, Z. (2008). A review of multi-temporal remote sensing data change detection algorithms. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol. XXXVII, Part B7, pp.757-762. URL: http://www.isprs.org/proceedings/XXXVII/congress/7_pdf/5_WG-VII-5/05. pdf. (Accessed on November 04, 2011).
79. Jin, S. and Sader, S.A. (2005). MODIS time-series imagery for forest disturbance detection and quantification of patch size effects. Remote Sensing of Environment, Vol. 99, pp. 462-470.
80. Johnson, J.F., Voorhees, W.B., Nelson, W.W. and Randall, G.W. (1990). Soybean growth and yield as affected by surface and subsoil compaction. Agronomy Journal, Vol. 82(5), pp. 973-979.
81. Justice, C.O., Townshend, J.R.G., Holben, B.N. and Tucker, C.J. (1985). Analysis of the phenology of global vegetation using meteorological satellite data. International Journal of Remote Sensing, Vol. 6, pp. 1271-1318.
82. Justice, C.O., Vermote, E., Townshend, J.R.G., DeFries, R.S., Roy, D.P., Hall, D.K., Salomonson, V.V., Privette, J., Riggs, G., Strahler, A., Lucht, W., Myneni, R., Knjazihhin, Y., Running, S., Nemani, R., Wan, Z., Huete, A.R., Leeuwen, van W., Wolfe, R.E., Giglio, L., Muller, J.-P., Lewis, P. and Barnsley, M. (1998). The Moderate Resolution Imaging Spectroradiometer (MODIS): Land remote sensing for global change research. IEEE Transactions on Geoscience and Remote Sensing, Vol. 36(4), pp. 1228-1249.
83. Karaburun, A. (2010). Estimation of C factor for soil erosion modeling using NDVI in Büyükçekmece watershed. Ozean Journal of Applied Sciences, Vol. 3(1), pp. 77-85.
84. Khlopenkov, K.V. and Trishchenko, A.P. (2008). Implementation and evaluation of concurrent gradient search method for reprojection of MODIS level 1B imagery. IEEE Transaction on Geoscience and Remote Sensing, Vol. 46(7), pp. 2016-2027.
85. Kite, G.W. and Droogers, P. (2000). Comparing evapotranspiration estimates from satellites, hydrological models and field data. Journal of Hydrology, Vol. 229, pp.3-18.

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86. Kogan, F.N. (1987). Vegetation index for areal analysis of crop conditions. In: Proceedings of 18th Conference Agricultural and Forest Meteorology and 8th Conference Biometeorology and Aerobiology, 15-18 September 1987, W. Lafayette, Indiana, AMS Publisher, pp.103-106.
87. Korontzi, S., Roy, D.P., Justice, C.O. and Ward, D.E. (2004). Modeling and sensitivity analysis of fire emissions in southern Africa during SAFARI 2000. Remote Sensing of Environment, Vol. 92, pp.376-396.
88. Kulkarni, S.S. and Bajwa, S.G. (2005). Spectral response of cotton canopy to soil compaction. Paper Number: 051066, The Society for engineering in agricultural, food, and biological systems, USA, pp.1-19.
89. Lambin, E.F. (1996). Change detection at multiple temporal scales - seasonal and annual variations in landscape variables. Photogrammetric Engineering & Remote Sensing, Vol. 62, pp.931-938.
90. Li, A., Liang, S., Wang, A. and Qin, J. (2007). Estimating crop yield from multi-temporal satellite data using multivariate regression and neural network techniques. Photogrammetric Engineering & Remote Sensing, Vol. 73(10), pp.1149-1157.
91. Lillesand, T.M. and Kiefer, R.W. (2000). Remote sensing and image interpretation. 4th Edition, John Wiley & Sons, Inc., New York, pp.124-156.
92. Lillesand, T.M., Kiefer, R.W. and Chipman, J.W. (2004). Remote sensing and image interpretation. 5th Edition, John Wiley & Sons, Inc., New York, pp.178-198.
93. Liu, H. and Zhou, Q. (2004). Accuracy analysis of remote sensing change detection by rule-based rationality evaluation with post-classification comparison. International Journal of Remote Sensing, Vol. 25(5), pp.1037-1050.
94. Liu, H.Q. and Huete, A.R. (1995). A feedback based modification of the NDVI to minimize canopy background and atmospheric noise. IEEE Transactions on Geoscience and Remote Sensing, Vol. 33(2), pp.457-465.
95. Liu, W.T. and Kogan, F. (2002). Monitoring Brazilian soybean production using NOAA/AVHRR based vegetation condition indices. International Journal of Remote Sensing, Vol. 23(6), pp.1161-1179.
96. Lloyd, D. (1990). A phenological classification of terrestrial vegetation cover using shortwave vegetation index imagery. International Journal of Remote Sensing, Vol. 11(12), pp.2269-2279.
97. Lobell, D.B., Asner, G.P., Ortiz-Monasterio, J.I. and Benning, T.L. (2003). Remote sensing of regional crop production in the Yaqui Valley, Mexico: estimates and uncertainties. Agriculture, Ecosystems and Environment, Vol. 94, pp.205-220.
98. Logan, T.L. (1999). EOS/AM-1 Digital Elevation Model (DEM) Data Sets: DEM and DEM auxiliary datasets in support of the EOS/Terra platform. JPL D-013508. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA.
99. Los, S.O. (1998). Estimation of the ratio of sensor degradation between NOAA-AVHRR channels 1 and 2 from monthly NDVI composites. IEEE Transactions on Geoscience and Remote Sensing, Vol. 36, pp.206-213.
100. Los, S.O., Collatz, G.J., Bounoua, L., Sellers, P.J. and Tucker, C.J. (2001). Global interannual variations in sea surface temperature and land surface vegetation, air temperature, and precipitation. Journal of Climate, Vol. 14, pp. 1535-1549.
101. Los, S.O., Collatz, G.J., Sellers, P.J., Malmström, C.M., Pollack, N.H., DeFries, R.S., Bounoua, L., Parris, M.T., Tucker, C.J. and Dazlich, D.A. (2000). A Global 9-yr biophysical land surface dataset from NOAA- AVHRR data. Journal of Hydrometeorology, Vol. 1, pp. 183-199.
102. Los, S.O., Justice, C.O. and Tucker, C.J. (1994). A global 1° by 1° NDVI data set for climate studies derived from the GIMMS continental NDVI data. International Journal of Remote Sensing, Vol. 15(17), pp. 3493-3518.
103. Los, S.O., North, P.R.J., Grey, W.M.F. and Barnsley, M.J. (2005). A method to convert AVHRR normalized difference vegetation index time series to a standard viewing and illumination geometry. Remote Sensing of Environment, Vol. 99(4), pp. 400-411.
104. Lowery, B. and Schuler, R.T. (1991). Temporal effects of subsoil compaction on soil strength and plant growth. Soil Science Society of America Journal, Vol. 55(1), pp.216-223.
105. Lu, D., Mausel, P., Brondizios, E. and Moran, E. (2004). Change detection techniques. International Journal of Remote Sensing, Vol. 25(12), pp. 2365-2407.



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106. Lyon, J.G., Yuan, D., Lunetta, R.S. and Elvidge, C.D. (1998). A change detection experiment using vegetation indices. Photogrammetric Engineering & Remote Sensing, Vol. 64(2), pp. 143-150.
107. Macdonald, R.B. and Hall, F.G. (1980). Global crop forecasting. Science, Vol. 208(4445), pp.670-679.
108. Macleod, R.D. and Congalton, R.G. (1998). A quantitative comparison of change detection algorithms for monitoring eelgrass from remotely sensed data. Photogrammetric Engineering and Remote Sensing, Vol. 64(3), pp.207-216.
109. Mahmoodzadeh, H. (2007). Digital change detection using remotely sensed data for monitoring green space destruction in Tabriz. International Journal of Environmental Research, Vol. 1(1), pp. 35-41.
110. Mambo, J. and Archer, E. (2007). An assessment of land degradation in the Save catchment of Zimbabwe. Area, Vol. 39(3), pp. 380-391.
111. Mas, J-F. (1999). Monitoring land-cover changes: a comparison of change detection techniques. International Journal of Remote Sensing, Vol. 20(1), pp. 139-152.
112. Meneses-Tovar, C.L. (2011). NDVI as indicator of degradation. Unasylva, Vol. 62(238), pp. 39-46.
113. Milich, L. and Weiss, E. (2000). GAC NDVI interannual coefficient of variation (CoV) images: Ground truth sampling of the Sahel along north-south transects. International Journal of Remote Sensing, Vol. 21, pp. 235-260.
114. Mirik, M., Michels, Jr. G.J., Kassymzhanova, M.S., Elliott, N.C. and Catana, V. (2006). Spectral sensing of aphid (Hemiptera: Aphididae) density using field spectrometry and radiometry. Turkish Journal of Agriculture and Forestry, Vol. 30, pp. 421-428.
115. Mirik, M., Norland, J.E., Biondini, M.E., Crabtree, R.L. and Michels, Jr. G.J. (2007). Relationships between remotely sensed data and biomass components in a big sagebrush (*Artemisia tridentata*) dominated area in Yellowstone national park. Turkish Journal of Agriculture and Forestry, Vol. 31, pp. 135-145.
116. MODIS (1999). MODIS Vegetation Index (MOD 13): Algorithm theoretical basis document pp.26-29 (version 3). URL: http://modis.gsfc.nasa.gov/data/atbd/atbd_mod13.pdf. (Accessed on December 04, 2008).
117. Moran, M.S., Inoue, Y. and Barnes, E.M. (1997). Opportunities and limitations for image based remote sensing in precision crop management. Remote Sensing of Environment, Vol. 61, pp. 319-346.
118. Moran, M.S., Jackson, R.D., Slater, P.N. and Teillet, P.M. (1992). Evaluation of simplified procedures for retrieval of land surface reflectance factors from satellite sensor output. Remote Sensing of Environment, Vol. 41, pp. 169-184.
119. Mouat, D.A., Mahin, G.C. and Lancaster, J. (1993). Remote sensing techniques in the analysis of change detection. Geocarto International, Vol. 2, pp. 39-50.
120. Moulin, S., Kergoat, L., Viovy, N. and Dedieu, G. (1997). Global scale assessment of vegetation phenology using NOAA/AVHRR satellite measurements. Journal of Climate, Vol. 10, pp. 1154-1170.
121. Myneni, R.B. and Asrar, G. (1994). Atmospheric effects and spectral vegetation indices. Remote Sensing of Environment, Vol. 47, pp. 390-402.
122. Myneni, R.B., Dong, J., Tucker, C.J., Kaufmann, R.K., Kauppi, P.E., Liski, J., Zhou, L., Alexeyev, V. and Hughes, M.K. (2001). A large carbon sink in the woody biomass of Northern forests. In: Proceedings of the National Academy of Sciences of the United States of America, Vol. 98, pp. 14784-14789.
123. Myneni, R.B., Hall, F.G., Sellers, P.J. and Marshak, A.L. (1995). The interpretation of spectral vegetation indices. IEEE Transactions on Geoscience and Remote Sensing, Vol. 33(2), pp. 481-486.
124. Myneni, R.B., Keeling, C.D., Tucker, C.J., Asrar, G. and Nemani, R.R. (1997). Increased plant growth in the northern high latitudes from 1981-1991. Nature, Vol. 386, pp. 698-702.
125. Nasr, A.H. and Helmy, A.K. (2009). Integration of Misrsat-1 and SPOT-2 data for quantitative change detection applications. ICGST-GVIP Journal, Vol. 9(5), pp.53-59. URL: http://www.icgst.com /gvip/volume9/Issue5/GVIP_V9_I5.pdf. (Accessed on November 04, 2011).
126. Nicandrou, A. (2010). Hydrological assessment and modelling of the river Fani catchment, Albania. Faculty of Advanced Technology, University of Glamorgan. URL: http://dspace1.isd.glam.ac.uk/dspace/handle/10265/461(Accessed on November 11, 2012).
127. Nicholson, S.E. and Farrar, T. (1994). The influence of soil type on the relationships between NDVI,


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rainfall and soil moisture in semi-arid Botswana: Part I. NDVI response to rainfall. Remote Sensing of Environment, Vol. 50, pp.107-120.
128. Nicholson, S.E., Tucker, C.J. and Ba, M.B. (1998). Desertification, drought, and surface vegetation: An example from the West African Sahel. Bulletin of the American Meteorological Society, Vol. 79, pp. 1-15.
129. Ouyang, W., Hao, F.H., Skidmore, A.K., Groen, T.A., Toxopeus, A.G. and Wang, T. (2012). Integration of multi-sensor data to assess grassland dynamics in a Yellow River sub-watershed. Ecological Indicators, Vol. 18, pp. 163-170.
130. Paruelo, J.M., Epstein, H.E., Lauenroth, W.K. and Burke, I.C. (1997). ANPP estimates from NDVI for the Central Grassland Region of the United States. Ecology, Vol. 78(3), pp. 953-958.
131. Pettorelli, N., Vik, J.O., Mysterud, A., Gaillard, J.M., Tucker, C.J. and Stenseth, N.C. (2005). Using the satellite-derived NDVI to assess ecological responses to environmental change. Trends in Ecology & Evolution, Vol. 20(9), pp. 503-510.
132. Piao, S.L, Mohammat, A., Fang, J.Y., Cai, Q. and Feng, J. (2006). NDVI-based increase in growth of temperate grasslands and its responses to climate changes in China. Global Environmental Change, Vol. 16(4), pp. 340-348.
133. Piao, S.L., Fang, J.Y., Zhou, L.M., Guo, Q.H., Henderson, M., Ji, W., Li, Y. and Tao, S. (2003). Interannual variations of monthly and seasonal NDVI in China from 1982 to 1999. Journal of Geophysical Research, Vol. 108(D14), pp. 4401-4413.
134. Potter, C.S., Randerson, J.T., Field, C.B., Matson, P.A., Vitousek, P.M., Mooney, H.A. and Klooster, S.A. (1993). Terrestrial ecosystem production, a process model based on global satellite and surface data. Global Biogeochemical Cycles, Vol. 7, pp. 811-841.
135. Prasad, A.K., Sudipta, S., Singh, R.P. and Kafatos, M. (2007). Inter-annual variability of vegetation cover and rainfall over India. Advances in Space Research, Vol. 39(1), pp.79-87.
136. Price, J.C. and Bausch, W.C. (1995). Leaf area index estimation from visible and NIR-infrared reflectance data. Remote Sensing of Environment, Vol. 52, pp. 55-65.
137. Price, K.P., Egbert, S.L., Nellis, M.D., Lee, R-Y. and Boyce, R. (1997). Mapping land cover in a high plains agro-ecosystem using a multidate Landsat thematic mapper modeling approach. Transactions of the Kansas Academy of Science, Vol. 100(1-2), pp. 21-33.
138. Prince, S.D. (1991). Satellite remote sensing of primary production: Comparison of results for Sahelian grasslands 1981-1988. International Journal of Remote Sensing, Vol. 12, pp.1301-1311.
139. Prince, S.D. and Tucker, C.J. (1986). Satellite remote sensing of rangelands in Botswana: II. NOAA AVHRR and herbaceous vegetation. International Journal of Remote Sensing, Vol. 7, pp.1555-1570.
140. Qi, J., Chehbouni, A., Huete, A.R., Kerr, Y.H. and Sorooshian, S. (1994). A modified soil adjusted vegetation index. Remote Sensing of Environment, Vol. 48, pp. 119-126.
141. Rahman, Md.R., Islam, A.H.M.H. and Rahman, Md.A. (2004). NDVI derived sugarcane area identification and crop condition assessment. Planplus, Vol. 1(2), pp. 1-12.
142. Reed, B.C., Brown, J.F., VanderZee, D., Loveland, T.R., Merchant, J.W. and Ohlen, D.O. (1994). Measuring phenological variability from satellite imagery. Journal of Vegetation Science, Vol. 5(5), pp.703-714.
143. Research System, Inc. (2004). Exploring ENVI, Boulder, CO. URL: http://www.ittvis.com (Accessed on November 28, 2011).
144. Richard, J., Radke, S.A., Omar, A.K. and Badrinath, R. (2005). Image change detection algorithms: A systematic survey. IEEE Transactions on Image Processing, Vol. 14(3), pp. 294-307.
145. Rosenthal, W.D. and Gerik, T.J. (1991). Radiation use efficiency among cotton cultivars. Agronomy Journal, Vol. 83(4), pp. 655-658.
146. Roth, G.W. (2002). The effect of water stress and soil compaction on cotton canopy reflectance and temperature. In: Proceedings of the 11th Cotton Conference, Brisbane, Australia, pp.623-630.
147. Rouse, J.W., Haas, R.H., Schell, J.A. and Deering, D.W. (1973). Monitoring vegetation systems in the Great Plains with ERTS. 3rd ERTS Symposium, NASA SP-351 I, pp. 309-317. URL: http://geol.hu/data/online_help/Vegetation_Indices.html.(Accessed on January 10, 2012).
148. Roy, D.P., Lewis, P.E. and Justice, C.O. (2002). Burned area mapping using multi-temporal moderate spatial resolution data – a bi-directional reflectance model-based expectation approach.



