CLANDESTINE AIRSTRIPS: OPPORTUNITY FOR NARCOTICS-TERRORISM NEXUS IN LAGUNA DEL TIGRE NATIONAL PARK, GUATEMALA

Gerby Marks

Fig. 1 Guatemalan Special Forces soldiers try to cross a river during an anti-drugs operation in the national park Laguna del Tigre, Guatemala near the border with Mexico, March 6, 2006. The mission of these soldiers is to destroy dozens of clandestine airstrips used by contraband-laden airplanes and reclaim the protected Maya Biosphere Reserve from destruction by drug wars. Source: AP.

Abstract

The Laguna del Tigre National Park, located in the Petén region of Guatemala and the largest of the 2 million hectare Maya Biosphere Reserve, has been revealed as a hub for illicit border activity arriving by aircraft from elsewhere in Latin America, entering Mexico, and subsequently into the U.S. While clandestine airstrips in Petén briefly became the public theater for Guatemala's anti-drug war operations in 2006 [Fig. 1], there is a rising concern from Washington about organizational links between drug trafficking routes and transnational terrorists operating in Central and South America's porous border zones. Using infrared color land cover detection of Landsat ETM+ imagery of Laguna del Tigre National Park and map algebra based on improvised airfield parameters, this research identifies suitable terrain for improvised/illicit airstrips near the Guatemala-Mexico border. This research presents a geospatial approach to better direct operations against illicit airfields and to safeguard zones likely to be claimed by contraband activities in remote regions of Latin America.

INTRODUCTION

Major concern has been raised about the cooperative relationship among narcotics traffickers and transnational terrorist groups in Latin America's permeable borders—from the Iguazu triborder zone of Argentina, Paraguay and Brazil, the Colombia-Venezuela border to the Guatemala-Mexico border. While the U.S. is working to secure its border with Mexico from MS-13, Al-Qaeda and others, it is critical that the U.S. provide intelligence support to the transnational Inter-American Committee Against Terrorism (CICTE) to combat Islamist terrorism as well as Latin America's anti-drug war. Of particular relevance to the geospatial intelligence (GEOINT) tradecraft is identification of clandestine airstrips for transit of weapons, drugs, and individuals. This research is therefore directed to detection of suitable sites for clandestine airstrip operation along the Guatemala-Mexico border by geospatial analytical techniques. This border zone is especially critical to U.S. interests: it is a sieve for illicit air trafficking from elsewhere in Latin America and subsequent filtering into the U.S. by other routes [Fig. 2].

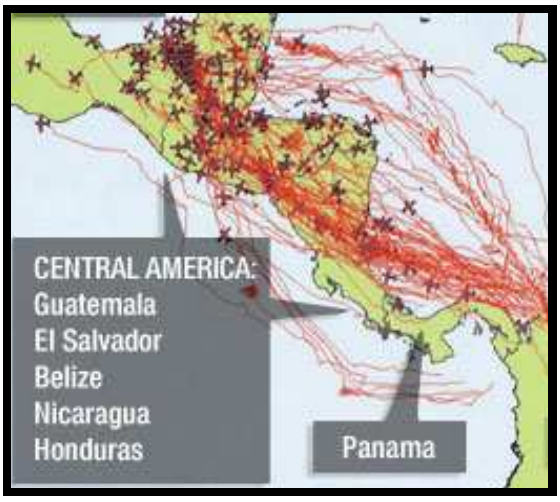


Fig. 2 Suspected drug trafficking flights documented in 2003. The Guatemala-Mexico border is a way station for illicit activity. Source: White House Office of National Drug Control Policy.

The Laguna del Tigre National Park, located in the Petén region of Guatemala and the largest of the Maya Biosphere Reserve (MBR), has been identified as a hub for illicit border activity. The existence and ongoing creation of clandestine airstrips in Laguna del Tigre is cited by international ecologists and military alike, despite the 2006 attempt by Guatemalan Special Forces to eradicate the problem. Continuing deforestation, induced and sustained by human activity, exacerbates the problem by providing new territory to be surreptitiously converted from national parkland to contraband no-man's land. MBR park and government officials in Guatemala note the challenge in identifying and responding to the problem in this remote region. This research presents a first step for the U.S. to extend its scientific and environmental diplomacy and national security efforts to protect the MBR, locate contraband activities, and preemptively seal the Mexico-Guatemala border.

STUDY AREA

Laguna del Tigre National Park is one of five national parks, four biological reserves (biotopes), a multiple use zone and a buffer zone in northern Guatemala. Together, these comprise 2 million hectares of land known the Maya Biosphere Reserve (MBR) and are part of Central America's largest continuous tropical moist forest. The MBR is located in the Petén department of Guatemala [Fig. 3].

