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Comparative Study of Theories of Change Detection Methods in Landuse and Landcover Using Remote Sensing Techniques

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ABSTRACT

Landcover is the natural surface of the earth undisturbed by human activities. It represents vegetation, natural or man-made features and every other visible evidence of land use. Landuse on the other hand refers to the use of land by humans. Change detection is a process of identifying differences in the state of an object or phenomenon by observing it in different times. Techniques of change detection identified in this paper are pre-classification and post-classification change detection which includes image differencing, image ratioing, change vector analysis, principal component analysis, post classification comparison, etc. Various results were achieved by different researchers based on the change detection techniques and data used; Post-classification comparison was adjudged to be the most accurate procedure and presented the advantage of indicating the nature of the changes. Most studies adopted one change detection technique and visual interpretation without comparison for errors detections or inaccuracies in the change detection processes.

Keywords : Change Detection, Remote sensing, Landuse, Landcover, Change Detection Techniques

I. INTRODUCTION

Land is an area of the surface of the earth together with the water, soil, rock, mineral, and hydrocarbon beneath or upon it and the air above it. It embraces all things which are related to fixed area or point of the earth including the area covered by water including the sea. [1]. Land is a finite resources and competition for it is intensifying because of rapid urbanization, growing populations, economic development, persistent insecurity of food, water and energy, and the effect of conflicts and disasters. The divide between urban and rural is diminishing. These areas are today interconnected by flows of goods, money, resources and people. Climate change and different land use patterns also affect rural areas including farmland, dry lands, wetlands and forests. Given that by the middle of this century, 70 percent of the world's people will live in urban areas, cities need to adapt to urban expansion and there is therefore an urgent need to prepare for growth and its related land requirements. This call for a realistic projection of urban land needs and innovative responses. Rural land also needs to be managed cautiously. Pressure on rural land is increasing as a result of a rising world population, climate change, declining soil fertility and the need for global food and fuel security. [2]

Generally, the earth's surface changes are divided into two categories; land use and land cover. Land cover refers to the natural surface of the earth undisturbed by human activities. It represents vegetation, natural or man-made features and every other visible evidence of land use e.g. forest, cultivated/uncultivated land, settlement, etc. Land use on the other hand, refers to the use of land by humans. It is the alteration done to land cover as a result of human activities such as farming, road construction, etc. [3]

Land cover initially describes the physical state of the land surface, which includes cropland, forests, and wetlands, but it has broadened in subsequent usage to contain human structures such as buildings, pavements and other aspects of the natural environment, including soil type, biodiversity, surface water and groundwater. In contrast, land use refers to the way in which human beings exploit the land and its resources including agriculture, urban development, grazing, logging and mining. However, land cover and land use are often used interchangeably because the two terms are interdependent and closely related. [4]
Regardless of that, land use/ land cover change (LULCC) is defined as the transformation of the land or replacement of one land-cover type on the earth's surface. LULCC is the impact of several related processes operating over a wide range of scales in space and time. [3] opined that land cover and landuse information should form part of the environmental data, which are kept in the form of inventories/infrastructures in many advanced and emerging economies. Most landuse change factors such as water flooding, air pollution, urban sprawl, soil erosion, deforestation, occur without clear and logical planning which results in serious environmental degradation with notable consequences globally.

Landuse landcover mapping is considered an essential element for modelling and understanding the earth as a system. Land cover maps are presently being developed from local to national to global scales [5]. Fortunately, there is now available documentation of the spatiotemporal pattern of land use/cover using satellite imagery, which allows scientists the ability to determine the causes and results of change in relation to human activity patterns therefore; studying changes in land use/land cover has become an important research theme in the remote sensing spatial analysis Since the 1970s [6].

