United Nations/Romania International Conference on Space Solutions for Sustainable Agriculture and Precision Farming

Cluj-Napoca, Cluj, Romania, 06-10 May 2019

UNITED NATIONS
Office for Outer Space Affairs

rosa romanian space agency - agenţia spaţială română

DETERMINATION OF THE SOIL PHYSICAL AND CHEMICAL PROPERTIES VIA USING UNMANNED AERIAL VEHICLES EQUIPPED MULTISPECTRAL CAMERA

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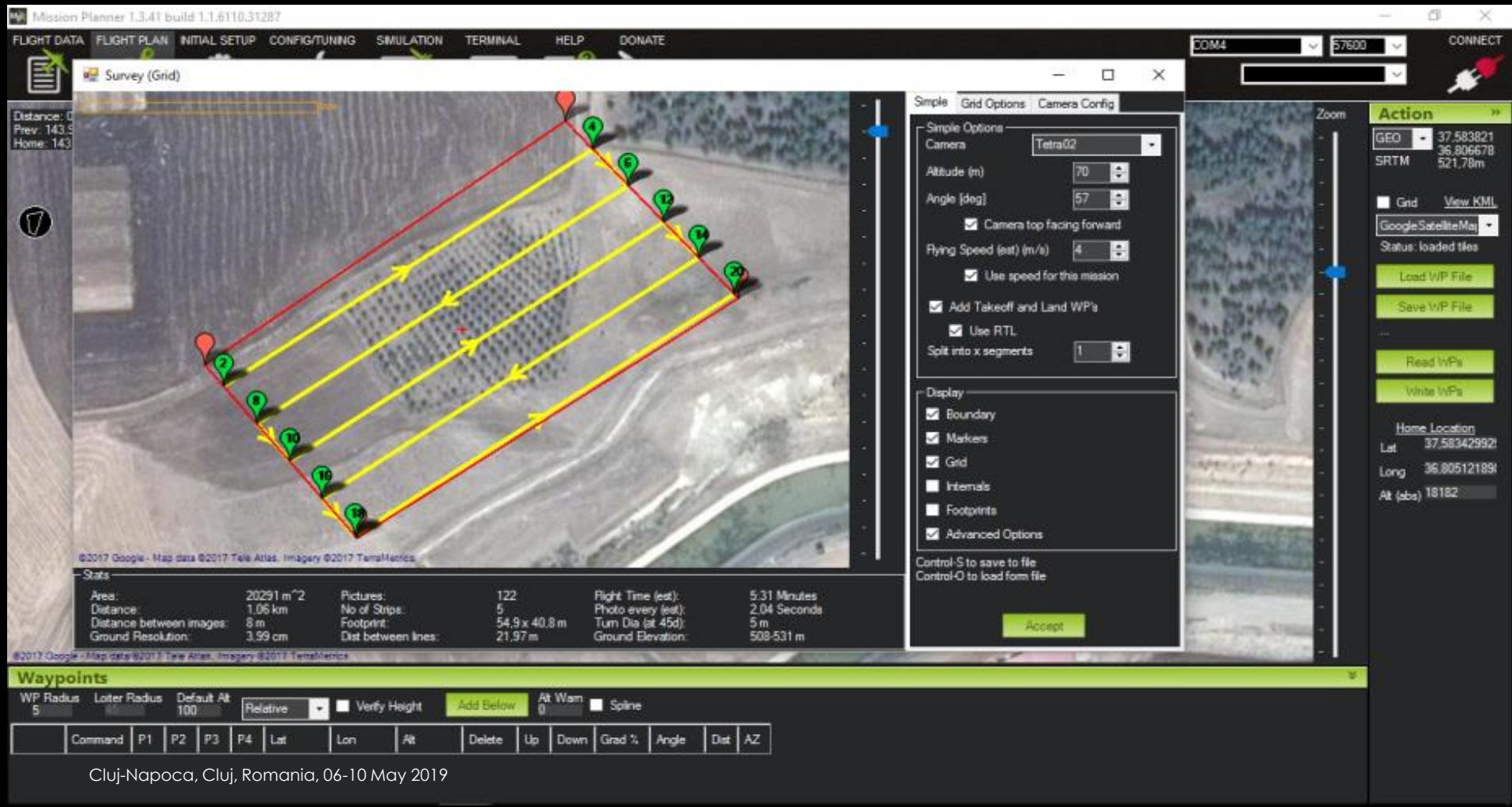
Multicopter Model	Geo V1
Platform	Hekza
Battery	Li-Po
Width	72 cm
Engine	6 piece
Weight	3,5 kg
Carring Capacity	4 kg
Flight time	35 dk
Max Speed	80 km/h
Remote control	Optimal 5 km