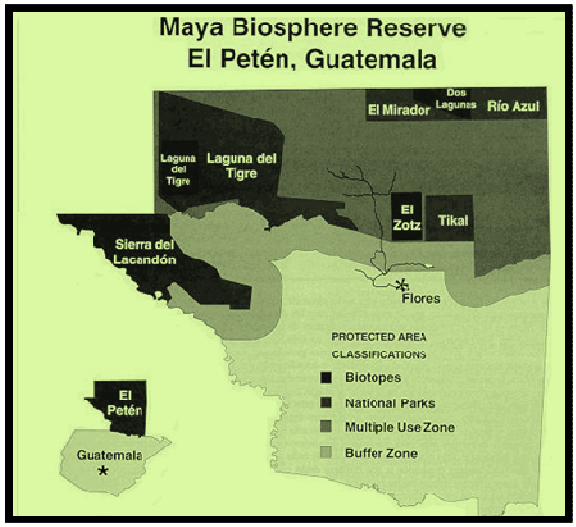
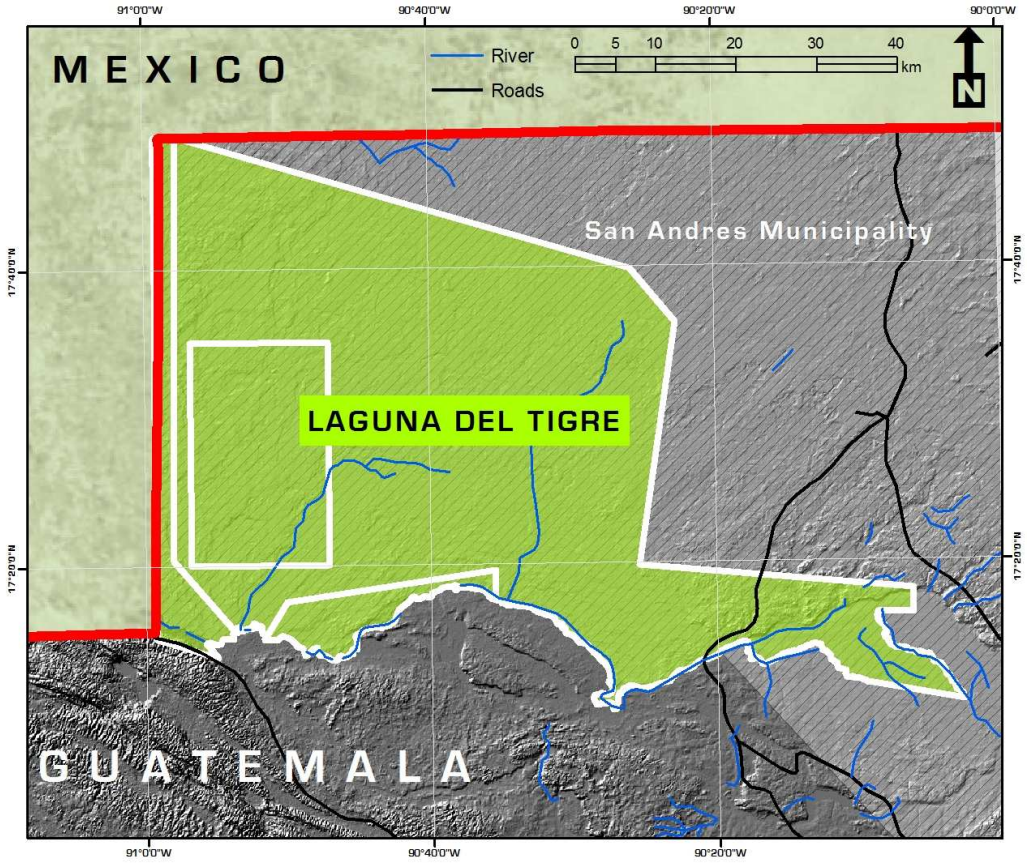


Fig. 3 Locational Image of Maya Biosphere Reserve in El Peten, Guatemala. Source: Parkswatch.org

Laguna del Tigre is in the municipality of San Andrés, department of Petén. The park is bordered to the north, east and west and south by the MBR Multiple Use Zone. The eastern and northern borders lie just a few kilometers from the edge of the Mexican states of Campeche and Tabasco. Laguna del Tigre, including both Laguna del Tigre-Park and Laguna del Tigre-Rio Escondido which is nestled within the larger park, covers 289,912 hectares, and is the largest in Guatemala. The legally established borders lie within 17° 11' 41" and 17° 48' 53.2" latitude, and 90° 58' 2.8" and 90° 2' 44.2" longitude.