For extracting LULC change information, traditional methods and remote sensing technology may be used. Traditional methods such as field surveys, map interpretation, collateral and ancillary data analysis are not effective to acquire LULC changes because they are time consuming, date-lagged and often too expensive, whereas the remote sensing technology method includes using aerial photographs, satellite images, spatial data set and other data and is a much more cost-effective and time-efficient means to study LULC changes, especially over regional or national areas in comparison with the traditional methods [7]
[8] define Remote Sensing (RS) as the instrumentation, techniques and methods to observe the Earth's surface at a distance and to interpret the images or numerical values obtained in order to acquire meaningful information of particular objects on Earth. Basically, there are two types of remote sensing instruments; passive and active. Passive instruments detect the natural energy that is reflected or emitted from the observed scene whereas active instruments provide their own energy (electromagnetic radiation) to illuminate the object or scene they observe. Remote sensing from airborne and space borne platforms provide a huge amount of valuable data about our earth's surface including aerial photographs, satellite images, spatial data set and other data. The increased availability of mid- to fine-resolution satellite imageries since the early 1990s, offers repetitive data variance among themselves in terms of spatial, radiometric, spectral, temporal resolution and its synoptic view [9] also the digital format makes them suitable for many computer image processing software. All these have made remotely sense data the main source for various remote sensing applications [10]. Remote sensing satellite imagery has given scientists a remarkable way to determine the reasons for land use/land cover changes and the resultant consequences due to human activity [4].

Change detection involves the use of multi-dates data sets to discriminate areas of land cover change between dates of imaging. These types of changes that might be of interest can range from short term phenomena such as snow or floodwater to long term phenomena such as urban fringe development or desertification [5]. Detecting and analyzing LULCC over large geographic areas as well as over regional areas have been highlighted both in a manner of discrete long-time span and in sequential time series with high temporal resolution remote sensing satellites through a process commonly called 'change detection' [11]. Various change detection techniques had been developed and are applicable based on the type of dataset available and change detection analysis intended. This study is to explore various change detection techniques, their applications, its pros and cons so as to explore which of the change detection techniques or combinations is best for landuse landcover mapping as well as change detection.

II. THEORETICAL BACKGROUND

2.1 Remote sensing

[12] described remote sensing as the acquisition of information about an object without physical contact with the object. The term usually refers to the gathering and processing of information about earth's environment, particularly its natural and cultural resources, through the use of photographs and related data acquired from an aircraft or a satellite. [13] viewed remote sensing from different perspective as the science of acquiring, processing and interpreting images that record the interaction between electromagnetic energy and matter. He further explained that remote sensing is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation. It is also known as the instrumentation, techniques and methods to observe the Earth's surface at a distance and to interpret the images or numerical values obtained in order to acquire meaningful information of particular objects on Earth.

Common to the three definitions by [13] is that data on characteristics of the Earth's surface are acquired by a device that is not in contact with the objects being measured and the result is usually stored as image data. The characteristics measured by a sensor are the electromagnetic energy reflected or emitted by the Earth's surface. This energy relates to some specific parts of the electromagnetic spectrum: usually visible light, but it may also be infrared light or radio waves. There is a wide range of remote sensing sensors. Sensors, linked to a certain platform, are classified according to their distance from the Earth's surface: airborne and spaceborne sensors. Together, they contribute to aerospace surveying, which is the combined use of remote sensing and ground-based methods to collect information.

Basically, there are two types of remote sensing instruments (sensor); passive and active. Passive instruments detect the natural energy that is reflected or emitted from the observed scene whereas active instruments provide their own energy (electromagnetic radiation) to illuminate the object or scene they observe. [4], [14] emphasized that remote sensors mounted in aircraft and satellite platforms are primarily used in inventorying, mapping, and monitoring earth resources. The components and characteristics of a remote sensing system from start to finish are as follows;

1. The energy sources
2. Propagation of energy through the atmosphere
3. The energy-matter interaction at the earth's surface
4. Recording of reflected and emitted energy by the remote sensor
5. The data processing and supply system
6. The user of remotely sensed data for various application

Successful application of remote sensing is improved considerably by taking a multiple view approach to data collection. This may involve multi-stage sensing, wherein data about a site are collected from multiple altitudes. It may involve multi-spectral sensing, whereby data acquired simultaneously in several spectral bands. Or, it may entail multi-temporal sensing, where data about a site are collected on more than one occasion or time. [5]

2.2 Landuse Landcover mapping

Landuse and landcover are distinct yet closely linked characteristics of earth's surface. Landuse is the use to which we put land and it could be grazing, agriculture, urban development, logging, and mining among many others. On other hand, the term landcover originally refers to the kind and state of vegetation, such as forest or grass cover but it has broadened in subsequent usage to include other thing such as human structures, soil types, biodiversity, surface and ground water. [15]

[5] described landcover as the type of feature present on the surface of the earth. Corn fields, lakes, maple trees and concrete highways are all examples of landcover types. Landuse was described as human activities or economic function associated with a specific piece of land. As an example, a tract of land on the fringe of urban area may be used for single-family housing. Depending on the level of mapping detail, its land use could be described as urban use, or single family residential use. The same tract of land would have a landcover consisting of roofs, pavement, grass and trees. Adequate knowledge of both landuse and landcover can be important for land planning and land management activities.

