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Research Article

Analysis of Two Methods of Remote Sensing Applied to the Municipality of Palm Trees of Goiás (GO-BR)

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Abstract

Currently, agriculture already has studies of supervised analysis by remote sensing, since in the act of photosynthesis, the plants absorb electromagnetic radiation, this absorption varies according to the species and with the intensification of the crop. This work aimed to identify, map and compare agricultural areas of the municipality of Palmeiras de Goiás, through two methods of remote sensing, allowing the differentiation of agricultural areas, native/planted forests and pastures. To identify the possible areas of agriculture, livestock and native forests planted in the municipality of Palmeiras de Goiás, we proceeded to classify satellite images annually. In the image classifications, the remote sensing processes were used by supervised classification of false RGB color images and the NDVI vegetation index. The NDVI supervised classification and the composition of false RGB color showed accuracy in the results of 79.31% and 93.10%, respectively. With representativeness of 32% of agriculture by NDVI Index and 41.3% by the composition of false RGB color in land use. We conclude the need for continuity in the studies of remote sensing, both in agriculture and evaluated, as in the most diverse areas of activity of the same, because its demonstration of precision in the results is satisfactory and has demonstrating Increase in its use.

Keywords: *Agriculture Database; Supervised Classification; Images*

Abbreviations

Agropensa: Strategic Intelligence system of Embrapa; CIS: Crop Enhancement Index; IAF: Leaf Area Index; IBGE: Brazilian Institute of Geography and Statistics; INPE: Institute of Nacional Space Research; NDVI: Normalized Difference Vegetation Index; RGB: Red Blue Green; SGBD: System of Management of Bank of Data; SIG: System of Information Geographical; SR: Sensing Remote; URSS: Union the Republics Socialists Soviet

Introduction

The SR is directly linked to the evolution of physics, which has been embracing since 1672 with the development of the theory of Light by ISAAC Newton, passing through the invention of photography, development of equipment for radiometry sensitive to infrared radiation, Development of space vehicles where it was the beginning of the launches of satellites and digital photographs of the area, and is improving each day, with more satellites and better resolutions [1].

Sausen and Solar [2] explain that remote sensors have three levels of data collection, soil, air and orbital, divide into imagers and non-imagers, which make their statement in tables, graphs and others, and also divide into Passive and active sensors, which require external radiation and those emitting their own radiation, respectively.

Today, agriculture presents studies in supervised analysis by remote sensing, because in the realization of photosynthesis happens the process of absorption of electromagnetic radiation, varying according to species and intensification of the culture. These absorptions reflect on the images captured by satellites, enabling the elaboration of maps and data, thus being possible the development of studies of agriculture by SR.

According to IBGE [3], agriculture has increased significantly in recent years, according to Agropensa in the last 40 years, the country has gone from importer to one of the leading food exporters to the world, with notoriety in Rice, maize and wheat crops, with an increase of 317%, 270% and 346% respectively, in addition to beans and soybean, which doubled their yields.

Among several scholars of the relationship Agriculture X remote Sensing, INPE has developed researches aimed at identifying and mapping agricultural areas, Motta., . [4] presented the work titled Verification of the accuracy of the estimation of Area cultivated with soybean by digital classification in Landsat images and in 2007 the Brazilian Agricultural Research magazine published the work of Rizzi and Rudorff [5], titled Images of THE MODIS sensor associated with an agronomic model to estimate the Soybean yield, both work performed soybean yield analysis by images of SR.

Geoprocessing is a comprehensive area and has been gaining prominence and studies, however, its use is already very frequent in several areas such as the development of remote sensing in agriculture. This has been improving its potentials and advancing its studies in the characterization of the development of crops and land use, aiming to improve the cultivated areas serving both producers and consultants.

Aim of the Study

This work aims to identify, map and compare agricultural areas of the municipality of Palmeiras de Goiás, through two methods of remote sensing, allowing the differentiation of agricultural areas, native/planted forests and pastures.

