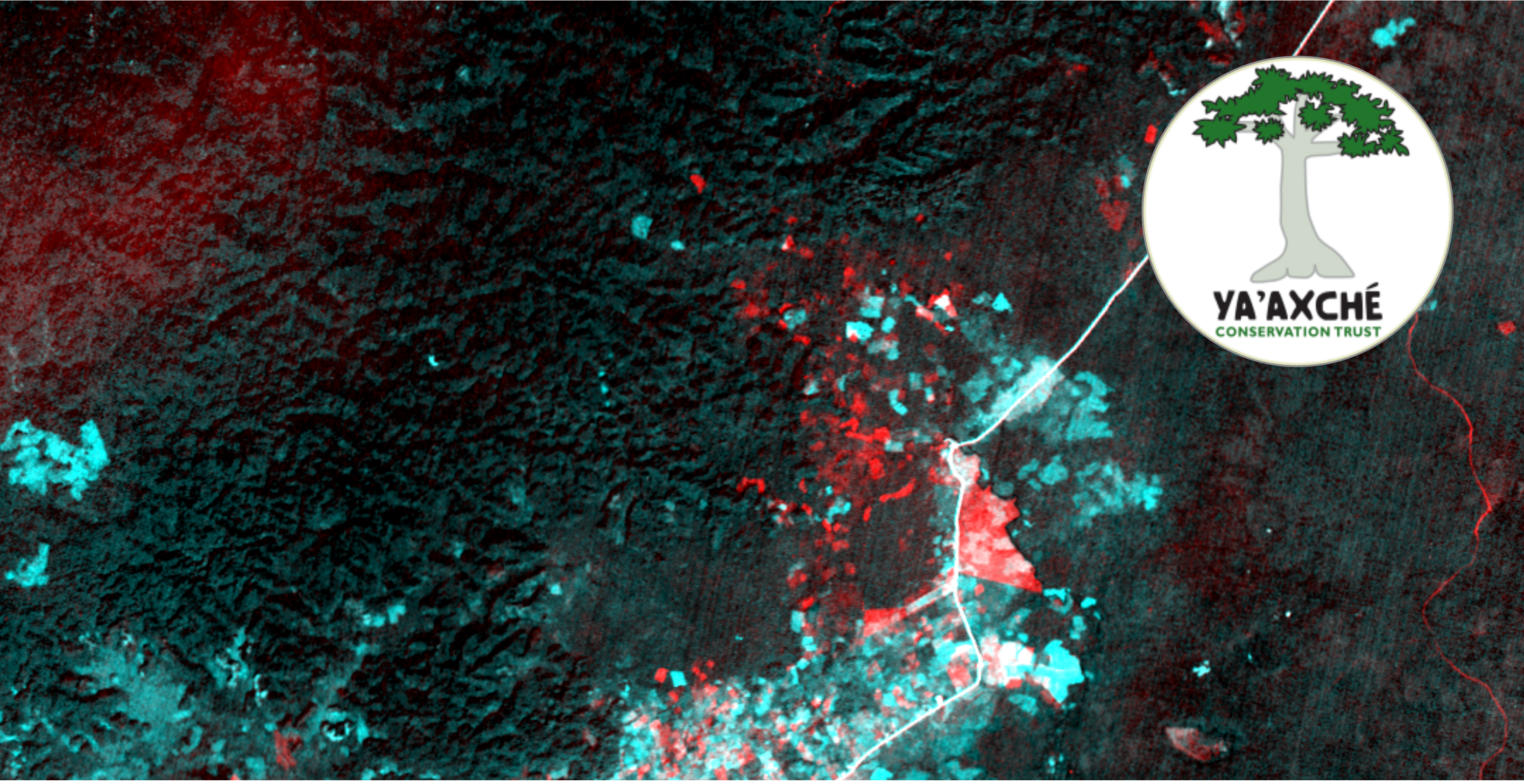

Land Use/Land Cover Change in the Maya Golden Landscape: 1980-2012

The Planet Action Project

May 2011 to August 2012

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List of acronyms

MGL	Maya Golden Landscape
CRFR	Columbia River Forest Reserve
DRFR	Deep River Forest Reserve
GSCP	Golden Stream Corridor Preserve
LULC	Land Use/Land Cover
ILM	Integrated Landscape Management

Introduction

Biodiversity Conservation cannot rely solely in the creation and maintenance of protected areas, it must also take into account the needs and development aspirations of the communities living around and within the protected areas (Mora & Sale, 2011). Our study has taken place in the context of the Planet Action Project, which has as an ultimate goal to come up with Integrated Landscape Management (ILM) strategies, that should translate into measures that foster Biodiversity Conservation through local communities sustainable development.

The Planet Action Project intends to monitor Land Use/Land Cover (LULC) change in the Maya Golden Landscape (MGL), a highly forested area within the Maya Mountain Marine Corridor (Toledo Province, southern Belize), and, therefore, an important component providing ecological connectivity between the Maya Mountain Massif, the lowland plain forests and the coastal ecosystems.

Belize has been recognized as a highly forested country (2010 United Nations Environment Program-funded GEO Belize national report), with a total forest cover of 62.7% of its total territory by February 2010 (Cherrington, 2010). In this study, we will try to assess the influence of Modern Mayan Agricultural techniques in the shaping of the Landscape of southern Toledo during the last 32 years (1980-2012), especially focusing in changes in extent and nature of its forest cover.

Toledo and Modern Mayan Agriculture

The district of Toledo in southern Belize is unique for its environment and for its culture, presenting high varieties of both ecosystems and ethnicities. In Ya'axché Conservation Trust, we focus in broadleaved forest dominated ecosystems, in which K'ekchi and Mopan maya communities have been installed for the last centuries. These generally start with a patch of forest being cleared through *slash and burn* (trees are knocked down and burnt) and the resulting land being cultivated with different crops. The main staples are corn and beans, and additional crops are rice, cassava, coco yam, plantains, banana, pumpkin, pepper, calaloo and ockra. A plot will be used until the farmer detects a decrease in productivity and it will be left to regrow natural vegetation for several years, bringing nutrients back to the soil for a following cultivation. This regrowth period is called *fallow period*, and, traditionally, it lasted bewtween 10 and 12 years, so soil had enough time to regain fertility. A farmer will normally have several plots so that he can establish a rotation between them, having one active plot and several plots in fallow. However, in the last decades, due to population increase and shortage of lands, a farmer may use patch of land successively without natural regrowth for longer periods than in the past, which sometimes implies use of organic and non-organic fertilizers. Another important consequence of this is reduction in fallow periods, letting soil less time to regain its fertility.

This has translated into more numerous and shorter agricultural cycles. In the past, farmers used to plant corn only once a year, in May, and because the soil was rich in nutrients, production was high and could last until the following year. But, according to the local farmers, soil has lost fertility and yields have decreased in the last decades, and corn production in May doesn't last for a year anymore. That is why nowadays, most farmers cultivate corn twice a year, in May (slash and burn, known as Milpa, which uses fire to clear the vegetation) and in November, know as Mata-hambre, in spanish literally "Hunger kill", which doesn't imply the use of fire, and is also known as slash and mulch. Generally, slash and burn is applied to a full grown forest, either old growth forests or long fallow period forests, whereas slash and mulch is applied to a relatively young regrowing vegetation. Both Slash and burn and slahs and mulch can be applied to a same plot in a rotary way throughout the years. However, Slash and burn is a much more extended practice, as it gives the farmer less work (it doesn't require as much weeding) and it produces a more in the short term fertile soil (the combustion process releases potassium into the soil)

The combination of both techniques, slash and mulch and slash and burn, its rotary nature and the variable fallow period scenario have generated a very complex agricultural matrix in a mainly forest dominated MGL. One year old abandoned patches will be basically grass dominated, while 2 to 3 year old abandoned parcels will be bush and small tree dominated between 2 and 4 meters high. A 5 to 10 year old abandoned patch will have dense tree cover of thin trees that can reach 10m in altitude for fast growing species. There are also patches of 15 to 20m high trees, in areas where conditions are not good for agriculture, due to the slope gradient or the presence of rocks.

Modern Mayan Farmers are aware of the scarcity of land and the importance of keeping an agricultural plot productive for as many years as possible. To increase soil fertility some farmers are using legumous plants such as mocuna beans, pigeon peas and inga. This practice encourages slash and mulch and stabilizes farmers to use a plot of land successively. On plots like these agroforestry practices are being initiated.

Project Overall Goals

The Planet Action Project had 4 initial goals:

1) Obtain and map Land tenure data for the MGL
   Partially achieved
2) Demarcating boundaries of communities within the MGL
   Partially achieved
3) Land use classification system for the MGL
   Achieved
4) Land use change over time
   Achieved

During the development of the project, 2 additional goals were included:

5) Analyze deforestation patterns in the MGL
   Achieved
6) Assess human footprint evolution in the MGL during the last 32 years
   Achieved

Materials and Methods

Landsat image classification

The Landsat Multispectral scanner (MSS), Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) sensors have been recording images of the earth on board of the Landsat satellites since 1972. The Landsat images used in this study have been obtained thanks to Emil Cheerington and CATHALAC, who have shared radiometrically processed, mainly cloud free Landsat images with the following characteristics:

Table 1. Landsat image characteristics

Date	Satellite	Sensor	Spatial resolution	Spectral resolution	Path	Row
14/11/1980	Landsat 3	MSS	60m	0.5-0.8µm	19	49
28/12/1989	Landsat 5	TM	30m	0.45-2.35µm	19	49
28/3/1994	Landsat 5	TM	30m	0.45-2.35µm	19	49
28/3/2000	Landsat 5	TM	30m	0.45-2.35µm	19	49
27/1/2004	Landsat 7	ETM+	30m	0.45-2.35µm	19	49
28/2/2010	Landsat 7	ETM+	30m	0.45-2.35µm	19	49

Further pre-processing was carried out with the Landsat images, using the software ENVI 4.7:

- Spatial sub-setting of the 6 band images to the area of interest (MGL).
- Geo-reference the 2000 image using the Belize Roads 2010 shape file in the BERDS database (www.biodiversity.bz), with projected coordinate system UTM 16N, WGS84.
- Co-register all of the other scenes with the 2000 image, obtaining a spatial match between 2 consecutives scenes (< 1 pixel error) in order to be able to conduct the multi-temporal study.
- Layer stack the bands corresponding to consecutive scenes, that is 1980-1989 (9 bands total), 1989-1994 (12 bands), 1994-2000 (12 bands), 2000-2004 (12 bands) , 2004-2010 (12 bands) and 2010-2012 (12 bands).

The classification process itself was performed using ENVI 4.7. It consisted in opening the 2-date layer stacks in an 11,5,5 (RGB) visualization (infrared bands). In this way, areas that were dark in the first date and bright in the second date will appear in varying tones of red. Thus, forest clearance would appear red. Areas that were forest in the first date and cloud in the second date would appear a deeper or brighter red. Areas that cleared in the first date and vegetated in the second date appear as blue. Areas cleared in both dates will appear white. Areas that were water in the first date and sand in the second date would also appear deep or bright red.

In this way, and with the use of the 4,5,3 (RGB) visualization of the 2 separate dates next to the 11,5,5 (RGB) visualization, training areas were designed according to the legend described in the next section of this study. Visual interpretation and previously existing classifications (Cherrington 2010, Meerman 2010, Meerman Ecosystem Map 2004, King et al. 1986, Land Use Change Map 1989-1992) were used to create the training areas.

Before using the training areas for the supervised classification, the separability of these classes on the different 2-date stacks was assessed through the Jeffries-Matusita and the Transformed Divergence indexes. Training areas were redesigned if these indexes' values were not close enough to its optimal value (which is 2). We then proceeded to a supervised classification through the Maximum Likelihood method.