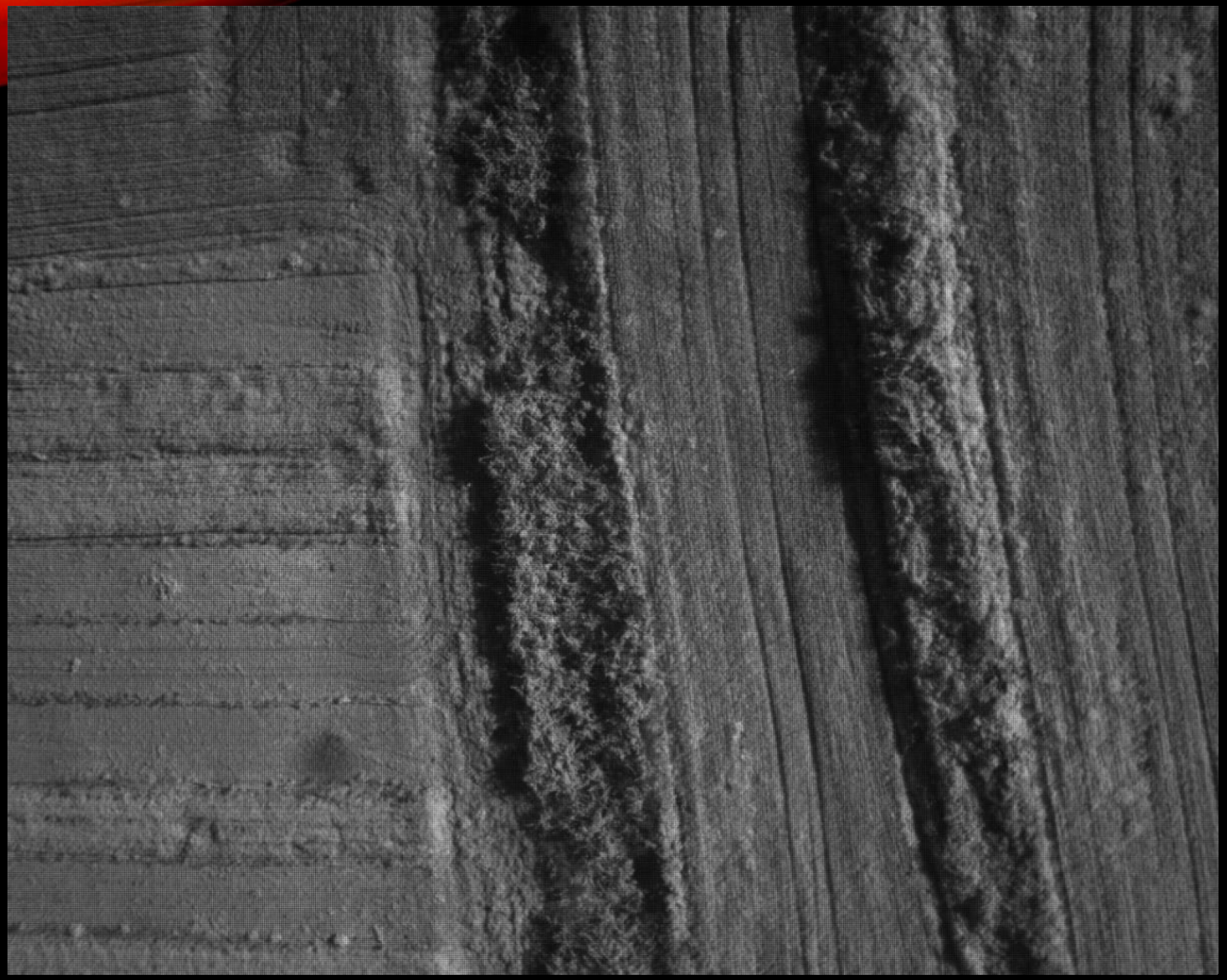
90 gram 3.2 MPel Multi-spectral R-G-NIR System principally designed for operation aboard unmanned aircraft

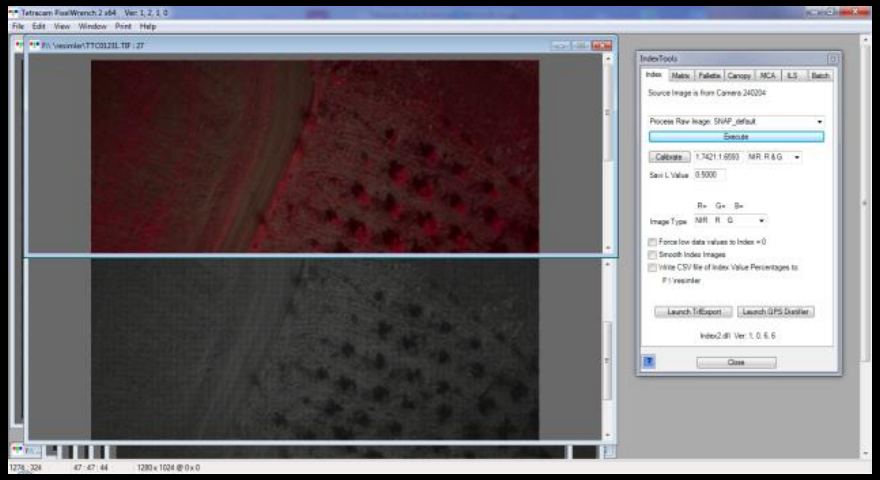
3-Fixed Green, Red, NIR (Equivalent to Landsat TM2, TM3, TM4)