Materials and Methods

Palm trees of Goiás

Palm trees of Goiásis a municipality located in the state of Goiás, Brazil, focuses on the South Goiano mesoregion, in the microregion of the Vale do Rio dos Bois, and its territorial boundary is Nazário to the north, Cezarina and Indiara to the south, Campestre de Goiás to the east and Palminópolis in the West (Figure 1). It had a population index of 23,338 people in the 2010 census, with an estimate for 27,304 people for 2017. With an area of 1,539,683 km^2 the population density of the city is 15.15 inhabitants/km^2. The municipality of Palmeiras de Goiás has a GDP of R $359,001,499,000 and GDP per capita of R $16,060.55 [3].

The agricultural sector is the largest contributor to the municipal economy, in the agricultural census of IBGE was registered 1,512 agricultural establishments in the municipality, and having prominence in the production: corn grain 78,609.670 tons; Forage maize 17,673.780 tonnes; Soybean grain 96,886.300 tons; Sorghum grain 24,763.340 tons; Forage sorghum 2,156.120 tonnes and tomato wedges 30,072.600 tonnes. In livestock, there were 114,354 heads in the bovine herd, being 12,347 milk heads and generating 29,034.312 liters of milk x1000; 241.490 dozen eggs x 1000 and 13,127 Pigs Heads (IBGE).

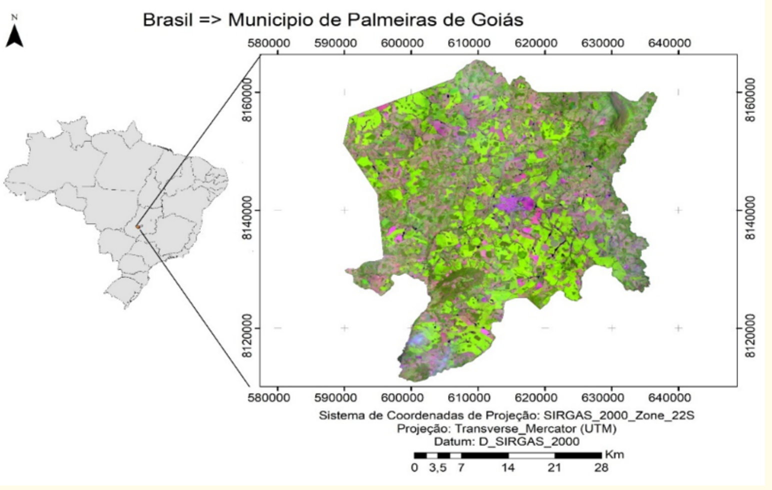

Figure 1: *Map of municipality of palm trees of Goiás formed by join of false colors in the RGB index.*

Data collection

To identify the possible areas of agriculture, livestock and native forests planted in the municipality of Palmeiras de Goiás, we proceeded to classify satellite images annually. In the image classifications, the remote sensing processes were used by supervised classification of false color RBG and NDVI.

The process of supervised classification RGB and by means of the NDVI index was performed in the year 2017, characterizing the occupations of the land of the municipality of Palmeiras de Goiás. For this, we used images of LANDSAT 8 satellites, obtained in the image catalogue of INPE- Http://www.dgi.inpe.br/catalogo. The image was selected according to the visibility of the area of the municipality, and in order to cover the Orbit 222 and the point 72, giving priority to images obtained between the months of January to April.

Data processing

With the acquisition of the image bands, the selection of the files/bands was initiated in the Medium Infrared range (band 5), the Near infrared (band 4) and the Red (band 3) of the electromagnetic spectrum. The procedures of image processing, the final edition of the maps and verification of the quality of the classifications was performed in the software arqgis 10.5.

In the processing of the supervised classification was employed an algorithm called "Maximum Likelihood" that uses 3 bands of the spectrum combined in a false RGB color image, in the case of this study, the combinations were of bands 5, 4.3 that allow To expose more clearly the boundaries between soil, vegetation and water [6].

In maximum likelihood, the classification of the image occurs from samples of color patterns, textures and shapes, previously selected for each desired class, being applied subsequently in the whole image. This method seeks to establish the maximum similarity between the sampled points and the other points of the scene or image. The vegetation cover and soil use classes were agricultural areas, pasture areas, native and planted forest areas and urban areas.

The NDVI vegetation index is an application of the processes used to estimate plant cover and in the detection of changes in pattern of land use and cover. The procedure consists of the application of enhancement in the vegetation by mathematical operations between bands, according to the equation described by Jensen (1996):

$$NDVI = \frac{(NIR - R)}{(NIR + R)}$$

Where:

NDVI is the normalized difference vegetation index;

NIR is the reflectance at the wavelength corresponding to the near Infrared (0.76 to 0.90 μm);

R is the wavelength reflectance corresponding to red (0.63 to 0.69 μm).