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Remote Sensing of Environment, Vol. 83(1-2), pp. 263-286.

149. Ruecker, G.R., Shi, Z., Mueller, M., Conrad, C., Ibragimov, N., Lamers, J.P.A., Martius, C., Strunz, G. and Dech, S.W. (2007). Cotton yield estimation in Uzbekistan integrating MODIS, Landsat ETM+ and field data. pp.123-128. URL: http://www.isprs.org/proceedings/xxxvi/8-w48/123_XXXVI-8-W48.pdf. (Accessed on September 18, 2013).
150. Running, S.W. and Nemani, R.R. (1991). Regional hydrologic and carbon balance responses of forests resulting from potential climate change. Climatic Change, Vol. 19, pp. 349-368.
151. Running, S.W., Justice, C.O., Salomonson, V.V., Hall, D., Barker, J., Kaufman, Y.J., Strahler, A.H., Huete, A.R., Muller, J.-P., Vanderbilt, V., Wan, Z.M., Teillet, P. and Carneggie, D. (1994). Terrestrial remote sensing science and algorithms planned for EOS/MODIS. International Journal of Remote Sensing, Vol. 15, pp. 3587-3620.
152. Sader, S.A., Hayes, D.J., Hepinstall, J.A., Coan, M. and Soza, C. (2001). Forest change monitoring of a remote biosphere reserve. International Journal of Remote Sensing, Vol. 22(10), pp.1937-1950.
153. Salomonson, V.V. and Toll, D.L. (1991). Execution phase (C/D) spectral band characteristics of the EOS moderate resolution imaging spectrometer-Nadir (MODIS-N) facility instrument. Advances in Space Research, Vol. 11, pp.231-236.
154. Schroeder, T.A., Canty, M.J. and Yang, Z. (2006). Radiometric correction of multi-temporal Landsat data for characterization of early successional forest patterns in western Oregon. Remote Sensing of Environment, Vol. 103, pp. 16-26.
155. Sellers, P.J. (1985). Canopy reflectance, photosynthesis and transpiration. International Journal of Remote Sensing, Vol. 6, pp.1335-1372.
156. Sellers, P.J., Los, S.O., Tucker, C.J., Justice, C.O., Dazlich, D.A., Collatz, G.J. and Randall, D.A. (1996). A revised land surface parameterization (SiB-2) for atmospheric GCMs. Part 2: The generation of global fields of terrestrial biophysical parameters from satellite data. Journal of Climate, Vol. 9(4), pp. 706-737.
157. Sellers, P.J., Tucker, C.J., Collatz, G.J., Los, S.O, Justice, C.O., Dazlich, D.A. and Randall, D.A. (1994). A global 1o by 1o NDVI data set for climate studies, Part 2: The adjustment of the NDVI and generation of global fields of terrestrial biophysical parameters. International Journal of Remote Sensing, Vol. 15, pp.3519-3545.
158. Senseman, G.M., Bagley, C.F. and Tweddale, S.A. (1996). Correlation of rangeland cover measures to satellite-imagery-derived vegetation indices. Geocarto International, Vol. 11(3), pp.29-38.
159. Sesnie, S.E., Gessler, P.E., Finegan, B. and Thessler, S. (2008). Integrating Landsat TM and SRTM-DEM derived variables with decision trees for habitat classification and change detection in complex neotropical environments. Remote Sensing of Environment, Vol. 112, pp.2145-2159.
160. Shi, Z., Ruecker, G.R., Mueller, M., Conrad, C., Ibragimov, N., Lamers, J.P.A., Martius, C., Strunz, G., Dech, S. and Vlek, P.L.G. (2007). Modeling of cotton yields in the Amu Darya river floodplains of Uzbekistan integrating multitemporal remote sensing and minimum field data. Agronomy Journal, Vol. 99(5), pp.1317-1326.
161. Shinners, K.J. and Binversie, B.N. (2007). Fractional yield and moisture of corn stover biomass produced in the Northern US Corn Belt. Biomass and Bioenergy, Vol. 31, pp.576-584.
162. Shippert, P. (2004). Why use hyperspectral imagery? Photogrammetric Engineering & Remote Sensing, pp.377-380. URL: http://www.iro.umontreal.ca/~mignotte/IFT6150/ComplementCours/HyperspectralImagery.pdf. (Accessed on November 20, 2011).
163. Singh, A. (1989). Digital change detection techniques using remotely sensed data. International Journal of Remote Sensing, Vol. 10(6), pp. 989-1003.
164. Singh, D. (2012). Evaluation of long-term NDVI time series derived from Landsat data through blending with MODIS data. Atmósfera, Vol. 25(1), pp.43-63.
165. Singh, R.P., Roy, S. and Kogan, F. (2003). Vegetation and temperature condition indices from NOAA AVHRR data for drought monitoring over India. International Journal of Remote Sensing, Vol. 24(22), pp. 4393-4402.
166. Smith, J.H. and Ramey, D.B. (1982). A crop area estimator based on changes in the temporal profile of a vegetative index. In: Proceedings of the Survey Research Methods Section, American Statistical Association, Cincinnati, Ohio, USA, pp.495-498. URL: http://www.amstat.org/sections/srms/Proceedings/papers/1982_095.pdf. (Accessed on September 21, 2013).

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Vegetation and temperature condition indices from NOAA AVHRR data for drought monitoring over India. International Journal of Remote Sensing, Vol. 24(22), pp. 4393-4402.
167. Sönmez, N.K. and Sarı, M. (2006). Use of remote sensing and geographic information system technologies for developing greenhouse databases. Turkish Journal of Agriculture and Forestry, Vol. 30, pp. 413-420.
168. Stow, D. (1995). Monitoring ecosystem response to global change: Multitemporal remote sensing analyses. In: Moreno, J. and Oechel, W. (Eds.), Anticipated Effects of a Changing Global Environment in Mediterranean Type Ecosystems, Springer-Verlag, New York, pp.254-286.
169. Symeonakis, E., Caccetta, P.A., Wallace, J.F. and Koukoulas, S. (2006). Multi-temporal land use/cover change detection in the Spanish Mediterranean coast. In: Proceedings of ISPRS Mid-Term Symposium, Remote Sensing: From pixels to processes, ITC, The Netherlands, pp.58-63. URL: http://www.isprs. org/proceedings/ XXXVI/ part7/PDF/058.pdf. (Accessed on November 04, 2011).
170. Tarpley, J.D., Schnieder, S.R. and Money, R.L. (1984). Global vegetation indices from NOAA-7 meteorological satellite. Journal of Climate and Applied Meteorology, Vol. 23, pp.4491-4503.
171. Taylor, H.M. and Gardner, H.R. (1963). Penetration of cotton seedlings tap roots as influenced by bulk density, moisture content and strength of soil. Soil Science, Vol. 96, pp.153-156.
172. Thenkabail, P.S., Smith, R.B. and Eddy De Pauw, E. De. (2000). Hyperspectral vegetation indices and their relationships with agricultural crop characteristics. Remote Sensing of Environment, Vol. 71, pp.158-182.
173. Thiam, A. (2003). The causes and spatial pattern of land degradation risk in southern Mauritania using multitemporal AVHRR-NDVI imagery and field data. Land Degradation & Development, Vol. 14, pp. 133-142.
174. Thomas, D.S.G. and Leason, H.C. (2005). Dunefield activity response to climate variability in the southwest Kalahari. Geomorphology, Vol. 64(1-2), pp.117-132.
175. Townshend, J.R.G. (1992). Improved global data for land applications: A proposal for a new high resolution data set. Report No. 20. International Geosphere–Biosphere Program, Stockholm, Sweden. URL: http://library.wur.nl/WebQuery/clc/916308. (Accessed on June 04, 2012).
176. Townshend, J.R.G. and Justice, C.O. (1988). Selecting the spatial-resolution of satellite sensors required for global monitoring of land transformations. International Journal of Remote Sensing, Vol. 9(2), pp.187-236.
177. Townshend, J.R.G., Justice, C.O., Li, W., Gurney, C. and McManus, J. (1991). Global land cover classification by remote sensing: present capabilities and future possibilities. Remote Sensing of Environment, Vol. 35(2-3), pp.243-255.
178. Tucker, C.J. (1979). Red and photographic infrared linear combinations for monitoring vegetation. Remote Sensing of Environment, Vol. 8, pp.127-150.
179. Tucker, C.J., Dregne, H.E. and Newcomb, W.W. (1991). Expansion and contraction of the Sahara Desert from 1980 to 1990. Science, Vol. 253, pp.299-301.
180. Tucker, C.J., Gatlin, J., Schnieder, S.R. and Kuchinos, M.A. (1982). Monitoring large scale vegetation dynamics in the Nile delta and river valley from NOAA AVHRR data. In: Proceedings of the Conference on Remote Sensing of Arid and Semi-Arid Lands, Cairo, Egypt, Ann Arbor, MI. pp.973-977.
181. Ulbricht, K.A. and Heckendorf, W.D. (1998). Satellite images for recognition of landscape and land use changes. ISPRS Journal of Photogrammetry & Remote Sensing, Vol. 53, pp.235-243.
182. Unger, P.W. and Kasper, T.C. (1994). Soil compaction and root growth: A review. Agronomy Journal, Vol. 86(5), pp.759-766.
183. USGS (2008). Earth Resources Observation and Science Center. URL: http://glovis.usgs.gov/ (Accessed on September 09, 2013).
184. USGS (2010). What is NDVI? United States Geological Survey: Science for Changing World. URL: http://ivm.cr.usgs.gov/ (Accessed on September 10, 2011).
185. Vazifedoust, M., Van Dam, J.C., Bastiaanssen, W.G.M. and Feddes, R.A. (2009). Assimilation of satellite data into agrohydrological models to improve crop yield forecasts. International Journal of Remote Sensing, Vol. 30(10), pp.2523-2545.
186. Verbesselt, J., Hyndman, R., Zeileis, A. and Culvenor, D. (2010). Phenological change detection while accounting for abrupt and gradual



© 2013 Global Journals Inc. (US)

trends in satellite image time series. Remote Sensing of Environment, Vol. 114(12), pp.2970-2980.

187. Vermote, E.F. and Vermeulen, A. (1999). Atmospheric correction algorithm: Spectral reflectances (MOD09) algorithm technical background document. URL: http: modis.gsfc.nasa.gov/data/atbd/atbd_mod08.pdf. (Accessed on September 07, 2011).
188. Vermote, E.F., El-Saleous, N.Z. and Justice, C.O. (2002). Atmospheric correction of MODIS data in the visible to middle infrared: First results. Remote Sensing of Environment, Vol. 83, pp.97-111.
189. Wan, Z. (2003). MODIS Land-Surface Temperature products users' guide. URL: http://www.icess.ucsb.edu/modis/LstUsrGuide/usrguide.html.(Accessed on September 07, 2011).
190. Wang, J., Rich, P.M. and Price, K.P. (2003). Temporal responses of NDVI to precipitation and temperature in the central Great Plains, USA. International Journal of Remote Sensing, Vol. 24, pp.2345-2364.
191. Wardlow, B.D., Egbert, S.L. and Kastens, J.H. (2007). Analysis of time-series MODIS 250 m vegetation index data for crop classification in the US Central Great Plains. Remote Sensing of Environment, Vol. 108(3), pp.290-310.
192. Wessels, K.J., Prince, S.D., Frost, P.E. and Zyl, van D. (2004). Assessing the effects of human-induced land degradation in the former homelands of northern South Africa with a 1 km AVHRR NDVI time-series. Remote Sensing of Environment, Vol. 91, pp.47-67.
193. Wiegant, C.L., Richardson, A.J. and Kanemasu, K. (1979). Leaf area index estimates for wheat from Landsat and their implications for evapotranspiration and crop modeling. Agronomy Journal, Vol. 71, pp.336-342.
194. Wolfe, R.E., Storey, J., Masuoka, E. and Fleig, A. (1995). MODIS Level 1A Earth location algorithm theoretical basis document. URL: http://modis.gsfc.nasa.gov/ (Accessed on December 14, 2012).
195. Wolfe, R.E., Nishihama, M., Fleig, A.J., Kuyper, J.A., Roy, D.P., Storey, J.C. and Patt, F.S. (2002). Achieving sub-pixel geolocation accuracy in support of MODIS land science. Remote Sensing of Environment, Vol. 83(1-2), pp.31-49.
196. Xie, Y. (2008). Remote sensing imagery in vegetation mapping: A review. Journal of Plant Ecology, Vol. 1(1), pp.9-23.
197. Yang, Y., Yang, L. and Merchant, J.W. (1997). An assessment of AVHRR/NDVI-ecoclimatological relations in Nebraska, USA. International Journal of Remote Sensing, Vol. 18(10), pp.2161-2180.
198. Young, A. (1998). Assessment of land degradation by remote sensing in land resources: Now and for the Future. Cambridge University Press, Cambridge. URL: http://www.uea.ac.uk/env/landresources/news-degradation-rs.html. (Accessed on January 20, 2013).
199. Zaeen, A.A. (2012). Remote sensing technique to monitoring the risk of soil degradation using NDVI. International Journal of Geographical Information System Applications and Remote Sensing, Vol. 3(1), pp.1-8.
200. Zhan, X., DeFries, R.S., Townshend, J.R.G., DiMiceli, C., Hansen, M.C., Huang, C. and Sohlberg, R.A. (2000). The 250m global land cover change product from the Moderate Resolution Imaging Spectroradiometer of NASA's Earth Observing System. International Journal of Remote Sensing, Vol. 21(6&7), pp.1433-1460.
201. Zhan, X., Sohlberg, R.A., Townshend, J.R.G., DiMiceli, C., Carroll, M.L., Eastman, J.C., Hansen, M.C. and DeFries, R.S. (2002). Detection of land cover changes using MODIS 250 m data. Remote Sensing of Environment, Vol. 83, pp.336-350.
202. Zhou, L.M., Tucker, C.J., Kaufmann, R.K., Slayback, D., Shabanov, N.V. and Myneni, R.B. (2001). Variations in northern vegetation activity inferred from satellite data of vegetation index during 1981 to 1999. Journal of Geophysical Research, Vol. 106(D17), pp.20,069-20,083.
203. Zoran, M. and Stefan, S. (2006). Climatic changes effects on spectral vegetation indices for forested areas analysis from satellite data. In: Proceedings of the 2nd Environmental Physics Conference, 18-22 February 2006, Alexandria, Egypt, pp.73-83.

