REFLECTION VALUE BASED MINERALS COMPOSITE ANALYSIS USING SATELLITE IMAGERY

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Abstract: Now a days Mineral composite analysis using satellite imagery is widely used with remotely sensing techniques to development the Agriculture. To examine the mineral composite can be used to identify the spatial distribution. This Study is used to classify clay, iron oxide and ferrous minerals in Kiliyar Basin, in this Basin located in North Tamil Nadu in an around of 914.45 km2 in South India. Satellite Images were processed using ERDAS imagine application, and the following tools used are briefly described the results of Mineral Composite index maps were summarized in seven classes by using 'natural breaks' classification method in GIS. This study is used IRS P6 LISS III in the year of 2002 and IRS P6 LISS IV Mx in the year of 2012 with Soil Map in the year of 2010 dataset. In generally, the method is used to identify the minerals using reflection values. The results interpretation separated using reflection based method in to seven index classes have been interpreted into five categories: rare, very rare, medium, high, and very high. The mineral composite maps indicated that clay minerals are predominant throughout the study area with very small concentration of ferrous minerals and iron oxides, which would indicate that the clay minerals may be less chlorite, bentonite, kaolin or illite throughout the study area.

Keywords: Remote Sensing, GIS, Minerals, Index Map, Satellite.

Introduction: Mineral has with own properties. The minerals are multifaceted of two or more elements; some minerals are made up of a single element. Copper, Silver and Gold are called local elements are obtained naturally is a purified form. Minerals have an orderly crystalline structure; this means that the atoms or irons that make up a mineral are arranged in an orderly and repetitive manner. The huge majority of minerals are compounds or mixtures of elements. There are about several minerals on earth depending on the ground truth natural resources. Each one is a unique substance with its own chemical formula. Most of these are very rare. That narrows down the study region somewhat a bit. There are only three groups of minerals that are common in study region. They are Ferrous Minerals, Iron Oxide and Clay Minerals During the period 2002 to 2012 the water levels for the Kiliyar sub basin decreased considerably due to insufficient arrival of water from Palar basin along with persistent to evaporation. The transformation rates that remained at 8 mm/day in winter and 35 mm/day in summer, which results in negative storage in the Kiliyar basin [07].

Using Remote Sensing and Geographical Information System [3] were able to calculate an annual average of 2.5 meters/year a constantly reduce in the water level in Kiliyar river basin for years 2002 to 2012, with Kiliyar basin being located in a depression. That creates a classified as in background for the Kiliyar region in which the flow of water is limited to evaporation and transpiration, which is instability and water coming from Palar river basin as influx. The high evapo transpiration rates cause an increase day to day in the salinity (in the river at Walajapet and Ranipet) of the water that precipitates evaporates when saturation levels are reached [2,07,22]. Also, evaporated minerals can be deposited within the salt flat muds called sabhka [22]. With decreasing water levels, the evaporate deposition has increased since 2001 in the Kiliyar area [3].

The soil chemical composition changed throughout the Kiliyar sub basin, which is less noticeable in Indian Remote Sensing images compared to water level and vegetation presence. However, soil chemical composition change is very important because it affects the quality and quantity of agriculture production. Important constituents of agriculture soil are clay minerals and iron containing minerals.

Clay minerals are structurally complex hydrous phyllosilicates that have a diameter of 5μm [26,5]. Clay minerals can retain moisture and plant element nutrients effectively due to their high porosity, low hydraulic conductivity, and high capillary force, which result in higher field capacity and wilting point [1,5]. As a result, clay content in soil is crucial for plant and productive agriculture [5]. Furthermore, iron is an important constituent in soil since it plays a vital role in chlorophyll synthesis and growth of plants [5,15,19]. Soils with poor iron content result in chlorosis of plants, which is the yellowing of the leaves with green veins that suppresses full development of plants [5,15].

In Remote Sensing, a tool for identifying mineral composite in an image can be used to identify the spatial distribution of ferrous minerals, iron oxides, and clay minerals. The spatial distribution of these minerals is important for environmental and agricultural modeling studies that can be performed using geographic information systems and remote sensing [5]. Utilizing remote sensing and geographic information systems, scientists were able to apply the tools successfully in assessing the following: mineral composition of Kiliyar Basin in North Tamil Nadu [5], salt affected soils [09], and rocks [18]. The main goals to develop present the spatial distribution of mineral composite of the Kiliyar river region for 2012, and quantify the difference in the mineral composite over area from 2002 to 2012 for Kiliyar region depression. The produced maps will be an excellent guide for environmental and agriculture decision making.