In the case of LANDSAT satellites, the wavelength of red and near infrared correspond to bands 3 and 4. These wavelengths are chosen due to the chlorophyll of the vegetation to perform a marked absorption in the region of the red (0.63, 0.69 μm) and reflect an intense energy in the near-infrared region (0.76 - 0.90 μm) caused by the cellular structure of Leaves.

The result of NDVI processing is values that fluctuate from-1 to + 1. The closer to 1, the higher the density of the plant cover and the other end (-1) represents areas or pixels with no vegetation, being more common to find this value in areas occupied with water. In the case of not very high positive values, there are usually bare soil without vegetation, or with care and sparse vegetation, and the presence of clouds the value of Ndvi is zero. To transform the NDVI values into the work wish classes, the generated image was also subjected to the supervised classification process, but not using a false color image and yes, the resulting NDVI image.

To standardize the classification process was performed for the current period (2017/2018), a classification based on information from parts of the points raised in the field of different types of land use, that is, this classification was performed by proceeding a "Calibration" and its result was also compared with points raised in the field, "Validation".

The field survey was initiated by obtaining georeferenced points of agricultural areas (cotton, rice, corn and soybean), pasture areas and native forest areas and planted in the municipality of Palmeiras de Goiás. The points were raised using GPS, numbered and characterized according to the type of vegetation present in the area. A total of 58 points were collected (Table 1), distributed more evenly among the types of vegetation specified in the work.

58 different points were marked, 24 of agricultural areas, 20 points of native and/or planted forests and 14 pasture points, thus designating half of the points marked for each agricultural specificity for calibration and the other half for validation. It is noteworthy that, we sought to select the points with areas larger than two hectares, in order to minimize the effects of spatial resolution in addition to facilitating the obtaining of points of reference in the classification, also the same points were used Calibration for both, since the larger the more precise areas of reference is the calibration, thus qualifying validation to the MayR possible success.

Nº	Feature	Nº	Feature	Nº	Feature	Nº	Feature
1	Agricultural area	16	Agricultural area	31	Forest	45	Pasture
2	Agricultural area	17	Agricultural area	32	Forest	46	Pasture
3	Agricultural area	18	Agricultural area	33	Forest	47	Pasture
4	Agricultural area	19	Agricultural area	34	Forest	48	Pasture
5	Agricultural area	20	Agricultural area	35	Forest	49	Pasture
6	Agricultural area	21	Agricultural area	36	Forest	50	Pasture
7	Agricultural area	22	Agricultural area	37	Forest	51	Pastures
8	Agricultural area	23	Agricultural area	38	Forest	52	Pasture
9	Agricultural area	24	Agricultural area	39	Forest	53	Pasture
10	Agricultural area	25	Forest	40	Forest	54	Pasture
11	Agricultural area	26	Forest	41	Forest	55	Pasture
12	Agricultural area	27	Forest	42	Forest	56	Pasture
13	Agricultural area	28	Forest	43	Forest	57	Pasture
14	Agricultural area	29	Forest	44	Forest	58	Pasture
15	Agricultural area	30	Forest				

Table 1: *Table of points raised distinguished its characterizations.*

Results and Discussion

Composition by NDVI index

In the use of the NDVI vegetation index to compare the occupations of the different agricultural areas, a map was generated (Figure 2) with color reflectance from-1 to 1, where it was colored for the facilitation of identification and variation of the reflected colors, since, This is an option of the software used because the image generated by the NDVI varies in scale from black to white. Subsequently the preparation of the map, were identified the calibration points collected with THE GPS, and demarcated in polygons the representativeness in color of each area, thus training THE NDVI Vegetation index for recognition and classification Maximum likelihood of the similar areas (Figure 3), in which a recognition caption of the areas to be analyzed in the validation process was generated.

To verify the satisfactory utilization of the NDVI vegetation index, the validation points represented in figure 4 were analyzed, which were arranged on the map and then analyzed on the identification Coherent area of demarcated areas.