Three filters atop the sensor limit the radiation that enters it to bands of green, red and near-infrared radiation equivalent to Landsat Thematic Mapper bands TM2, TM3 and TM4. These bands are the basis for the standard "false color" composite images that have become associated with multi-spectral imagery. They provide excellent early warning signs of plant stress and their use as indicators of other specific plant and soil conditions has been documented by scientists for decades.

FLIGHT PLAN


Mission Planner 1.3.41 build 1.1.6110.31287
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
COM4
57600
CONNECT
Survey (Grid)
Simple
Grid Options
Camera Config
Simple Options
Camera
Tetra02
Altitude (m)
70
Angle [deg]
57
Camera top facing forward
Flying Speed (est) (m/s)
4
Use speed for this mission
Add Takeoff and Land WP's
Use RTL
Split into x segments
1
Display
Boundary
Markers
Grid
Internals
Footprints
Advanced Options
Control-S to save to file
Control-O to load form file
Accept
Zoom
Action
GEO
37.583821
SRTM
36.806678
521.78m
Grid
View KML
GoogleSatelliteMap
Status: loaded tiles
Load WP File
Save WP File
Read WPs
Write WPs
Home Location
Lat
Long
Alt (abs)
18182
©2017 Google - Map data ©2017 Tele Atlas, Imagery ©2017 TerraMetrics
Stats
Area: 20291 m^2
Distance: 1.06 km
Distance between images: 8 m
Ground Resolution: 3.99 cm
Pictures: 122
No of Strips: 5
Footprint: 54.9 x 40.8 m
Dist between lines: 21.97 m
Flight Time (est): 5.31 Minutes
Photo every (est): 2.04 Seconds
Turn Dia (at 45d): 5 m
Ground Elevation: 508-531 m
Waypoints
WP Radius 5
Loiter Radius
Default Alt 100
Relative
Verify Height
Add Below
Alt Warn 0
Spline
Command
P1
P2
P3
P4
Lat
Lon
Alt
Delete
Up
Down
Grad %
Angle
Dist
AZ





(a)

(b)

PixelWrench software and tiff photo (NIR / R / G)

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

•Reference: Tucker, C.J. (1979) 'Red and Photographic Infrared Linear Combinations for Monitoring Vegetation', *Remote Sensing of Environment*, **8(2)**,127-150.

$$GNDVI = \frac{(NIR - Green)}{(NIR + Green)}$$

Reference: Gitelson, A., and M. Merzlyak. "Remote Sensing of Chlorophyll Concentration in Higher Plant Leaves." *Advances in Space Research* 22 (1998): 689-692.