Once the classification was performed, post-classification procedures were applied. A majority analysis (3x3 Kernel size) was performed to change spurious pixels within a large single class to that class, thus simplifying the image, with an associated risk of losing information (although these scattered pixels might also be an error of the classification process). In the same way, obvious classification mistakes were manually corrected through the ENVI 4.7 Spatial Pixel Editor. A validation of the classification analysis was performed using digital files from Cherrington (2010), Meerman (2010) and the Belize Land Cover Map 1989-1992. Regions of interest were digitized over these files and were used as "Ground truth Regions of Interest" in the validation process. It must be pointed out that only the LULC types that were coincident in both this study's classification and the digital files used as ground truth have been validated. For the 2004-2010 and the

2010-2012 classifications, GPS points taken in 3 different ground truthing campaigns in the spring of 2012 were used as ground truths in the validations. For all the other classifications, LULC types present in this study's classification and not present in the ground truth digital maps have not been validated. These are *regrowth* and *shrubland* categories, which have been supervised in the post-classification process through manual editing of the classification results. Implications of this will be further discussed in this report.

In order to extract numerical data from these classifications, thematic rasters were vectorized and layer stacked. In this way, through attribute selection, the areas of the different land cover types were calculated for each of the classifications. In the same way, and in accordance to one of the objectives of this study, it was possible to determine, for each multi-temporal classification (except for the 1980-1989 one), what proportion of the deforestation had happened in the agricultural matrix and what proportion had happened in old-growth forest areas, as well as which were the transitions between agricultural related categories.

SPOT image classification

SPOT images have been provided by an ESRI grant in the context of the Planet Action Project. The same pre-processing has been conducted for the SPOT images that included a significant part of the MGL (three images, corresponding to the years 1989, 1999 and 2010. The pre-processing included: radiometric rectification (from Digital Numbers to reflectance values), spatial sub-setting of the images to our area of interest (MGL), geometric rectification (using the *BERDS Belize roads map 2010*), co-registration (with an error of less than a pixel), and layer stacking. Training areas where digitized and its separability checked. Maximum likelihood supervised classification was the method to classify the image, and a majority analysis (3x3 Kernel size) was performed to its output. A validation using the Landsat classifications adn the 2012 points were used to perform the validation of these classifications. All of the processes here mentioned were performed using ENVI 4.7. The following table shows the characteristics of the used SPOT images:

Table 2. SPOT images characteristics

Date	Satellite	Sensor	Spatial resolution	;pectral resolution
5/3/1980	SPOT	HRV	10m	0.5-0.89µm
27/4/1999	SPOT	HRVIR	10m	0.5-1.75µm
20/1/2010	SPOT	HRG	2.5m	0.5-1.75µm

Results

Land Tenure in the MGL

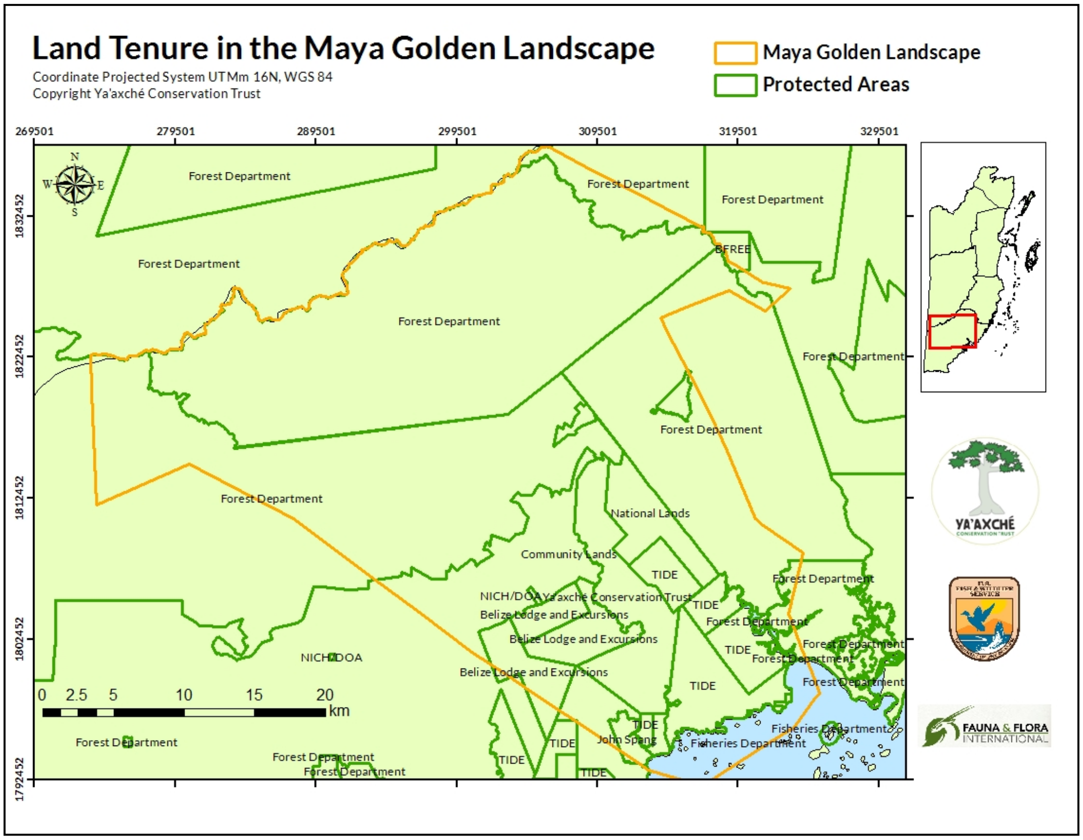

Figure 1. Land tenure in the MGL as of 2012.

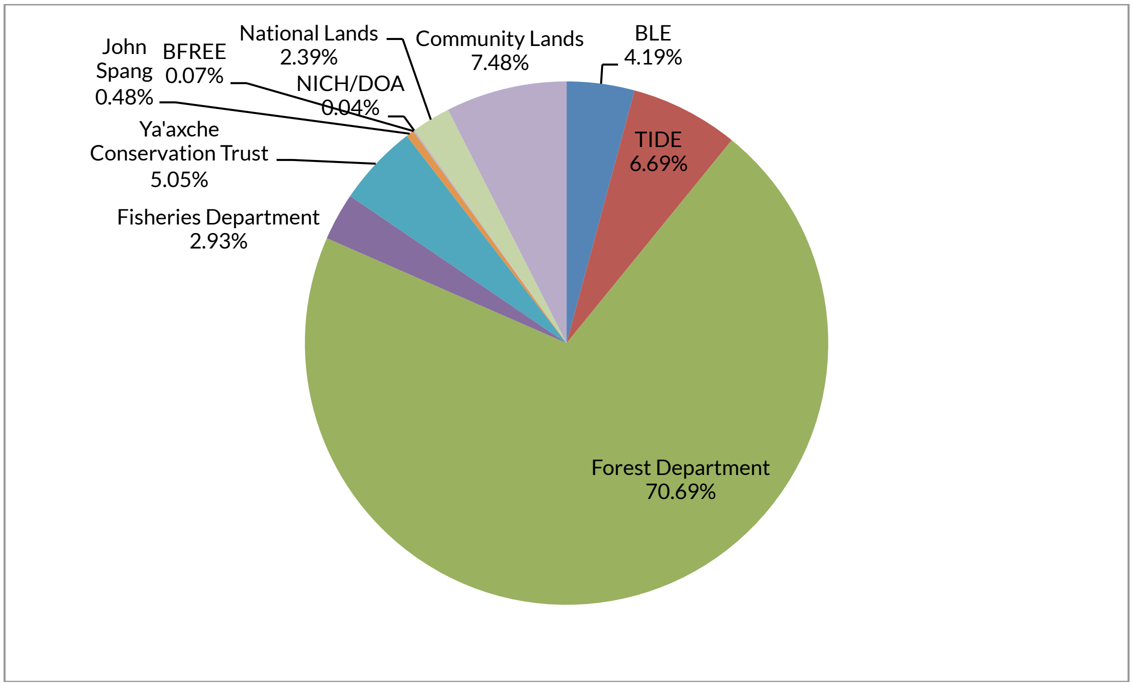

Figure 2. Percentage of Land tenure by different agencies and stakeholders in the MGL.

Demarcating boundaries of communities within the MGL

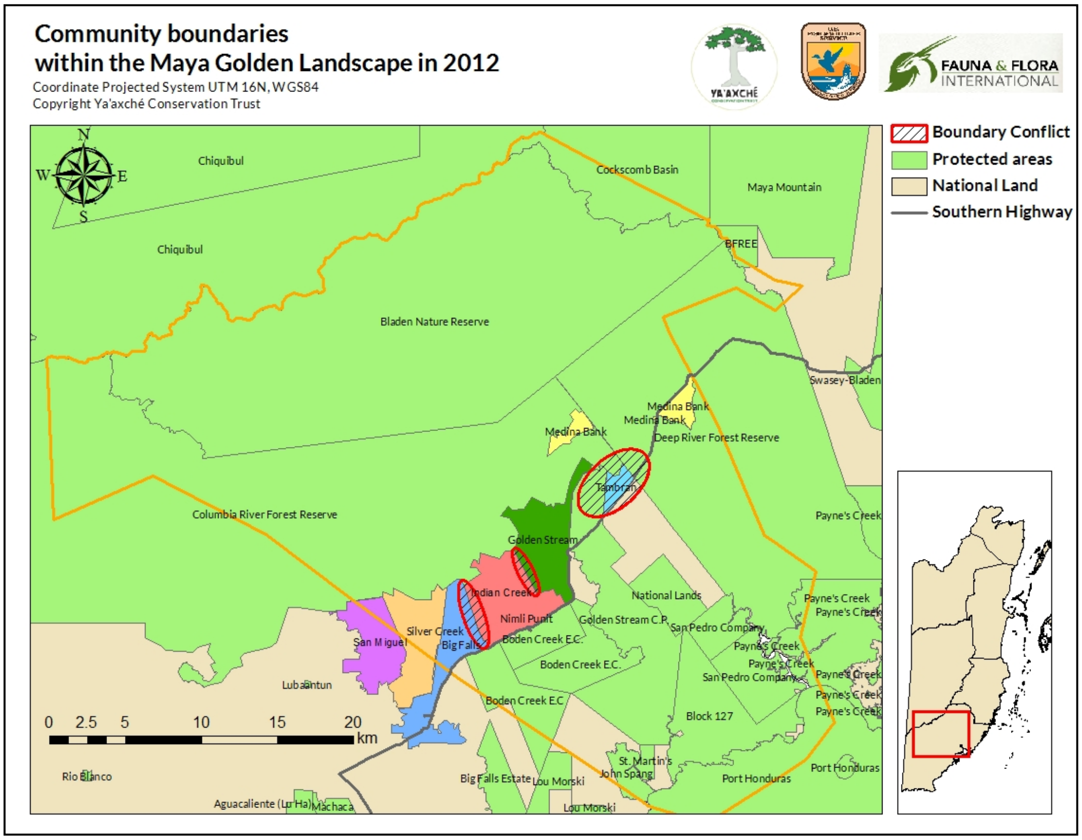

Figure 3. Community boundaries within the MGL.

The northern boundaries of communities within the MGL are mainly delimited by the CRFR boundaries. Medina Bank is completely delimited by Forest Reserves boundaries, CRFR and DRFR. Golden Stream presents a well defined northern boundary through the CRFR and a well defined eastern boundary through GSCP. However there is a conflict between Golden Stream and Indian Creek. Both of these communities have a southern boundary well defined by the southern highway and the Boden Creek Ecological Preserve. Indian Creek has also a conflict in its western boundary with Big Falls, whereas Silver Creek and San Miguel seem to have well defined and accepted boundaries with its neighbouring communities.

LULC Legend for the MGL

Forest: Four different vegetation associations fall under this category in this study: old-growth broad-leave forests in the CRFR and BNR, secondary broad-leave forests (locally known as broken ridge) and pine forests to be found in the MGL's lowlands, and regrowth wamil as a result of long fallow periods in the villages community lands.

Recent deforestation: Corresponds to areas that appear recently (that is in relation to the second date) completely or almost completely cleared. They can happen in forested areas or within the other agricultural classes.