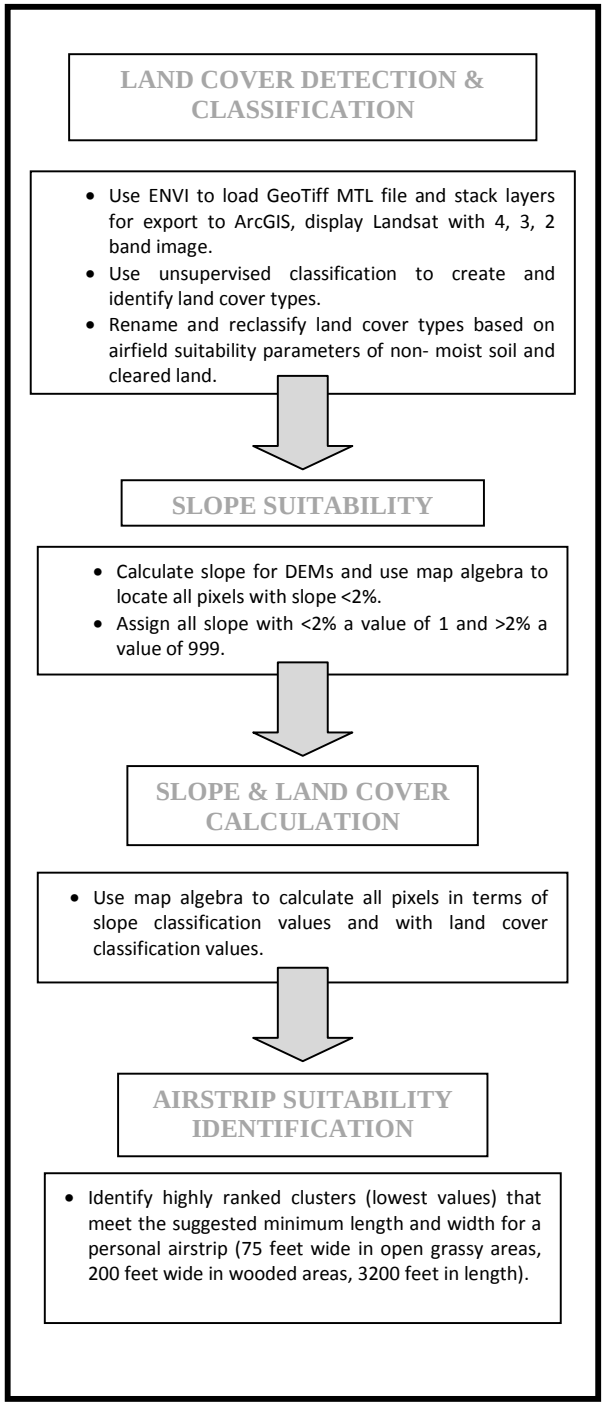
Land cover in Laguna del Tigre includes transitional woodlands, oak forest, flooded savannah, and marshes. For the purposes of this study and to facilitate monitoring of Laguna del Tigre and its immediate periphery, the region of analysis selected includes both Laguna del Tigre-Rio Escondido (which is circumscribed within the National Park), Laguna del Tigre-National Park as well as the Multiple Use slivers which are monitored by Laguna del Tigre officials as well as shown in the graphic below.



METHODS OVERVIEW

Vector and raster data and analytical outputs selected for this project intend to evaluate the Laguna del Tigre Park for suitable terrain for extant and future improvised/illicit airstrips. Data includes vector files provided by Guatemala's Consejo Nacional de Areas Protegidas (CONAP), Landsat TM 15 m imagery from the 2005 Global Land Survey (GLS) and 3" Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM).While the MBR spans UTM 15 and 16N, Laguna del Tigre is located in 15N and data was thus projected to this zone. An overview of the workflow is shown in Fig. 5. It first identifies extant clearings based on 15 m resolution satellite imagery, likely induced or sustained by human intervention. Using 3" DEM, terrain is then evaluated according to airfield parameters of slope. ArcGIS and ENVI will be used.

Fig. 5 Workflow Diagram.

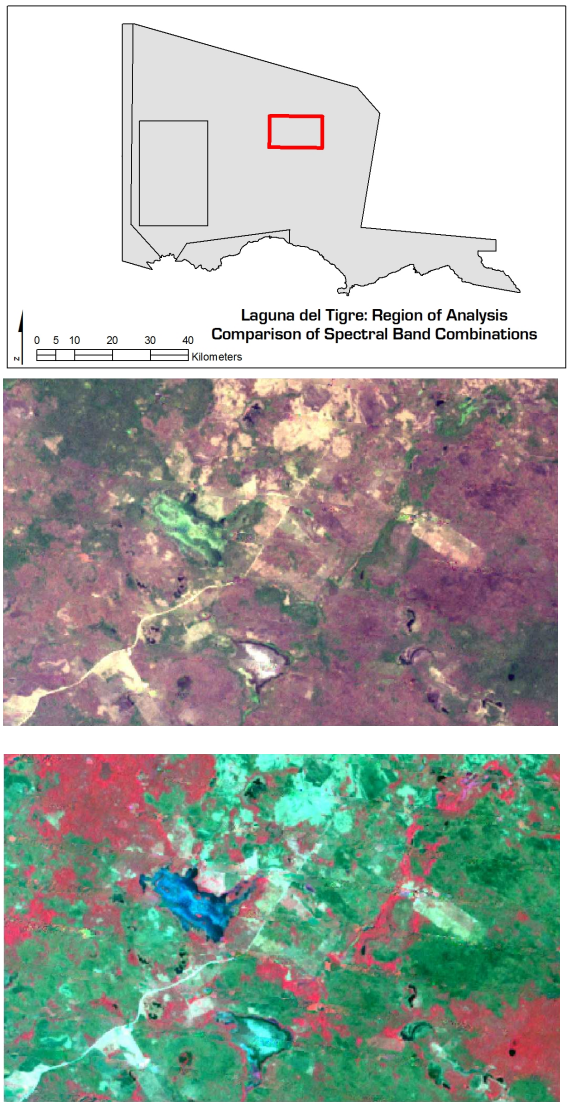


ANALYTICAL WORKLFOW

DATA PREPARATION

First, a new vector file for the Laguna del Tigre complex was created, comprising both the Rio Escondido, National Park, and Multi-Use Zones. Composite band layers were stacked for the GLS 2005 Landsat TM, re-sorted into a 4,3,2 combination and then clipped to the Laguna del Tigre region of analysis mask. The Landsat TM band combination 4,3,2, or infrared color, was selected rather than natural color to better display wetlands and vegetation [Fig. 6]. As the infrared version shows, actively growing canopy appears bright red, bare soil appears blue-green, and water appears black in this combination of near infrared, visible red, and visible green bands.