$$MSAVI = \frac{(NIR - RED)(1 + L)}{NIR + RED + L}$$

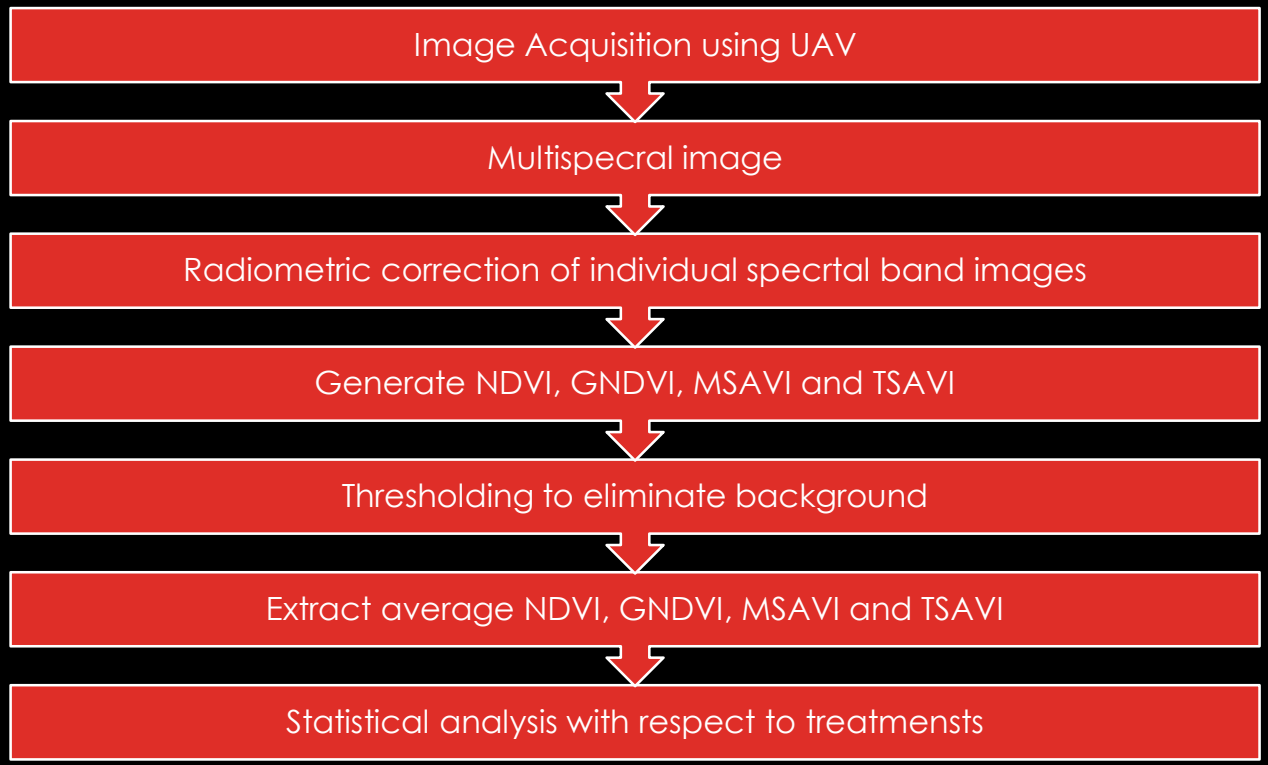
Reference: Qi J., Chehbouni A., Huete A.R., Kerr Y.H., 1994. Modified Soil Adjusted Vegetation Index (MSAVI). Remote Sens Environ 48:119-126.

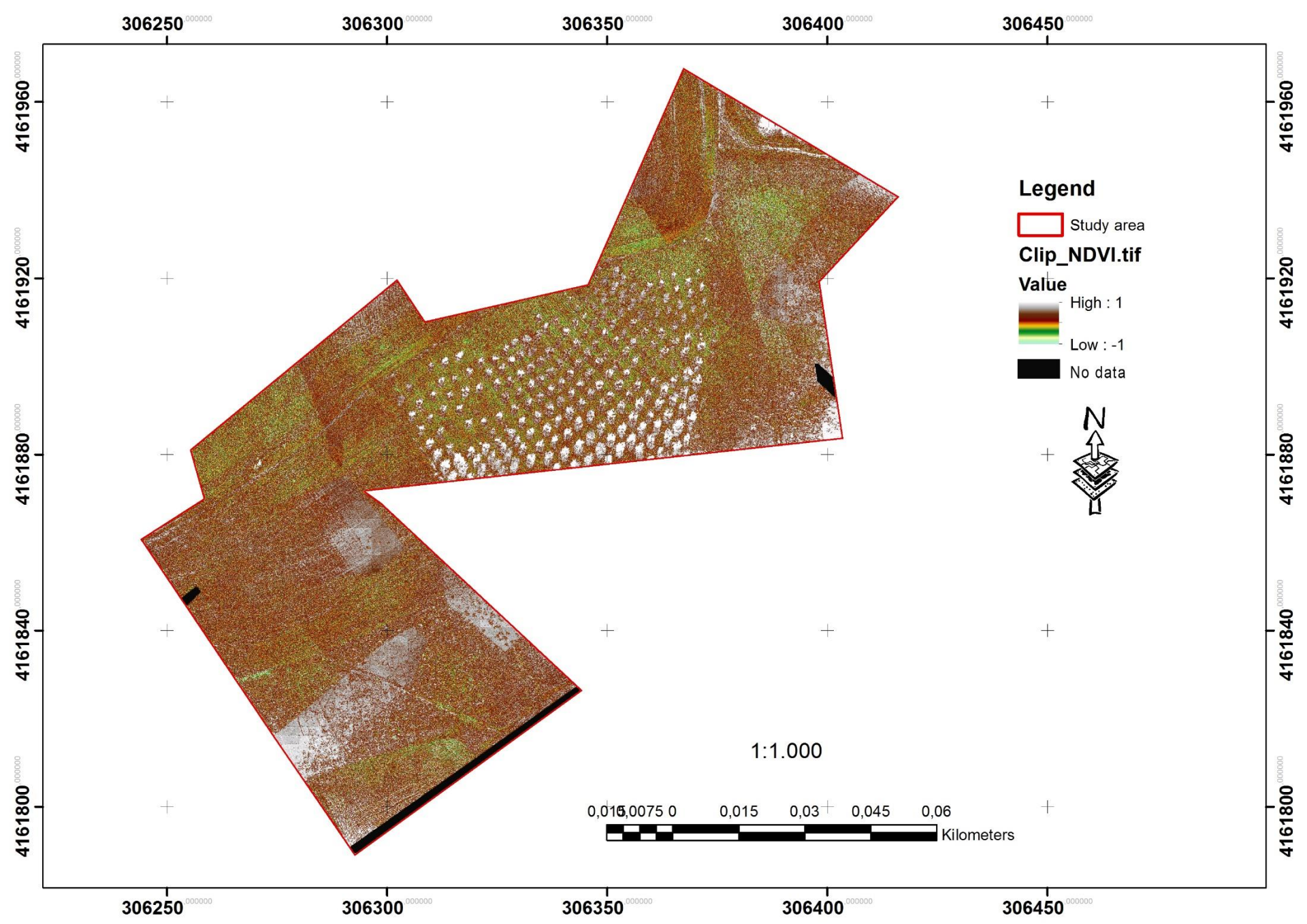
$$MSAVI2 = \frac{\left(2 * NIR + 1 - \sqrt{(2 * NIR + 1)^2 - 8 * (NIR - RED)}\right)}{2}$$