Older deforestation

These are patches of forest that have been cleared for agricultural uses, but the time lapse between the 2 dates conforming every classification allowed for the plot to be cleared, planted, harvested and left to regrow, so that it doesn't appear completely cleared in the latest date, but with a certain vegetation cover, normally high grasses or a category similar to the *shrubland* (with the difference that in this case this category does imply change). They can happen in forested areas or within the other agricultural classes.

Shrubland

This land cover type appears in two different location in the MGL and arising of different processes: in grasslands/shrublands along the southern highway below the villages of Indian Creek and Golden Stream, and as a regrowth form of agricultural practices within the villages community lands.

Non-forest (for the 1980-1989)

Due to the radiometric nature of the Landsat 1980 image, it was not possible to distinguish a "Cleared in both dates" category in the 1980-1989 classification. Instead, "Cleared in both dates" and "Shrubland" categories seem to fuse in a single class that has been called "Non-forest".

Regrowth

This category corresponds to areas were there has been a clear agricultural abandonment. They were cleared in the first date and have suffered a natural vegetation regrowth in the second date. They also appear as regeneration after a wild fire.

Cleared in both dates

Corresponds to areas, normally urban, recurrently burned grasslands or treeless savannah like vegetation that appears as cleared in both dates of each stack.

Savannah

This category corresponds to the areas of eastern MGL, where large extensions of savannah like vegetation are to be found. Its evolution in time depends on induced fire regimes, as it is actively managed for the extraction of pine wood, but it is mainly conformed by low grass with very sparse tree cover.

Intensive citrus

Citrus plantations expanded throughout the Stann Creek and Toledo Districts of Belize during the 80's and the 90's, and the MGL wasn't an exception to this. This areas appear as large polygonal clearings that have seen an expansion within the last years, more specifically in the Golden Stream village, where citrus plantations appear within its community lands and also below the highway, in lands that now limit with the Boden Creek Ecological Preserve and the Golden Stream Ecological Preserve.

Mangroves

Ease to classify mangroves as a single separate class varied widely between different multi-temporal stacks. For that reason, and because they were not the main focus of this study, mangrove cover show in this classification correspond to the ones done by Emil Cherrington and CATHALAC in 2010.

LULC Change in the MGL

Landsat (1980-2012)

Table 3. Overall accuracies for the Landsat Classifications.

Period	Overall accuracy (%)
1980-1989	88.4
1989-1994	88.9
1994-2000	92.2
2000-2004	86.9
2004-2010	88.7
2010-2012	91.6

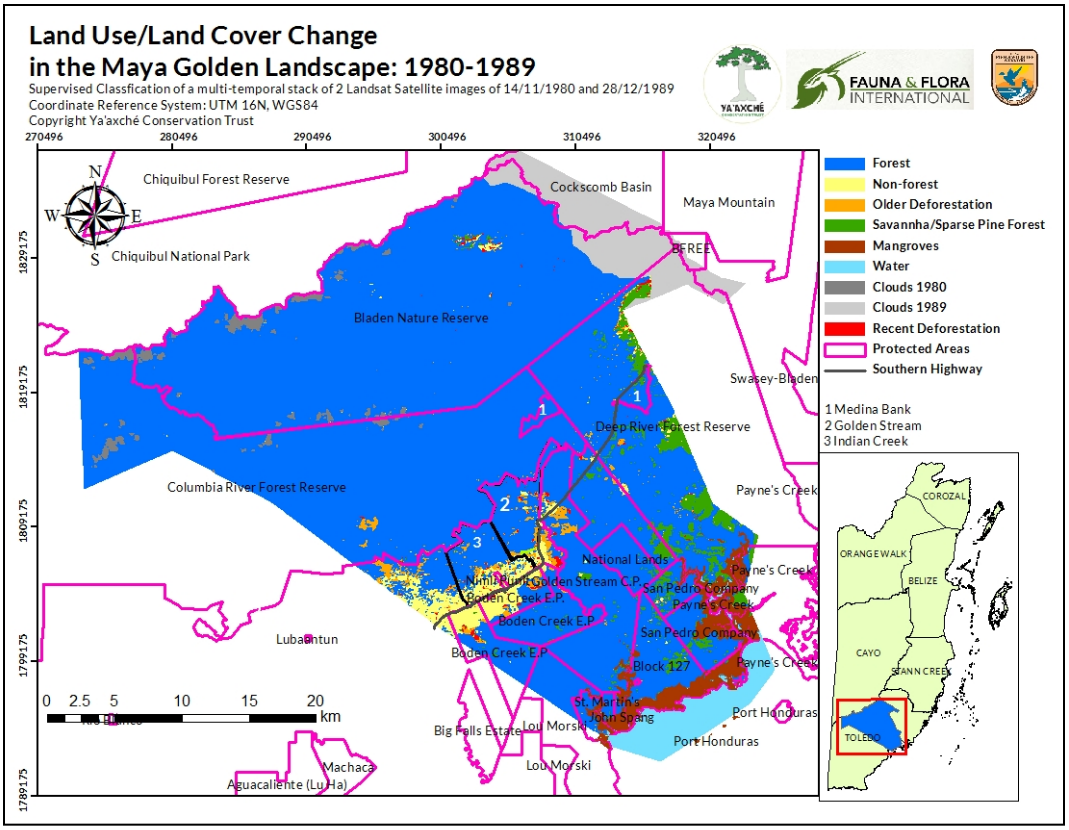

Figure 4. LULC Change in the MGL from 1980 to 1989

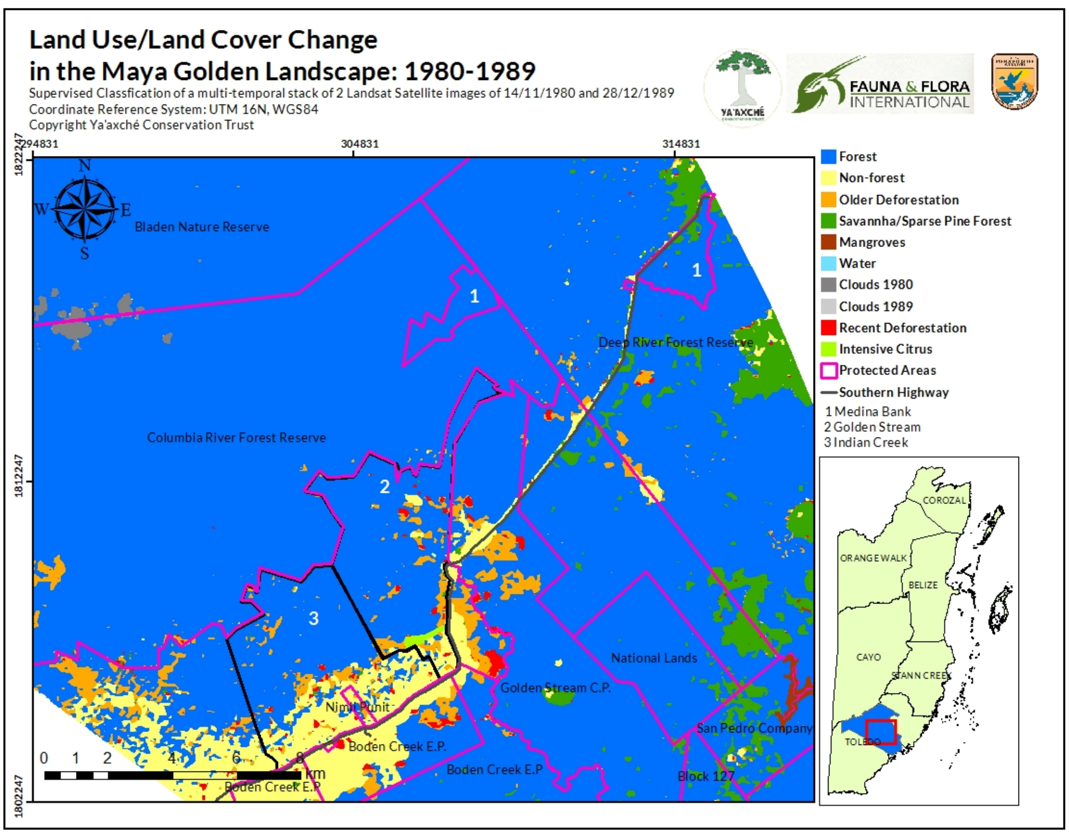

Figure 5. Zoom in of LULC Change in the MGL from 1980 to 1989.