Fig. 6 A zone of Laguna del Tigre displayed in the **"**natural color" Landsat band combination 3, 2, 1 (**top**) and in the "infrared color" Landsat band combination 4, 3, 2 (**bottom**).



LAND COVER DETECTION & CLASSIFICATION

Pixels from the infrared color GLS 2005 were next sorted into different land cover types. Both supervised and unsupervised classes as well as different *n* classes and training sets were tested. Without having ground-test data, visual examination showed that unsupervised classification and 8 classes performed the best for distinguishing between land cover types in Laguna del Tigre for the purposes of this investigation [See Fig. 7]. In addition, the 4,3,2 combination helped detect and classify areas that might be "clear" of canopy but are in fact soggy zones, including marshes and flooded savannah. The ability to simultaneously detect ground moisture with land cover proved significant because digital soil data available for Guatemala is at too coarse a resolution to bring additional insight into this study. The eight classes were defined as water/flooded savannah, marshes, dense forest canopy, transitional forest, light vegetation, transitional clearing, light clearing, and full clearing.

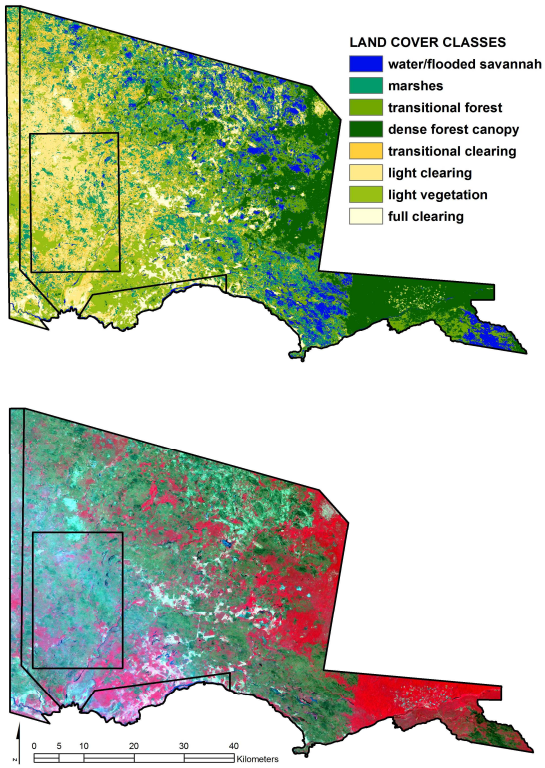


Fig. 7 Unsupervised Classification with 8 classes proved to be the best method for detecting and defining land cover classes in Laguna del Tigre.

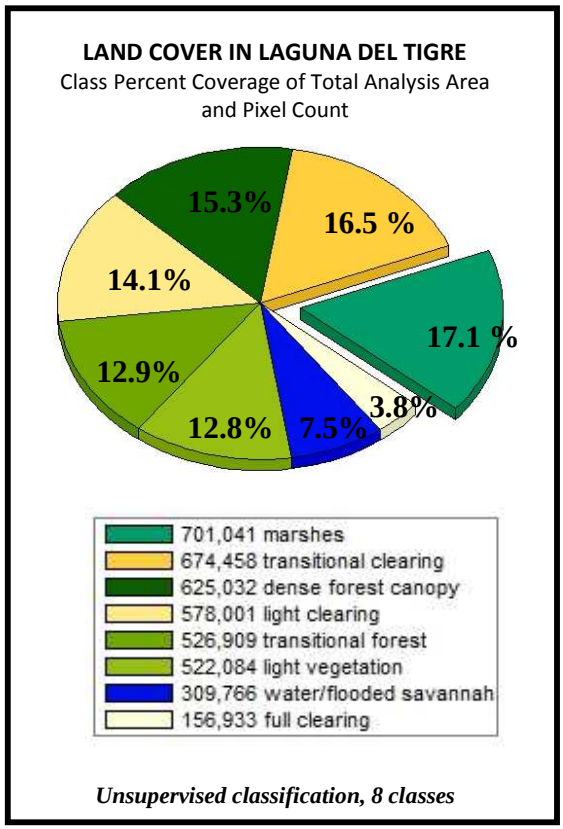


Fig. 8 Graph of quantified Land Cover classes in Laguna del Tigre.

These land cover types are represented as shown in Fig. 8 within Laguna del Tigre. Water/ flooded savannahs, marshes, dense canopy, transitional forest comprise an increasingly smaller amount of coverage each year in Laguna owing to human intervention (For comparison see GLS 2000 of the same region). It is not surprising to see that land cover ripe for human activity comprises 46.2% of Laguna del Tigre.