2.3 Landuse Landcover Classification

Classification in remote sensing involves clustering the pixels of an image to a relatively small set of classes, such that pixels in the same class are having similar properties. The majority of image classification is based on the detection of spectral response patterns of landcover classes.

Normally, multispectral data are used to perform the classification, and the spectral pattern present within the data for each pixel is used as numerical basis for categorization. That is, different feature types manifest different combination of DNs based on their inherent spectral reflectance and emittance properties. The term *classifier* refers loosely to a computer program/algorithm that implements a specific procedure for image classification. Over the years, scientists have devised many classification strategies. From these alternatives, the analyst must select the classifier that will best accomplish a specific task. At present, it is not possible to state that a given classifier is "best" for all situations because Characteristics of each image and the circumstances for each study vary so greatly. The traditional methods of classification mainly follow two approaches: ***unsupervised and supervised.*** These are also referred to as a pixel-based classification.

[16] explain that unsupervised classification algorithms cluster data according to several user-defined statistical parameters in an iterative fashion until either some percentage of pixels remain unchanged or a maximum number of iterations have been performed. This method of classification is most useful when no previous knowledge or ground truth data of an area is available. However, the classes determined by the algorithm still require land cover identification by an experience analyst, which can be a significant disadvantage in using this method. In supervised classification, the image analyst supervises the pixel categorization process.

Supervised classification can be defined normally as the process of samples of known identity to classify pixels of unknown identity. Samples of known identity are those pixels located within training areas.

Pixels located within these areas term the training samples used to guide the classification algorithm to assigning specific spectral values to appropriate informational class. The basic steps involved in a typical supervised classification procedure are the training stage, Feature selection, Selection of appropriate classification algorithm, post classification smoothening and accuracy assessment.

The recent method of image classification object oriented image analysis (OBIA). In pixel based classification, the ability of this method to classify the image is also limited when objects have similar spectral information. Two most evident differences between pixels-based image analysis and object-oriented analysis are; (i) object-oriented based analysis uses image object as the basic processing unit and not a single pixel (ii) object-oriented image analysis uses soft classifiers that are based on fuzzy logic not hard classifier.

The USGS devised a landuse and land cover classification system for use with remote sensing data in the mid-1970s. This document remains vital document in landcover classification from Landsat data. In this document proposed by [17], the following landuse and landcover classification system for use with remote sensor data at level I and Level II. Level I is the basic level while Level II is detail break down of Level I. Level I was classified into nine (9) sub-categories which are Urban or build-up land, Agricultural land, Rangeland, Forest Land, Water, Wetland, Barren land, Tundra and perennial Snow/Ice.

2.4 Landuse Landcover Change

Land cover can be altered by forces other than anthropogenic. Natural events such as weather, flooding, fire, climate fluctuations, and ecosystem dynamics may also initiate modifications upon land cover. Globally, land cover today is altered principally by direct human use: by agriculture and livestock raising, forest harvesting and management and urban and suburban construction and development. There are also incidental impacts on land cover from other human activities such as forest and lakes damaged by acid rain from fossil fuel combustion and crops near cities damaged by tropospheric ozone resulting from automobile exhaust [18]

Hence, in order to use land optimally, it is not only necessary to have the information on existing land use land cover but also the capability to monitor the dynamics of land use resulting out of both changing demands of increasing population and forces of nature acting to shape the landscape. Conventional ground methods of land use mapping are labour intensive, time consuming and are done relatively infrequently. These maps soon become outdated with the passage of time, particularly in a rapid changing environment. In recent years, satellite remote sensing techniques have been developed, which have proved to be of immense value for preparing accurate land use land cover maps and monitoring changes at regular intervals of time. In case of inaccessible region, this technique is perhaps the only method of obtaining the required data on a cost and time – effective basis. [19]