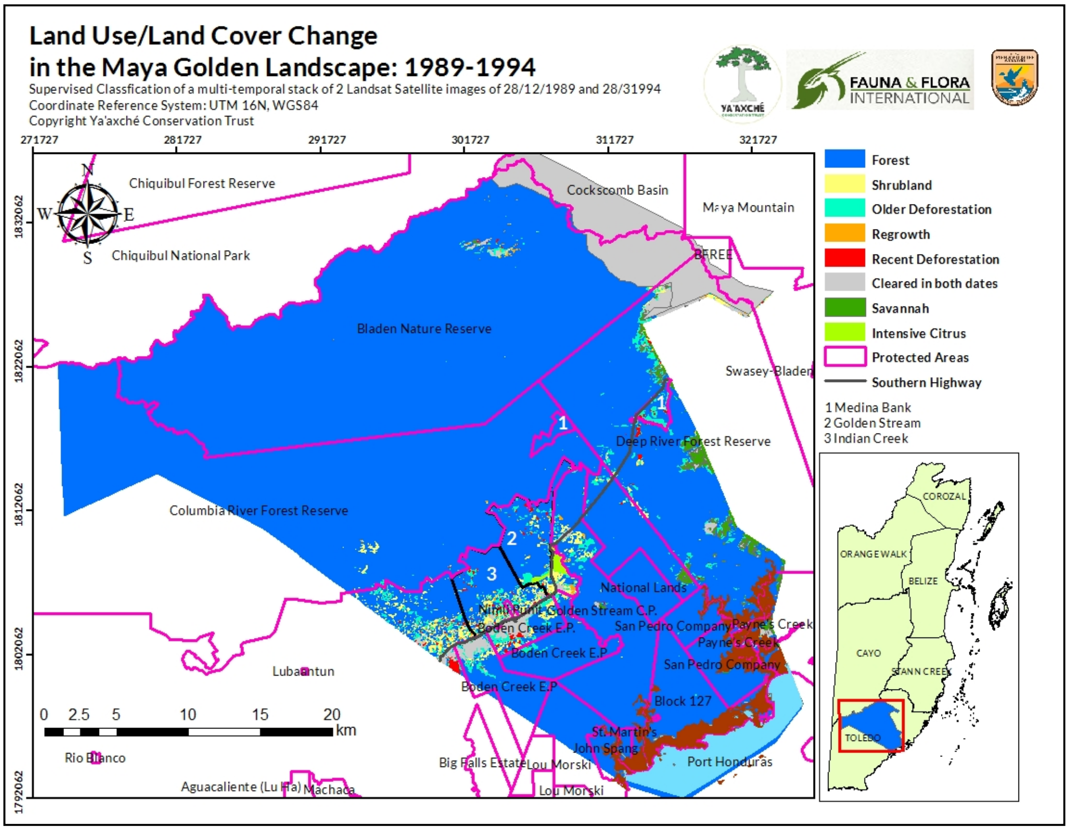

Figure 6. LULC Change in the MGL from 1989 to 1994

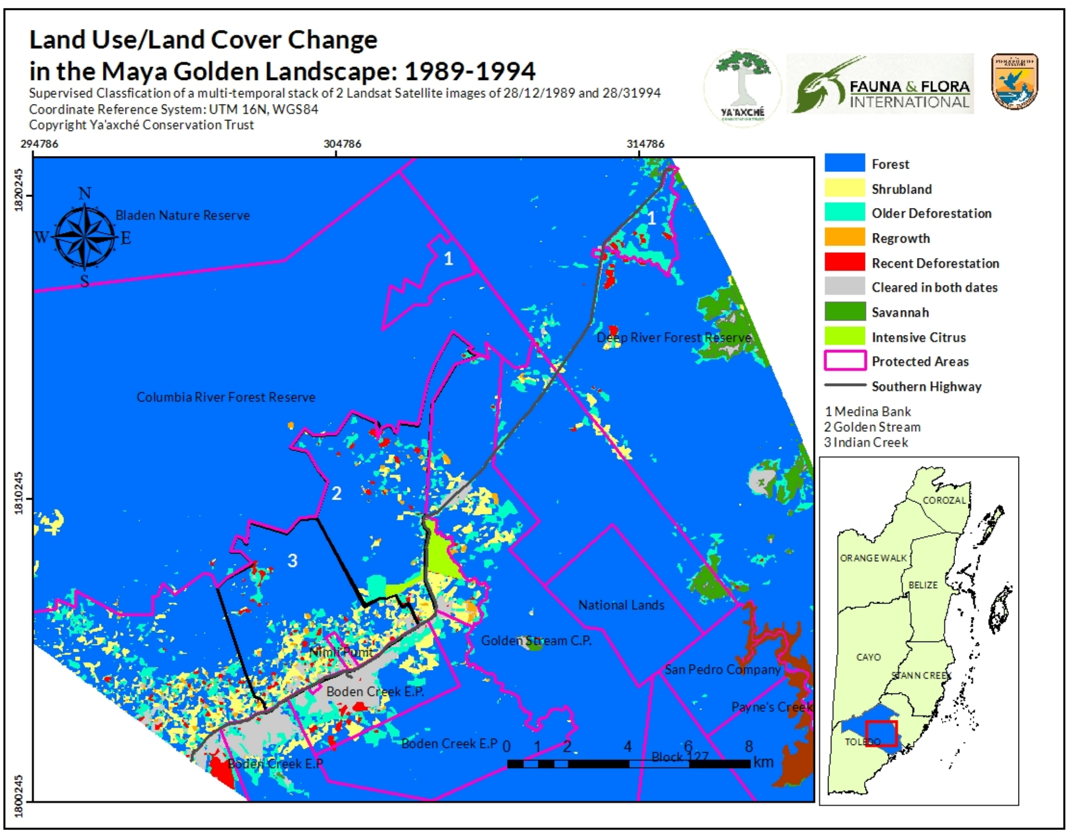

Figure 7. Zoom in of LULC Change in the MGL from 1989 to 1994

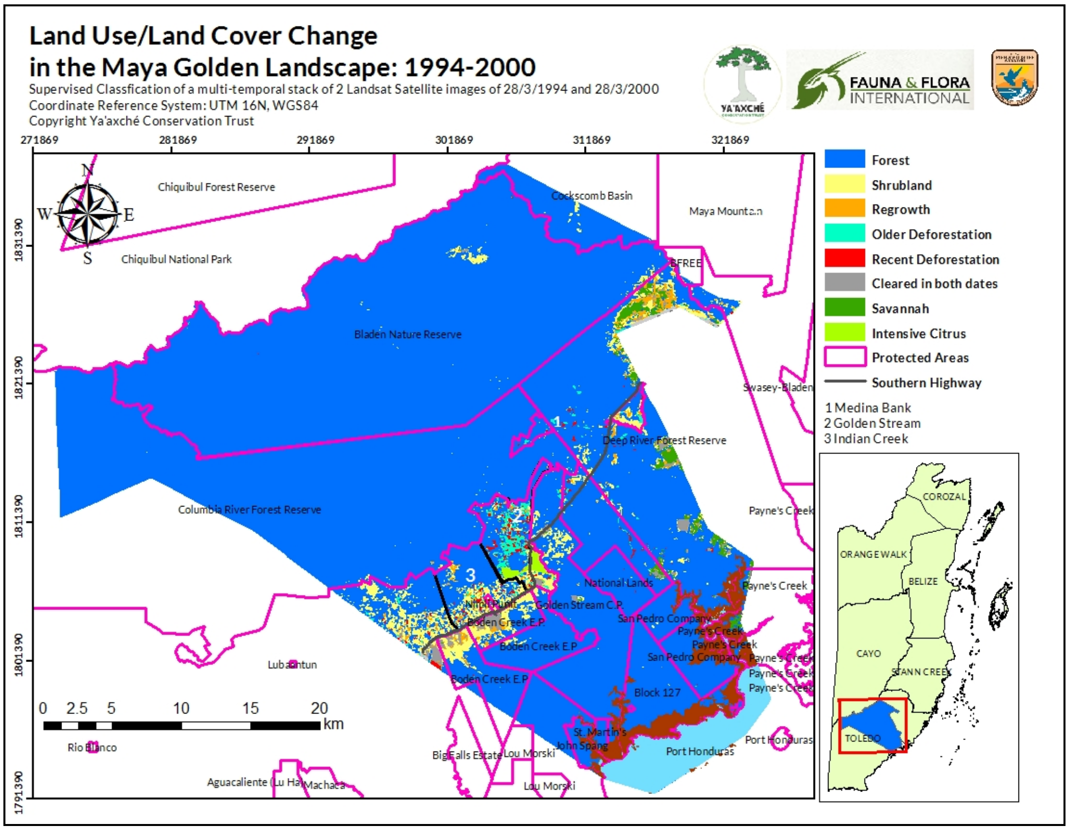

Figure 8. LULC Change in the MGL from 1994 to 2000.

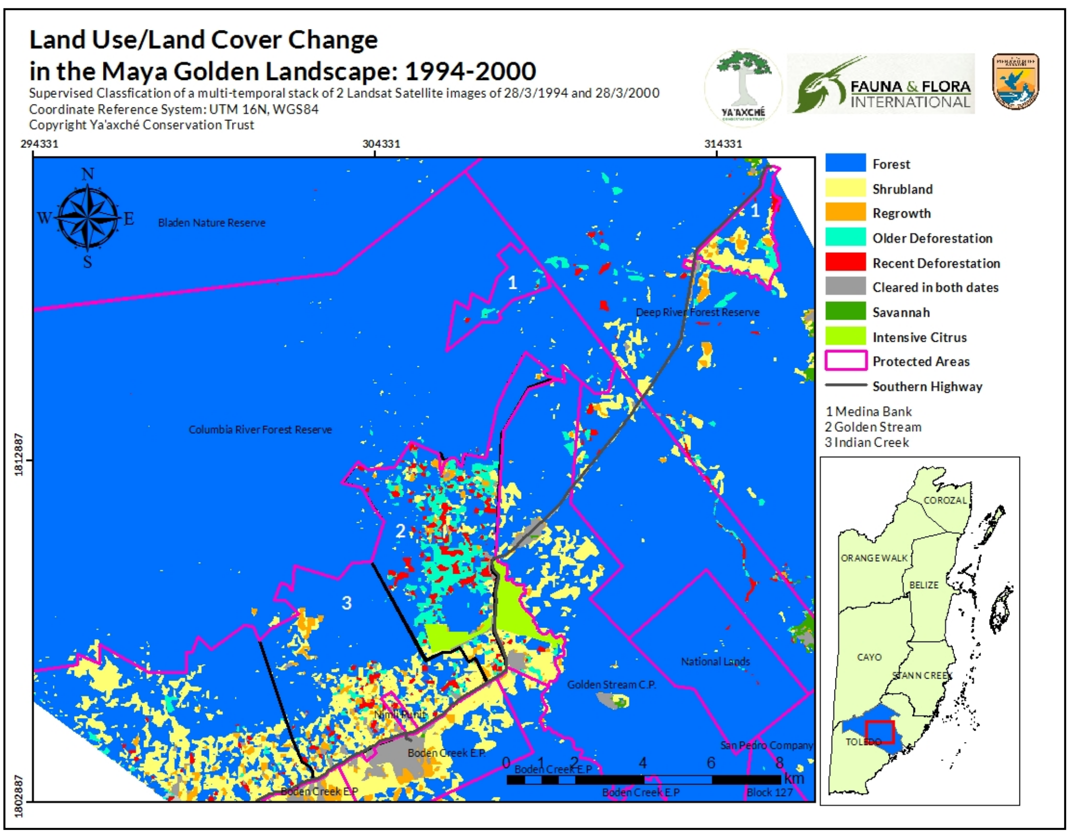

Figure 9. Zoom in of LULC Change in the MGL from 1994 to 2000.

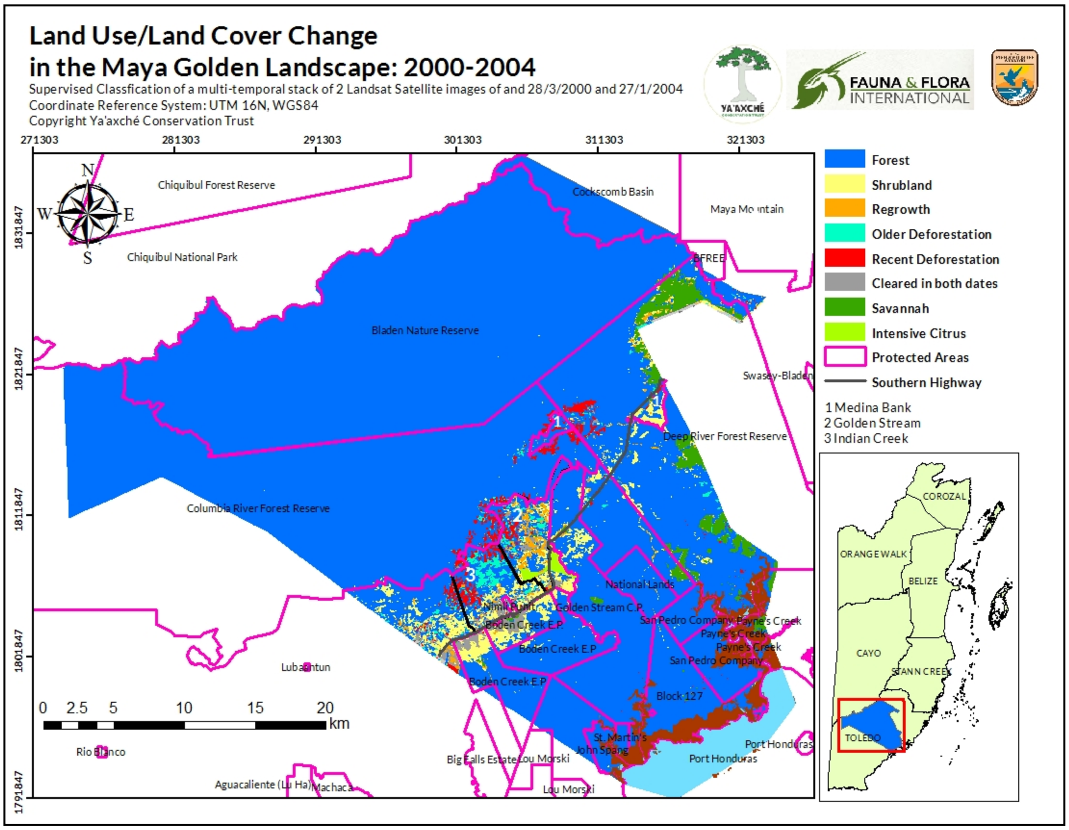

Figure 10. LULC Change in the MGL from 2000 to 2004.