The land cover types were next reclassified according to their suitability for building illicit airstrips as Fig. 9 shows. Rankings 1-5 represents the most to least likely to have *extant* airstrips, owing the existence (and perhaps human maintenance) of cleared terrain. Light vegetation is ranked 15 because this area, while occupied by woody shrub, is not particularly dense or difficult to remove. Indeed, the ever shrinking forest of the MBR suggests that in 2010, light vegetation areas may now be cleared. Transitional forest, dense forest canopy,

marshes, water and flooded savannah have all been assigned 999 as “impossible” values. While an airstrip may be built within a vegetative copse, it is probable that the bare soil or cleared ground would be visible from the satellite image.

Land Cover	Value
water/flooded savannah	999
marshes	999
dense forest canopy	999
transitional forest	999
light vegetation	15
transitional clearing	5
light clearing	1
full clearing	1

Fig. 9 Table of Land Cover Types and reclassified values.

SLOPE SUITABILITY

The next phase of analysis considered the basic parameter of slope necessary to create an improvised airstrip. A raster slope map was created from the 3” DEM SRTM. Terrain with slope < 2% was identified as *for airstrip* or *not possible* and pixels were classified with values of 1 (Y) and 999 (N) as shown in Fig. 10.

Fig. 10 Reclassified slope values in the Maya Biosphere Reserve.

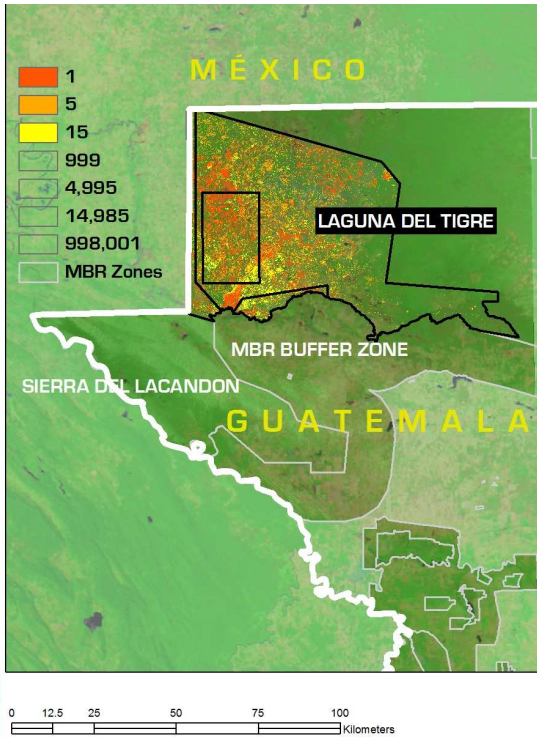


Fig. 11 Output of Slope & Land Cover Calculation for Laguna del Tigre.