Study Area Analysis: Main part of the study area is in the eastern part of Tamil Nadu, between Latitude (12°41'9''N and 12°22'32''N) and longitude (79°53'26''E and 79°25'10''E) as shown in figure-1. The study area focuses on the eastern side that is 914.45 km2, which consists of the Lakes and small portion of Lakes. The lakes are located in the hyper arid zone, which receive precipitation once every decade [3]. The evaporation rates are 8 mm/day during winter and 35 mm/day during summer with a monthly overall average of 189.7 mm [07,3].

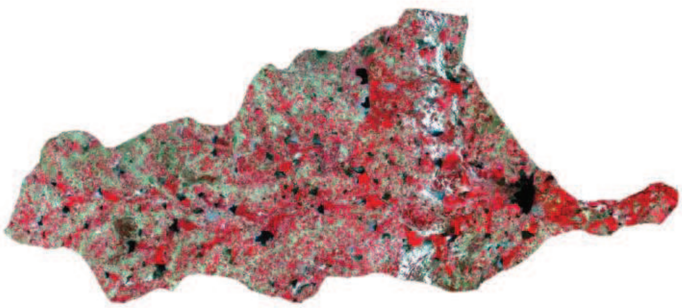

Figure 1: Location of the Study Area

Satellite Imagery Analysis: Images were processed using ERDAS imagine application, and the following tools used are briefly described. That image has individual color bands, which needed to be stacked into one image so that could perform my analysis. The images are collected with ortho geo cover attributes, and the geometric correction of the images has been tested using ground control points for lack of data. The stacked images were subset to attain the area of interest (AOI). Atmospheric correction was applied to the subset image to remove any noise that can be attributed to haze and higher solar luminosity. Atmospheric correction significantly increases the accuracy of image classification [8,13]. Normalized difference vegetation index (NDVI) analysis algorithm shown below in the table-1 was performed on the images to assist in distinguishing vegetation areas during the analysis process. Index maps for Ferrous Minerals, Iron Oxide, and Clay Minerals were created from the atmospherically corrected images and the related algorithms [5].

Table 1: Equations for the Indices, and Band Information

Indices	Mineral Types	Band Selection
Mineral Composite	Ferrous Minerals(FM) Iron Oxide(IO) Clay Minerals(CM)	band 5 / band 4 band 3 / band 1 band 5 / band 7
Transformed Normalized Difference Vegetative Index (NDVI)		$\sqrt{\frac{IR-R}{IR+R}+0.5}$
Vegetative Index		IR-R
Simple Ration		$\frac{IR}{R(TM4/TM3)}$
Root of sample ration		$\sqrt{\frac{IR}{R}}$
Band	**Wavelength (μm)**	**Spectrum**
Band 1 Band 3 Band 4 Band 5 Band 7	0.45 – 0.515 0.63 – 0.69 0.75 – 0.90 1.55 – 1.75 2.09 – 2.35	Visible (Blue) Visible (Red) Near Infrared Mid Infrared Mid Infrared

Developed index maps were reclassified in remote sensing applications using reflection based land cover method. Reflection method was used because the class boundaries are set where there are significant changes in data [5,17].

Imagery Band Selections: A methodology for optimizing selection of spectral bands for multispectral instruments such as those on the LANDSAT series of satellites is described. The method is applied to a collection of laboratory and outdoor spectra of natural and artificial materials. These reflectance spectra represent the visible and near-infrared spectral ranges at high (0.01-μm) spectral resolution. For most natural materials 15-25 spectral bands appear to be sufficient to describe spectral variability, whereas description of minerals and some artificial substances may require double this number of bands.

Three additive colors (i.e., red, green and blue) were used to display multispectral bands in the color composite method where the spectral response of the minerals indicates a maximum in their reflectance. This enhancement is achieved by combining bands in the visible and the infrared portion.

Figure-1 illustrated hydrothermal alteration areas showing deep green color of false color composites (RGB) of bands 4:7:2. The band ratio is a technique that has been used for many years in remote sensing to display spectral variations effectively. It is based on highlighting the spectral differences that are unique to the materials being mapped. Identical surface materials can give different brightness values because of the topographic slope and aspect, shadows, or seasonal changes in sunlight illumination angle and intensity. These variances affect the viewer's interpretations and may lead to misguided results.