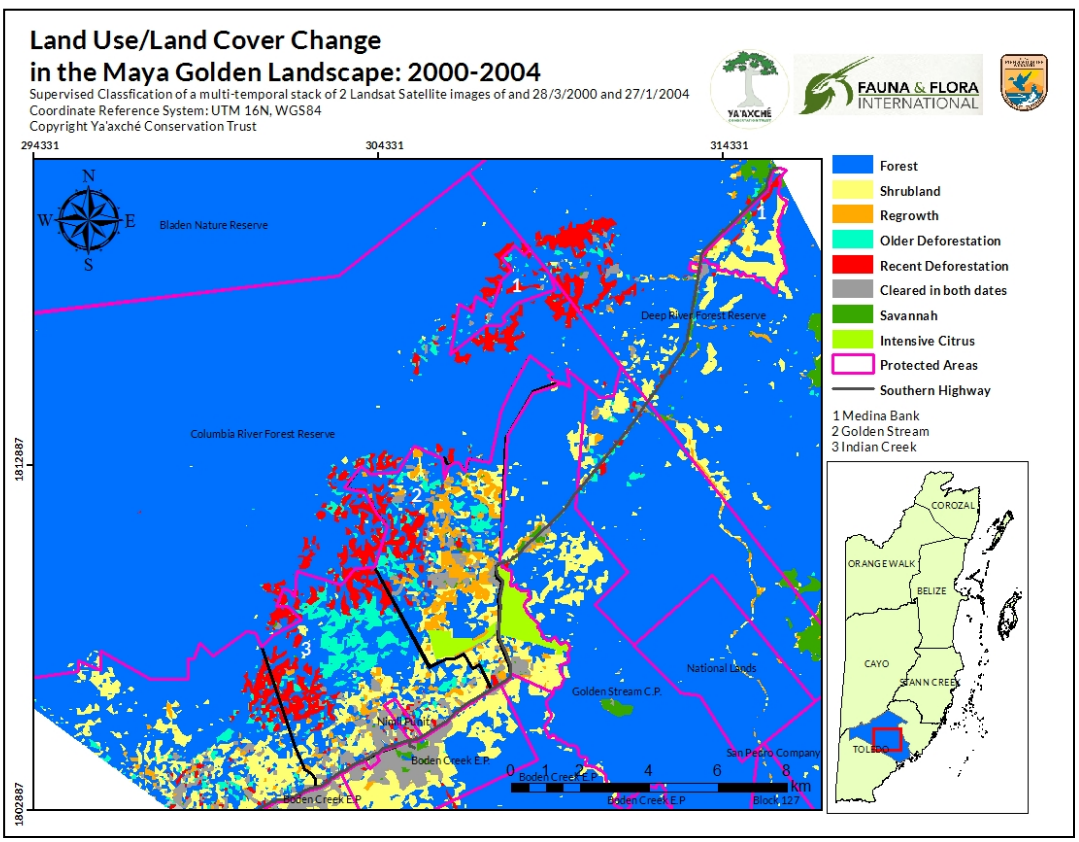

Figure 11. Zoom in of LULC Change in the MGL from 2000 to 2004.

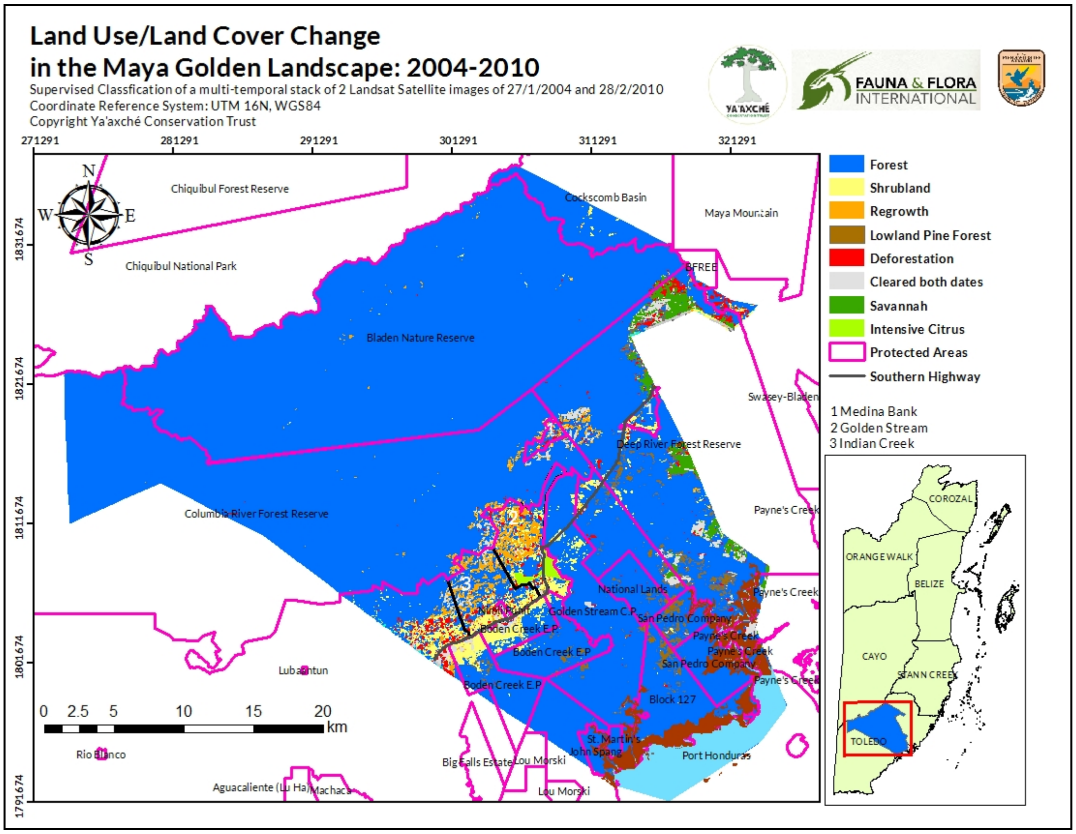

Figure 12. LULC Change in the MGL from 2004 to 2010.

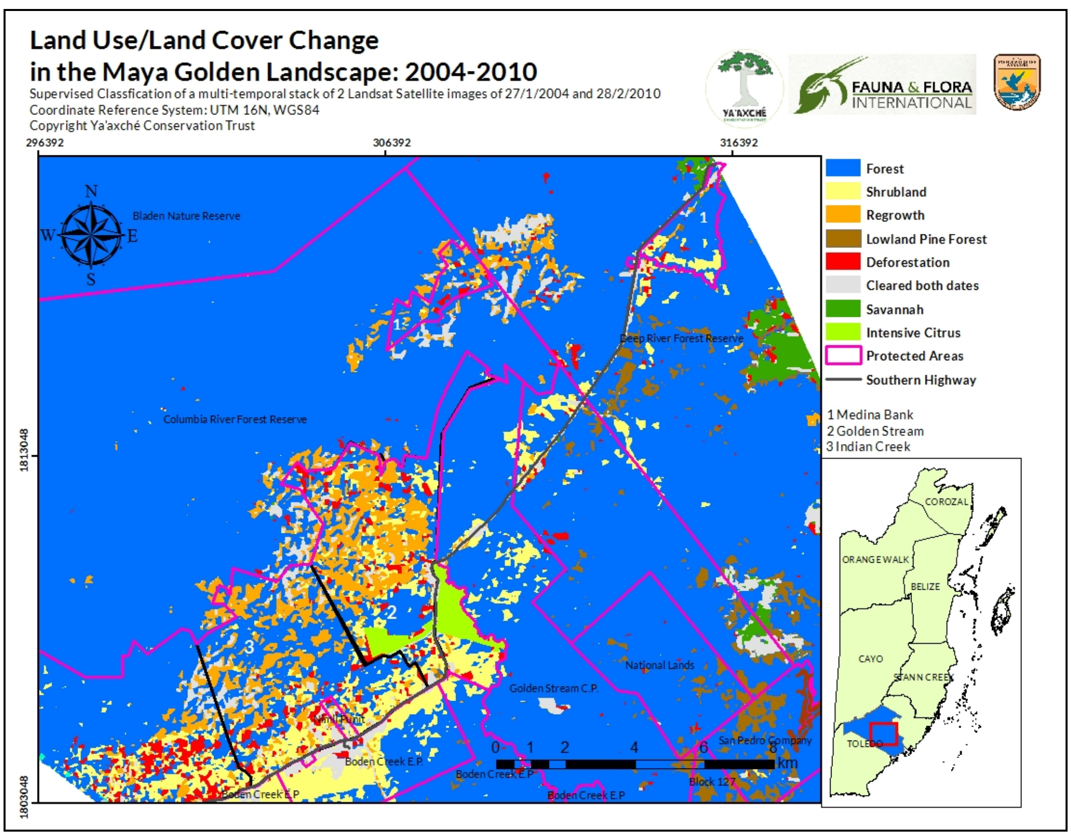

Figure 13. Zoom in of LULC Change in the MGL from 2004 to 2010.

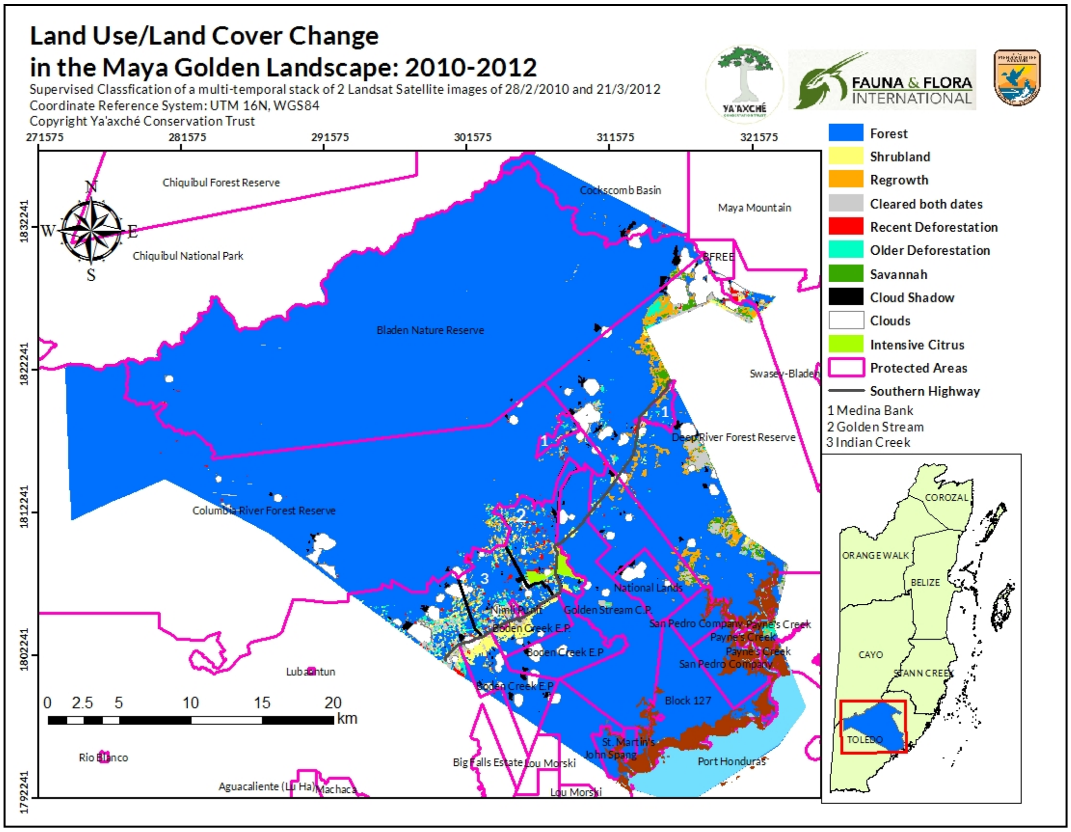

Figure 14. LULC Change in the MGL from 2010 to 2012.

