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A Study of the Mississippi River Delta Using Remote Sensing

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Abstract

This project is focused on the Mississippi River Delta in New Orleans, U.S. The purpose is to identify any change in the shape of the delta. For this, images from 2011 to 2014 were downloaded from the web page Earth Explore and then processed in the software ENVI 5.2. Each image required a preprocessing before analyzing them which were layer stacking, spatial subset and atmospheric correction. Then, two supervised classification was performed. This included minimum distance and maximum likelihood. The last analysis was NDVI to estimate the vegetation index of the delta. The results were that from the minimum distance analysis the image that show more suspended sediment was the MSS of 2012 and the less amount suspended sediment was OLI of 2014. The maximum likelihood gave an error of identifying the class of city in different parts of the delta meaning that it was not useful for analyzing like the minimum distance. The NDVI interpretation was that the year with highest green zone was 2013 of OLI and the year with lowest green zones was 2012 of MSS. In conclusion, no change in the form of the delta was identify except for the variation in the suspended sediment.

Introduction

Deltas are define by Prothero et al. (2004) as a "body of sediment formed when a river dumps it load into a lake or the sea." They are form when marine erosion can't carry away the sediment from the rivers into the sea (Prothero and Schwab 2004). Most of the Deltas have form of a triangular in plain view, but not always it has that shape (Prothero and Schwab 2004). The shape of the delta it will depend on variation in the sediment supply, waves and tidal currents (Prothero et al. 2004). Some of the predominant shape are elongate, lobate, tidal dominated and wave dominated (Prothero and Schwab 2004).

The Mississippi River Delta is located in New Orleans, Louisiana, USA (see fig. 1). The coordinates are 29°08' N, 89°12' W. It has an elongate shape caused by its large sediment supply. The morphology is influence by wind activity and discharge effects. The delta, discharge directly into deep water (Koller et al. 2014). Its dimension are approximately 45 km of length and 55 km of width.

Figure 1. The Mississippi River Delta showing its location (from: Google Earth).

Objectives

The main objective of this project is to identify any significant change on the shape of the delta. Also, one image from four different years will be analyze to identify any change. The range of years will be from 2011 to 2014. The sensors used for this analyses was OLI, MSS and TM located in Landsat satellites.

Sensor	Dimensions (km)	# of Bands	Pixel size	Projection
OLI (Operational Land Imager)	185 x 185	9	30 m	UTM, Zone 16 N
MSS (Multispectral Scanner)	185 x 185	4	80 m	UTM, Zone 16 N
TM (Thematic Mapper)	4000 x 2000	7	30 m	UTM, Zone 16 N

Procedure

First, search and download images of 2011-2014 from Landsat in the web page of Earth Explorer. Second, use the software ENVI 5.2 for preprocessing each image. The preprocessing include layer stacking of the red, green, blue and IR bands. Then, a spatial subset of the Mississippi River Delta was made to have a better and closer look of the area. The last step of preprocessing was to perform an atmospheric correction of the subset using the dark substract method. For the analyses, multispectral classification procedure was made to each image for interpretation. In this step, supervised classification was used. This included minimum distance and maximum likelihood to compare them. For the supervised classification A ROI file with 5 classes: ocean, clouds, suspended sediment, vegetation and city was prepare. The final analysis was estimating the vegetation index of each image using the Normalized Difference Vegetation Index (NDVI). In

the NDVI analysis there was selected fifteen points for compare the values. The figure 2 shows the point 12 were it was selected a value. Finally, after having the images from each procedure they were compared and analyzed for conclusions.