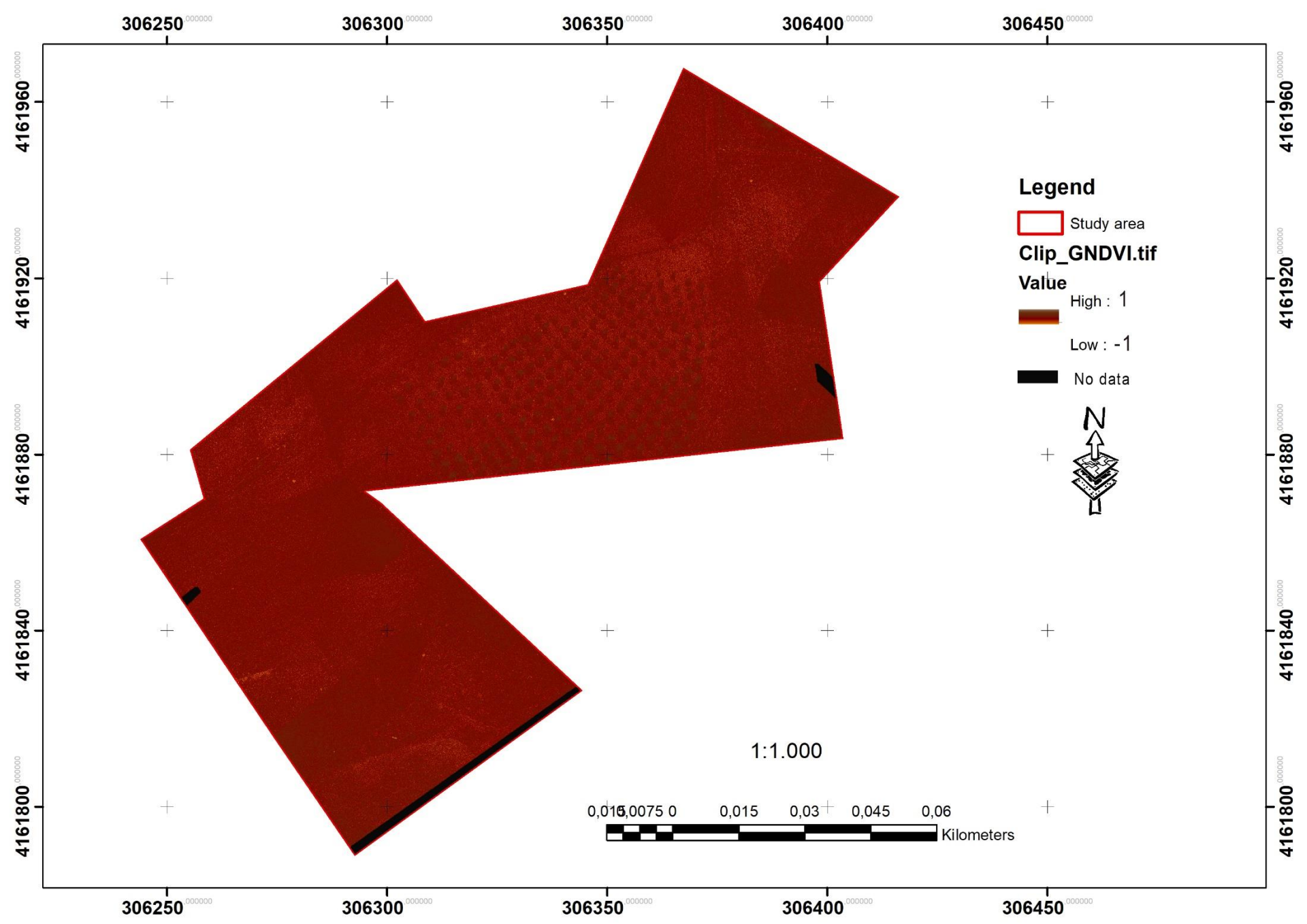
$$GSAVI = 1.5 * \frac{(NIR - Green)}{(NIR + Green + 0.5)}$$