2.5 Change detection

Change detection involves the use of multitemporal data sets to discriminate areas of land cover change between dates of imaging. These types of changes that might be of interest can range from short term phenomena such as snow or floodwater to long term phenomena such as urban fringe development or desertification. Ideally, change detection procedures should involve data acquired by the same sensor or similar sensor and be recorded using the same spatial resolution, viewing geometry, spectral bands, radiometric resolution and time of the day. Often *anniversary dates* are used to minimize sun angle and seasonal differences. Accurate spatial registration of the various dates of imagery is also a requirement for effective change detection. Registration to within ¼ to ½ pixels is generally required. Clearly, when mis-registration is greater than one pixel, numerous errors will result when comparing the images. [5]

The reliability of the change detection process may also be strongly influenced by various environmental factors that might change between image dates. In addition to atmospheric effects, such factors as lake level, tidal stage, wind, or soil moisture condition might also be important. Even with the use of anniversary dates of imagery, such influences as different planting dates and season-to-season changes in plant phenology must be considered.

Change detection techniques are applicable in the following areas;
Land-use and land-cover (LULC) change, Forest or vegetation change, Forest mortality
Defoliation and damage assessment, Deforestation, regeneration and selective logging, wetland change, forest fire and fire-affected area detection, landscape change, urban change, environmental change, drought monitoring, flood monitoring, monitoring coastal marine environments, desertification, and detection of landslide areas. Other applications include crop monitoring, shifting cultivation monitoring, road segments, and change in glacier mass balance and facies. [20]

III. CHANGE DETECTION TECHNIQUES

Change detection as a process of identifying differences in the state of an object or phenomenon by observing it in different times. This is considered an important process in monitoring landuse landcover change (LULCC) because it provides quantitative analysis of the spatial distribution of the population of interest and make LULCC study a topic of interest in remote sensing applications [4].
[8] identified six (6) main steps in using remotely sensed data to detect landuse landcover changes, the six steps are as follows;

i. Nature of change detection problems
ii. Selection of remotely sensed data and Image pre-processing
iii. Image processing and classification
iv. Selection of change detection algorithms
v. Accuracy assessment and Evaluation of change detection results.
vi. Final product generation

Before implementing change detection analysis, the following conditions must be satisfied;
i. Precise registration of multi-temporal images;
ii. Precise radiometric and atmospheric calibration or normalization between multi-temporal images;
iii. Selection of the same spatial and spectral resolution images if possible

A good change detection study should provide the following results;
i. An identifiable area of change and change rate
ii. Spatial distribution of change types
iii. Change trajectories of land-cover types
iv. Accuracy assessment of change detection results

Since the launch of the first Landsat Satellite system in 1972, a wide range of data have been provided. The availability of a large archive of data leads to the development and evaluation of many change detection techniques and methods for analyzing and detecting LULC changes [4].

[10] categories change detection method into *pre-classification and post classification change detection techniques.* He described the ***pre-classification techniques*** also as binary change or non-change information detection techniques that directly use the multi-temporal satellite imageries to generate change vs. no-change maps. Many techniques in pre-classification category include Image Differencing, Improved Change-Vector Analysis, Band Image Differencing, RGB-NDVI, Spectral Change Vector Analysis, Principal Component Differencing, Change

Vector Analysis, etc. the basic premise in these techniques is measuring the nature of changes, which implies that change in the feature of interest that will result changes in reflectance value. They are identified as the most accurate change detection techniques because they are straight forward, effective for identifying and locating change and are easy to implement. However, three aspects are critical to pre-classification techniques: selecting suitable thresholds or Vegetation Index to identify the changed areas, being sensitive to mis-registration of pixels and they cannot provide details of the nature of change or provide a matrix of change information.

The ***post classification technique*** has been proved to be one of the most popular approaches in change detection analysis. This approach is based on rectification of more than one classified image; where it involves the classification of each of the images independently, and then the thematic maps are generated, followed by a comparison of the corresponding labels or themes to identify areas where change has occurred. The advantages of this technique is that it minimizes sensor, atmospheric, and environmental differences because data from two dates are separately classified, thereby minimizing the problem of normalizing for atmospheric and sensor differences between two dates and it provide complex matrix of land cover change when using multiple image. Main technique in the post classification category is maximum likelihood supervised classification [10] [8].