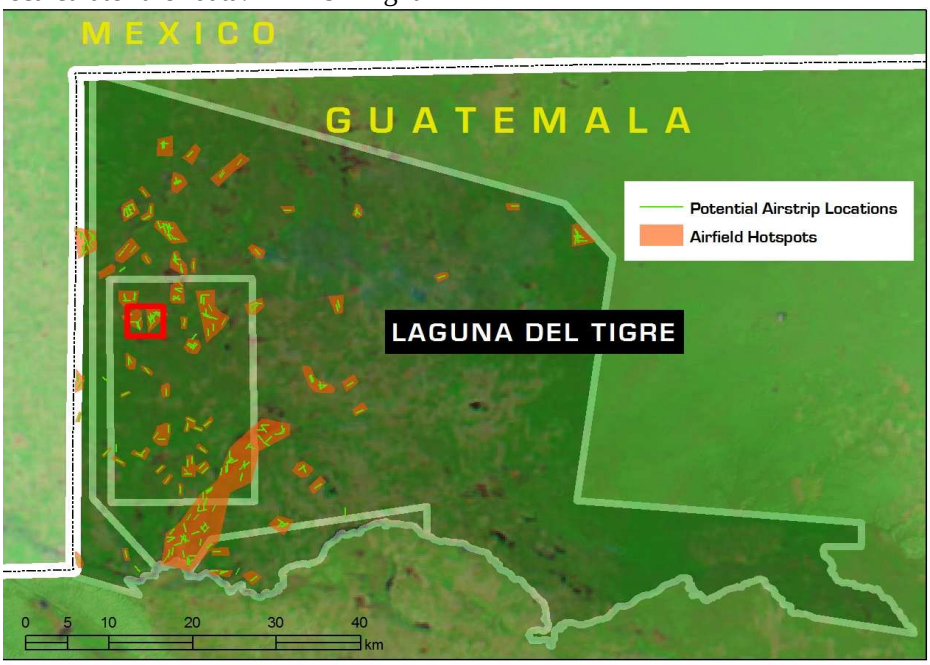
SLOPE & LAND COVER CALCULATION

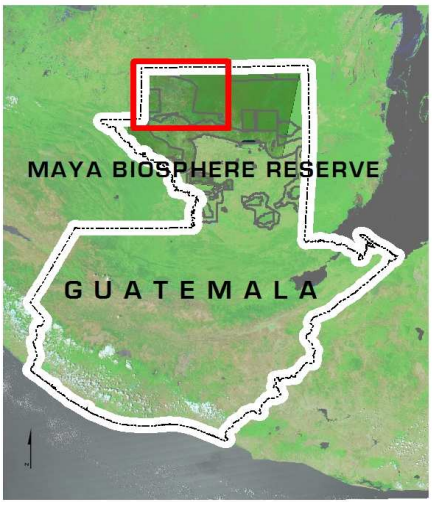
The reclassified values of both slope and land cover were multiplied to identify pixels with both slope < 2% and appropriate land cover/ground moisture for building an improvised airstrip. Pixels values 1, 5, and 15 from the map algebra were retained for further analysis [Fig. 11], with 1 as the highest rank (slope <2% and light or full clearing) and 15 (slope < 2% and light vegetation) as the lower rank for airstrip probability. However, owing to stringent parameters for values assigned to land cover, all ranks 1 through 15 represent very real possibility of extant or future airstrips.

IDENTIFY AIRSTRIP OPPORTUNITY

The last phase of analysis involved visual scanning of pixel clusters ranked 1-15 to identify clusters that provided enough area to locate the minimum suggested requirements for an airstrip in open and wooded terrain. These parameters are: a minimum of 3200 ft (975.36 m) in length, 75 ft (22.86m) width in open, grassy terrain or 200 ft (60.96m) width in wooded terrain. Airstrip lines were digitized at the minimum suggested length and with width buffers set to

11.5 m on each side and 30.5 m on each side to account for possible variation in minimum width. While not every single airstrip opportunity was identified, "hotspots", or terrain with multiple opportunities for airstrips, were. It should be noted that opportune pixel clusters were interrupted by intermittent "impossible" pixels. For the most accurate assessment of airstrip opportunity, it would be important to double check these "impossible" pixels and to potentially recalculate the data. This might include allowing for a slightly larger slope (i.e. 2.5%) or to check the "impossible" pixel against the original Landsat 4, 3, 2 imagery to verify that the pixel was appropriately classified with respect to land cover. The identification of broader "hotspots" and actual geographic locations of specific airstrips intends to provide a simple compensation for the aforementioned uncertainty in the final classification. Figures 12 and 13 demonstrate the final outputs.





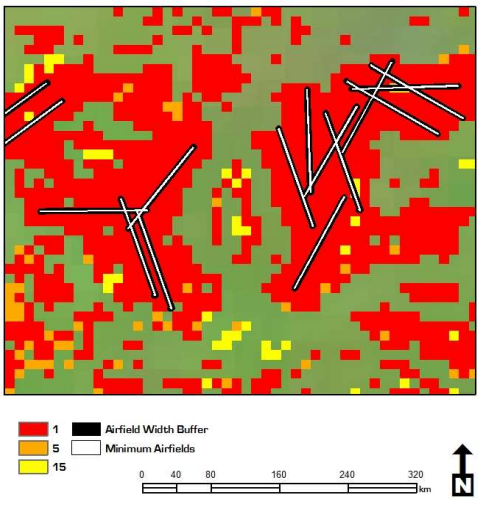


Fig. 12 (above) and 13 (below) Digitized potential airfield locations, based on presence of pixel clusters valued 1-15. Airfields are shown with the minimum requirements for open, grassy terrain and with a width buffer for wooded terrain. There is clearly ample for room for all manner of illicit airstrip in the detail image in the lower left. Such zones have been identified as "hotspots" with digitized polygons.