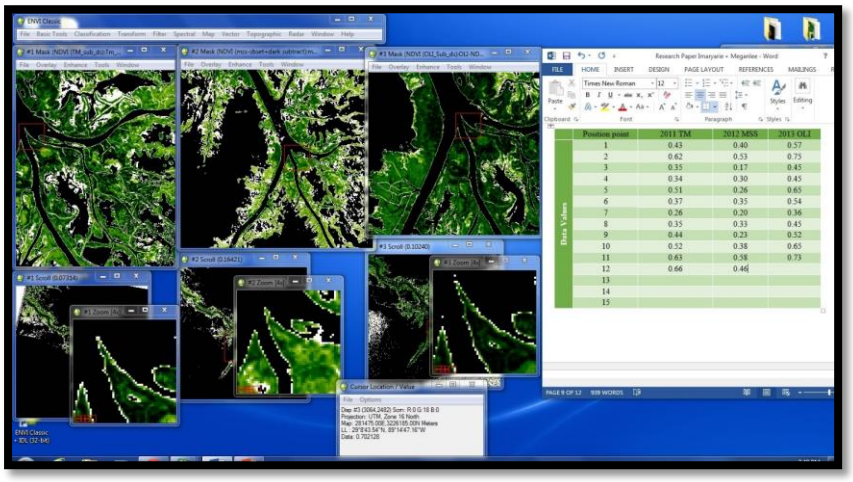

Figure 2. The NDVI values identification points. Only in the first 3 images.

Results

I. Supervised Classification: Minimum Distance

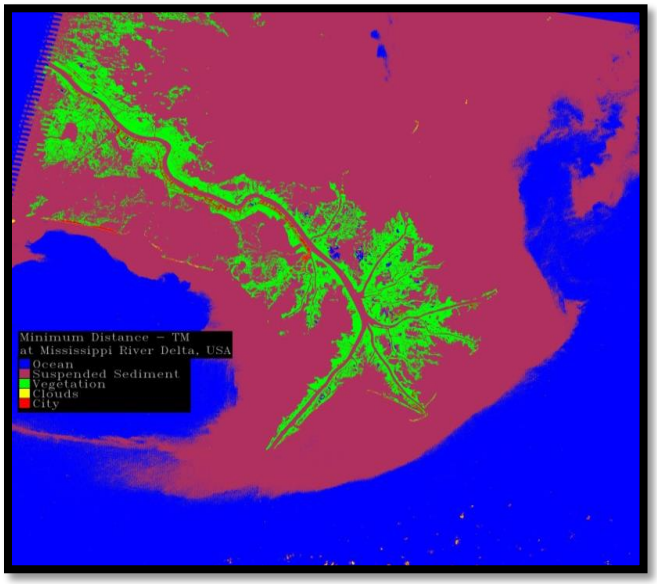

Figure 3. The image for the 2011 year minimum distance. Image from the sensor TM. Date: Oct/03/2011.

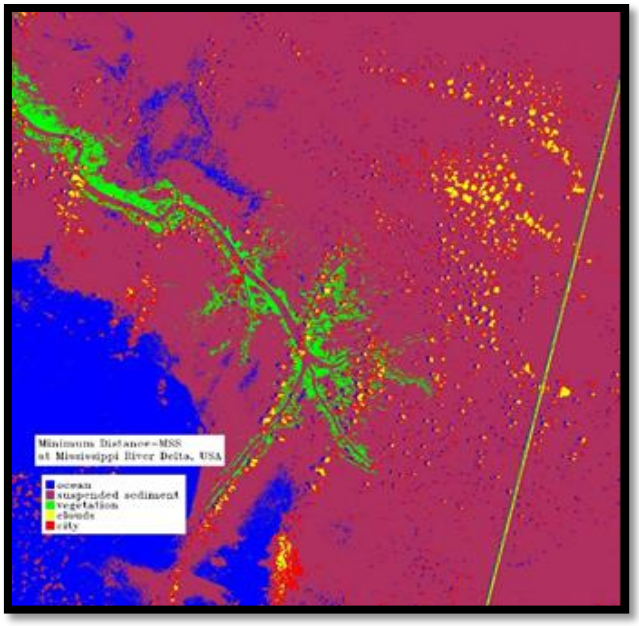

Figure 4. The image for the 2012 year minimum distance. Image from the sensor MSS. Date: Jul/17/2012.