In studies, the NDVI vegetation index reached a result of 79.31% of satisfaction to the recognition of the marked points, and in the agricultural areas we reached the exact physiological of 100% of correct answers, the Unidentified points are related to 4 points of planted/native forests and 2 pasture points, being identified in table 1 by the numbers 35, 36, 38, 43, 55 and 56 respectively, thus registering a hit of 60% planted/native forests and 71.43% in pasture areas.

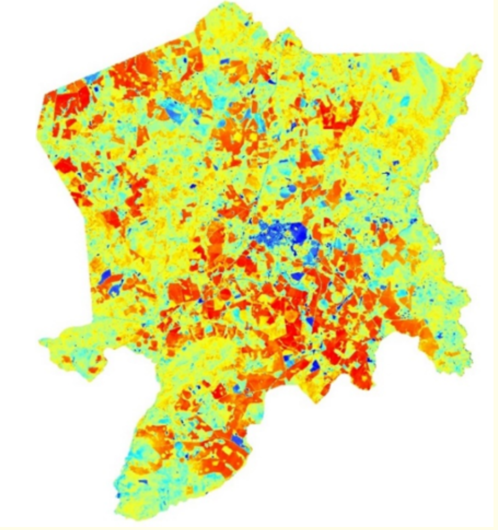

Figure 2: *Map generated by composition of index of vegetation NDVI.*

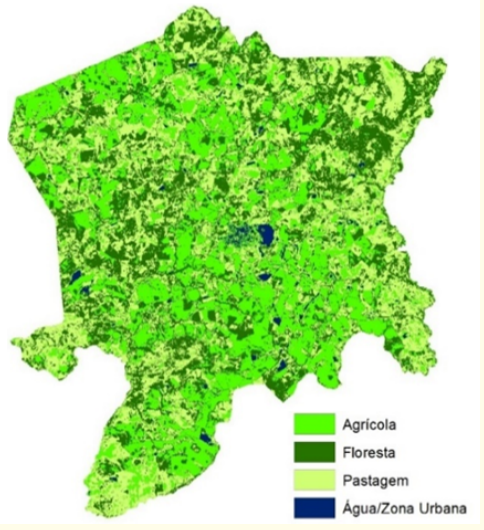

Figure 3: *Map e legend generated by classification supervised of maximum verisimilitude through of index NDVI.*

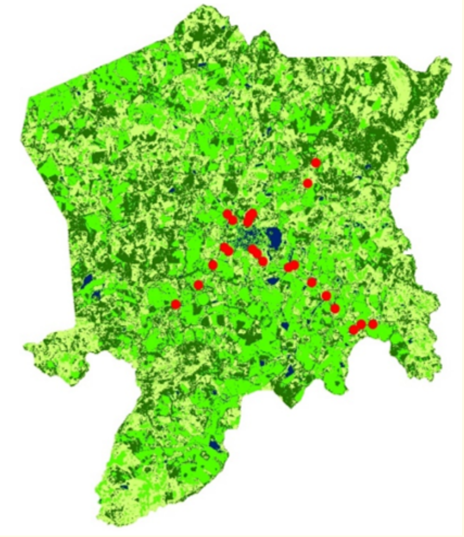

Figure 4: *Points of validation willing no map generated by index of vegetation NDVI.*

According to the classification developed by the NDVI index data were generated for quantification of land use QUE are expressed in table 2, with the amount of land used and its relative percentage, according to the analyses through Of the NDVI vegetation index, the preserved forest represents a total of 31% of the municipality, reached a percentage above the mandatory preservation area, which represents a total of 20% of the demarcated area of the municipality.

NDVI Classification Table		
Filed	**Area**	**%**
Agricultural	497350,8	32%
Forest	474249,6	31%
Pasture	540304,2	35%
Water/urban Area	27036,9	2%

Table 2: *Classification of Use of Earth by Index NDVI.*

Composition by false RGB color

The map depicted in figure 5 is the result of the combination of images of false RGB colors composed of bands 5, 4 and 3, according to the reference of the captured satellite, The map was generated when the images were triggered by command in the Software. After the differentiation of the formation of the map, the NDVI index and the composition of false RGB color follow the same parameter to perform the supervisory classification of maximum likelihood.