[20]categorise change detection techniques as follows;

1. Algebra Based Approach: The algorithm used in this approach as common characteristics, i.e. selecting threshold to determine the changed areas. This methods (excluding CVA) are relatively simple, straightforward, easy to implement and interpret but these cannot provide complete matrix of change information. The methods in this approach include image differencing, image regression, image ratioing, vegetation index differencing and change vector analysis.
2. Transformation of data sets approach: The methods in this approach include Principal component analysis (PCA), Tassled Cap, Gramm-Schmidt and chi-square.
3. Classification Based Approach: The methods in this approach include post-classification comparison, Spectral-Temporal combined analysis, EM transformation, Unsupervised change detection, Hybrid Change Detection, Artificial Neural Networks (ANN)
4. Advanced Models: The methods in this approach include Li-Strahler Reflectance Model, Spectral Mixture Model and Biophysical parameter method.
5. GIS Approach: The method in this approach is mainly the integrated GIS and RS approach.
6. Visual Analysis: This is mainly the visual interpretation approach.
7. Other Change Detection Techniques are measure of spatial dependence, knowledge-based vision system, area production method, combination of vegetation indices, land surface temperature and spatial structure, change curves, generalized linear models, curve-theorem-based approach and spatial statistics-based method.

All the afore-mentioned techniques have their own advantages and disadvantages. Some of the most commonly used change detection methods are discussed in the subsequent sections.

3.1 Image Differencing

Image differencing is one of the most widely used to determine changes between images, and has been used in a variety of geographical environments. The difference between two images is calculated by subtracting the imagery of one date from that of another, and generating an image based on the result, and generating an image based on the result. The subtraction results in large positive or negative values in areas of radiance change and values close to zero in areas of no change. A critical challenge of this method is deciding where to place the threshold boundaries between change and no change pixels. This method is also sensitive to mis-registration and mixed pixels. To obtain good result, the two images must first be aligned so that corresponding points coincide. The complexity of image pre-processing needed before differencing varies with the type of image used.

$$ID\ (TMi) = TMi(t_1) - TMi(t_2) \ldots\ldots\ldots\ldots\ldots.. (1)$$

3.2 Principal Component Analysis (PCA)

PCA is often as accepted as an effective transforms to derive information and compress dimensions. Most of the information is focused on the first two components. Particularly, the first component has the most information. The difference of the first PCA component of two dates has the potential to improve the change detection results, Lu, et al (2005)

$$PCA= PC1\ (t_1)–PC1\ (t_2) \ldots\ldots\ldots\ldots\ldots.. (2)$$

The change detection is implemented based on thresholds.

Principal component analysis is a technique used extensively in remote sensing images analysis in application well beyond that of change detection. PCA has been used for determining the intrinsic dimensionality of multi spectral imagery, data enhancement for geological application, and land cover change detection. This method is often used to reduce the dimensionality of the data without reducing its overall information content. However, estimation of the PCA projection from data has its own limitations. Its computational complexity makes it difficult to deal directly with high dimensional data, like satellite images. Secondly, the number of examples available for the estimation of the PCA projection is typically much smaller than the ambient dimension of the data and this can lead to over fitting of the projection.

3.3 Post Classification Comparison

Post classification comparison is the most intuitive methods of change detection, is GIS overlay of two independently produced classified images. The post-classification comparison can be used to identify not only the amount and location of change, but also the nature of change. The method can produce from-to information [10]. However, the accuracy of the change detection is highly dependent on the accuracy of the classification result. The method reduces the need to perform geometric and atmospheric corrections [8] [10]. Post-classification comparison is made on classified images. [21] suggested that post classification is often considered a priory to be the superior change detection method and is therefore, used as the standard for evaluating the results of other methods. However, every inaccuracy in the individual data classification map will also be propagated in the final change detection map.

Therefore, it is imperative that the individual classification maps used in the post-classification change detection methods be as accurate as possible. In-addition to these the image classification stage of this method takes a long time because the accuracy of the classification needs to be high to get a good change detection result. [10]. The advantage of post-classification comparison is that it can provide from-to information which helpful to differentiate which land cover or land use class is changed to another class.

3.4 Change Vector Analysis (CVA)

This is a change detection procedure that is a conceptual extension of image differencing. Two spectral variables (e.g., data from two bands, two vegetation components) are plotted at dates 1 and 2 for a given pixel. The vector connecting these two data sets describes both the magnitude and direction of spectral change between dates. A threshold on the magnitude can be established as the basis for determining areas of change, and the direction of the spectral change vector often relates to the type of change [5].