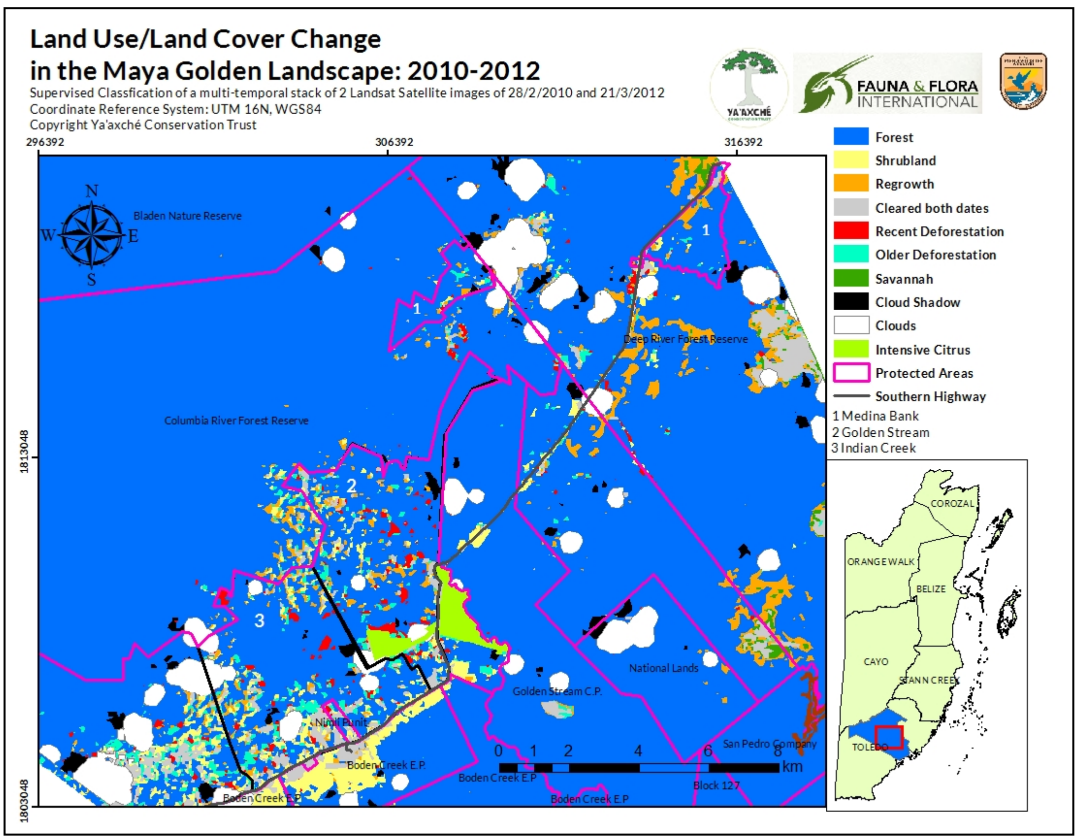

Figure 15. Zoom in of LULC Change in the MGL from 2010 to 2012.

Spot (1989-2010)

Table 4. Overall accuracies for the Spot Classifications.

Classification	Overall accuracy (%)
1989-1999	91.3
1999-2010	93.9

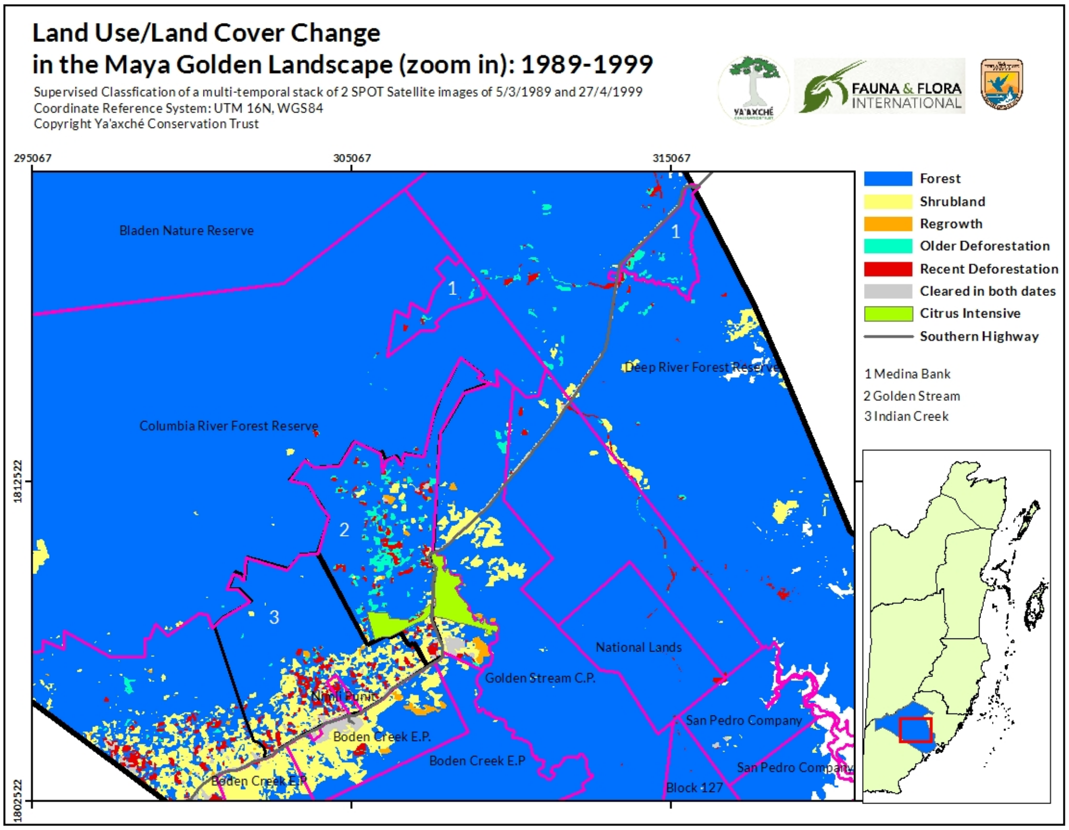

Figure 16. LULC Change in the MGL from 1989 to 1999.

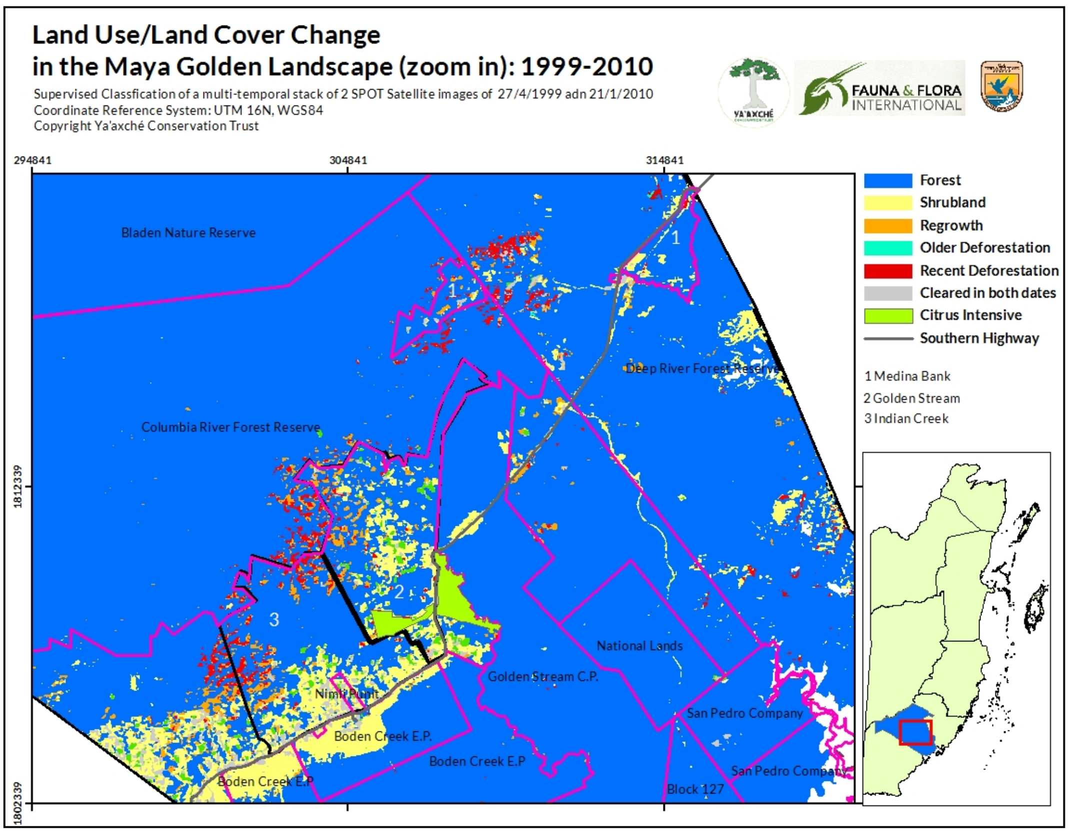

Figure 17. LULC Change in the MGL from 1999 to 2010.

Cumulative Human Footprint in the MGL

Figure X presents the evolution of human footprint in the MGL from 1989 to 2012 in a cumulative way. It includes the categories *cleared in both dates*, *recent deforestation*, *older deforestation*, *regrowth* and *shrubland*. As indicated in the introduciton, Modern Mayan agricultural practices will involve fallow periods which can see a deforested patch transform into a secondary forest in a few years. Once a forest patch has been transformed to agriculture, it will regrow going through different phases from grasses, to shrubland, to low wamil, to high wamil, whose trees can reach 10 to 15m high if left regrow for 10 to 12 years. However, this forest will have a very different structure from the original mature tropical rainforest (without defined forest layers emergent, canopy, subcanopy, understorey and forest floor), and that is why this cumulative perspective of LULC change is presented.