The band ratios images are known for enhancement of spectral contrasts among the bands considered in the ratio operation and have successfully been used in mapping of alteration zones. From the theoretical knowledge of mineral's spectral properties, it is well recognized that the bands ratios of 3/1, 5/7, 5/4 are analyzed for iron oxides, Clay Minerals, ferrous Minerals, respectively.

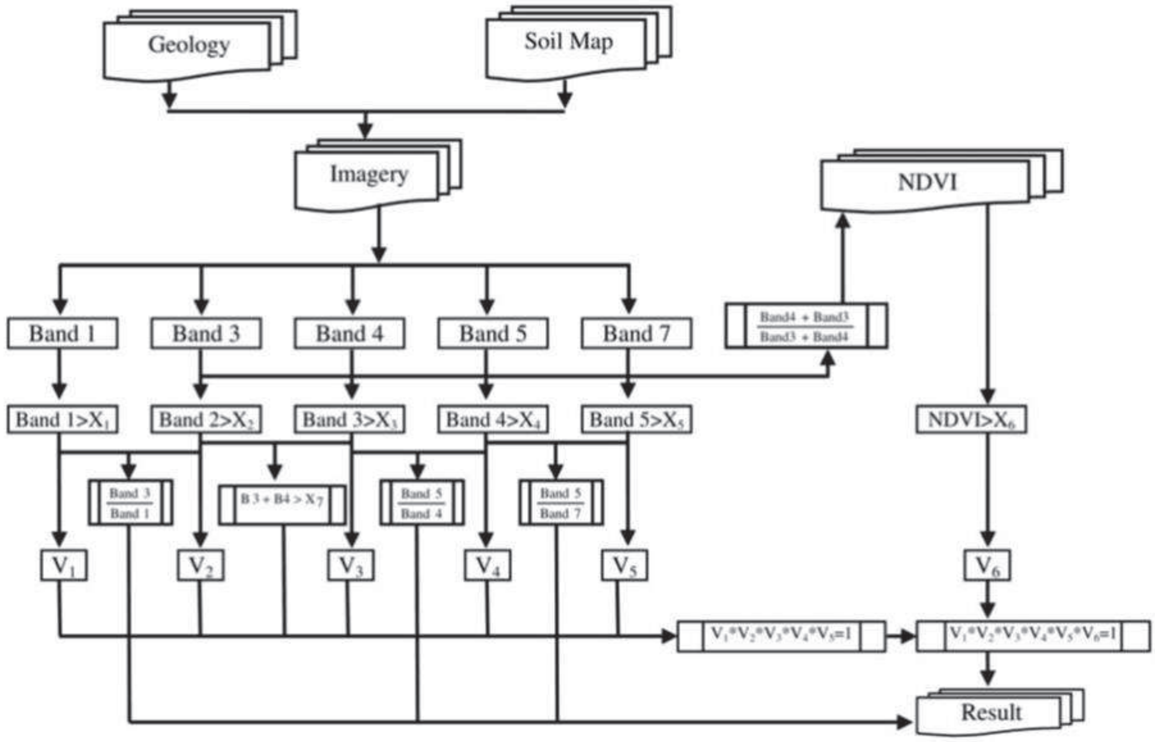

Figure 2: Methodology of Mineral Composite Analysis using Ground Reflection Values (RBMCA)

Reflection Based Mineral Composite Analysis Methodology: Two images are collected from research department, one image from February, 2002 was provided by IRS LISS III and second image from March, 2012 was provided by IRS LISS IV Mx. The method is used for the mineral composite analysis. The mineral composite analysis procedure developed in this study was named Reflectance Based Mineral Composite Analysis (RBMCA). Whose diagrammatic flowchart is presented in below figure-2. RBMCA was developed in the ERDAS Imaging Modeler Environment.