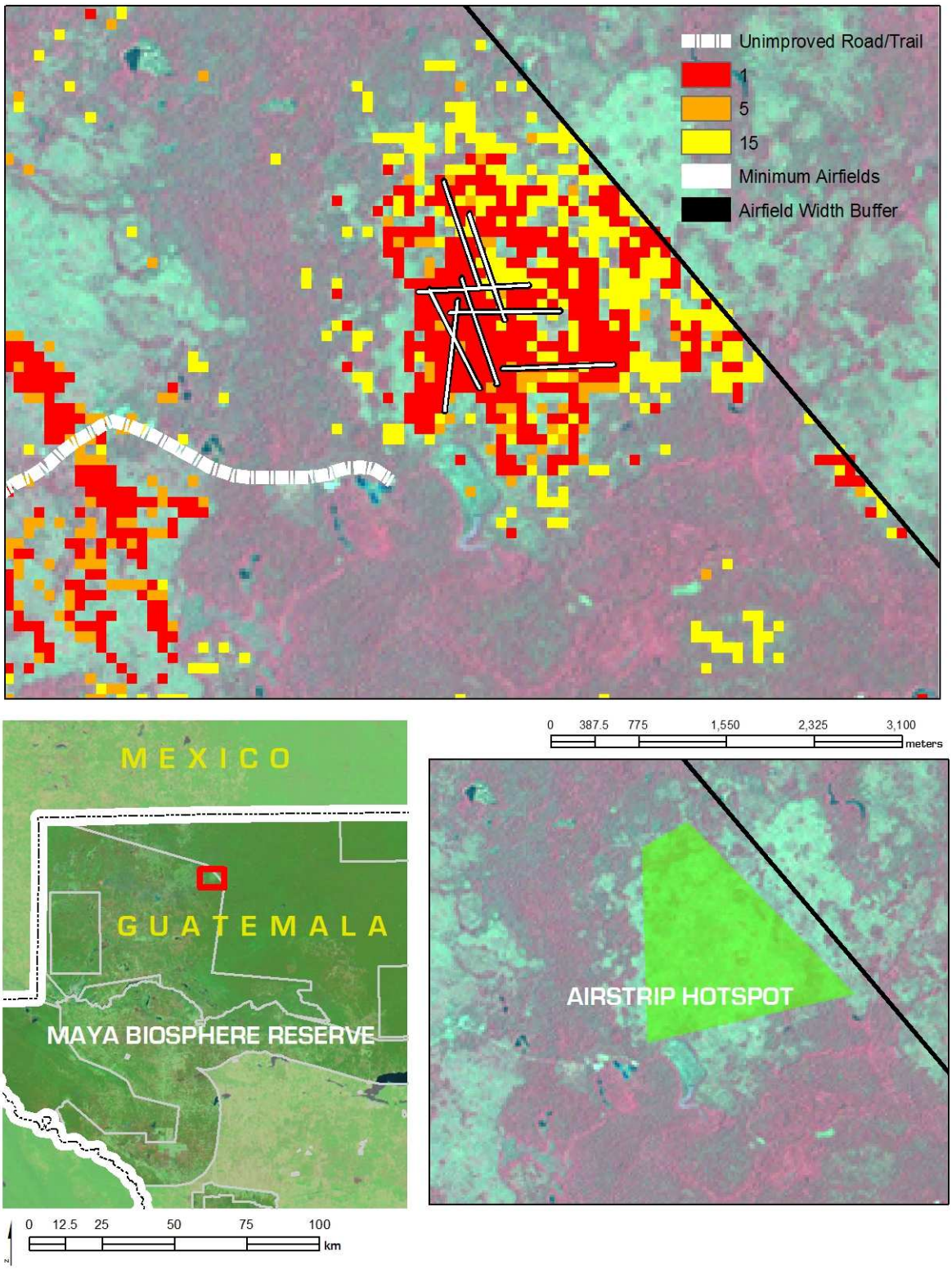


Fig. 13 The upper image shows the possibility of digitizing unimproved roads, visible in the infrared color satellite image, and linking these to airstrip hotspots. This spectral cluster on the periphery of Laguna del Tigre is prime for security investigation.

CAVEATS

The short timeframe of this capstone project and especially the limitation to public geospatial data confines the ability for this analysis to meet high standards of accuracy or timeliness for Guatemalan Special Forces. Analysis and tactical planning could be significantly improved with more current imagery as well as digitization of park infrastructure, as rudimentary as it may be. There is much licit activity in Laguna del Tigre in recent years that remains to be tracked and mapped: recent investigations at sites of archaeological significance (El Peru) as well as biological research facilities (Guacamayas Biological Station) and tourist hostels (if any). In geospatially analyzing terrain of a largely (digitally) unmapped region, it is critical to identify legal and beneficial land usage to ensure there is no conflict of analysis.

FINDINGS & CONCLUSION

Although these findings are based solely on satellite imagery collected in 2005, they nonetheless suggest a reasonable method to objectively identify, prioritize, and—with the inclusion of digitized Laguna del Tigre trail maps—coordinate on-the-ground operations by Guatemalan Special Forces and/or to create a monitoring route for CONAP and conservation officials. Additionally, creation of a geographic visualization for securing Laguna del Tigre provides Guatemalan, Mexican, and U.S. forces alike with a common operational picture. While Guatemala security undertook an anti-contraband mission to Laguna del Tigre in March 2006, it is unknown how many clandestine airstrips were discovered and destroyed or what hearsay information the operations were based upon, let alone what potential zones remain unchecked. Indeed, with continuing deforestation in Laguna del Tigre, opportunities for contraband activities along its remote periphery have certainly increased since the imagery used for this analysis, acquired in 2005. Moreover, U.S. concerns for the narcotics-terrorism nexus operating in coordinated trafficking routes across Latin America, and for ultimate destination into the United States, makes the Guatemala-Mexico border a region of heightened and immediate concern. The Maya Biosphere Reserve, a protected, biodiverse landscape with significant archaeological remnants and species of flora and fauna demands special treatment in the fight against drugs, weapons, illicit migration, and organized crime training/trafficking. Geospatial analysis for detection of illicit activity in deforested terrain provides a non-invasive approach for international authorities to identify and intervene, or to provide Guatemalan officials with the necessary information to protect the borders of the Americas, her landscape, people and heritage.

Overall, this research suggests that the GEOINT tradecraft has tremendous opportunity to address and confront the most elusive, illicit activities in the most remote regions of the world.