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# The Fishers of the Pedro Bank, Jamaica: Through the Lens of Their Livelihoods

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*Abstract-* The complex lives of fishermen are generally not understood outside of the fishing community. The Pedro Bank, the island's primary fishing area is 80 km south of Jamaica and is source to the largest export of Queen Conch from the Caribbean. Using 154 structured interviews, the mechanisms by which the Pedro fishers, construct their livelihoods derived on the Banks were examined. For the estimated 150 to 1200 Fishers, decision to settle on respective Cays, method of fishing and use of resources from Pedro Bank fishing were all determined by place of origin on mainland Jamaica. 85% of fishers on North East Cay were from rural communities while 65% of Fishers on Middle Cay were from urban communities. 56% of rural fishers and 65% of urban fishers had never fished before arriving at Pedro. Behavioral dynamics and livelihood strategies of the Pedro Bank fishers are critical in developing future management plans.

*Keywords: jamaica should be Jamaica, pedro bank, fishers, livelihoods, coral reefs.*

*GJHSS-B Classification : FOR Code: 07049, 059999*

THE FISHERS OF THE PEDRO BANK, JAMAICA THROUGH THE LENS OF THEIR LIVELIHOODS

*Strictly as per the compliance and regulations of:*

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# The Fishers of the Pedro Bank, Jamaica: Through the Lens of Their Livelihoods

Rachel Allen[α] & Dale Webber[σ]

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## I. Introduction

In many countries throughout the world, small-scale fisheries are critical for the provision of food, income and livelihoods (Teh and Sumalia, 2005; Andrew et al., (2007), especially to the world's poorest (Allison and Ellis, 2001; Bene et al., 2008). In the face of Climate Change, small scale fisheries in developing countries is described as, at most, fragile and vulnerable (Bunce, et al., 2010, Pomeroy et al., 2006) and is expected to place considerable additional stress on the systems that determine livelihoods security (Ziervogel and Zermoglio, 2009).

Climate Change impacts (as identified by the IPCC[1]) along with increasing dependence on an already heavily exploited fishery as well as a fragile social and economic system, have resulted in a growing concern that the fishing industry which once represented an opportunity for poverty reduction in coastal areas, is fast becoming threatened. This increased burden is largely borne by the fishers who also have to find new and creative ways to adapt in order to diversify their livelihoods to avoid poverty.

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The current and standardized solution for building resilience for many developing countries is to employ adaptation strategies through the development of alternative livelihoods. Much of this discussion on the livelihood approach takes place within the confines of building adaptive capacity and enhancing resilience (Adger, 1999, Adger and Vincent, 2005, Allison and Ellis, 2001; Ostrom, 2008). In many cases, these livelihood assessments have been merely a presentation of a "menu" of options to fishers, without a comprehensive understanding of the complex and diverse livelihood strategies which describe and define their lives. Badjeck et al., (2010) further emphasize that many studies have been done on vulnerability and adaptive capacity assessments but "until recently there has been little directed analysis at the local scale of how climate variability and change is affecting the lives and livelihoods of the "tropical majority" of small scale fisherfolk."

Allison and Ellis (2001) propose that a fundamental aspect of the livelihood approach is to "identify what the poor have, rather than what they do not have" and [to] strengthen people's own inventive solutions, rather than to substitute for them." Further, Parvin et al., (2008), highlight the need and importance for understanding the community's unique perceptions and assessments of their own adaptive and proactive capacities.

The Pedro Bank, Jamaica presents one such area in that, although it provides the majority of fisheries based export earnings for the country, the livelihoods of Pedro fishers has never been studied. Numerous studies have been done on the coral reefs, fauna, avifauna, and a draft management plan developed. A designated fish sanctuary has been established on South West Cay, and alternative livelihood projects developed in some of the communities of origin on the mainland Jamaica. Since the work of Espeut in 2006, no comprehensive assessment of the complexities and diversity of the people has been done and no research has included the lives and livelihood options both on the Cays and on mainland Jamaica. Given the distance of the Pedro Bank to the mainland, the fishers of Pedro Bank appear to be misunderstood and marginalized, which according to Ribot (1996) is among the most important determinants of vulnerability. This research sought to characterise the fishers of Pedro Bank by examining their livelihood, priorities and choices. This

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choices. This was achieved by the execution of 154 interviews with fishers on both Cays as well at their homes on the mainland. As well, 34 open ended surveys were conducted with fishers who did not feel comfortable doing a survey, but wished to be included. Open ended conversations were had with families back on the mainland, which assisted in verifying the information given by fishers on the Pedro Bank. This was conducted over a period of 14 months.

While different groups and places within countries differ in their ability to adapt (Kates 2000) this paper highlights the complexities of the lives of the Pedro Bank Fishermen who come from varying places on the places on the mainland. It was this factor that was found to be the determinant of i) ability to adapt, ii) method of fishing, iii) livelihood strategies and iv) perceptions of the environment and climate change.

## II. Background

The lives of the Pedro Bank fishermen are dynamic; their relationship with the sea, coral reefs and Pedro Bank, is a web of complexities driven by factors that are not generally understood. These men (and women) travel 80 km to fish on the Pedro Bank, and remain there for periods of up to 8 months. In the absence of potable water, or sanitary convenience, and with cases of piracy, the lives of the people who opt to remain on the Pedro Bank, is not one of ease. Yet, they remain there, and in some cases, prefer to remain there than return to the mainland.

### *a) Study Site: The Pedro Bank, Jamaica*

The Pedro Bank is located approximately 80 km south-southwest of mainland Jamaica. It is a sharp seamount which rises abruptly and stretches from about 500 m and extends more than 161 km east to west. The Bank covers an area of 8040 km$^2$ it is one of the largest offshore banks in the Caribbean Basin (Espeut 2006, The Nature Conservancy 2011 and Ainsworth 2011).

i. *Insert Figure 1 Here*

The Bank is important for regional, social and economic reasons providing US $34 million in exports (I. Jones, Fisheries Division; Personal Communication. January 24, 2013) as well as a livelihood for up to 1,000 fishers.

Within the area defined as the Bank, the seamount breaks the surface in eight places. Of these four are rocks which are inhabited by birds. Historical reports (Zans 1958) and more recently Espeut (2006) refer to there being a fourth Cay, namely South Cay. However, during the period of this research this Cay was inundated with tide and surge. This is consistent with the more recent findings of Hay (2006) and Ainsworth (2011) which describe South Cay as now existing as shallow shoal with a sandy beach.

This research focused on the two Cays which are inhabited by Fishers; namely the North East Cay and the Middle Cay, referred to "Top" and "Party" Cay, respectively.

ii. *Insert Figure 2 Here*

### *b) North East Cay*

Commonly referred to as "Top Cay", this is the most northerly of the three cays. This Cay possesses a 10.66 m lighthouse which was erected in 1956. There is 1 dry pit toilet, 1 shop and an empty water tank/cistern. NE Cay was the former location for the Jamaica Defence Force (JDF) which fisher's state was relocated to the Middle Cay in the early 1980's. With the relocation of the JDF base, a number of residents of NE Cay have also relocated to Middle Cay.

### *c) Middle Cay*

Commonly referred to as "Party Cay" by the fishers, this Cay is located approximately 4 km from NE Cay. Measuring approximately 4 hectares (Zans 1958), it is the smallest of all the Cays as well it is the most heavily populated. The Jamaica Defence Force has a permanent post on this Cay in addition to a research station managed by the Fisheries Division. In the "old" part of Middle Cay, the remnants of concrete structures can be seen. Numerous huts adjoining each other extend to the shoreline. There are more than 20 shops, no running water and 2 dry pit toilets which are out of commission. There is also a "mechanics" shop where compressors used for diving are repaired.

### *d) South West Cay*

South West Cay is commonly referred to as "Bird Cay". It measures 15 hectares and is the largest of the three cays. As found by Espeut (2006), Hay (2006) and Ainsworth (2011), there are no permanent residents on this Cay. The remnants of stone shelters built by egg collectors and guano miners are still obvious however a water well, referred to by Zans (1958), was not observed. SW Cay is home to the seabird the rare Masked Booby (*Sula dactylatra dactylatra*). While no fishers reside on this cay, there are occasional short term visits by fishers.

## III. Method

In an effort to understand the lives of the fishers of the Pedro Bank, 9 trips were made over a period of 14 months, between November 2010 and November 2012. Length of stays ranged from 1, 3 and 7 days. Transportation was facilitated by the Coast Guard as well key fishers with speed boats.

Structured and semi-structured approaches were used to collect data, along with participant observations. During this time, 154 detailed questionnaires were executed, and 34 open ended surveys with fishers who did not wish to do a detailed

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questionnaire but who preferred "just to talk". Basic statistics, demographics and other characteristics were generated from the data collection process.

In an effort to maintain the relationship with fishers, visits were made to them in their fishing communities whenever they returned to the mainland. In an effort to corroborate information given by fishers, open ended interviews were held with the families of fishers. This assisted in the validation of information on livelihood earnings given by fishers out on the Bank.

## IV. Results

This study examined the lives of Fishers on the Pedro Bank, and highlighted the correlation between place of origin on the mainland, age of Fishers, Cay selection for habitation, dishing should be fishing practices and livelihood strategies employed.

*a) Mainland Origin and residence on NE Cay and Middle Cay*

Of the total 154 respondents the 40 residents of NE Cay were interviewed of which 85% originated from St. Elizabeth, a Parish considered rural. The remaining 15% of residents on NE Cay came from other Parishes but were also from "rural" fishing communities, specifically, Westmoreland (5), Manchester (7), St. Thomas (4) and Portland (1). All fishers who resided on NE Cay identified themselves as only being Pot fishers. At no time during the time of this research did the population on NE Cay surpass 45 persons which is a significant decrease from the 70 recorded by Espeut in 2006. The dwellings were not densely packed together and many dwellings were identified as being abandoned, empty and padlocked.

On Middle Cay, this research found the predominant respondents (67.5%) originating from urban mainland communities in the Parishes of Clarendon (29) St. Catherine (28), Kingston & St. Andrew (17). A smaller proportion of the Middle Cay population (32.5 %) originated from rural communities such as Westmoreland but this was still more than found by Espeut in 2006. Additionally, unlike the findings of Espeut (2006) there was increased representation from other rural Parishes, such as St. Ann, St. Mary and Portland. St. James, the second city of Jamaica, and St, Ann, are both tourism areas. Portmore, St, Catherine has also been designated City status. Other parishes identified as rural are agriculture based.

*b) Insert Figure 3 Here*

Map of Parishes[1] of Jamaica indicating rural and urban areas.

*i. Type Of Fishing*

All fishers who lived on NE Cay were identified as only Pot Fishers with occasional line fishing. In contrast, the fishers on Middle Cay engaged in a variety of fishing types with the main type being the hookah. Where a compressor (placed in the back of a boat) supplies air to a diver via a small tube, which is placed in the diver's mouth. Specifically, fishers used the hookah to engage in spear fishing and diving for lobster and conch. The fishers on Middle Cay from Westmoreland, St. Ann, St. Thomas, Kingston and St. Andrew identified their primary method of fishing as hookah diving but also participated in some amount of pot fishing. This differed from the Westmoreland fishers on NE Cay, who were strictly pot fishers, and who were unlike their fellow Westmorelander's who resided on Middle Cay and engaged in all fishing methods. The fishers from the rural fishing communities of Manchester and St. Elizabeth who reside on Middle Cay remained primarily pot fishers. Urban fishers all (100%) listed free dive spearfishing as their second choice of fishing method after hookah spear fishing while only 10% of rural fishers identified spearfishing as a second choice of method and 50% viewed it as the third choice if necessary.

When the lobster and conch seasons were opened a significant increase in the number of fishers from Clarendon, St. Catherine, St. Elizabeth and Westmoreland came to the Pedro Bank to participate in hookah diving. At this time they used "lobster wires" to catch lobster and their hands (and knives) for conch.

*ii Age of Fishers*

The oldest fishers interviewed were all from rural fishing communities in St. Elizabeth, Manchester and Westmoreland with an average age of 31, 32 and 35 respectively (Table 1). The oldest fisher on the Pedro Bank during the time of this research was 65 years old, from Westmorland and who lived on NE Cay. The average age of all the fishers on NE Cay (of rural origin) was 31 which was much higher than the average age of the fishers on Middle Cay (predominantly urban) which was 23 with St. Catherine, Clarendon and Kingston and St. Andrew being 19, 21 and 23 respectively (Table 1). It is important to note that the highest average age of fishermen originating from urban communities (27 years old) is the same as the lowest average age for fishers originating from rural communities.

*c) Insert Table 1 Here*

*i. Livelihoods and Choices*

Although many fishers had been coming to Pedro Bank for an average of 7 years, approximately 65.48% of urban fishers on Middle Cay had no prior training or work experience in fishing. In contrast 56% the fishers from the rural fishing communities in St. Elizabeth, Manchester, St. Thomas and Portland were in engaged in some form of fishing activity before coming to Pedro. The reasons purported by the Pedro Fishers for deciding on the Pedro Bank fishing as livelihood rather than staying on mainland Jamaica were ranked as follows: i) to avoid getting into crime, ii) to seek employment as none was available on land and iii) they

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enjoyed the party and easy life which is less stressful than on the mainland.

Once the fishers did arrive on the Pedro Bank, they were afforded an opportunity to earn a living, take care of households on the mainland and support other livelihoods strategies (Table 2). The fishers from rural fishing communities identified and ranked their spending priorities as: i) send children to school and ii) repair/make new fishing pots and iii) buy grain, seeds for farming. In contrast the fishers from the urban fishing communities ranked their spending priorities as: i) "buy and sell" goods and ii) "set up a shop". They highlighted their desire to make "quick money".

Surprisingly even though 53 of the 57 respondents from Clarendon and St. Catherine, had at least 1 child, they did not rank education of their children a priority or consider it an investment. In contrast, the fishers from rural fishing communities identified education of their children as first priority of the spending of income. Secondly, their "Pedro income" was used to reinvest in fishing through the fixing and making of new pots.

While responses were varied, there is a clear distinction between rural and urban fishers, and the priorities of livelihoods (spending of their earnings). Fishers from rural fishing communities engaged in farming as a secondary livelihood, and used earnings to invest in this. They cited the impacts of drought and flooding as agents that make it harder for them to stay in farming. Respondents also attributed the hurricanes in the recent past as having set them back financially. This was in direct contrast with the younger fishing population who found running a store/business or having "pay parties" more entrepreneurial and less labor intensive than farming. In an abnormal case in Clarendon (urban), farming only became an option due to the ease with respondents could grow the cash crop Callalloo and sell to a nearby Callalloo factory. Most respondents by the 3rd choice of livelihood activity, indicated that activities on the mainland were not as "sure" as on Pedro, but that they would do anything to earn an additional income when not on Pedro Bank (Table 3).