Initially, surface reflectance values for minerals during soil development were tested. Based on published spectral characteristics [10,14] of bands 3-5 of IRS P6 Liss III and Liss IV Mx imagery, mineral classification typically presents a standardize reflectance of about 5%, 50% and 21% respectively. It is because those reflectance values, usually available in literature, are averaged from standardized conditions and represent imagery at full pixel coverage over study areas. It is well known that in both drought and drought free years, well developed vegetation reflects just a little part of incident solar radiation in the visible band of spectrum, due to chlorophyll absorption properties and other plant pigments that absorbs sunlight. In the near Infra-Red plants reflect much more, due to a scattering effect caused by the internal structure of plants and water content [20]. Depending on the intensity of water deficit due to drought, seasonal heat waves or both effects coupled together, [15] it is possible that vegetation remains green for a time lag after the onset of water stress [12].

In this way, it is expected that bands 3 (red) and 4 (Near Infra-Red) do not retrieve detectable changes during this time lag. Additionally, reflectance at band 5 of IRS is closely associated to vegetation moisture [21] and therefore, its behavior through time needs to be more deeply investigated. However, it is also known to have the property of penetrating thin clouds due to wavelength size [25], which tends to be very useful in a mapping study and land use change. It became clear that the challenge is to find out those accurate reflectance values located at the lower limits of the spectral range (lower reflectance values) for each band, in a way that includes not only mineral pixel values at the normal conditions, but also under water deficit development or mixed pixels located at the border of study imagery. Those lower limits values were defined in this work as X1 min, X2 min, X3 min, X4 min and X5 min. The study region were mapped and selected by using false-color composition of bands (RGB-453).

Those minimum reflectance values for each band are also associated to the limits of border regions between full-pixel coverage. Pixels below R3 min are typically associated to cloud shadows or water bodies. Actually, it was observed at the study region that vegetation reflectance, even under different development conditions, stands lower than 0.07 in the red, band 3; stands greater than 0.42 in the NIR band 4; and stands greater than 0.18 in the Short-wave Infrared (SWIR) band, band 5. In terms of reflectance, these are crucial as input parameters to mineral characterization. For a given year available Liss III and LISS IV Mx imagery from the maximum development period were combined into the RBMCA method. In doing so, five computational steps were established in order to get the best use of Physically Driven Components (PDC) that rule agriculture spectral behavior in bands 3–5.

- Pixels with reflectance values that fall under the defined X1 min, X2 min, X3 min, X4 min, X5 min, X6 min were tagged as study region according to condition V1, V2, V3, V4, V5, V6 correspondingly
- Pixels which the reflectance are above the sum of bands 3 and 4 were tagged as study region according to condition V7
- Pixels with NDVI values which are above NDVI minimum were tagged as study region according to condition X5, in figure-2.

In the final step, all conditions are multiplied and a pixel that is representative of a study area must have the value one. In this procedure, a pixel will be automatically classified as mineral values if it adheres simultaneously to conditions X1, X2, X3, X4 and X5. By using mathematical Boolean rule, a pixel will be selected as paddy and groundnut if all conditions are simultaneously satisfied. Pixels with a calibrated reflectance that does not follow at least one of defined rules X1, X2, X3, X4 or X5, are selected, because they will study area. Additionally, all four conditions are modulated by NDVI values greater than 0.6 units in order to avoid background and/or cloud contamination that usually have high values of reflectance. Also, saturation effects of Normalized Difference Vegetation Index (NDVI) when Leaf Area Index (LAI) is greater than 3 can mask water stress.

Testing and Results: Land cover mineral mapping are based on the 2002 and 2012 analysis imagery with spatial distribution maps of FM, IO, and CM were developed, and using interpretation method the seven index classes have been interpreted into five categories: very rare, rare, medium, high, and very high. The scale for the five categories varies for FM, IO, and CM because the scale is based on the index values that are represented by the five equal sized data subsets, or quintiles. Based on the spatial distribution of FM, the concentrations are considerably low throughout the study area, and 99.96 % of the study area was assessed in a *very rare* category. Spatial distribution of IO was better than that of FM, in which 72.76 % of the study area was assessed in the *very rare* category, 17.01 % of the study area was assessed in the *very rare-rare-medium* category, 3.48 % of the area was assessed in *rare – medium* category, 3.33 % of the area was assessed in *medium - high* category, and 3.42 % of the area was assessed in the *high - very high* category. On the other hand, CM concentrations were much higher than that of FM and IO [06, 23].