Reference: Sripada, R., et al. "Determining In-Season Nitrogen Requirements for Corn Using Aerial Color-Infrared Photography." Ph.D. dissertation, North Carolina State University, 2005

FLOWCHART OF ANALYSES STEPS




306250
306300
306350
306400
306450
4161960
4161920
4161880
4161840
4161800
Legend
Study area
Clip_NDVI.tif
Value
High : 1
Low : -1
No data
N
1:1.000
0,0075 0
0,015
0,03
0,045
0,06
Kilometers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4161960
4161920
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Legend
Study area
Clip_GNDVI.tif
Value
High : 1
Low : -1
No data
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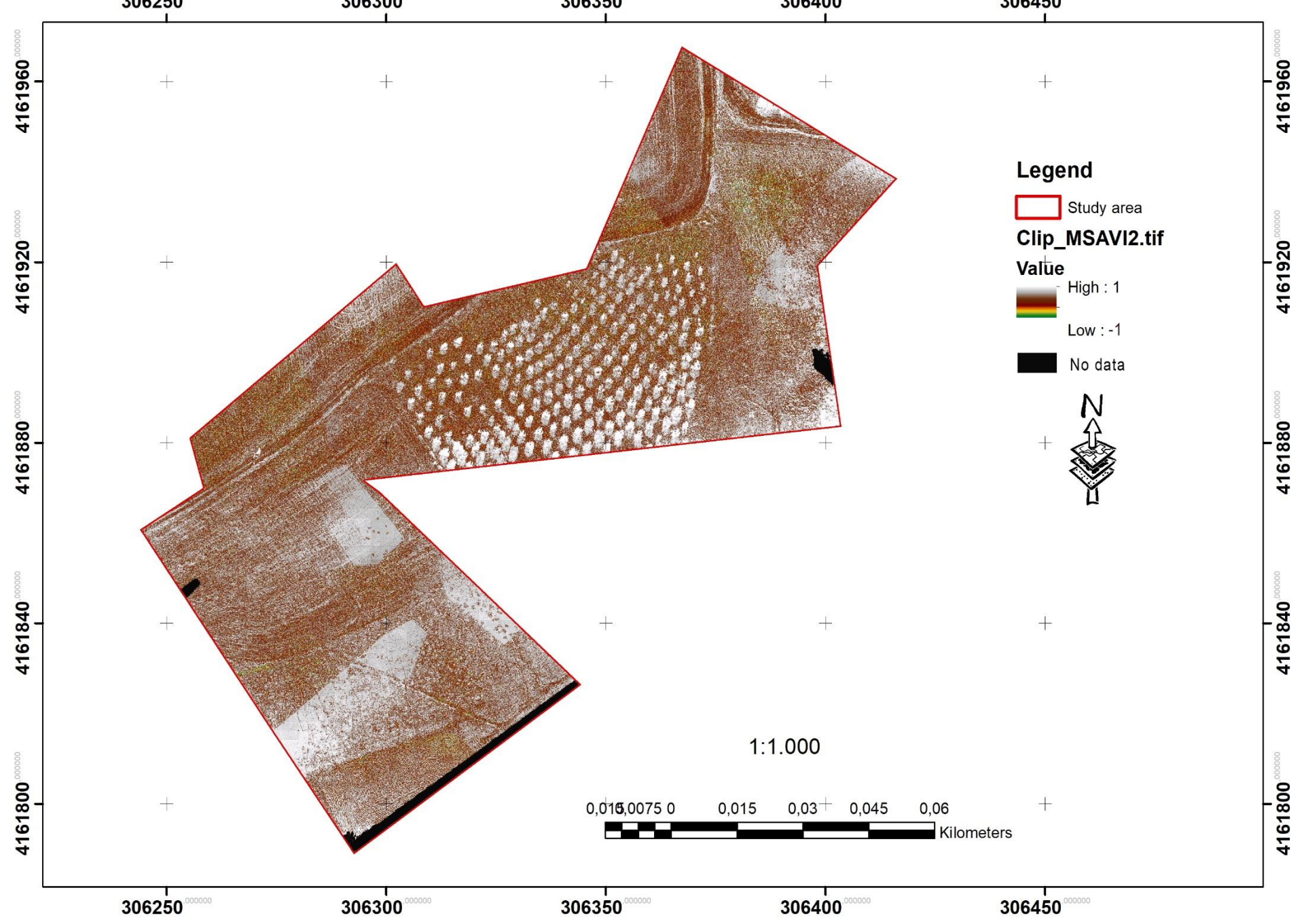
1:1.000
0,0150,0075 0 0,015 0,03 0,045 0,06
Kilometers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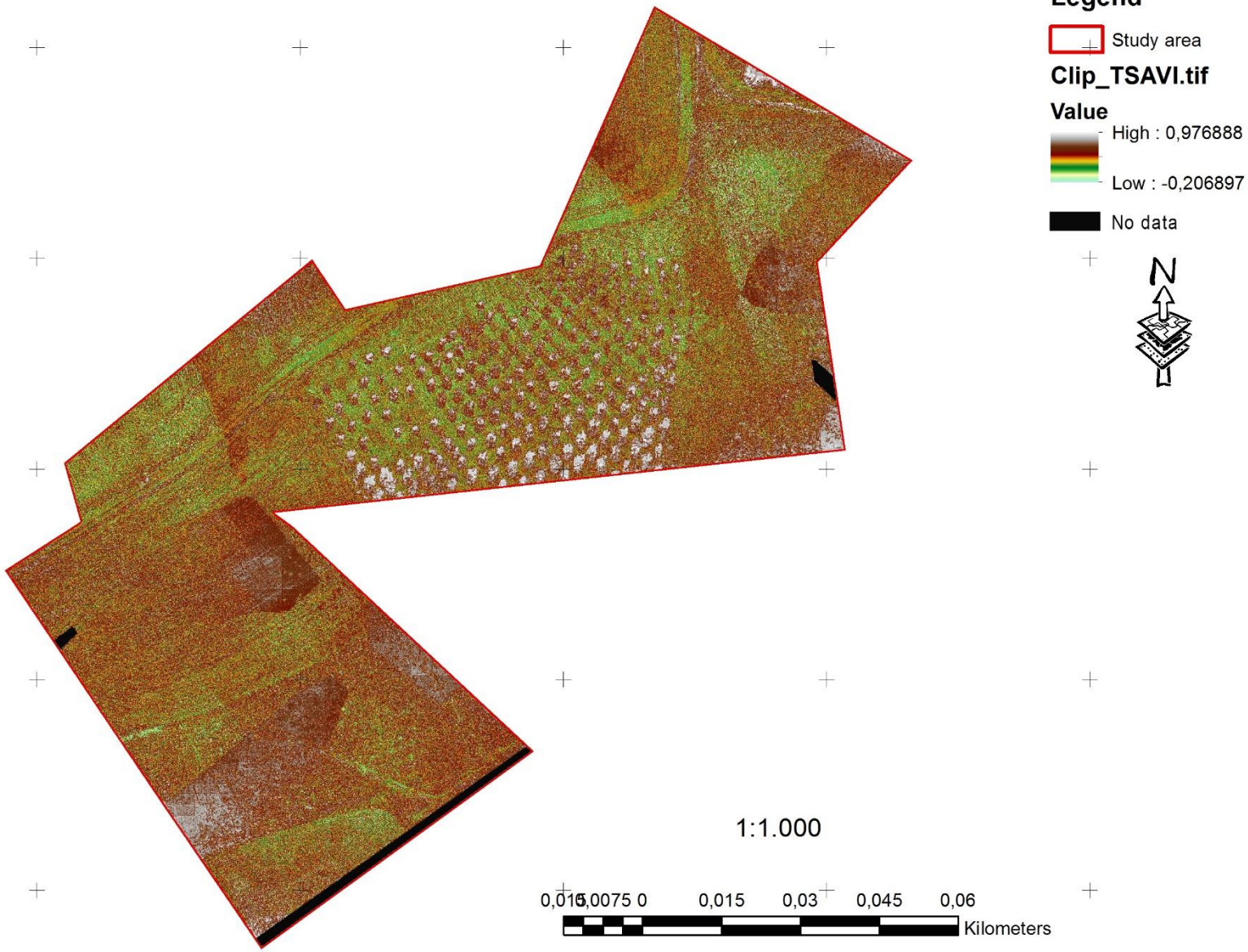
306350
306400
306450
4161960
4161920
4161880
4161840
4161800
Legend
Study area
Clip_MSAVI2.tif
Value
High : 1
Low : -1
No data
N
1:1.000
0,0075 0
0,015
0,03
0,045
0,06
Kilometers


Legend
Study area
Clip_TSAVI.tif
Value
High : 0,976888
Low : -0,206897
No data
N
1:1.000
0,0075 0 0,015 0,03 0,045 0,06
Kilometers