*d) Place Tables 2 & 3 here*

The population on Middle Cay was observed to be at a low of 150 persons during the month of January to an increased average of 350 persons during hurricane season, based on the number of licenses granted by the Fisheries Division. However, during the Conch and Lobster seasons, the population on the Cay increased to an estimated 1,200 persons[2]. The most populated months were February, March and July which were identified as the time when both lobster and conch seasons overlapped. During this time, Middle Cay was heavily populated, and up to 150 persons were observed sleeping on make shift beds on the ground.

## V. Discussion

Typically the Pedro Fishers are treated as "renegade fishers" and decisions on the management of the resources at Pedro Banks are made without much understanding of the complexities of life on the Bank, fisheries behavior or the direct and indirect drivers that guide their decisions. The direct and indirect drivers of the decisions that they make on the Cays and on the mainland are determined by a number of variables. The diversity of livelihood strategies is in part due to where they are from on the mainland, specifically, urban or rural fishing communities. This factor, correlated with age, both determined the type of fishing activity in which they engage. This research explores those drivers and explains the reasons for some of the behavior and presents a measure of the complexities.

The fishers on NE Cay are predominantly from St. Elizabeth, older and are pot fishers. Many who moved from NE Cay to Middle Cay indicated that they would prefer to live on (return to) NE Cay, but cited firstly, the lack of safety as a deterrent since the move of the JDF based from Top Cay to Middle Cay, as well as increased piracy. This corresponds with the findings of (Ainsworth, 2011) that the presence of the Coast Guard on the Middle Cay was a contributing factor to the increase in population. Secondly, it was increasingly more difficult to access the packer boats to sell their fish from NE Cay, as the packer boats go mainly to Middle Cay. Thirdly, they cited the cultural differences between rural fishers and urban fishers. Specifically, the noise level at Middle Cay from the music and constant party atmosphere attracts the younger fishers regardless of origin but does not find favour with the older usually rural fishers. Furthermore the lack of cleanliness by spear fishers and the lack of regard for fishing environment as seen in actions such as spear fishing at night by the young, (urban) fishers, killing the sleeping fish are thought to be depriving the pot fishers of catching fish. This was also a reason cited for the increased altercations on Middle Cay between rural pot fishers and "urban" hookah divers. It was observed that an "understood" yet, subtle boundary was present on Middle Cay, which confirmed the divisions.

There is a clear correlation that has been established between where fishers originate on the mainland, age, the Cay on which they choose to settle, method of fishing and how earnings generated on Pedro are used. Based on these correlations, two groupings of fishers on Pedro Bank were identified.

The first and most predominant grouping of fishers on the Pedro Bank is from the "urban" fishing communities of Clarendon and St. Catherine. This

[2] Estimate generated by opinion of researcher, Coast Guard and Fishers themselves.

grouping represents the youngest population and the ones that had the least experience in fishing prior to coming to the Pedro Bank. Their eagerness to make a living is evidenced by i) their choice of fishing method, i.e. hookah/spear fishing (even at night), ii) use of earnings to 'buy and sell" and have "quick rewards" on the mainland. This young, majority group of hookah divers and spear fishermen which have chosen to settle on Middle Cay have indicated that this represents a level of freedom and security not felt on the mainland.

The second grouping of fishers on the Pedro Bank is from the "rural" fishing communities on the mainland. This grouping represents the oldest population on the Cay. They were found to engage in traditional pot fishing and lived on the NE Cay. Their relocation from NE Cay to Middle Cay is not one of choice, nor done willingly and has resulted in 'forced integration' of fishing cultures on Middle Cay. They use their earnings to support livelihoods on the mainland. Their investment is in education for their children.

Any attempt at reducing the fishing pressure on the Pedro Bank will have to consider the complexities of the lives of the Pedro fishermen, which suggest that neither the proposed fish sanctuary nor the alternative livelihoods programme will be sustainable without comprehensively considering the age and corresponding fishing practices of the fishers. The greatest numbers of fishers are hookah/spear fishers from urban fishing communities on the mainland. As such, education and management plans for the Pedro Bank should be tailored to this dominant group. Further, the alternative livelihood options provided to the fishers have to take into account the communities from which they originate on the mainland so as to consider sustainability.

Numerous fish sanctuaries and marine protected areas being established across the Caribbean, without any real comprehensive understanding of the fishers who use the resource. The very popular adaptation strategy of providing alternative livelihoods should necessarily consider those activities which are already being employed by fishers and support given to these.

The approach offered by the paper is one that can be replicated across the Caribbean so as to ensure higher success of measures being implemented to reduce fishing pressure as well as alternative livelihood adaptation strategies.

## References Références Referencias


1. Adger, N.W. (1999). Social vulnerability to climate change and extremes in coastal Vietnam. *World Development*, *27* (2), 249-269.
2. Adger.W., & Vincent, K. (2005). Uncertainty in adaptive capacity. *Comptes Rendus Geoscience*, *337* (4), 399-410.
3. Ainsworth, P.J. (2011). The determination of the breeding success of the Masked Booby, *Sula Dactylatra Dactylatra*, at Middle Cay, Pedro Bank, Jamaica. M.Phil Thesis. The University of the West Indies, Mona, Jamaica.
4. Allison, E., & Ellis, F. (2001).The livelihoods approach and management of small-scale fisheries. *Marine Policy, 25*: 377–388.
5. Andrew, N.L., Bene, C., Hall, S. J., Allison, E.H., Heck, S., & Ratner, B. (2007). Diagnosis and management of small-scale fisheries in developing countries. *Fish and Fisheries, 8*: 227 – 240.
6. Badjeck, M.C., Allison, E., Halls A., & Dulvy, N. (2010). Impacts of climate variability and change on fishery-based livelihoods. *Marine Policy, 34*: 375-383.
7. Bene, C.N., Andrew, N., Russell. A., Sinaba F., Ovie S., Morand. P., & Lemoalle, J. (2008). Managing resilience in West African small-scale fisheries. Fighting poverty through sustainable water use: *Proceedings of the CPWF 2nd International Forum on Water and Food,* Addis Ababa, Ethiopia, November 10—14, 2008: Volume II. Colombo, Sri Lanka: *CGIAR Challenge Program on Water and Food, 2*: 237 – 240.
8. Bunce, M., Rosendo, S., & Brown, K. (2010). Perceptions of climate change, multiple stressors and livelihoods on marginal African coasts. *Environment, Development and Sustainability*, *12*: 407-440.
9. Espeut, P. (2006). The Wild Frontier: Living and Fishing on the Pedro Cays of Jamaica – A socio-Economic Assessment. Jamaica. *The Nature Conservancy.*
10. Grant, S, Berkes F., & Brierley, J. (2007). Understanding the Local Livelihood System in Resource Management: The Pelagic Long line Fishery in Gouyave, Grenada. *Gulf and Caribbean Research*, *19* (2), 113–122.
11. Hay, D.B. (2006). Biological Survey of the Pedro Cays. Jamaica. *The Nature Conservancy*.
12. Kates, R. (2000). Cautionary tales: Adaptation and the Global Poor. *Climatic Change, 45*: 5 – 17.
13. Ostrom E. (2008). Frameworks and Theories of Environmental Change. *Global Environmental Change, 18*: 249-252.
14. Pomeroy, R., Ratner, D.B., Hall S., Pimoljinda.J., & Vivekanandan, V. (2006). Coping with Disaster: Rehabilitating Coastal Livelihoods and communities. *Marine Policy, 30*: 786-793.
15. Parvin, G.A., Takahashi, F., & Shaw, R., (2008). Coastal hazards and community-coping methods in Bangladesh. *Journal of Coastal Conservation, 12*: 181 – 193.
16. Ribot, J.C. (1996). Climatic Variability, Climate Change and Vulnerability. "Moving Forward by




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looking back”. Cambridge: Cambridge University Press.

17. Teh, L.C., & Sumalia, U.R. (2005). Contribution of marine fisheries to worldwide employment. *Fish and Fisheries, 14*: 77-88.
18. The Nature Conservancy. (2011).The Draft Management Plan for the Pedro Bank, Jamaica. Pp. 1 – 48.
19. Zans, V.A. (1958). The Pedro Cays and Pedro Bank. Geological Survey Department, Jamaica W.I. Bulletin No. 3.
20. Ziervogel, G., & Zermoglio, F., (2009). Climate Change scenarios and the development of adaptation strategies in Africa: Challenges and Opportunities. *Climate Research, 40*: 133-146.


*Figure 1 :* Location of the Pedro Bank

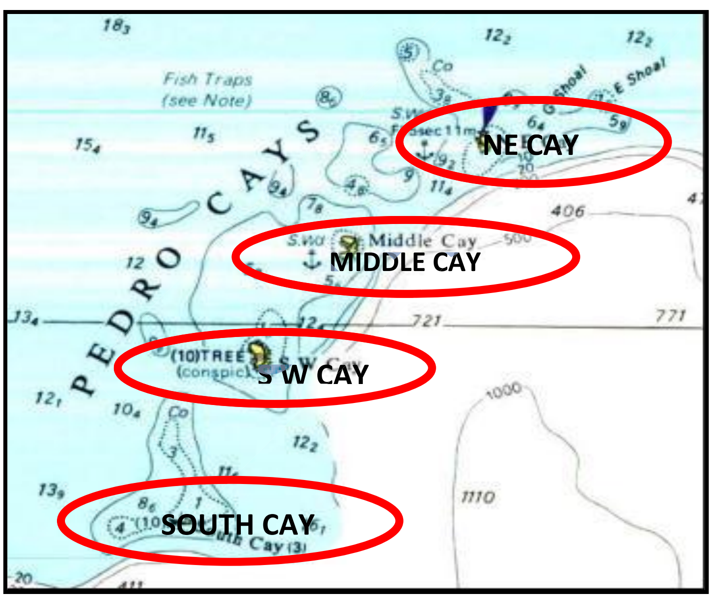


*Figure 2 :* Location of Cays on the Pedro Bank



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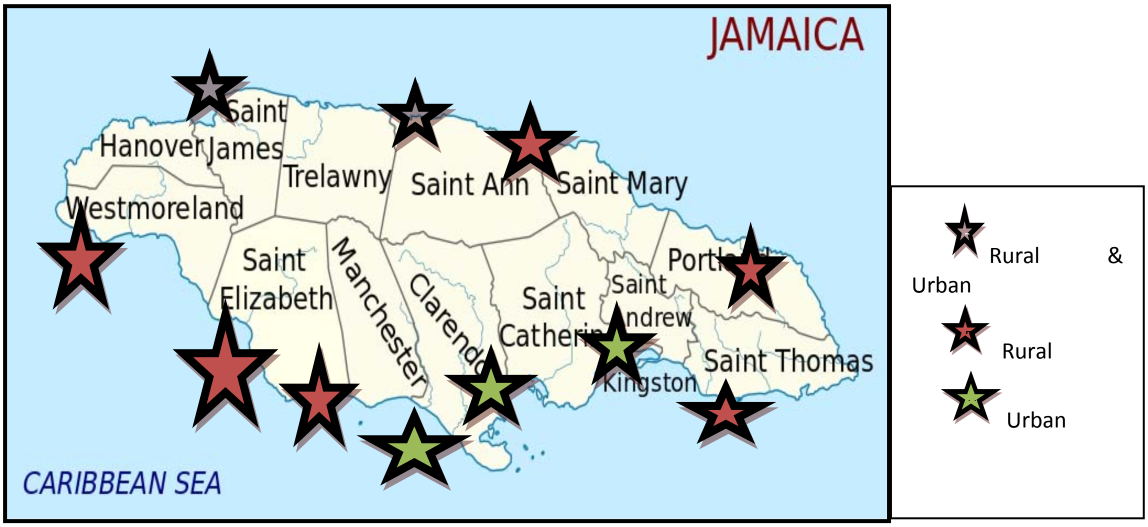


*Figure 3 :* Map of Parishes[3] of Jamaica indicating rural and urban areas.

*Table 1:* Place of Origin on Mainland, Age of Fishers and Type of Fishing Method used

| Parish Mainland | Fishing Community | N= 154 | Top Cay | Middle Cay | Avg Age | Type of Fishing 1st | 2nd | 3rd |
|---|---|---|---|---|---|---|---|---|
| St. Elizabeth | Rural | 27 | 23 | 4 | 31 | Pot | Line | Spear |
| Manchester | Rural | 12 | 7 | 5 | 32 | Pot | Line | Spear |
| Westmoreland | Rural | 18 | 5 | 13 | 35 | Hookah | Pot | Line |
| St. James | Urban | 3 | 0 | 3 | 27 | Hookah | Spear/FD* | FD |
| St. Catherine | Urban | 28 | 0 | 28 | 19 | Hookah | Spear/FD | Line |
| Clarendon | Urban | 29 | 0 | 29 | 21 | Hookah | Spear/FD | Line |
| KSA | Urban | 17 | 0 | 17 | 23 | Hookah | Spear/FD | Pot |
| St. Thomas | Rural | 12 | 4 | 8 | 27 | Spear | Pot | Line |
| Portland | Rural | 5 | 1 | 4 | 26 | Pot | Spear | Line |
| St. Mary | Rural | 2 | 0 | 2 | 27 | Pot | Spear | Line |
| St. Ann | Rural | 1 | 0 | 1 | 26 | Pot | Spear | Line |

** FD = Free Dive*



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*Table 2 :* How earnings generated on Pedro are spent

| Parish | How Earnings made on the Pedro Bank are Spent | | |
|---|---|---|---|
| | No. 1 Rank | No. 2 Rank | No. 3 Rank |
| St. Elizabeth | School/Children | Make/Fix Pots | Seeds/Farm |
| Manchester | School/Children | Make/Fix pots | Seeds/Farms |
| Westmoreland | Education | House/Fix Pots | Farm/S. Cane |
| St. James | Fix House | School/Children | |
| St. Catherine | Buy for shop | Farm* Callaloo | School/Children |
| Clarendon | House/Shop | School/Children | Farm |
| KSA | Boat Repairs | School/Children | House |
| St. Thomas | Farm | School/Children | Save |
| Portland | Children | Family | Farm |
| St. Mary | Children | Farm | Save |
| St. Ann | Children | Buy things to sell | Farm |

*Table 3:* Additional Livelihood Activities on the Mainland, when not fishing on Pedro

| Parish | Additional Livelihood Activities of Fishers | | |
|---|---|---|---|
| | No. 1 Rank | No. 2 Rank | No. 3 Rank |
| St. Elizabeth | Farmer | Make Pots | Misc. A/T *Carpentry |
| Manchester | Farmer | Painter | Mechanic |
| Westmoreland | Farmer | Cut/Farm Cane | Mechanic/Pots |
| St. James | Buy and Sell | Farm | Misc Anything |
| St. Catherine | Shop Keeper | Mechanic | Entertainment |
| Clarendon | Shop Keeper/bar | Farm* | Misc Anything |
| KSA | Buy and sell | Mechanic | Painter |
| St. Thomas | Farmer | Misc. A/T | Misc Anything |
| Portland | Farmer | Painter | Misc. Anything |
| St. Mary | Farmer | Misc A/T | Misc. Anything |
| St. Ann | Buy and Sell | Misc. A/T | Misc. Anything |



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# An Exploration of the Value of Indigenous Knowledge Adaptation Strategies in Ensuring Food Security and Livelihoods in Southern Zimbabwe

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*Abstract-* Extreme weather events such as droughts and El Nino induced events have become more frequent and intense in southern Zimbabwe leading to food and livelihood insecurity for most households. Disadvantaged groups, such as the poor, widowed and orphaned, are more vulnerable to these events which are a result of climate variability and change. This is a result of the absence, weak and maladaptation practices to climate variability and change in most cases. High vulnerability has threatened food and livelihood security as evidenced by hunger, outbreak of diseases and loss of livestock. Maladaptation tends to be a result of the imposition of foreign adaptation strategies that do not augur well with specific environments. Conventional adaptation methods such as dam construction, borehole drilling and irrigation schemes are less robust due to the effects of climate change that has led to the shrinking of water bodies and lowering of the water table. Pre-colonial communities knew and managed their environments very well through observations and direct experience with their natural environments and this led to the development of indigenous knowledge systems which enabled people to get the most out of their environments. Indigenous knowledge adaptation strategies tend to ensure sustainable food and livelihood security because they are 'culture-fit' and accessible to all people. It is recommended that communities in southern Zimbabwe should synergise ethno-science and techno-science adaptation strategies in order to build a robust resilience against climate variability and change.