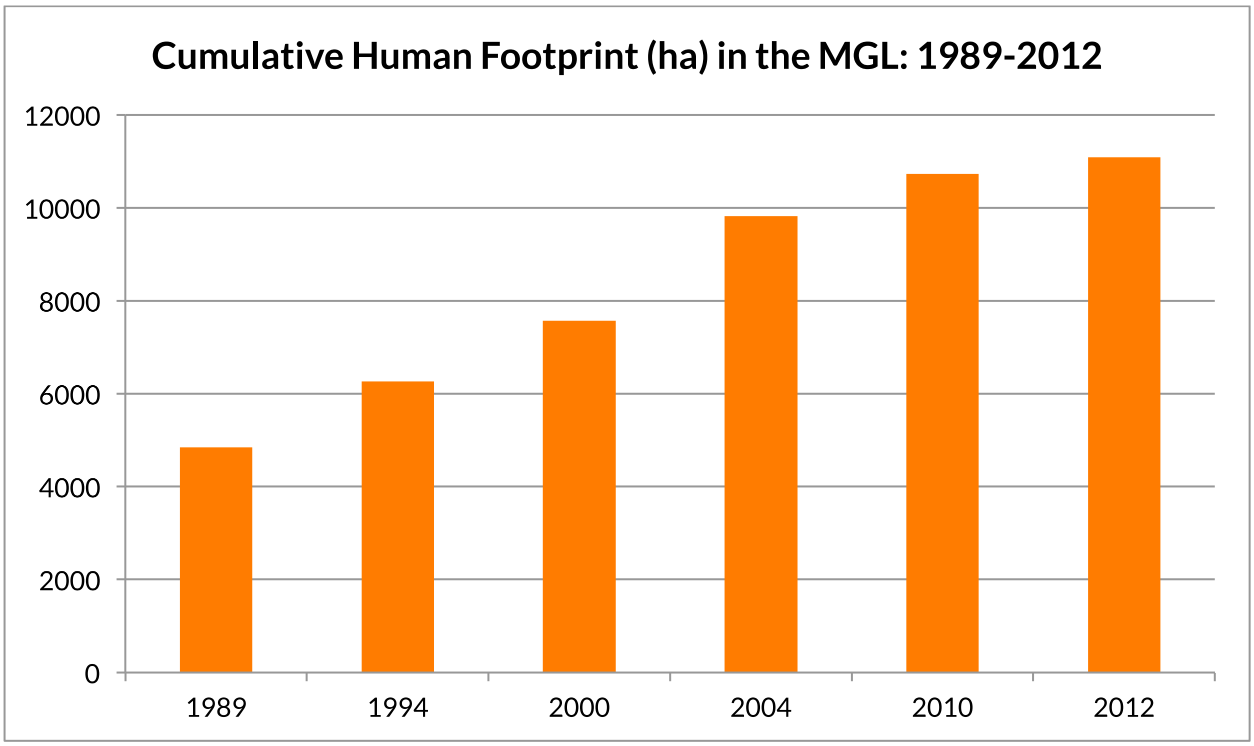

Figure 18. Cumulative Human footprint in the MGL

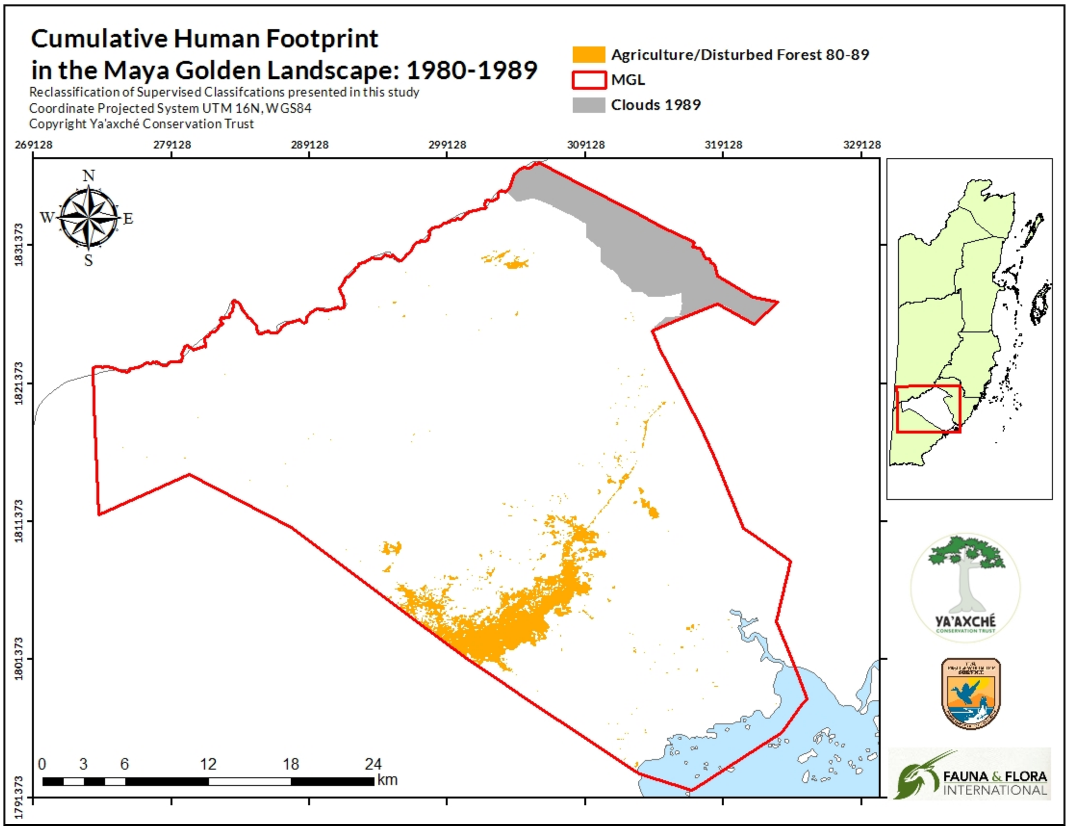

Figure 19. Cumulative Human Footprint in the MGL from 1980 to 1989.

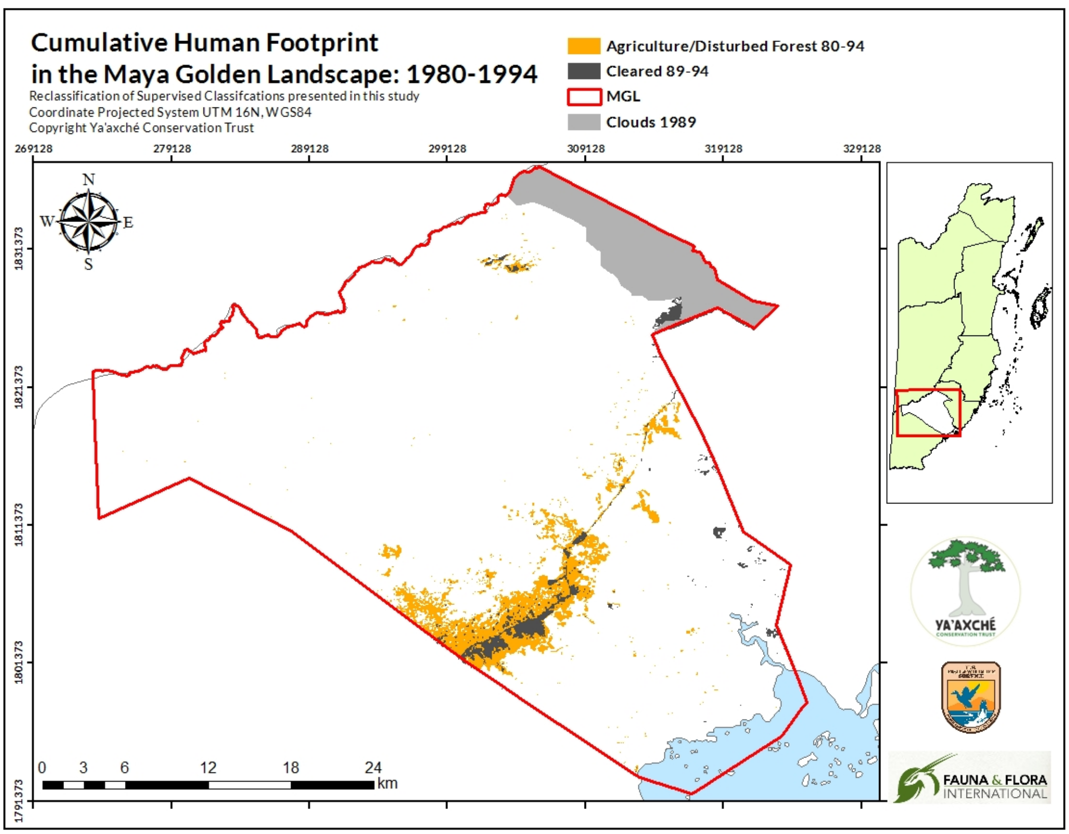

Figure 20. Cumulative Human Footprint in the MGL from 1980 to 1994.

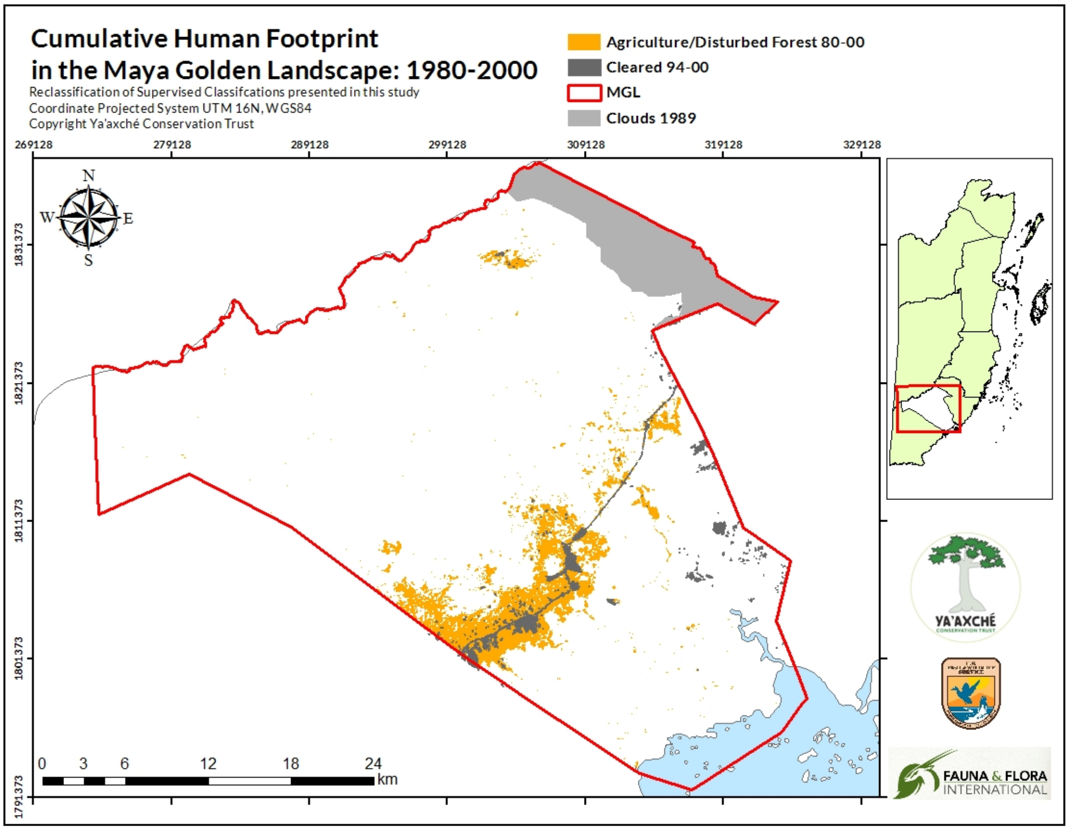

Figure 21. Cumulative Human Footprint in the MGL from 1980 to 2000.

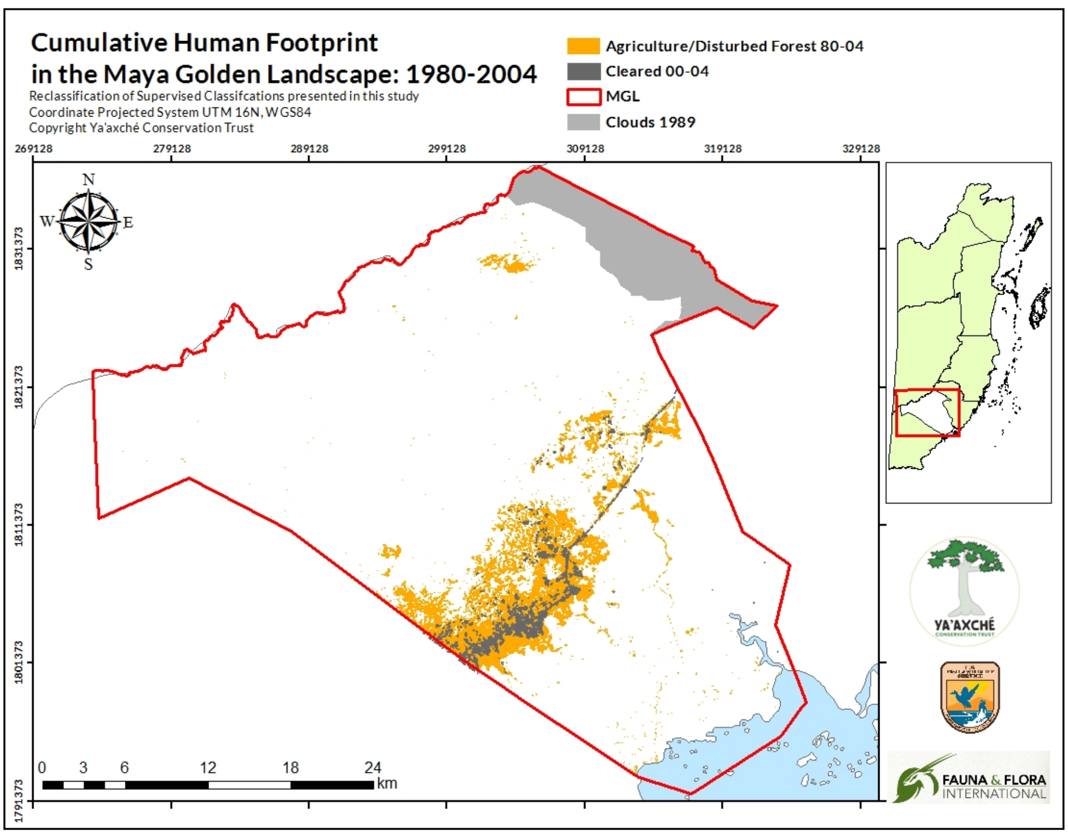

Figure 22. Cumulative Human Footprint in the MGL from 1980 to 2004.