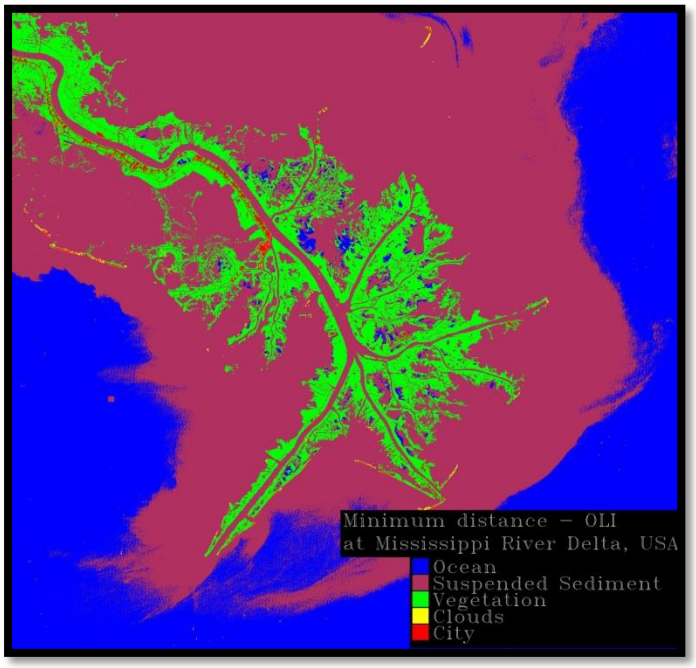

Figure 5. The image for the 2013 year minimum distance. Image from the sensor OLI. Date: Oct/24/2013.

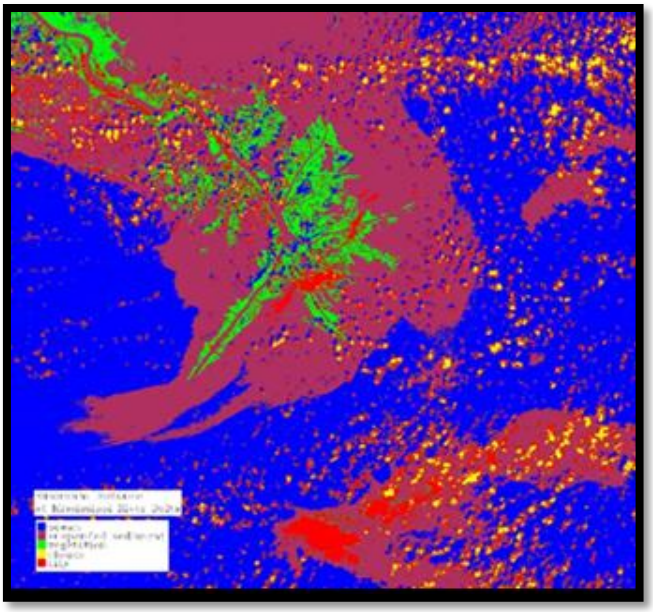

Figure 6. The image for the 2014 year with minimum distance. Image from the sensor OLI. Date: Sept/25/2014.

II. Supervised Classification: Maximum likelihood

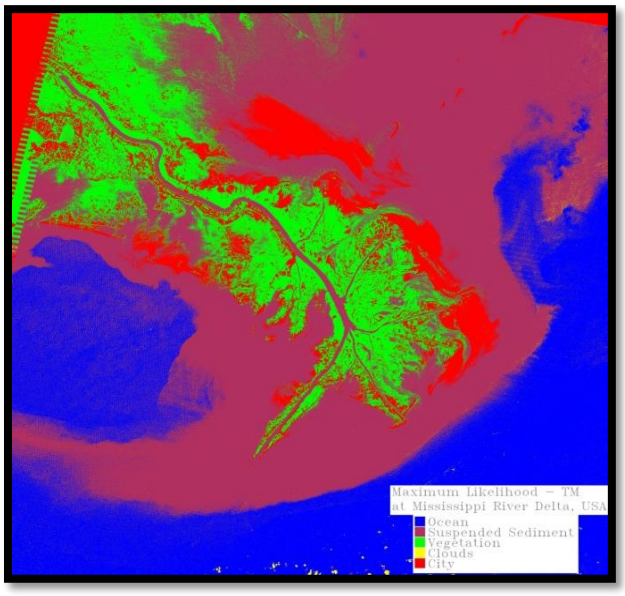

Figure 7. The image for the 2011 year with maximum likelihood. Image from the sensor TM. Date: Oct/03/2011.