Table 8.2. Ferrous Minerals for the Study Area along with the Interpretation of Classes

Class	Index Values		Cover Area km2	% of the Study Area	Interpretation	
	From	To			Category	% of the Study Area
1.	0	0.5	121.55	12.9323	Very Rare	99.964
2.	0.6	1.2	401.01	42.6645		
3.	1.3	2.1	416.47	44.3097		
4.	2.2	4.2	0.55	0.0578		
5.	4.3	6.9	0.18	0.0197	Very Rare	0.032
6.	7.0	11.5	0.12	0.0128		
7.	11.6	23	0.03	0.0032	Medium - High- Very High	0.003
Total			**939.91**	**100.00**		**100.00**

Table 8.3. Iron Oxide for the Study Area along with the Interpretation of Classes

Class	Index Values		Cover Area km2	% of the study area	Interpretation	
	From	To			Category	% of the study area
1.	0	4 .5	457.16	48.6386	Very Rare	48.639
2.	4.6	14.8	226.69	24.1185	Very Rare - Rare -Medium	41.129
3.	14.9	26.7	125.01	13.3002		
4.	26.8	36.2	34.87	3.7104		
5.	36.3	53.1	32.71	3.4802	Rare - Medium	3.480
6.	53.2	72.1	31.29	3.3286	Medium - High	3.329
7.	72.2	105	32.18	3.4235	High - Very High	3.424
Total			**939.91**	**100.00**		**100.00**

Table 8.4. Clay Minerals for the Study Area along with the Interpretation of Classes

Class	Index Values		Cover Area km2	% of the study area	Interpretation	
	From	To			Category	% of the study area
1.	0	0.3	125.87	13.3914	Very Rare	13.391
2.	0.4	0.7	9.60	1.0218	Very Rare - Rare	1.022
3.	0.8	0.9	45.61	4.8523	Medium	4.852
4.	1.0	1.1	252.19	26.8313	Medium - High	26.831
5.	1.2		256.36	27.2752	High	45.353
6.	1.3		169.92	18.0779		
7.	1.4	1.75	80.36	8.5501	High - Very High	8.550
Total			**939.91**	**100.00**		**100.00**