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*Strictly as per the compliance and regulations of:*

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## I. Introduction

Successive droughts in southern Africa have threatened food and livelihood security for most rural households. Agricultural production that determines food security in Africa is placed under considerable stress by climate change (FAO, 2007). Southern Zimbabwe's vulnerability is very high because most of the households depend upon rain-fed agriculture. The general consequences tend to be adverse for the poor and the marginalized that do not have the means to withstand shocks and changes (Boko et al, 2007).

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Incorporating indigenous knowledge systems can add value to the development of sustainable climate change adaptation strategies that are rich in local content, and planned in conjunction with local people (Nyong et al, 2007). Since the poor are considered the most vulnerable to climate change impacts, it is often believed that financial capital is the most important indicator of adaptive capacity. Building on local knowledge is the first step to mobilize such capital (Phillips and Titilola, 1995). Capacity building should emphasize the need to build on what exists, to utilize and strengthen existing capacities (Nyong et al, 2007). Indigenous knowledge systems play a significant role in the sum total of what exists in a local community. It is against this background that indigenous coping strategies need to be encouraged so as to increase a community's resilience to drought. The purpose of this paper is to characterize and explore the value of indigenous knowledge adaptation strategies in ensuring food security and livelihoods in Southern Zimbabwe.

## II. Indigenous Knowledge Systems

Briggs (2005) explains indigenous knowledge as the sum total of the knowledge and skills which a given community possess and enable it to get the most out of its environment. Indigenous knowledge is specific to communities. In most cases indigenous knowledge exists only in theory, people speak about it but do not have any practical experience of it. Briggs (2005) asserts that traditional practices have not been used and people have become alienated from their resources since colonial days, so it is very difficult to translate the stories into action. Communities should fully embrace this knowledge because it sustains the community and its culture and maintains genetic resources necessary for the continued survival of the community. Indigenous knowledge systems are forms of knowledge that have originated locally and naturally (Altieri, 1995). They are used for the benefit of specific communities. According to Nyong et al (2007) indigenous knowledge is rarely taken into consideration in the design and implementation of modern adaptation strategies. Any meaningful attempt at implementing adaptation

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strategies to reduce the vulnerability of the people in southern Zimbabwe to the impacts of future climate change should start by examining how the communities in the region had successfully reduced their vulnerabilities and coped with past impacts.

## III. Indigenous Knowledge Adaptation Strategies

Adaptation is defined by the Intergovernmental Panel on Climate Change (IPCC) as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (Parry et al, 2007). This implies that natural or human systems are adjusted in order to minimize the harm that might be caused by extreme weather events, for example. Adaptation methods are those strategies that enable the individual or the community to cope with or adjust to the impacts of the climate in the local areas (Nyong et al, 2007). Strategies that can be adopted in southern Zimbabwe include indigenous weather forecasting and farming methods. Fujikura and Kawanishi (2011) argued that since drought is localized and specific, it requires local, ecological particular responses. Conventional methods such as dam construction and borehole drilling have been affected by climate change in that; it has led to the shrinking of water bodies and lowering of the water table. Mapara (2009) argues that, western knowledge systems that have been forced upon the world are not the only important knowledge systems but are representative of one side of humanity.

### a) *Indigenous Weather Forecasting Methods To Improve Drought Management*

Indigenous knowledge systems have been applied in weather forecasting by various cultural groups of southern Zimbabwe. The Ndebele and Shona people like the Tangwena people (Mapara, 2009) have through experience based on observation of trees, animals, insects, terrestrial objects and bird behaviour learnt the art of indigenous weather forecasting. Amongst the Shona people fruit trees like muchakata (parinari curatellifolia), gan'acha (lannea discolor) and mushuku (uapaca kirkiana) are frequently used to predict the eminence of the rain season and the quantities of rainfall in any given agricultural season (Muguti and Maposa, 2012). The Ndebele people also rely on wild fruits like black-berries umtshwankela, (Vitex mombasa) umkhuna (Parinari curatellifolia) and umthunduluka (Ximenia caffra). These cultures have observed that if there is an abundance of these wild fruits towards the rain season then below normal rainfall would be experienced. Due to migration and inter-marriages it is now difficult to really single out indigenous methods that are specific to given cultures.

Birds are also used for weather forecasting. Mapara (2009) states that if people hear the sounds of insingizi (bucorvus leadbeateri) and inkanku (Clamator jacobinus) then the rains will fall in some few hours time. When chickens feed when it is drizzling it indicates that the drizzle will be of long duration for about two or three days which increases the amount of soil moisture. Muguti and Maposa (2012) stated that animals like rock rabbit, when it squeaks in ways that are unusually, it heralds the imminence of rainfall in a particular season. This belief is very common in all cultures of southern Zimbabwe.

The emergence of insects like amatheza (ants), when it starts to collect a lot of grass for storage underground it indicates that the rain season is imminent. Chiondegwa in Muguti and Maposa (2012) states that the behaviour of these insects is an indication that the growing season would be good so much that people are expected to work hard just like the amatheza insects. People also make use of inyeza (cicadas) to forecast the onset of the rains. When these insects (cicadas) start to 'sing' then people do their dry planting because the rains would be coming two to three weeks time. The appearance of locusts in large numbers has been used to be predict a drought year.

Terrestrial objects are also used in indigenous weather forecasting. When there is a cloud like-structure or ring around the moon (umkhumbi) that is indicative of a good rainfall season. The larger the ring, the more rainfall is received that season and the reverse is also true (Muguti and Maposa, 2012).

These are some of the most common indigenous weather forecasting methods that people rely on for their drought management efforts. In times where there would be many wild fruits, such as uapaca kirkiana and parinari curatelli-folia, these have been gathered and stored as supplementary feed for the drought season.

### b) *Adoption of Indigenous Farming Methods*

Indigenous knowledge farming systems encompass stover storage and the use of night kraals for organic manure, intercropping, zero-tillage, fallow system and transhumant movement. These indigenous knowledge farming systems are cost-effective and environmentally friendly compared to exotic technologies. They can be practiced in the communal areas since they rely on locally available resources.

#### i. *Stover storage and the use of night kraals*

One of the adaptation strategies used in southern Zimbabwe is the storage of fodder. The fodder storage is put in kraals where animals are fed, normally from August to October. Animals are fed at night after spending the day in the pastures. It is used as supplementary feed. The fruits of indigenous trees such as amawohlo, ihabahaba and acacia are collected and are also used as supplementary feed for the animals.

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The remains of the feeds add to the amount of manure which is used to improve soil fertility.

ii. *Intercropping*

Intercropping is the most practiced indigenous farming system. It has proven to be a better agricultural practice when compared to monoculture in the sense that it helps to maintain soil moisture and reduce soil erosion caused by run-off water because the soil is under permanent cover (Mapara, 2009). According to Mapara (2009) the colonialists brought with them the practice of monoculture whereby one crop is planted in one field. Intercropping is also used as a method of weed control. Most of the farmers intercrop maize with groundnuts; maize with cowpeas and maize with beans. In most cases maize and sorghum are intercropped with legumes. When several crops are grown on a piece of land, farmers will be assured of a harvest. Panda (2007) points out that the main objective of inter-cropping is to lessen the risk of total crop failure. It leads to high total yields due to maximum water and weed control thereby assuring farmers with food security.

iii. *Zero tillage*

Moisture loss is accelerated by high temperatures leading to low agricultural output. Conservation farming such as zero tillage should be adopted for the optimum use of moisture. Smith (2006) defines zero tillage as a method of planting where the soil is not disturbed and the seed is drilled directly into the mulch or stubble of the previous crop. It leads to the conservation of soil moisture because of the availability of mulch.

iv. *Indigenous methods of cattle management*

Climate variability and change have led to the loss of pastures and drying up of watering holes for livestock. Large numbers of livestock, especially cattle, die each year due to food and water shortages. Indigenous cattle management strategies such as destocking and transhumance can assist farmers to reduce the loss of livestock. Destocking in the form of loaning (ukusisa) to relatives and friends in better areas assists farmers to control overgrazing. Animals will not exceed the carrying capacity of the land. Transhumant movement is also practiced to a larger extent in southern Zimbabwe. Animals are moved to areas with better pastures during the winter season. If long distances are involved, farmers tend to hire trucks to transport cattle from one area to another. This has reduced the mortality of livestock to a greater extent. The conventional method of feed-lots is effective but cost prohibitive for the rural poor. Most people prefer the methods of loaning cattle and transhumance.

## IV. Conclusion

This paper concludes that southern Zimbabwean communities like other communities in sub-Saharan Africa and the world at large are very rich in indigenous knowledge systems that are embedded in the cultured ways that should be tapped to improve food and livelihood security. While the conventional survival strategies have been promoted in most cases they tend to be cost prohibitive, hence are not readily applicable to the rural communities, making the indigenous knowledge adaptation strategies the only option to be used to minimize the negative impacts of climate variability and change in southern Zimbabwe.

## V. Recommendations

The paper strongly recommends the vigorous promotion of the indigenous knowledge systems to the communities found in southern Zimbabwe. Traditional structures should be used in conducted workshops that would promote the adoption of various indigenous adaptation strategies. Community members who are experts in indigenous intervention strategies should be identified and encouraged to share their experiences with the other community members. Government institutions and organizations such as Agritex and schools should also be incorporated in the promotion of the indigenous adaptation strategies. Agritex officers and traditional institutions should be encouraged to assist in the awareness campaigns of indigenous adaptation strategies, while the schools should be encouraged to include indigenous knowledge systems in their curricula. The integration of indigenous adaptation strategies and the conventional strategies is to be encouraged if the battle against climate variability and change is to be won in the areas of southern Zimbabwe.

## References Références Referencias


1. Altieri, M.A (1995) Agroecology: The Science of Sustainable Agriculture London: IT Publications.
2. Briggs, J (2005) The Use of Indigenous Knowledge in Development: Problems and Challenges Progress in Development Studies 5: 99-114.
3. Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo and P. Yanda(2007) 'Africa', in M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden and C. E. Hanson (eds) (2007)Climate Change: Impacts, Adaptation and Vulnerability. Contribution of working Group11 to the fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge: Cambridge University Press.
4. FAO (Interdepartmental Working Group on Climate Change) (2007b) Climate Change and Food Security: A Framework for Action FAO, Rome, Italy.
5. Fujikura, R and Kawanishi, M (ed) (2011) Climate Change Adaptation and International Development: Making Development Cooperation More Effective London: Earthscan.




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6. Jerie, Sand Matanga, E'The Effectiveness of Ethno-science Based Strategies in Drought Mitigation in Mberengwa District of Southern Zimbabwe' Journal of Sustainable Development in Africa (Volume 13, No.4, 2011).
7. Mapara, J. 'Indigenous Knowledge Systems in Zimbabwe: Juxtaposing Postcolonial Theory', in The Journal of Pan African Studies, Vol.3, No.1, September 2009.
8. Muguti, T and Maposa, R.S 'Indigenous Weather Forecasting: A Phenomenological Study Engaging the Shona of Zimbabwe' The Journal of Pan African Studies, vol.4, no.9, January 2012.
9. Nyong, A., F. Adesinaand B. Osman Elasha 'The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel', Published online: 14 June 2007.
10. Panda, S.C (2007) Crop Production and Tillage Jodhpur: Agrobios.
11. Parry, M. L., O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson (eds) (2007) Climate change: Impacts, Adaptation and Vulnerability. Contribution of Working Group 11 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge: Cambridge University Press.
12. Phillips AO, Titilola T (1995) Indigenous knowledge systems and practices: case studies from Nigeria. NISER, Ibadan, Nigeria.
13. Smith, B (2006) The Farming Handbook Durban: University of KwaZulu-Natal Press.




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# Rocks are Human Beings: Researching the Humanizing Metaphor in Earth Science Scientific Texts

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*Abstract-* This paper describes a corpus-based analysis of the humanizing metaphor <<ROCKS ARE HUMAN BEINGS>> and supports that constitutive metaphor in science and technology may be highly metaphorical and active. The study, grounded in Lakoff's Theory of Metaphor and in Langacker's relational networks, consists of two phases: firstly, Earth Science metaphorical terms were extracted from databases and dictionaries and, then, contextualized by means of the "Wordsmith" tool in a digitalized corpus created to establish their productivity. Secondly, the terms were classified to disclose the main conceptual metaphors underlying them; then, the mappings and the relational networks of the metaphor <<ROCKS ARE HUMAN BEINGS>> were described. Results confirm the systematicity and productivity of the metaphor in this field, show evidence that metaphoricity of scientific terms is gradable, and support that Earth Science metaphors are not only created in terms of their concrete salient properties and attributes, but also on abstract human anthropocentric projections.

*Keywords: conceptual metaphor, relational networks, metaphorical gradability, earth science terms, lexicalized metaphors, specialized corpus linguistics.*

*GJHSS-B Classification : FOR Code: 260000, 269999*

ROCKS ARE HUMAN BEINGS RESEARCHING THE HUMANIZING METAPHOR IN EARTH SCIENCE SCIENTIFIC TEXTS

*Strictly as per the compliance and regulations of:*

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# Rocks are Human Beings: Researching the Humanizing Metaphor in Earth Science Scientific Texts

Georgina Cuadrado[α] & Pilar Durán[σ]

*Abstract-* This paper describes a corpus-based analysis of the humanizing metaphor <<ROCKS ARE HUMAN BEINGS>> and supports that constitutive metaphor in science and technology may be highly metaphorical and active. The study, grounded in Lakoff's Theory of Metaphor and in Langacker's relational networks, consists of two phases: firstly, Earth Science metaphorical terms were extracted from databases and dictionaries and, then, contextualized by means of the "Wordsmith" tool in a digitalized corpus created to establish their productivity. Secondly, the terms were classified to disclose the main conceptual metaphors underlying them; then, the mappings and the relational networks of the metaphor <<ROCKS ARE HUMAN BEINGS>> were described. Results confirm the systematicity and productivity of the metaphor in this field, show evidence that metaphoricity of scientific terms is gradable, and support that Earth Science metaphors are not only created in terms of their concrete salient properties and attributes, but also on abstract human anthropocentric projections.

*Keywords: conceptual metaphor, relational networks, metaphorical gradability, earth science terms, lexicalized metaphors, specialized corpus linguistics.*

## I. Introduction

Linguistics has undergone a cognitive shift giving a greater emphasis on meaning and on the conceptual structures underlying language. This paradigm has affected the study of the conceptual system of science and technology, where Cognitive Theory and the Contemporary Theory of Metaphor (CTM) are now generally accepted to be essential to the analysis of concept formation and development. However, further empirical support is still needed, especially within scientific and technical contexts.