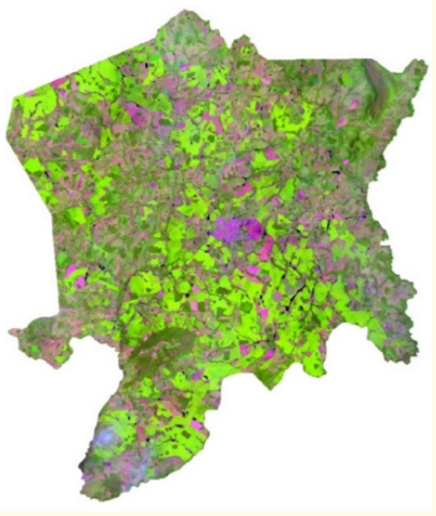

Figure 5: *Map generated by composition the bands RGB.*

After the production of the map by false RGB colors, the calibration was performed, previously described method, which resulted in a new map through the classification of maximum likelihood with specific staining in each type of soil use, thus generating A representativeness caption for identification of the areas in analysis (Figure 6). After that, the validation points of the method under study were arranged on the current map (Figure 7), so that there would be the qualification of the points determining the ability to adequately classify the demarcated areas.

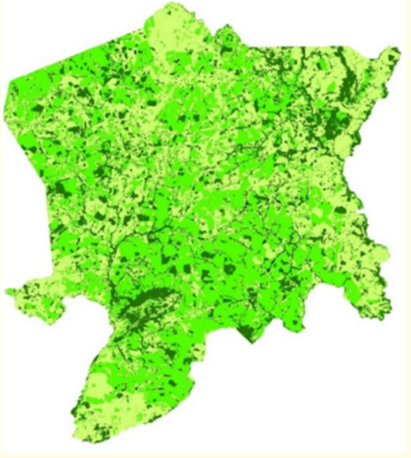

Figure 6: *Map and subtitle generated by classification supervised of maximum verisimilitude through of composition of false color RGB.*

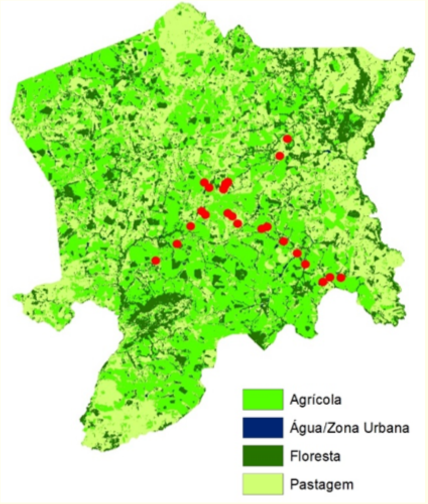

Figure 7: *Validation points wrapped over the map generated by the images of false RGB colors for qualification of the demarcated areas.*

The composition of false RGB color presented 93.10% success in the classification of land use areas, similar to the NDVI index, totaled a percentage of 100% in the agricultural areas. While in the forest and pasture areas there was no recognition of two points, being one point in each area. The unverified point of the pasture, represented by the position 55 in the table of characteristics, also presented variation in the NDVI index, however, the unvalidated point of the forest area was altered to the others of the NDVI index, represented by the position 37 of the table 1, thus totaling a percentage of accuracy of 90% in planted/native forests and 85.71% in pastures. The maximum likelihood rating of RGB generated data from Quantification of Land Use, shown in table 3, with the amount of the area used and percentage referent, Second the analyses through the images of false color, the forest pre-Bovicola represents a total of 18.2% of the municipality, thus, not reached the percentage certain preserved area.

RGB Classification Table		
Filed	**Area**	**%**
Agricultural	635265,9	41,3%
Forest	280536,3	18,2%
Pasture	617931,9	40,2%
Water/urban Area	5207,4	0,3%

Table 3: *Classification of soil use by RGB*

Discussion

Fitz [6], claimed the reflected colors of the objects are according to the wavelength emitted by the same, this occurs according to the proportion of radiation absorbed or reflected by the same. This allegation is evidenced when we issue the relation of the images of the NDVI index and the composition of images of false RGB color, since the areas were duly classified with considerable hit value, this, due to the fact that the type of land use emitted a Similar reflectance, varying according to the area of agriculture, forest and pastures, regardless of the location they are located.