CVA generates two outputs: a change vector image and a magnitude image. The spectral change vector explains the direction and magnitude of change from the first to the second date. The total change extent per pixel is calculated by determining the Euclidean distance between end points through dimensional change space of CVA is its ability to process any number of spectral bands required and to obtain detailed information on any detected change [22]

A particular advantage of the change vector analysis method is the potential capability to process any number of spectral bands desired. This is important because not all changes are easily identified in any single band or spectral feature. Nevertheless, since no effective method has been developed to handle more than two spectral bands [18]

3.5 Image Ratioing

Image ratioing is another method for change detection in which two images from two dates are divided band by band and pixel by pixel. If the ratio of two images is equal to 1, then no change has occurred, but if the ratio is greater than or less than one that means change has occurred. A threshold needs to be decided. The common way for deciding this has been to set a threshold value and then evaluating the change detection. Image ratioing produces images with a non-gaussian distribution of pixel values are if a threshold is decided based on standard deviations from the mean, the change will not be equal on both sides. This feature of image ratioing has been criticized [23] [10]. One of the most common ratio is called Normalised Difference Vegetation Index (NDVI) is (NIR-RED)/ (NIR + RED) or simplified as NIR/RED. The advantage of image ratioing is that the effect of different sun angles, shadows and topography is reduced, the disadvantage is the non-gaussian distribution of the ratio image making threshold selection difficult [10].

IV. CONSIDERATIONS FOR CHOSEN CHANGE DETECTION TECHNIQUES

It is not an easy task to determine the most appropriate method of detecting changes in a particular area under study. This is because of the varying nature of the physical characteristics of the features of interest, problems with image registration, cloud/haze detection, sensor anisotropy or hysteresis, advantages and disadvantages of change detection methods themselves and lack of knowledge about approach [4]. Generally speaking, to select a suitable method of detecting change is very significant because there is no single method that can be efficiently applied to all study areas. Selection of an appropriate change-detection technique, in practice, often depends on the nature of the change detection problem under investigation, which considers a critical step in change detection studies, the requirement of information, application, the data sets availability and quality, time and cost constraints of the data sets, analysis skill and experience, and registration of multiple image data sets [22].

Regardless of the technique used, the success of change detection from imagery can be affected by many factors: the quality of image registration between multi-temporal images, the atmospheric conditions, acquisition times, illumination, viewing angles, soil moisture, noise, shadow present in the images, vegetation phenological variability or differences, sensor calibration. [5] reiterated that in addition to the landscape and topography characteristics of the study areas, analyst's skill and experience, selection of the change detection technique, besides, the different steps during the implementation of change detection procedure that can produce problems and errors and affect the success of change detection, for example, image pre-processing [10] [8].

V. CONCLUSION

Detecting and analysing LULC changes by using remote sensing satellites can be done through a process commonly called ‘change detection’. Since launching the first of the Landsat satellite system in 1972, a wide range of data has been provided thus lead to the development and evaluation of many digital change detection techniques for analysing and detecting LULC changes. Pre-classification and post-classification change detection techniques are identified among many other categories. Most of the pre-classification techniques are identified as the most accurate change detection techniques because, they are straight forward, effective for identifying and locating change and are easy to implement. While the post-classification comparison technique has been proven to be the most popular approach in change detection analysis because of there are several advantages to this technique: it minimizes sensor, atmospheric, and environmental differences and it provides a complete matrix of land cover change when using multiple images. For many researchers in the field of remote sensing is not an easy to determine the most appropriate method of detecting LULC changes in a particular area under study because of the varying nature of the physical characteristics of the features of interest, problems with image registration, cloud/haze detection, sensor anisotropy or hysteresis, advantages and disadvantages of change detection methods themselves and lack of knowledge about approach.

In summary, there are many considerations that are important for most of researcher in the remote sensing field which are considerations about remote sensing systems and environmental characteristics must be satisfied. These include geometric and registration of multi-temporal images, radiometric and atmospheric calibration or normalization between multi-temporal images, and similar phonological states between multi-temporal images. There is also the need to consider the selection of the same spatial and spectral resolution images if possible as well as understanding the major steps of image processing in order to reduce errors or uncertainties in each step.

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