Recent research in metaphor use within different fields of science and technology points to the fact that specific knowledge is organized by means of metaphorical conceptualization: Cuadrado and Durán, 2013, in science and technology; Roldán & Ubeda, 2013, in Civil Engineering; Robisco, 2011, in Aeronautics; Cuadrado, 2010, in Mechanical Engineering; White 2004, White and Herrera 2009, in Economy; Cuadrado and Berge, 2003 in Physics, to mention a few. However, no previous work has been found concerning the gradability of metaphorical scientific and technical terms other than Cuadrado and Duran's recent publication (2013), which needs to be further developed. Regarding metaphor gradability in general language several studies are found (Müller, 2008; Svanlud, 2007; Hanks, 2006); yet, these studies are not concerned with scientific technical language.

Accordingly, this paper presents an analysis of the semantic structure of metaphors that contribute to conceptualize the world of Earth Science, based on the Conceptual Theory of Metaphor (Lakoff & Johnson, 1980, 1999; Lakoff, 1987, 1993) and on Langacker's notion of models of relational networks (1987, 1990). The semantic study of this metaphor relates to a larger research project of metaphorical terms in science and technology concerned with topics such as conceptual structure, category organization, and knowledge representation[1]. The humanizing metaphor of rocks has been selected due to the large number of metaphorical terms and mappings found, and its relevance in order to illustrate the systematicity and productivity of metaphors.

The first aim of the study is to determine the metaphors underlying the conceptualization of the entity 'rocks', and establish the systematicity and productivity of the mappings in this complex well-structured conceptual metaphor, very frequently found in the fields of geology, environmental science, mineralogy, geophysics, and other related fields. For this purpose, corpus-based analysis was used. Then, the models activated by the metaphorical terms found were established.

The second aim of the study is to apply the notion of metaphorical gradability to Earth Science terms, and to confirm that scientific metaphors can be highly metaphorical. When applied to metaphor, gradability refers to the degree of metaphoricity a metaphor has, thus implying that some metaphors are more metaphorical than others. According to the Prototype theory, concepts are defined in terms of their properties. This gives rise to the notions of centrality and metaphorical gradability, by which some concepts are more central than others. Thus, according to Hanks

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(2006), the fewer semantic properties the source domain and the target domain share, the more metaphorical a metaphor is, and vice versa. However, Hank's study is concerned with metaphor as a figure of speech. "His findings are based on BNC and provides good, clear examples''. from general language such as 'a storm of..', 'a sea of..', 'an oasis of..'. On the other hand, Müller's (2008) and Svanlud's (2007) studies are concerned with the different dimensions of conventionality and do not include the idea of centrality, nor analyse scientific terminology.

We propose that the parameters to measure metaphoricity in science and technology may be based on an objectivist description of the concepts, and on the distance between the real objective world and the metaphor (Cuadrado & Durán, 2013), rather than on linguistic factors such as conventionality, the salient meaning of a word, or other pragmatic aspects. Although we consider that Hank's (2006) proposal, based on the semantic attributes of words can also be applied to metaphorical terms in science and technology, we argue that another important aspect to be taken into account when approaching metaphorical gradability is that of centrality. Both approaches are complementary rather than competing, and add on to the argument that some metaphors are more metaphorical than others. Thus, the present work will show that terminological metaphors created from central models of the relational networks of a concept are less metaphorical than those derived from non-central models. The term 'mother rock' will be presented as a case study to illustrate this thesis.

Whereas high metaphoricity has long been expected to occur in literature, this has not been the case when referring to abstract, scientific concepts. The assumption that scientific terms can be highly metaphorical contradicts the widespread belief that, -to be consistent with the ideal of clear, simple, accurate and unambiguous scientific and technical communication-, metaphorical terms have to be justified in terms of logical motivation or of their explanatory power. It also contradicts scientists' belief that good scientific metaphors must derive from the source and target domains essential attributes, and, accordingly, the more semantic properties the source domain and the target domain share, the better a scientific metaphor is (Cuadrado, 2005).

Moreover, Schmitt (2005) proposed three criteria for the identification of metaphor so as to avoid subjective intuitions, which comprise the understanding that (i) a word in a given context may carry a meaning different from its literal meaning; (ii) the literal meaning comes from an area of physical or cultural experience (the source area); (iii) this meaning is transferred to a another, often abstract, target area. This proposal unveils his view of the use of a concrete source domain to explain abstract concepts. More recently, Roldán and Ubeda (2013: 109), when dealing with metaphor in the civil engineering context, state that "In metaphor, abstract concepts are understood in terms of concrete, physical ones. In other words, physical concepts act as a source domain for abstract concepts in the target domain". This paper questions such generalised belief and focuses on data showing that the source domain (human experience in our case) is frequently quite more abstract than the target domain (rocks' scientific terms), at least in Earth Science fields.

## II. Methodology and Description of the Corpus

The methodology adopted, which starts with the analysis of metaphorical terms to unfold the cognitive mappings underlying language, involves the study of meaning in context; hence, corpus-based analysis was used. The unfolding of such metaphors involved these stages:

a) Hand searching of metaphorical terms in specialized dictionaries.
b) Definition and decomposition of the terms into their semantic components.
c) Contextualization of lexicalized constitutive metaphors using the electronic corpus of specialized written texts created for this purpose; examples were provided to illustrate the metaphorical terms. This corpus constitutes the third main source of scientific and technical metaphorical entries.
d) Analysis and classification of the metaphorical terms included in the database to establish conceptual metaphors and mappings.

### *a) Hand searching of metaphorical terms in specialized dictionaries*

Our first task was to determine which dictionaries to use for the hand searching phase. After consultation with some professors from the area, we selected some updated specialized dictionaries, containing a substantial number of entries, which covered all the areas under study. These are the most representative:

- *Dictionary of Geology*. Dorothy Farris Lapidus. Collins London and Glasgow. 1987.
- *Dictionary of Mining Terms*. Paul W. Thrush and the Staff of the Bureau of Mines. Maclean Hunter. 1990.
- *Glossary of Geology*. Neuendorf, K., Mehl, J., Jackson, J.A. (eds). American Geological Institute (4th Edition), 2000.
- *Oxford Dictionary of Earth Sciences*. (1991/ 2003/ 2008), web linked Earth Science terms and definitions, with 6,250 entries.
- *Oxford Dictionary of Environment and Conservation* (2007), with over 8000 entries with coverage of economic, geographical, and political terms.

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- *McGraw-Hill Dictionary of Scientific and Technical Terms* (2000), with some 110,000 terms and 125.000 definitions of 104 specific fields.

The search was completed with Electronic dictionaries on the web, mostly corpus-based.

In looking for metaphorical terms, the method in which researchers examine terms and decide what is metaphorical is perhaps the commonest approach to identification (Low, 1999: 49). However, Low adds that, in identifying metaphorical terms, there is a problem related to familiarity with specific words and that the researcher's knowledge of the topic area being studied may be considered a variable in metaphor identification. To avoid this handicap, we consulted with professors specialised in the areas dealt with whenever we had a doubt; this was possible because of our status as linguists and faculty members of the Agronomy and Mining Engineering Schools at UPM.

Therefore, the following common criteria constituted the basis for our decisions:

1. Determine the literal meaning (or meanings) of the word in non-scientific language.
2. Determine the specific meaning in the area of Earth science.
3. Contrast the specific scientific meaning and the basic meaning of the term in general language, and
4. Decide whether the scientific meaning provides more information than the basic meaning, and whether the term cannot be completely understood if only the general meaning is applied.

Based on these selection criteria, an initial list of metaphorical terms was elaborated. All the terms selected constitute technical or sub-technical vocabulary, i.e. they appear systematically in the specialised language studied.

*b) Definition and decomposition of the terms into their semantic components*.

At this stage, both the specific scientific definitions of the terms and their semantic components were analysed. During the process, we found out that definitions themselves constituted an important source of further lexicalized metaphors.

In our database we incorporated many words that are metaphoric in their origins because we observed that in science and technology, as in general language, in most of the cases of lexicalized metaphors, metaphorical mappings are still active and generate a series of new metaphors, both lexicalized and non-lexicalized.

*c) Contextualization of lexicalized metaphors by means of a specific corpus*

A specific untagged corpus of on-line scientific and technical reviews, created for the larger METACITEC[1] project, was used. Only this time, we limited the corpus to the subject areas under study, to about two million words from the period 1999-2007. We considered this size appropriate for our purposes, as "not only [specialised corpora] are likely to contain fewer words in all, but it seems as if the characteristic vocabulary of the special area is prominently featured in the frequency lists, and therefore a much smaller corpus will be needed for typical studies than is needed for a general view of the language" (Wynne, 2004:18).

Contextualization of lexicalized metaphors by means of a digitalized corpus offers a discourse approach to terminological analysis. Besides, corpora also favour the identification of those semi-technical lexicalized metaphors which are usually generated by other metaphors in real communication, with the advantage of finding those semi-technical terms as well as other frequent common vocabulary in science and technology, which may not be recorded in most specialised dictionaries.

The list of periodicals from which the research articles were taken appears in the reference section. The selection criteria of the texts is summarised in table 1.

*Table1:* Text selection criteria

| | |
|---|---|
| Mode of text | electronic (on line and web published paper periodicals ) |
| Type of text | scientific articles; research papers; popular science |
| Domain | academic; professional |
| Subject areas | engineering geology, petrology, geochemistry, geography, tectonics, seismology, vulcanology, mineralogy, and geophysics. |
| Language varieties | American English; British English |
| Date | From year 2000 onwards |

At this stage, all the metaphoric scientific and technical terms found in a visual inspection of specific dictionaries were studied with the Wordsmith programme. The use of a digitalized corpus provides two different dimensions to linguistics research. The horizontal one showed the information concerned to the particular text in a linear string; this dimension revealed the power of metaphorical terms to generate new metaphors, as well as the related metaphors belonging to the same domains. The vertical dimension made it possible to compare and observe the differences and regularities among the 23 lines which were shown at once in every particular screen.



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Once we had contextualized a word by means of that software, and to avoid a possible over-interpretation of the data as metaphors when they were not, we read and analysed each expanded concordance lines found. By way of an example, we bring the metaphorical compound term 'host rock' (fig 1). We found out that it appeared in 45 different cases (frequency). Obviously, the collocation of the word *host* followed by *rock* meant that the former was always metaphorical, since host defines a person who receives guests, and there was no possible over-interpretation of the term as a metaphor. However, a possible case of over-interpretation could have taken place in line number 3, where *dominant* was found preceding the compound 'host rock'. But, as it was part of the word group 'dominant host rock type', the word was discarded to be considered metaphorical.

Although the information concerning word frequency is not of primary importance for this particular study, the analysis of the association of words and lexical constellations provides substantial information about the potential of metaphor to generate new metaphors and new meaning; this serves as a cognitive model in scientific language and thought. In our analysis we looked for the selected words within a span of five places to the right and five places to the left of the node word (search term), looking for new possible metaphors generated by the metaphorical term itself. Thus, in line 4, we found the metaphorical terms from plants 'outcrop' and 'foliation'; in lines 13 and 23 the anatomical terms 'quartz vein', 'veins', etc. So, the development of an electronic corpus as a source of empirical data has allowed us to establish different conceptual mappings underlying this field of scientific thought other than the humanizing ones.

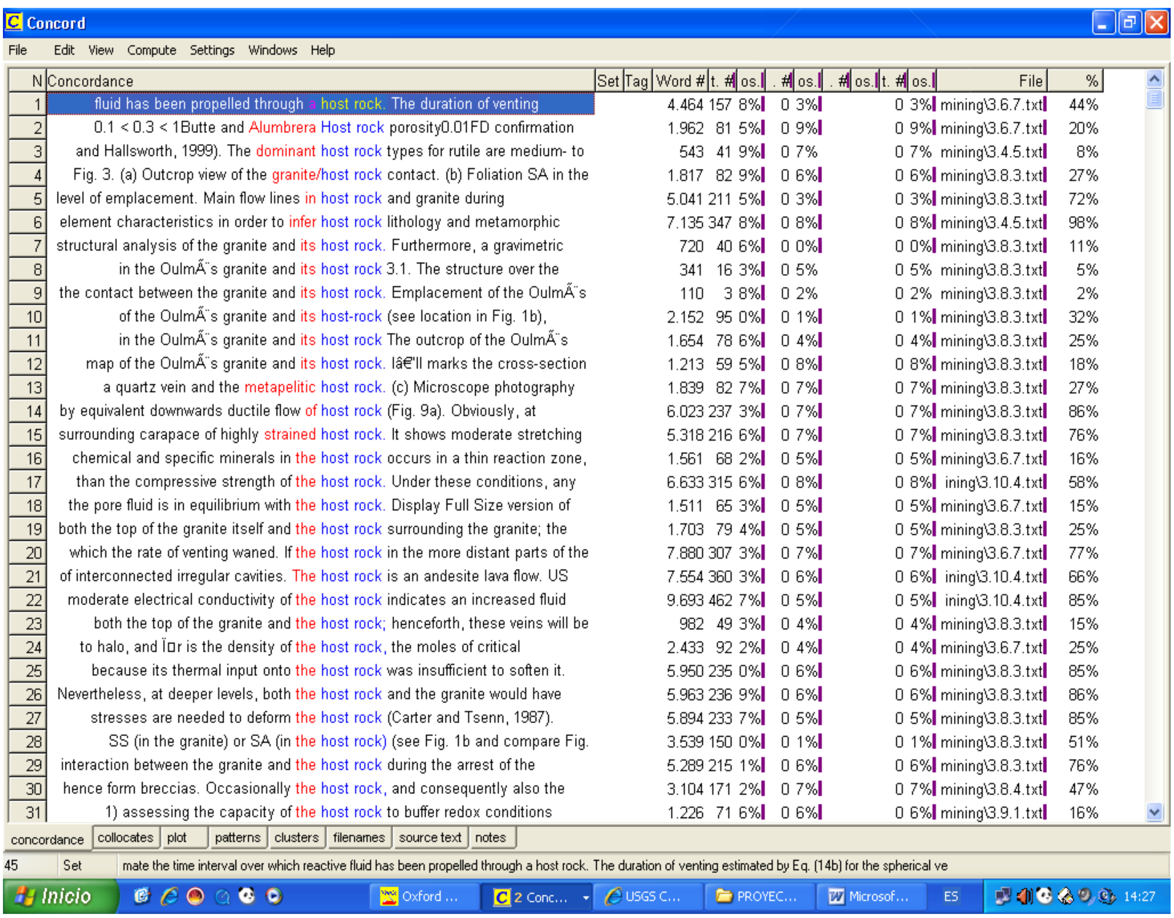


*Figure 1:* Fragment of Concordances of The Word "Host Rock" Found in the Digitalized Corpus of Earth Sciences.

*a) Analysis and Classification of the Metaphorical Terms Found in the Corpus*

In this work, we identified over 1000 Earth Science metaphorical entries, which were analysed and classified, both thematically and structurally. Metaphorical gradability was measured by means of (i) the comparison of the word definitions of both the source and the target domain, and their decomposition into their semantic components, that is, by analysing their shared properties and attributes (quantity); and (ii) by establishing which models are activated in the source and target domains, and if any of these models are more central than others (quality).

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## III. Results

After the analysis, we found out that over 35 terms were related to the description of rocks by means of the humanizing conceptual metaphor; since research is in progress, this number is by no means definite. The frequent presence of the humanizing metaphor shows that it is deeply embedded in the collective experience of the scientific community.