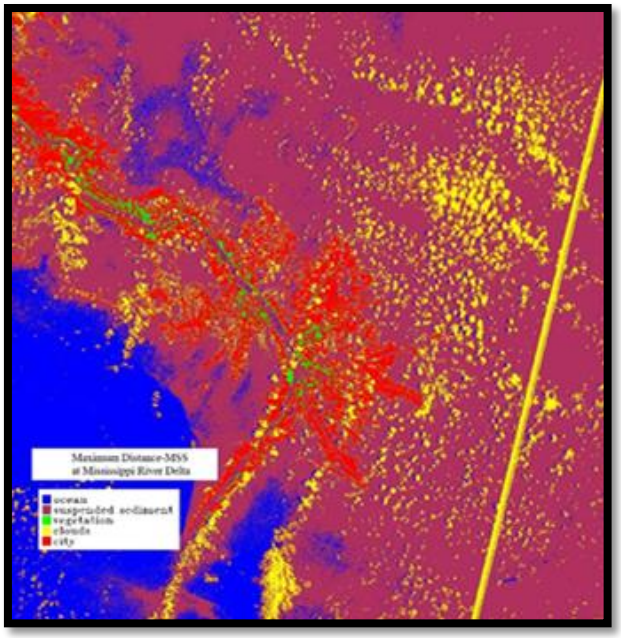

Figure 8. The image for the 2012 year with maximum likelihood. Image from the sensor MSS. Date: Jul/17/2012.

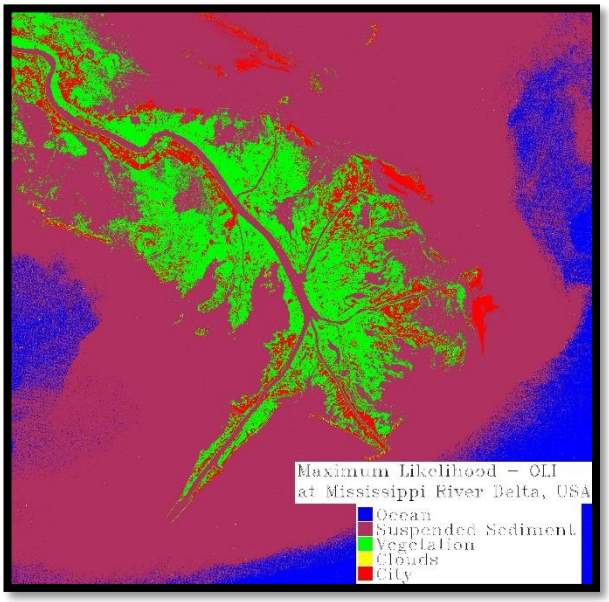

Figure 9. The image for the 2013 year with maximum likelihood. Image from the sensor OLI. Date: Oct/24/2013.

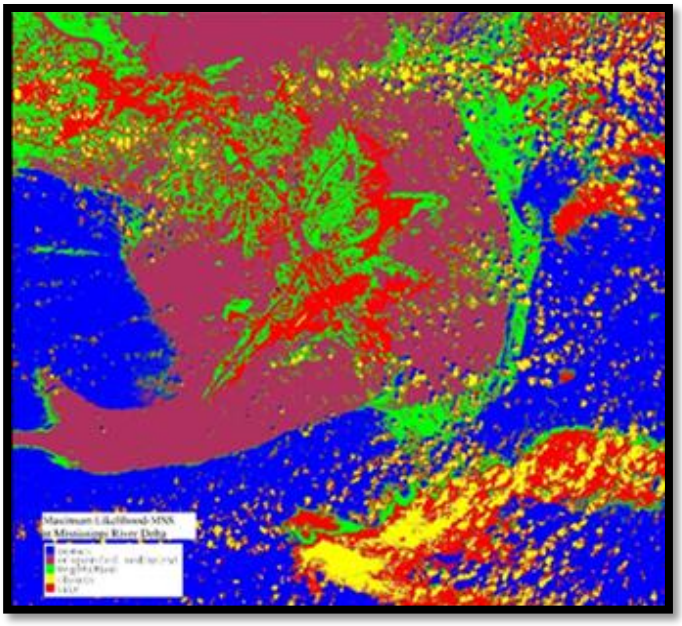

Figure 10. The image for the 2014 year with maximum likelihood. Image from the sensor OLI. Date: Sept/25/2014.