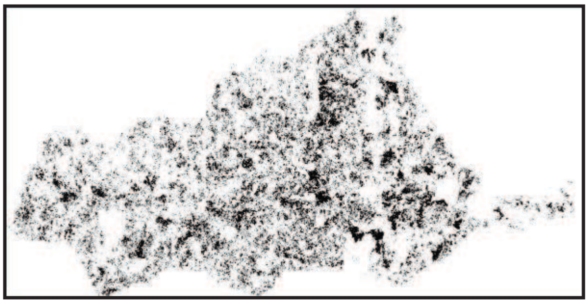

Figure 3: Ferrous Minerals Analysis

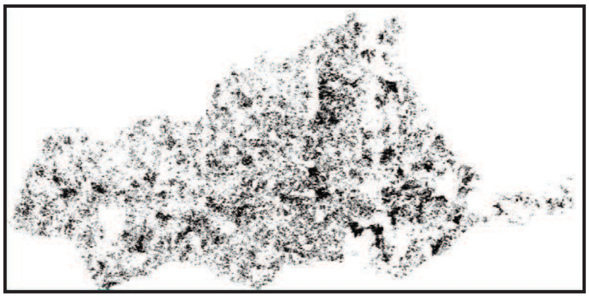

Figure 4: Iron Oxide Analysis

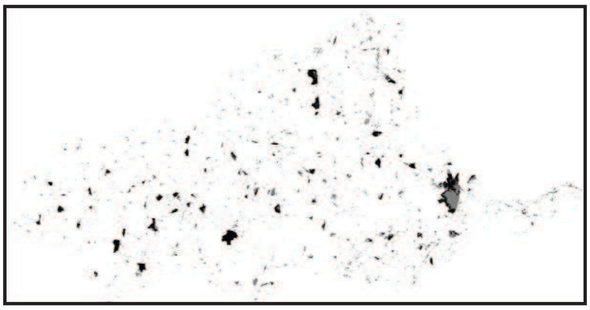

Figure 5: Clay Mineral Analysis

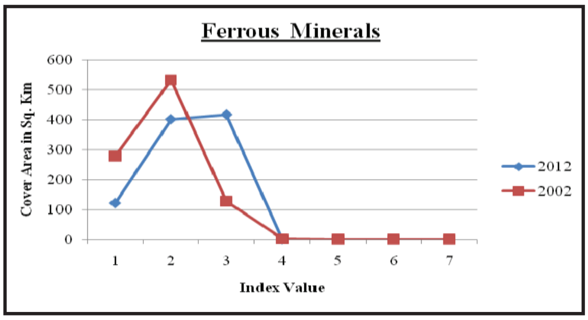

Figure 6: Ferrous Minerals Variation of Different Years of Study area

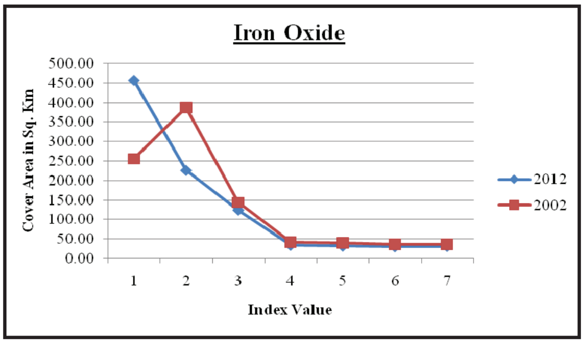

Figure 7: Iron Oxide Variation of Different Years of Study Area

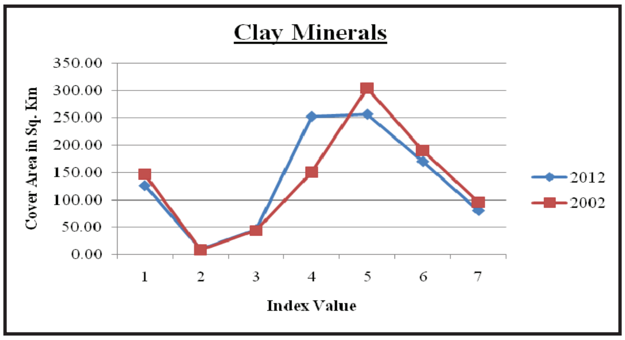

Figure 8: Clay Mineral Variation of Different Years of Study Area

The results for CM are: 13.39 % of the study area in very rare category, 1.02 % of the study area in the very rare - rare category, 4.85 % of the study area in the medium category, 26.83 % of the study area in the medium - high category, 45.35 % of the study area in the high category, and 8.55 % of the study area in the high - very high category. The concentrations of FM and IO have not changed as much from Feb 2002 image to March 2012 image, but the concentrations of CM have changed drastically from 2002 to 2012.

Land cover change indicates a successful rehabilitation of 772.5 km2 of barren land into water, vegetation, and potential agriculture land. However, with persisting droughts since 2002, there is an increase of evaporate deposits, which totaled to 492.56 km2. [3] suggest that Lakes water level will continue to reduce until it eventually vanishes by year 2020. In the process, the increase in the salinity in the lakes will harm the aquatic habitat that has been established, and the precipitation of evaporates will reduce the amount of potential agriculture land. Furthermore, the agriculture communities will not be able to use the surface water due to high salinity, and the groundwater from the palar basin will not be able to sustain the demand due to lower aquifer thickness in the area of study and also the higher saline water in the west will migrate to east, which would contaminate the water wells. The results for the mineral composite maps indicated that majority of the area has clay minerals but poor ferrous minerals and iron oxides. This indicates that the dominant clay minerals have low to no iron content, which would mean that the clay minerals could possibly be smectite, illite, kaolinite, or chlorite in the study area. This outcome was supported by a similar study by [5] in which mineral composition of the River Basin was assessed and results indicated that clay minerals had negative correlation with ferrous minerals and iron oxides.

Conclusion: Using IRS P6 Liss III and IRS P6 Liss IV Mx is used as a land use / land cover change for the Study area between February 2002 and March 2012 the result is calculated in which 49.20 km2 of additional lake water, 52.39 km2 of vegetation, 41.22 km2 of potential agriculture land, and 95.56 km2 of evaporite land cover area was generated. The mineral composite maps indicated that clay minerals are predominant throughout the study area with very small concentration of ferrous minerals and iron oxides, which would indicate that the clay minerals may be smectite, illite, kaolinite, or chlorite throughout the study area. The maps developed in this study are reliable to be used as guides in environmental and agricultural decision making, but they are not dependable for the modeling studies since the maps have not been verified with field data.

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