Results showed that <<ROCKS ARE HUMAN BEINGS>> activates two different sub-metaphors: (i) rocks are living organisms, encompassing the metaphors of age, the reproductive behaviour, and the family, all of which make up the genealogical model; and (ii) rocks are collective entities with social traits, which forms the social model.

*a) The genealogical model*

Related to the first sub-metaphor, the terms found in specialised dictionaries and contextualized in the corpus are the following: 'mature', 'immature', 'maturity', 'juvenile', 'young', 'age', 'generation', 'family', 'parent rock', 'parent material', 'mother rock', 'parental rock', 'coupling', 'daughter element', 'twin crystal', 'twin rocks', 'to twin', 'to descend', 'descendant', 'ancestor' and 'ancestral'. These terms involve the following mappings:

- <a class of minerals and rocks is a family of rocks>
- <rocks from which minerals and rocks are descended are parent rocks or mother rocks>
- <an element from which later elements are descended is a parent element>
- <an element descending from another is a daughter element>
- <an organism from which later organisms are descended is an ancestral organism>

Next, all the terms related to the genealogical model are presented, including a brief explanation of their meaning in context and showing an illustrative example taken from the digitalized corpus or the web[2].

- 'Generation': meaning a class, or set of rocks.

*Example 1:* "A new *generation* of zircon, characterized by very high Th/U and low U, grew at that time. That event — deformation and possibly a minor rise in temperature — produced widespread perturbations of other isotopic systems throughout the Napier Complex." (*Science Direct,* 2007: 2-20*).*

- 'Family': meaning a class of rocks. In the following example, we identified the expression "to form a family".

*Example 2:* "The site settles with great amount of igneous rocks, sandstone, shale and limestone as well as where the strong effects of metamorphism happened because of the movement of mountain building. Consequently, the *family* of metamorphosed complex has formed mainly consisting of black schist, green schist, siliceous schist and marble."(*ScienceDirect,* 2007: 2-20*).*

- 'Parent rock' and other related terms. They refer to the original rock from which other material was formed. The term 'parent rock' is also used in the context of metamorphic rocks where 'parent rock' refers to the original rock before metamorphism takes place. 'Parent rock' is the main source of soil. This type of soil is also called residual soil. Similar terms are 'parent body', 'parent mineral', 'parent substances', and 'parent material'; the latter meaning the underlying geological material in which soil is formed, sometimes, synonym with 'bedrock'.

*Example 3:* "Provenance analysis aims to reconstruct and to interpret the history of sediments from the initial erosion of *parent rocks* to the final burial of their detritus, encompassing all factors such as the geologic, physiographic and climatic context of the source area". *(Provenance of Albian sandstones in the São Luís–Grajaú Basin (northern Brazil) from evidence of Pb–Pb zircon ages, mineral chemistry of tourmaline and palaeocurrent data.)*

*Example 4:* 'parental rock' and 'age': "Essentially all paleosols, regardless of *age*, retain some characteristics of soils formed under an oxic atmosphere, such as increased Fe3+Ti ratios from their *parental rocks*". *(Evidence in pre–2.2 Ga paleosols for the early evolution of atmospheric oxygen and terrestrial biota, Hiroshi Ohmoto, Geology, The geological society of America)*

- 'Bedrock'. The term 'bedrock' may be considered as part of the genealogical model sub-metaphor as it refers to the native solid rock that produces loose 'parent material', such as soil, sand, clay or gravel, which make up local rocks or hold them in place.

*Example 5:* "The earth's crust is composed of rock. But the type of rock is different in most places. Rock which occurs at any given place on the earth is called that location's *bedrock*. In some cases the *bedrock* is actually exposed, and is said to outcrop at the surface. *Outcropping bedrock* is great stuff, because it allows geologists to determine the local geology, and helps them put together the geologic history of the earth." (http://www.jersey. uoregon. edu/~mstric/AskGeoMan)

- 'Mother rock', meaning the rock in which minerals are found implanted.

*Example 6:* "The type of Nannihu oversize molybdenum deposit belongs to skarn-porphyry type, which ore-forming *mother rock* is almost the same with 25 deposits in east Qinling-dabie mountain ore-forming belt." (*Environmental Science Technology,* 35: 6, 1067*).*

- 'Daughter element', meaning the element formed when a radioactive element undergoes radioactive decay.

*Example 7:* "The quantitative AFC model we have developed to explain isotopic variation in Ruapehu lavas is undoubtedly a simplification of the complex processes that might have actually been involved; for example, progressive contamination from the assumed



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*parent* to a single end-member *daughter composition* …" (*Science Direct,* 2007: 437-451).

- 'Age', meaning the ratio of the traces of the 'parent rock' and the 'daughter', expressed in years. This allows for comparison of the 'ages' of different rock strata.

*Example 8:* "The discovery of radioactivity enabled scientists to develop techniques for determining the *age* of fossils, rocks (…) Precise laboratory measurements of the number of remaining atoms of the *parent* and the number of atoms of the *daughter* result in a ratio that is used to compute the *age* of a fossil or rock in years. (…) one layer of rock is younger or older than another" (*Evolution and the Fossil record, pp 16-17*).

- 'Twin' and 'twin crystals': identical rock crystals are considered 'twin crystals'.

*Example 9:* "*Twinning* of the e-plane is the dominant crystal–plastic deformation mechanism in calcite deformed below about 400 °C. Calcite in a *twin* domain has a different crystallographic orientation from the host calcite grain. So-called thin *twins* appear as thin black lines when viewed parallel to the twin plane at 200–320× magnification under a petrographic microscope. Thick *twins* viewed in the same way have a microscopically visible width of *twinned material* between black lines." (Calcite twin morphology: a low-temperature deformation geo-thermometer, D.A. Ferrill, A.P. Morris, M.A. Evans, M. Burkhar, *Journal of Structural Geology*, Vol 26, Issue 8, August 2004, pp 1521–1529).

- 'Ancestor' and 'ancestral rock': an organism from which later organisms are descended is considered an ancestral organism.

*Example 10:* "Sources for a few suites having compositions indicative of recycled orogenic provenances were probably cover strata eroded off the crests of subdued basement uplifts. The sandstones were derived from highlands within the *ancestral rock* (…) (http://gsabulletin. gsapubs.org/ content/94/2/222. short)

- 'To descend' and 'descendant', meaning to derive from an earlier form.

*Example 11:* "Documentation of *ancestor-descendant* relationships among organisms comes from all fields. (…) The fossil record remains first and foremost among the databases that document changes in past life on Earth" (*Evolution and the Fossil record,* p 3).

*b) The social model*

The terms involved in the humanizing sub-metaphor <rocks are social entities> are: 'population, community, member, assemblage, native rock, host rock (developed from the peripheral features from the social domain), to host, intrusive rock, and allied rock'. 'Intrusive rock' activates the metaphor of war and is related to the terms 'intrusion, intruder, invasion, and allied'. Next, some examples in context[2] are provided.

- 'Population' meaning all the organisms that constitute a specific group or occur in a specified habitat.

*Example 12:* This zircon is part of a *population* of zircons within the metamorphosed conglomerate, which is believed to have been deposited about 3060 Ma, which is the age of the youngest detrital zircon in the rock. (http://en.wikipedia.org/wiki/Oldest_rock# Oldest_terrestrial_material)

- 'Community', taken as a group of interdependent organisms in the same region, which share some characteristics in common, as in the case of 'sea floor communities'.

*Example 13:* "Benthic, or sea floor, *communities* gave rise to the Cincinnatian Series limestone through a process called lithification. These *communities* were diverse and underwent frequent dramatic changes, which contributed to sediment formation. Such changes were often precipitated by events that wiped out most life in a given local *community*". http://www.cas.muohio. edu/glg/museum/students/conceptsingeology/benthicc ommunities.html.

- 'Member': a part of a lithostratigraphical formation is a member

*Example 14:* "The Alderley Edge data have been divided into two groups, one representing discontinuities in the Wilmslow Sandstone Formation (marked (W), and one representing discontinuities in the Thursaston *Member* of the Helsby Sandstone Formation (T)." *(ScienceDirect - Journal of Contaminant Hydrology:* Vol 93, Issues 1-4, 15, August 2007, pages 38-57).

- 'Mineral assemblage', meaning a gathering of minerals that form together in a rock at the same pressure and temperature at a given time

*Example 15:* If a rock is taken to some high pressure and temperature, then the *mineral assemblage* that develops should represent stable chemical equilibrium (*Earth Environmental Sciences. Metamorphic Mineral Assemblages, 2003).*

- 'Native rock': a mineral/element occurring in nature in its free state is a native mineral/element.

*Example 16:* "Modified asphalt was successfully prepared based on AH-70 bitumen with *native rock* asphalt modifier, and favorable performance was obtained. *Native rock* asphalt dramatically upgraded its high-temperature performance, improved its thermal susceptibility (…)". (*Influence of Performance of Modified Asphalt by Native Rock-Asphalt*, Fan, Shen, Journal of Building Materials, 2007)

- 'To host' and 'host rock': a 'host rock' refers to a rock which contains other rocks or mineral deposits.

*Example 17:* "Prior to granite *intrusion*, the *host rocks* were affected by a main deformation phase responsible for the development of a penetrative slaty cleavage and regional-scale folds. Granite emplacement

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gave way to a 2 km-thick strain aureole, which includes both the uppermost part of the stock and the surrounding *host rocks*."

- (*Journal of African Earth Sciences*, Volume 48, Issue 5, August 2007, pp 301-313).

- 'Intrusion', with a two-fold meaning: a) The forcing of molten rock into an earlier formation, and b) the rock mass produced by an intrusive process. See example 17 above.
- 'Intrusive rock': it is the rock resulting when magma cools and crystallizes slowly within the earth "crust; synonym with plutonic rock".

*Example 18:* "It is believed that there are some special actions to form reservoir spaces, especially the solution pores and cracks in the *intrusive rock* and its exomorphic zones, because the rock's diagenetic evolution was completed in a reduction environment". ("The lithofacies and reservoir model of *intrusive rock* and its exomorphic zones". *Petroleum Exploration and Development* 2000-02. Zhang, Ying Hong; et al. 2000, 27 (2): 22-26).

- 'Rock creep', referring to the slow and continued movement of small pieces of rock on hillsides.

*Example 19:* "Under the same general heading [rock-falls and rock slides] come the very slow movements of surface layers on slopes, such as soil creep and *rock creep* on hillsides, which continue over a long period and may ultimately displace trees, fences, and lines of communication". (Blyth & Freitas, 1974, *A Geology for Engineers,* p. 51).

- 'Dike swarm' referring to a large group of more or less parallel dikes.

*Example 20:* "The orientations of intrusive rocks from a carbonatitic lamprophyre *dike swarm* and the history of emplacement relative to country-rock schist structures are compatible with intrusion into tension fractures and Riedel shears formed during initiation of the dextral wrench system of the Alpine fault". (Cooper, Barreiro, Kimbrough, & Mattinson. *Geology*, The geological society of America).

- 'Allied rock', referring to rocks belonging to related families ranking between an order and a class.

*Example 21:* "There are, however, no hard and fast boundaries between *allied rocks*. By increase or decrease in the proportions of their constituent minerals they pass by every gradation into one another, the distinctive structures also of one kind of rock may often be traced gradually merging into those of another". *Journal of Petrology* 1986, 27(1): 155-196).

- 'Coupling', meaning the union of two elements that produce new substances.

*Example 22:* "Carbonates from subducted oceanic lithosphere may be remixed into the Earth's deep mantle via both redox "freezing" and melting that is driven by carbon and iron redox *coupling*, caused by redox capacity changes in the mantle." (*Nature,* March 2011. Rohrbach & Schmidt "Redox freezing and melting in the Earth's deep mantle resulting from carbon–iron redox *coupling*" Vol 472, pp 209-212. http://www.nature.com/natura/journal/v472/n7342.html)

*c) Case study: Mother rock.*

The term 'mother rock' has been brought here as an example to illustrate a highly metaphorical term which has not been created solely in terms of its salient "motherly" properties, but in terms of human imagination, as we shall demonstrate. The term shares both essential and non essential attributes with the human concept of "mother".

Thus, the word "mother" is defined primary as: "A female parent; a woman who has given birth to a child. Correlative with son or daughter" (OED, 1989, vol. IX, 1121). In figurative language, it can be used "with reference either to a metaphorical giving birth, to the protecting care exercised by a mother, or to the affectionate reverence due to a mother".

Its more prominent attributes are "female parent" and the process of "giving birth". According to the OED, by means of metaphorical extension of its properties, it activates the concepts: "protecting care" and "affectionate reverence".

-A stone or a rock is defined as "a hard mineral substance (other than metal) of a small or moderate size". Accordingly, its prominent properties are hardness and size, marked by the elements that make up the rock. By metaphorical extension of its properties it activates the attributes: motionless or fixity, stability or constancy. In figurative sense, the words 'stone' or 'rock' are applied to "chiefly as the supposed substance of a hard heart, also a hard or unfeeling person" (OED, 1989, vol. XVI 757).

Within the Earth science context, a 'mother stone' is "The matrix of a mineral; also, a stone from which other mineral are derived by structural or chemical change" (OED, 1989, vol. IX, 1123). This implies that human imagination describes the changes by which a rock derives into other minerals turning to the concept of motherhood.

At this point, cognitive linguists may want to find out which semantic properties and attributes take part in the model involved. So, in order to determine the degree of metaphoricity of this particular term, we have to establish which models are activated in the term, and if any of these models are more central than others. First of all, we observe that it activates the metaphorical model of genealogy, which in the source domain is absolutely peripheral, if not inexistent. That is, it is not central to the concept of rock. Therefore, we may deduce that the number of attributes and properties that human motherhood and 'mother rock' share in common only exist in human imagination.

As Santibanéz (2001) explains "none of the sub-models suffices to characterize the concept on its own". However, some of the sub-models characterizing a



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given metaphorical term are more central than others, and suggests that certain models provide the invariant for the concept (Wierzbicka 1996). For instance, 'mother rock' and 'parent rock' derive from the genealogical model, which is in fact another conceptual metaphor. Thus, it is possible to affirm that this complex system of related metaphors is not created from central models, and allows us to conclude that it is an example of high metaphoricity. Furthermore, the analysis of metaphorical terms in Earth Sciences also confirms the theory that metaphors are not created solely in terms of their salient properties, but in terms of human imagination as well, i.e. metaphors are created from both, essential and non essential attributes.

## IV. Discussion

In order to illustrate the evidence that humanizing metaphors in Earth Science have a large component of human imagination, we have developed a table showing the relationships among the lexicalized metaphors involved in <<ROCKS ARE HUMAN BEINGS>> that fall under the two main models analysed, the genealogical and the social model (table 2). Under the genealogical model three other sub-models converge: the generation, birth and marital models, which coincide with Lakoff's (1987:37) analysis of the concept of mother. Lakoff's model encompasses five aspects: birth, marital, genetic (supplies genetic material), nurturance (takes care), and genealogical. In our study, the genetic and the nurturance models have not been found, and terms such as parent(al) rock, parent material, parent body, and mother rock have been classified under both the birth and the marital sub-models, as they share properties of both of them; we may add that 'parent material' could have been interpreted to fall under the genetic model.