III. NDVI

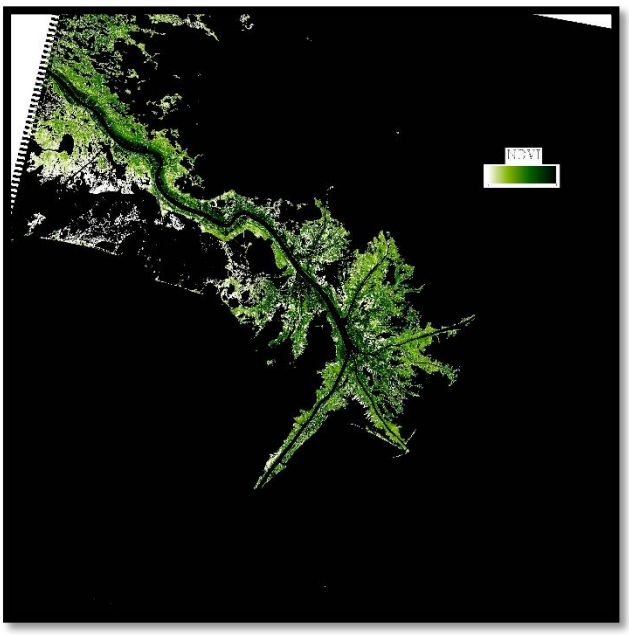

Figure 11. The image for the 2011 year with NDVI. Image from the sensor TM. Date: Oct/03/2011.

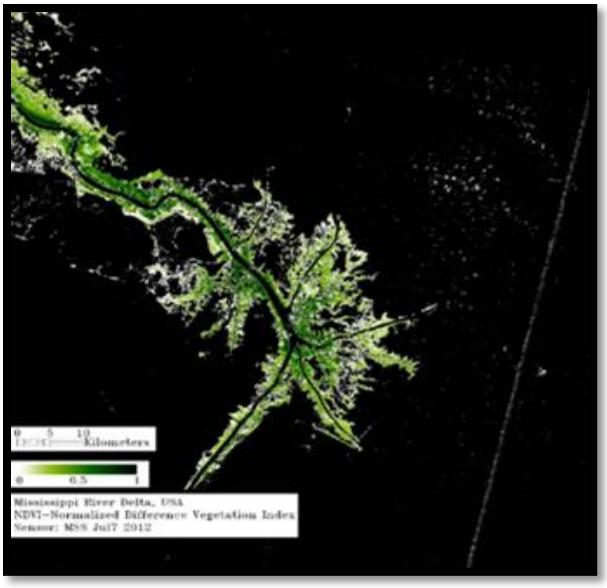

Figure 12. The image for the 2012 year with NDVI. Image from the sensor MSS. Date: Jul/17/2012.

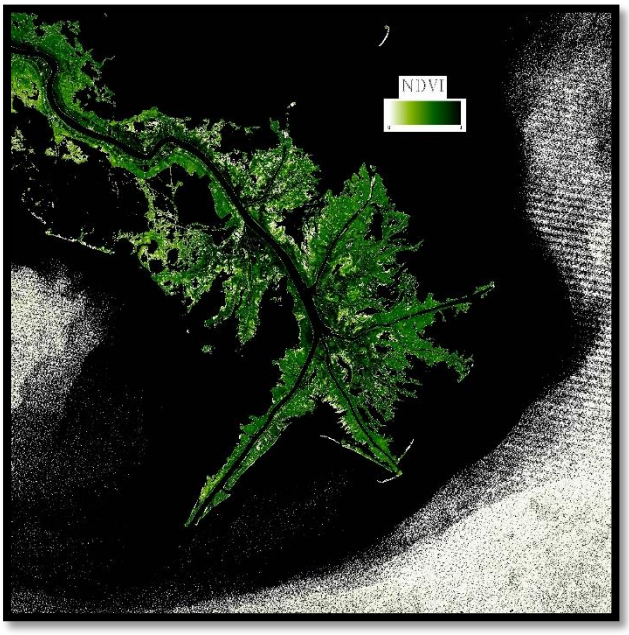

Figure 13. The image for the 2013 year with NDVI. Image from the sensor OLI. Date: Oct/24/2013.

Figure 14. The image for the 2014 year with NDVI. Image from the sensor OLI. Date: Sept/25/2014.

Discussion

The Mississippi River Delta has a very distinguish flora. One of its famous trees are the cypress. The figure 14 shows these types of tress which grows in swamps.