Maciel [7] states that remote sensing in agriculture is able to perform the activity of surveying and characterizing soils or identifying and mapping different cultures. With the results obtained in the present study, the credibility of larger, better and more detailed studies is given, always aiming at improving agriculture, with more precision and increased productivity, considering the results achieved by the analyses of NDVI index and the composition of false RGB color, the satisfaction of the use of SR in agriculture is declared according to the statement cited.

Ponzoni., *et al*. [8], emphasized that the interaction between electromagnetic radiation and vegetation occurs by the realization of photosynthesis, which is a mechanism based on the absorption of electromagnetic radiation through photosynthesizing pigments. When the present work is related to this statement, we investigate its total truthfulness, since, areas with greater intensification of plants, thus, higher occurrence of photosynthesis, the absorption was proportionally higher, highlighting the large areas And forests, which showed more intensified colors even before the supervised classification.

The process of interaction between electromagnetic radiation and vegetation is explained by Ferreira., *et al*. [9], based on the fact that the energy reflected in the red and near infrared is directly related to the photosynthetic activity of the vegetation, as well As in the assumption that the use of two or more spectral bands can substantially minimize the main sources of noise affecting the vegetation response. Based on this statement, it is evident that the compositions of the spectral bands used for the formation of the images studied had great responsibility in the excellence of identification of the areas.

Florenzano [10], highlights that the multi-temporal aspect of satellite imagery allows us to monitor the changes that occur, providing its monitoring over time and registering them in maps, allowing its use in agriculture activities Precision. With this characterization, it is evident the ability to control and improve agriculture through SR, considering the results shown, can still complement the author's argument, declaring the functionality of the current s software Capable of assisting in the studies of the area, since they play, convincingly, the analyses with an equivalent percentage.

Satellites present an average magazine period of 17 days, the satellite used was Landsat 8, which fulfills the period in 16 days, similarly to Landsat 5, which is also widely used. Even with this interval of days to obtain new images, it is possible to continuously evaluate the development of crops and through analysis to estimate the productivity, Almeida., *et al*. [11] declared this when he stated that a great use of the SR is already present. Soybean crops in the present day.

With images of Landsat and without the use of supervised classification, Motta; Fontana and Weber [4] estimated the prediction of large-scale soybean crops on a regional scale, in which the obtained result was declared efficient. Comparing to the cited work, although there were no separately referenced agricultural crops, the result was of almost exact precision in the separation of the areas, however, both assessments concluded the analyses in 100% of identification of the areas Agricultural.

Rizzi and Rudorff [5], estimated soybean yield in the harvests from 2000/2001 to 2002/2003 in Rio Grande do Sul, concluding an objective and quantitative evaluation of the effect of meteorological conditions on soybean yield, using IAF values Estimated from the MODIS sensor images of the TERRA satellite. Based on this work, we increase the accuracy of the use of SR in agriculture, since, despite the use of satellite and non-egalitarian sensors to the case study, the completion of the cited work was undeniably satisfactory.

Characterizing the precise use of other satellites, Rizzi., *et al*. [12], evaluated and evidenced the potentiality of MODIS images, through the use of the CIS vegetation index in the identification, mapping and estimation of the planted area with soybean in large Regions quickly and in a timely manner.

In the analysis of the methods of maximum likelihood classification, notoriously the composition of false RGB color had better results, with differentiation of 13.79 percentage in the accuracy of the recognition of areas. Thus, the table of representation of the soil use of the RGB shows that the use of the area for forests is 18.2%, so not reaching the percentage assumption in the Ministry of Agriculture that is composed of 20%, unlike the table of representation of the NDVI index Where it has a value of 31%. However, it is still noticeable the efficacy of the RGB classification through the issued maps, since, in the same colors that characterize each area have a more significant representativity in their percentages described.

Conclusion

In the present work, the efficiency of the classification of Landsat 8 images with the use of the normalized Difference Vegetation index (NDVI) and the composition of images of false RGB color, with significant results of 79.31% and 93.10%, respectively, is confirmed. With representativeness of 32% of agriculture by the NDVI index and 41.3% by the composition of false RGB color in the land use of Palm trees of Goiás.

We conclude the need for continuity in the studies of remote sensing, both in agriculture and evaluated, as in the most diverse areas of activity of the same, because its demonstration of precision in the results is satisfactory and has demonstrated an increase in their use.

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