By contrast, we have found another model, the social one, including concepts related to grouping and to individual social traits. In this case, we have also come across terms which we consider to share properties from two sub-models, the marital –under the genealogical model-, and the grouping sub-model –under the social model. These terms are: 'family' and 'coupling', first classified under the marital sub-model, but which also have a social component. Finally, terms included in the social model like 'allied rock' vs 'intrusive rock' generate a new sub-model of human behaviour based on friendship and the acceptance or rejection of a new member in the group. This is the case of Boninite, which is defined as a high-magnesian basalt dominated by pyroxene, and of 'dike' or 'dyke', which in geology is a type of sheet intrusion referring to any geologic body that cuts discordantly across.

*Table 2 :* lexicalized metaphor models for the conceptual metaphor <<ROCKS ARE HUMAN BEINGS>>

| THE GENEALOGICAL MODEL | | / THE SOCIAL MODEL | | |
|---|---|---|---|---|
| GENERATION M. / | BIRTH M. / | MARITAL M. / | GROUPING / | SOCIAL TRAITS |
| to descend | parent(al) rock | parent(al) rock | population | native rock |
| descendant | parent material | parent material | community | to host |
| ancestral rock | parent body | parent body | member | host rock |
| ancestor | mother rock | mother rock | assemblage | intrusive rock |
| age | daughter element | bedrock | dike swarm | allied rock |
| maturity | to twin | coupling | coupling | to intrude |
| mature/ immature | twin crystals | family | family | intrusion |
| young, juvenile | twin rocks | | | rock creep |

The findings portrayed in section 3 seem to contradict the stance of the CTM that the source domain is less abstract, i.e. more accessible to sense perception, than the target domain. In all cases shown in table 2, as in the case study of the term 'mother rock', the concrete physical domain of rocks is conceptualized by means of more complex abstract domains, including social traits such as hostility ('intrusive rock'), hospitality ('host rock'), and friendship ('allied rock'). Moreover, these findings provide further support to maintain that part of the main content of natural science is organized by the humanizing metaphor based on human experience and projection (Cuadrado and Durán, 2013).

## V. Conclusions

The humanizing metaphor of rocks, one of the most productive conceptual patterns found in our corpus analysis, shows that metaphorical lexical units are not independent one from another but constitute connected semantic networks that give support to the conceptual system of this area of science. The findings also show that lexicalised metaphorical terms are highly active, and that a great part of geological science is organized by the humanizing metaphor, given the relevance of the conceptualization of rocks in this discipline. The understanding of the natural world is based on inherent semantic relations among words which are conceptualized by means of different intertwined models and sub-models of human



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experience; this is the case of the genealogical and the social models applied to the analysis of the conceptual metaphor <<ROCKS ARE HUMAN BEINGS>>.

This semantic analysis contradicts some assumptions of conceptual metaphors, thus opening new research lines in the CTM. Given the importance of the conceptualization of rocks in the study of geology, this analysis provides empirical support to maintain that: (i) the trend from abstract to concrete, postulated by the CTM in general language, is not followed in Earth Science, and, therefore, contradicts the rationale proposed for general language, where abstract difficult to handle domains are often understood in terms of concrete domains. As shown in the previous analysis, the concrete, physical domain of rocks is conceptualized by means of more complex abstract domains, including human social traits such as friendship, hostility and hospitality. Results knock down the notion that (ii) metaphor in science is usually understood in terms of its explanatory or informative power, and (iii) that in science, metaphorical thought is usually based on analogical reasoning rather than on human experience and imagination.

This work also shows evidence that gradability can be applied to metaphorical terms in this field by means of the decomposition into the terms' semantic components. And, more importantly, it provides a theoretical framework to evaluate metaphoricity based on the centrality of the models of relational networks which are activated by a metaphorical term. Results offer empirical evidence that scientific metaphors are not mainly defined in terms of their salient properties and attributes but in terms of human experience.

Although many other factors must be taken into account in order to establish metaphoricity, for example, the quantity of properties, and the salient meaning of a word, this paper can open a new research line in the right direction, as it has aimed to demonstrate that, in science and technology, different metaphorical terms present different degrees of metaphoricity, some of them being highly metaphorical. The implications of these results may provide the basis for further studies on the generation and role of metaphor in constructing meaning within science and technology.

*Notes*

[1]METACITEC is a terminological database result of a research project financed by the regional government of Madrid (Spain) and the Universidad Politécnica de Madrid (UPM), integrated into the research and development lines (R+D) of 'Science and Society'.

[2]Contextualised terms have been highlighted in italics by the authors.

[3]The research articles contained in the corpus were extracted from the following sources: *Journal of Earthquake Engineering, Geodiversitas, Earth Moon and Planets, Chemical Geology, International Journal of Applied Earth Observation and Geoinformation, Earth and Planetary Science Letters, Soil Dynamics and Earthquake Engineering, Journal of African Earth Sciences, Journal of Contaminant Hydrology, Geothermics, The Electronic Journal of Geotechnical Engineering, Applied Clay Science, Computers and Geosciences, Sedimentary Geology.*

## References Références Referencias


1. Cuadrado, G. (2005). La bondad y las funciones de la metáfora en el lenguaje científico: evaluación y criterios basados en miembros de la comunidad científica e investigadora. In M.L. Carrió (Ed,), Perspectivas interdisciplinares de la lingüística aplicada (pp. 231-240).
2. Cuadrado, G. (2010). Un sistema de engranajes es un sistema planetario: análisis de la metáfora cognitiva y los modelos mentales en el campo de la ingeniería. In T. Bungarten (Ed.), Akten des IX Internationaler Kongress der Europäischen Gesellschaft für Fachsprachen. Hamburg: Universität Hamburg.
3. Cuadrado, G. & Berge Legrand, J. (2005). A cognitive semantic analysis of metaphor in conceptualizing Particle Physics. Annual Review of Cognitive Linguistics, 3, 165-181.
4. Cuadrado, G. & Durán, P. (2013). Proposal for a Semantic Hierarchy of Terminological Metaphors in Science and Technology. International Journal of English Linguistics, 3: 4, 1-14.
5. Hanks, P. (2006). Metaphoricity is gradable. In A. Stefanowitsch & S.T. Gries (Eds.), *Corpus-based approaches to metaphor and metonymy*, (pp.17-35).
6. Lakoff, G. (1987). *Women, Fire and Dangerous Things. What Categories Reveal about the Mind.* Chicago: University of Chicago Press.
7. Lakoff, G. (1993). The Contemporary Theory of Metaphor. In Ortony, A. (Ed.), *Metaphor and Thought.* Cambridge UK: Cambridge University Press (pp 202- 251).
8. Lakoff, G. & M. Johnson, (1980). *Metaphors we Live By*, Chicago: The University of Chicago Press.
9. Lakoff, G. & M. Johnson, (1999). *Philosophy in the Flesh. The Embodied Mind and its Challenge to Western Thought.* New York: Basic Books.
10. Langacker, R. W. (1987). *Foundations of cognitive grammar: Theoretical Prerequisites.* Stanford, CA: Stanford University Press.
11. Langacker, R.W. (1990). *Concept, Image, and Symbol: The Cognitive Basis of Grammar.* Berlin/New York: Mouton de Gruyter.
12. Low, G. (1999). Validating metaphor research projects. In Cameron, L. & G. Low (Eds.), *Researching and Applying Metaphor.* Cambridge UK: Cambridge University Press (pp. 48-66).




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13. Müller, C. (2008). *Metaphors dead and alive, sleeping and waking: a dynamic view*. Chicago: Chicago University Press.
14. Robisco, M.M. (2011). *Análisis cognitivo de las preposiciones en torno al eje de verticalidad en el inglés para la aeronáutica.* Madrid: Editorial Doppel.
15. Roldán, A.M. & P. Ubeda, (2013). Metaphor in the ESP engineering context. *IBÉRICA 25,* 107-126.
16. Rosch, E. (1978). Principles of categorization. In E. Rosch & B.B. Lloyd (Eds.), *Cognition and Categorization* (pp. 27-48). Hillsdale, NJ: Lawrence Earlbaum Associates.
17. Santibáñez, F. (2001). Towards a relational account of semantic structure. In *La Lingüística Aplicada a finales del siglo XX. Ensayos y propuestas* (pp. 377-381). Madrid: Universidad de Alcalá.
18. Schmitt, R, (2005.) Systematic Metaphor Analysis as a Method of Qualitative Research. *The Qualitative Report 10,* 358-394.
19. Svanlud, J. (2007). Metaphor and Convention. *Cognitive Linguistics 18:1*, 47–89.
20. White Hayes, M. (2004). Turbulence and turmoil in the market or the language of a financial crisis. *IBÉRICA 7*: 71-86.
21. White, M. & Herrera, H. (2009). How business press headlines get their message across: a different perspective on metaphor. In A. Musolff and Zinken, J. (Eds.), *Metaphor and Discourses*. Basingstoke: Palgrave-Macmillan (pp.135-152).
22. Wierzbicka, (1996). *Semantics: Primes and Universals*. Oxford UK: Oxford University Press.
23. Wynne, M. (2005). *Developing linguistic corpora: A guide to good practice.* Oxford, UK: Oxbow Books.

*Dictionaries*

24. *The Oxford English Dictionary*. Oxford: Clarendon Press. 2nd edit. 20 vols., 1989.
25. Collins English Dictionary

*Scientific Journals Cited*

26. *ScienceDirect - Journal of Contaminant Hydrology:* Transport of Escherichia coli through variably saturated sand columns and modeling approaches. *93*, Issues 1-4, 15 August 2007, pp 2-20.
27. *ScienceDirect - Journal of Contaminant Hydrology:* Estimating the hydraulic properties of the fracture network in a sandstone aquifer. *93*, Issues 1-4, 15 August 2007, pp 38-57.
28. *ScienceDirect - Chemical Geology:* U–Th–Ra fractionation during crustal-level andesite formation at Ruapehu volcano, New Zealand. *244*, issues 3-4, 15 Oct 2007, pp 437-451.
29. *Environmental Science Technology*, 2001, *35* (6), pp 1064–1071.
30. Geological Character Research of Ore-Forming Mother Rock of Nannihu Oversize Molybdenum Ore Deposit of Luanchuan. In *Henan China Molybdenum Industry* 2006-03, LIU Yong-chun, FU Zhi-guo, GAO Fei, JIN Yong-hu, ZHAO Yun-lei.
31. *Evolution and the Fossil record*. Projeta, J. & Dale A. Spriger. American Geological Institute. The Paleontological Society, pdf application accessed November 2011, pp 16-17).
32. *Geology. The geological society of America*. Lamprophyre dike intrusion and the age of the Alpine fault. New Zealand, A. F. Cooper, B. A. Barreiro, D.L. Kimbrough, J. M. Mattinson. Abstract. http://geology.geoscienceworld.org/search?author1=J.+M.+Mattison&sortspec=date&submit=Submit)
33. *Journal of Structural Geology*, *26*, Issue 8, August 2004 (pp 1521–1529) Calcite twin morphology: a low-temperature deformation geothermometer, D. A. Ferrill, A. P. Morris, M. A. Evans, M. Burkhard, R. H., Groshong Jr., C. M. Onasch).
34. *Journal of Building Materials,* (2007). Influence of Performance of Modified Asphalt by Native Rock-Asphalt. Fan, She
35. *Journal of African Earth Sciences*, Volume 48, Issue 5, August 2007, pp 301-313.
36. *Journal of Petrology* 1986, 27(1): 155-196 doi:10.1093/petrology/27.1.155. N. M. S. ROCK. http://en.wikipedia.org/wiki/Rock_(geology).
37. *Nature,* March 2011. Arno Rohrbach & Max W. Schmidt "Redox freezing and melting in the Earth's deep mantle resulting from carbon–iron redox coupling" Vol 472, pp 209-212. http://www.nature.com/natura/journal/v472/n7342.html
38. *Petroleum Exploration and Development* 2000-02. Zhang, Ying Hong; et al. "The lithofacies and reservoir model of intrusive rock and its exomorphic zones". 2000, *27:2,* (22-26), in http://en.cnki.com.cn/Journal_en/B-B019-SKYK-2000-2002. html
39. *Physical Chemistry B*, (2005). *109:3,* (pp.1155–1161). Flowerlike ZnO Nanostructures via Hexamethylenetetramine-Assisted Thermolysis of Zinc−Ethylenediamine Complex. Xiangdong Gao, Xiaomin Li, & Weidong Yu, *J.*

*Web Pages Cited*

http://www.cas.muohio.edu/glg/museum/students/conceptsingeology/benthiccommunities.html. Karl E. Limper. Geology Museum, updated September 2010.
http://en.wikipedia.org/wiki/Oldest_rock#Oldest_terrestrial_material *Earth Environmental Sciences. Metamorphic Mineral Assemblages 2003,* Stephen A. Nelson: http://www.tulane.edu/~sanelson/eens212.

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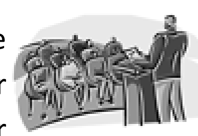

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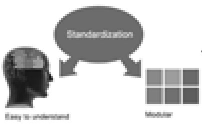


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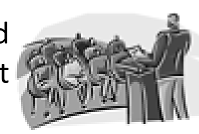

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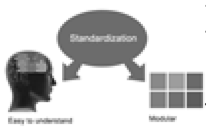


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5. Structure and Format of Manuscript,

6. After Acceptance.

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**7. Use right software:** Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

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**9. Use and get big pictures:** Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

**10. Bookmarks are useful:** When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

**11. Revise what you wrote:** When you write anything, always read it, summarize it and then finalize it.

**12. Make all efforts:** Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

**13. Have backups:** When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

**14. Produce good diagrams of your own:** Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

**15. Use of direct quotes:** When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

**16. Use proper verb tense:** Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

**17. Never use online paper:** If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

**18. Pick a good study spot:** To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

**19. Know what you know:** Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

**20. Use good quality grammar:** Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

**21. Arrangement of information:** Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

**22. Never start in last minute:** Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

**23. Multitasking in research is not good:** Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

**24. Never copy others' work:** Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

**25. Take proper rest and food:** No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

**26. Go for seminars:** Attend seminars if the topic is relevant to your research area. Utilize all your resources.

**27. Refresh your mind after intervals:** Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

**28. Make colleagues:** Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

**29. Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

**30. Think and then print:** When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

**31. Adding unnecessary information:** Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

**32. Never oversimplify everything:** To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

**33. Report concluded results:** Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

**34. After conclusion:** Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

## Informal Guidelines of Research Paper Writing

**Key points to remember:**

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

**Final Points:**

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

**General style:**

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

**Title Page:**

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

**Abstract:**

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including <u>definite statistics</u> - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

**Introduction:**

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

**Procedures (Methods and Materials):**

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

**Results:**

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

**Discussion:**

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

## Administration Rules Listed Before Submitting Your Research Paper to Global Journals Inc. (US)

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- Do not give permission to anyone else to "PROOFREAD" your manuscript.
- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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| ***Abstract*** | Clear and concise with appropriate content, Correct format. 200 words or below | Unclear summary and no specific data, Incorrect form<br><br>Above 200 words | No specific data with ambiguous information<br><br>Above 250 words |
| ***Introduction*** | Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited | Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter | Out of place depth and content, hazy format |
| ***Methods and Procedures*** | Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads | Difficult to comprehend with embarrassed text, too much explanation but completed | Incorrect and unorganized structure with hazy meaning |
| ***Result*** | Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake | Complete and embarrassed text, difficult to comprehend | Irregular format with wrong facts and figures |
| ***Discussion*** | Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited | Wordy, unclear conclusion, spurious | Conclusion is not cited, unorganized, difficult to comprehend |
| ***References*** | Complete and correct format, well organized | Beside the point, Incomplete | Wrong format and structuring |

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