Figure 15. Cypress found in the Mississippi River Delta. The scientific name is Tupelo gum “Nyssa aquatica.” (Picture from: http://www.nature.org/)

Moreover, the NDVI analyses contributes to estimate the primary production of vegetation. For calculated the variation in the NDVI values fifteen points were selected over only three images. This is because the final image from the OLI sensor, Sep/25/2014, revealed a problem for calculated this analyses this its greenish color in the clouds and some parts were it was ocean instead of a vegetation zone. The figure 15 shows the location of the points selected. Furthermore with this points a table was created, see table 1. With this results an image was selected for the highest NDVI values and the lowest NDVI values. Despite the scale for NDVI is from 0 to 1, were 0 is less vegetation zones and 1 higher vegetation zones. Therefore, the OLI image from 2013 had the highest values for the fifteen points, and from this points the bigger was: 0.75 and the lower was: 0.36. The image with lowest values in the fifteen points was: MSS, and from this points the bigger was: 0.58 and the lower was: 0.17.

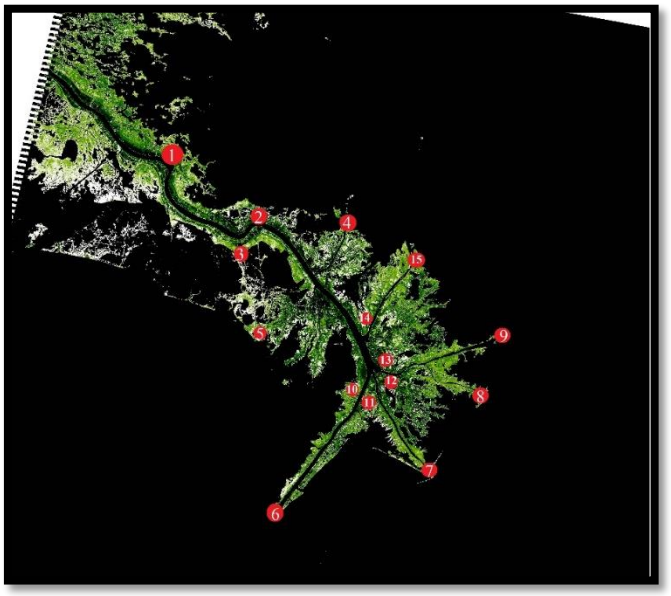

Figure 16. The image shows the location of the fifteen points used for compared the NDVI values along the three years, from 2011 to 2013.

Data Values	Position point	2011 TM	2012 MSS	2013 OLI
	1	0.43	0.40	0.57
	2	0.62	0.53	0.75
	3	0.35	0.17	0.45
	4	0.34	0.30	0.45
	5	0.51	0.26	0.65
	6	0.37	0.35	0.54
	7	0.26	0.20	0.36
	8	0.35	0.33	0.45
	9	0.44	0.23	0.52
	10	0.52	0.38	0.65
	11	0.63	0.58	0.73
	12	0.66	0.46	0.70
	13	0.54	0.46	0.68
	14	0.41	0.31	0.55
	15	0.36	0.24	0.46

Table 1. The table shows the variation in the values for the NDVI for only three images. The red cell is the highest value and the grey cell is the lowest value obtained in each image.

Conclusions:

According with the obtained results from the two supervised classifications, in the minimum distances results it could be seen that the image with more suspended sediments was MSS Jul-17-2012. Moreover, the image with less amount of suspended sediments was OLI Sep-25-2014.

In other hand the maximum likelihood results shows that the image with more suspended sediment was OLI-Oct-24-2013 and the one with less amount was OLI-Sep-25-2014. But this maximum likelihood application in all the samples gives error in identifying the class city in places where there are not. The image that shows less this error was OLI-Oct-24-2013 and the image that shows more this error was the MSS-Jul-17-2012 because almost all the deltas channels appears complete on red.

Moreover, the results of the supervised classification, it can be seen, that in the last four years, there was no significant amount in its form, except for its variation in suspended sediment discharge.

Base on the observation of the NDVI the image with more NDVI was the year 2013 OLI sensor and the one with less was the image of 2012 MSS. The reason is because it has more points with greater values closes to one (0.36-0.75). In the other hand, the one with less zone greens is because it has lowest values closest to cero in the fifteen point selected for the four images (0.17-0.58).

Only in the NDVI an augmentation of the green zones can be seen, although it is hard to tell in the last year due to the clouds.

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