REFERENCES

(2009). "Terrorism and Drug Routes." *Center for Threats Awareness.* March 27 2009. http://threatswatch.org/rapidrecon/2009/03/terrorism-and-drug-routes/

(2009). "Hezbollah uses Mexican Drug Routes in to the U.S." *The Washington Times.* March 27 2009. http://www.washingtontimes.com/news/2009/mar/27/hezbollah-uses-mexican-drug-routes-into-us/

(2009). "Border Lawmakers Fear Drug-Terrorism Link." March 7, 2009. http://www.house.gov/list/hearing/az02_franks/thehill_franks_border_Mar72009.html

(2008). "Fears of a Hezbollah Presence in Venezuela." *The Los Angeles Times.* August 27. http://articles.latimes.com/2008/aug/27/world/fg-venezterror27

(2008). "Guatemala boosts armed presence on border with Mexico." *The Los Angeles Times.* September 27.

http://latimesblogs.latimes.com/laplaza/2008/09/guatemala-ups-a.html

Chepesiuk, Ron. (2007). "Dangerous Alliance: Terrorism and Organized Crime." September 11. *Global Politician*. http://www.globalpolitician.com/23435-crime

Choi, Charles Q. (2008). "Drug traffickers and other outlaws endanger forest preservation efforts." *Scientific American Magazine*. October. http://www.scientificamerican.com/article.cfm?id=drug-traffickers-endanger-preservation

Ciment, James D. and Frank G. Shanty (2008), eds. *Organized Crime: From Trafficking to Terrorism, Vol. 1*. Santa Barbara: ABC-CLIO.

Craddock, Gen. Bantz J. (2006) "The Americas in the 21st Century: The Challenge of Governance and Security". FIU/AWC/SOUTHCOM Conference. February 2. http://www.southcom.mil/AppsSC/files/1UI1I1169398593.pdf

Craddock, John and Barbara Fick. "The Americas in the 21st Century: The Challenge of Governance and Security." http://www.dtic.mil/doctrine/jel/jfq_pubs/4208.pdf

Forero, Juan. (2008). "Venezuela steps up efforts to thwart cocaine traffic." *The Washington Post*. April 17. http://www.washingtonpost.com/wp-dyn/content/article/2008/04/06/AR2008040602158.html

Gato, Pablo and Robert Windrem. "Hezbollah Builds a Western Base." http://www.hacer.org/current/LATAM228.php

Grainger, Sarah (2008). "Budget Woes Weaken Guatemalan Army." Reuters. October 2. www.reuters.com/article/idUSN02263140

Hudson, Rex (2003). *Terrorist and Organized Crime Groups in the Tri-Border Area of South America*. Federal Research Division, Library of Congress. http://www.loc.gov/rr/frd/pdf-files/TerrOrgCrime_TBA.pdf

Sader, Steven and Daniel Hayes (2001). "Comparison of Change-Detection Techniques for Monitoring Tropical Forest Clearing and Vegetation Regrowth in a Time Series ." *Photogrammetric Engineering & Remote Sensing*. September 67(9):1067-1075.

Sader, S.A. C. Reining, T. Sever, and C. Soza (1997). "Human migration and agricultural expansion: a threat to the Maya tropical forests." *Journal of Forestry* 95: 27-32.

Sader, S.A., D.J. hayes, M. Coan and C. Soza (2001). Forest change monitoring of a remote biosphere reserve. *International Journal of Remote Sensing* 22: 1937-1950.

Schmid, Alex (2008). "Drug Trafficking, transnational crime, and International Terrorist Groups." In *Organized Crime: From Trafficking to Terrorism, Vol.* , ed. by James D. Ciment and Frank G. Shanty. 342-345.

http://www.wikihow.com/Build-a-Grass-Landing-Strip

IMAGE SOURCES

Fig 1. http://www.militaryphotos.net/forums/showthread.php?77266-Today-s-Pic-s-Sunday-April-02-2006

Fig. 2 http://www.npr.org/news/images/2007/oct/12/suspect_tracks_map2006.jpg

Fig 3. http://www.parkswatch.org/parkprofiles/maps/ltre_eng.gif

APPENDIX

Data Specifications and Sources

Raster Data

- SRTM 3" DEM, 30 m resolution. 2002. srtm_18_09.img. Source: http://edcsns17.cr.usgs.gov/EarthExplorer/
- 2005 Global Land Survey Satellite Multispectral Image, 15 m resolution. Landsat 5 ETM+ WRS-2, Path 020, Row 048, Coordinates: 17.3131, -90.2426, Acquisition date 2005-04-10. Entity ID: LE70200482005100ASN00 Source: http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp
- 2010 MODIS AQUA Satellite Base Map 7, 2,1 Band Combination, 250 m resolution. Acquisition date: 2010-01-07. Source: http://earthobservatory.nasa.gov

Vector

- National Park Boundary files for the Maya Biosphere Reserve and Laguna del Tigre. Consejo Nacional de Area Protegidas (CONAP) of Guatemala. Courteously provided by Fernando Castro, Director of CONAP, 2010-03-18. fercastro@conap.gob.gt
- Political Boundary Files. Guatemala/Mexico border, boundaries for the Petén department and its municipalities. www.gadm.org
- Other country files www.gisdatadepot.org (Digital Chart of the World and Gazetteer).