VI VALUES IN SOIL SAMPLING POINT

Descriptive Statistics

	N	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
GNDVI	36	,187	,836	,5166	,0248	,1490	,022
MSAVI	36	,265	,932	,6670	,0321	,1928	,037
TSAVI	36	,239	,795	,5112	,0270	,1625	,026
NDVI	36	,153	,875	,5318	,0348	,2090	,044
Valid N (listwise)	36						

CONCLUSION

Correlations												
	Rangeland		pH	Clay (CL)	Sand (SD)	Silt (SL)	Lime (LC)	OM	Moist (MC)	GNDVI	NDVI	MSAVI	TSAVI
GNDVI		Pearson Correlation	-,056	-,198	,242	-,177	-,363	-,044	-,784**	1	,721**	,652*	,732**
NDVI		Pearson Correlation	,506	-,320	,319	-,168	-,282	,223	-,605*	,721**	1	,988**	,997**
MSAVI		Pearson Correlation	,549	-,411	,420	-,233	-,210	,258	-,543	,652*	,988**	1	,977**
TSAVI		Pearson Correlation	,504	-,275	,270	-,138	-,266	,204	-,596*	,732**	,997**	,977**	1
**. Correlation is significant at the 0.01 level (2-tailed).													
*. Correlation is significant at the 0.05 level (2-tailed).													

CONCLUSION

Correlations											
	Cropland (Wheat)	pH	Clay (CL)	Sand (SD)	Silt (SL)	Lime (LC)	OM	Moist (MC)	GNDVI	NDVI	MSAVI	TSAVI
GNDVI	Pearson Correlation	,584*	-,357	,272	-,058	,238	-,185	-,240	1	,547	,569	,525
NDVI	Pearson Correlation	,651*	-,399	,312	-,075	-,067	,334	-,180	,547	1	,995**	,997**
MSAVI	Pearson Correlation	,651*	-,402	,366	-,137	-,073	,329	-,229	,569	,995**	1	,986**
TSAVI	Pearson Correlation	,646*	-,377	,252	-,021	-,075	,330	-,118	,525	,997**	,986**	1
*. Correlation is significant at the 0.05 level (2-tailed).												
**. Correlation is significant at the 0.01 level (2-tailed).												

CONCLUSION

Correlations											
	Olive Garden	pH	Clay (CL)	Sand (SD)	Silt (SL)	Lime (LC)	OM	Moist (MC)	GNDVI	NDVI	MSAVI	TSAVI
GNDVI	Pearson Correlation	-,163	-,060	,040	-,009	-,298	-,163	,096	1	,452	,469	,450
NDVI	Pearson Correlation	,415	-,053	,122	-,189	-,524	,360	,196	,452	1	,989**	,994**
MSAVI	Pearson Correlation	,428	-,091	,139	-,178	-,500	,281	,151	,469	,989**	1	,971**
TSAVI	Pearson Correlation	,422	-,032	,117	-,205	-,521	,372	,232	,450	,994**	,971**	1
**. Correlation is significant at the 0.01 level (2-tailed).												
*. Correlation is significant at the 0.05 level (2-tailed).												

CONCLUSION

	Moisture and MSAVI		
Rangeland	Polynomial	$y = -0,0493x^2 + 1,7931x - 15,413$	$R^2 = 0,3347$
Olive	Linear	$y = 0,0785x - 1,0963$	$R^2 = 0,0227$
Cropland	Polynomial	$y = -0,3745x^2 + 17,1x - 194,32$	$R^2 = 0,2298$

	Moisture and TSAVI		
Rangeland	Linear	$y = -0,049x^2 + 1,7922x - 15,66$	$R^2 = 0,4133$
Olive	Linear	$y = 0,104x - 1,8145$	$R^2 = 0,0539$
Cropland	Polynomial	$y = -0,3065x^2 + 14,034x - 159,96$	$R^2 = 0,1837$

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KAHRAMANMARAŞ SÜTÇÜ İMAM ÜNİVERSİTESİ

III. International Mediterranean Forest and Environment Symposium

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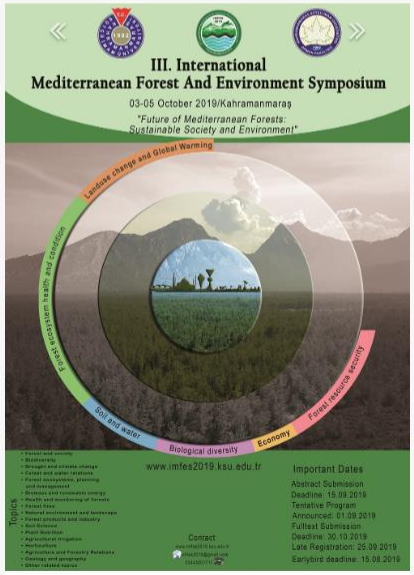

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Thank you for your attention…