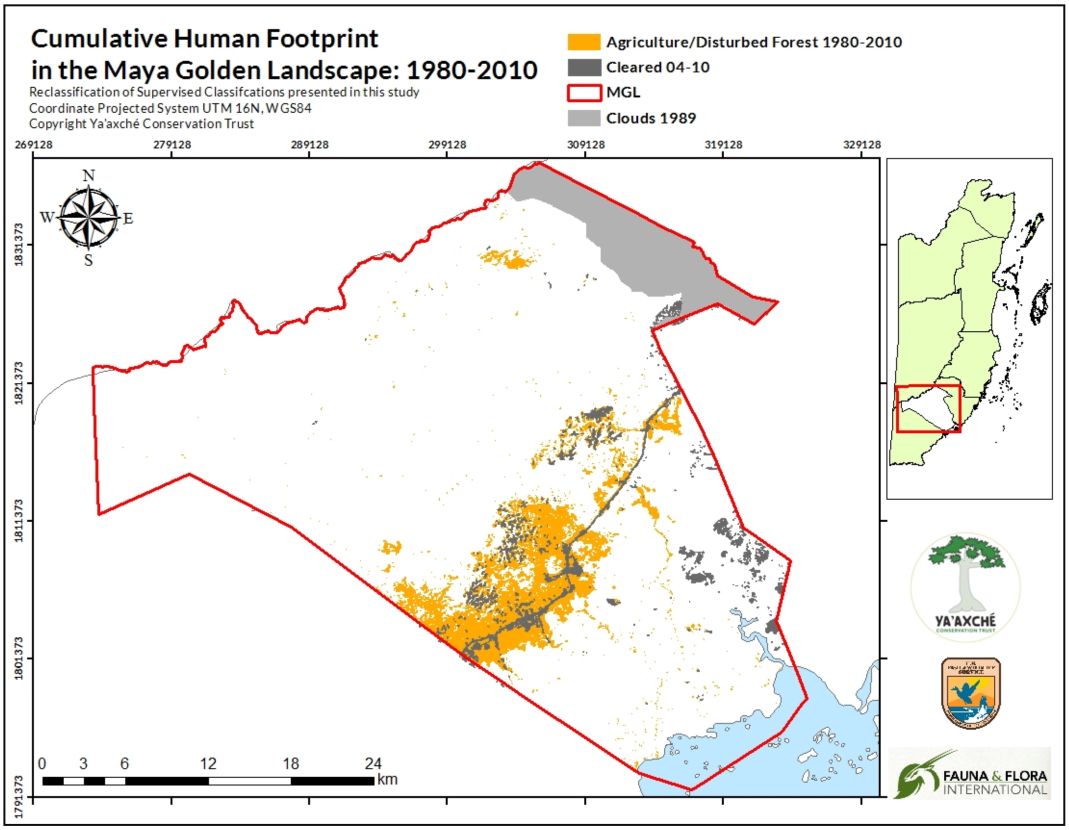

Figure 22. Cumulative Human Footprint in the MGL from 1980 to 2010.

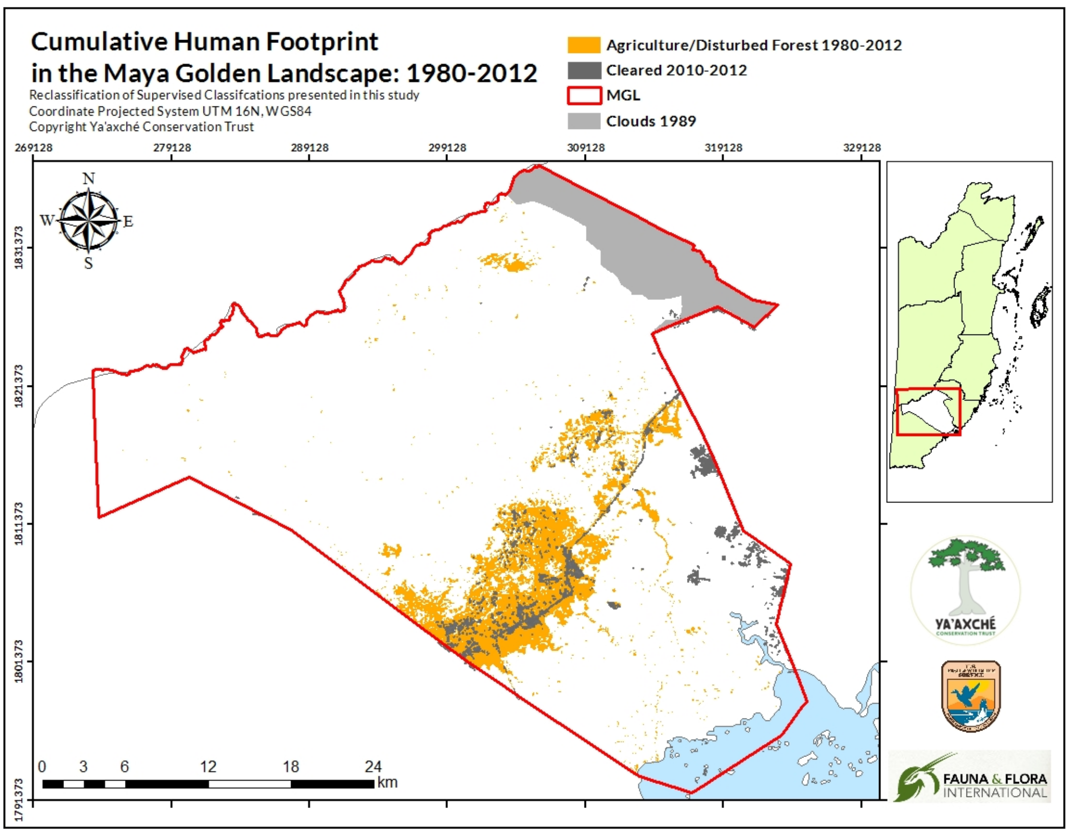

Figure 23. Cumulative Human Footprint in the MGL from 1980 to 2012.

Community Lands Forest Cover

Figures 24, 25 and 26 show effect of human footprint on community lands. This are a first version of the maps that will be shown to communities to encourage them to have Community Development Plans.

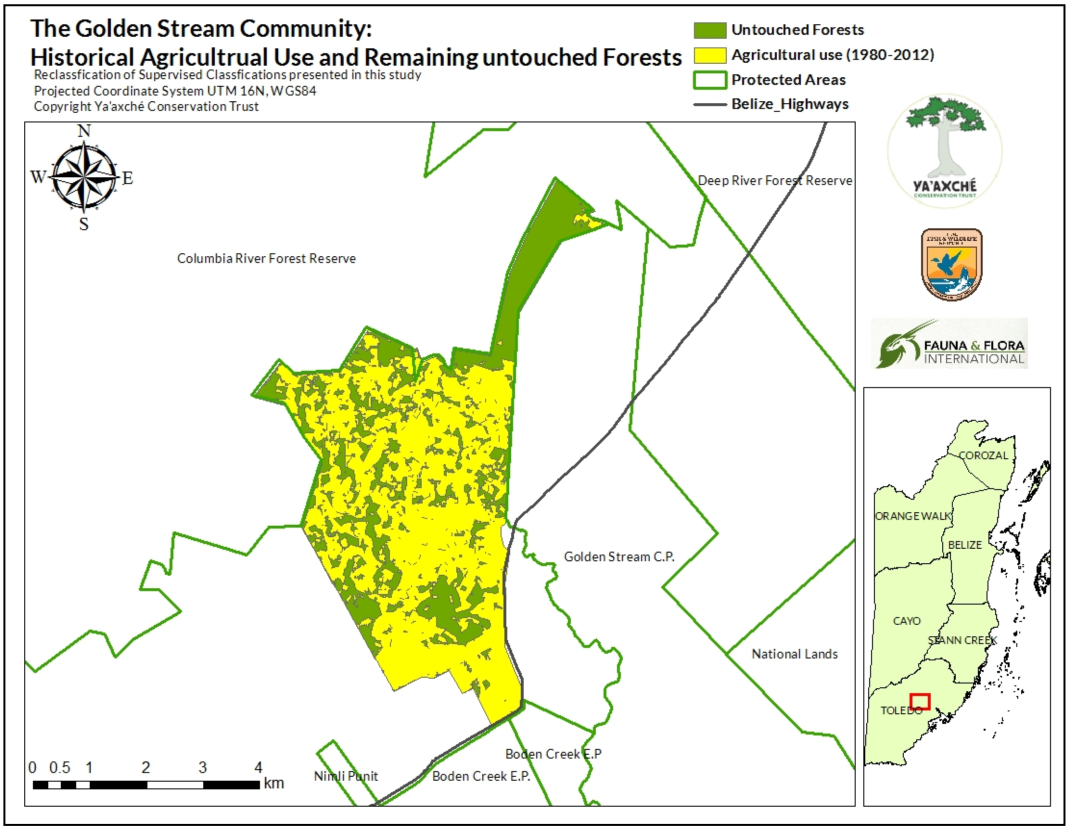

Figure 24. Cumulative Human Footprint in the Golden Stream from 1980 to 2012.

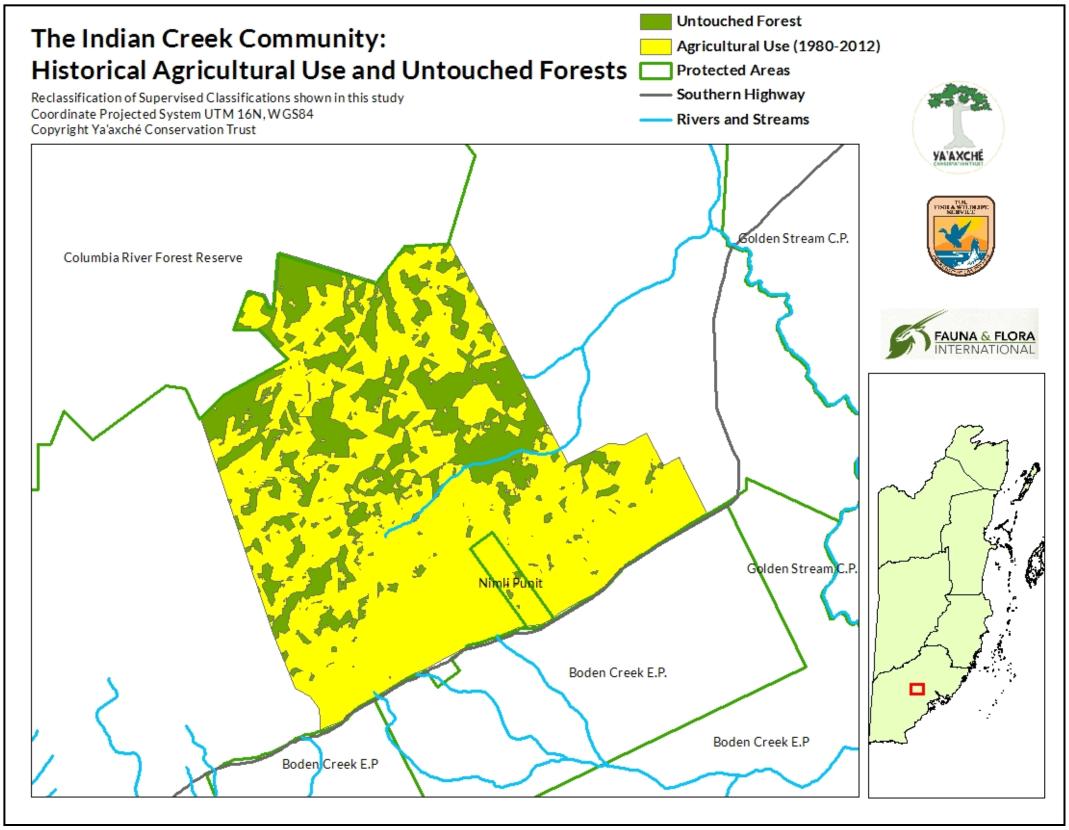

Figure 25. Cumulative Human Footprint in Indian Creek from 1980 to 2012.

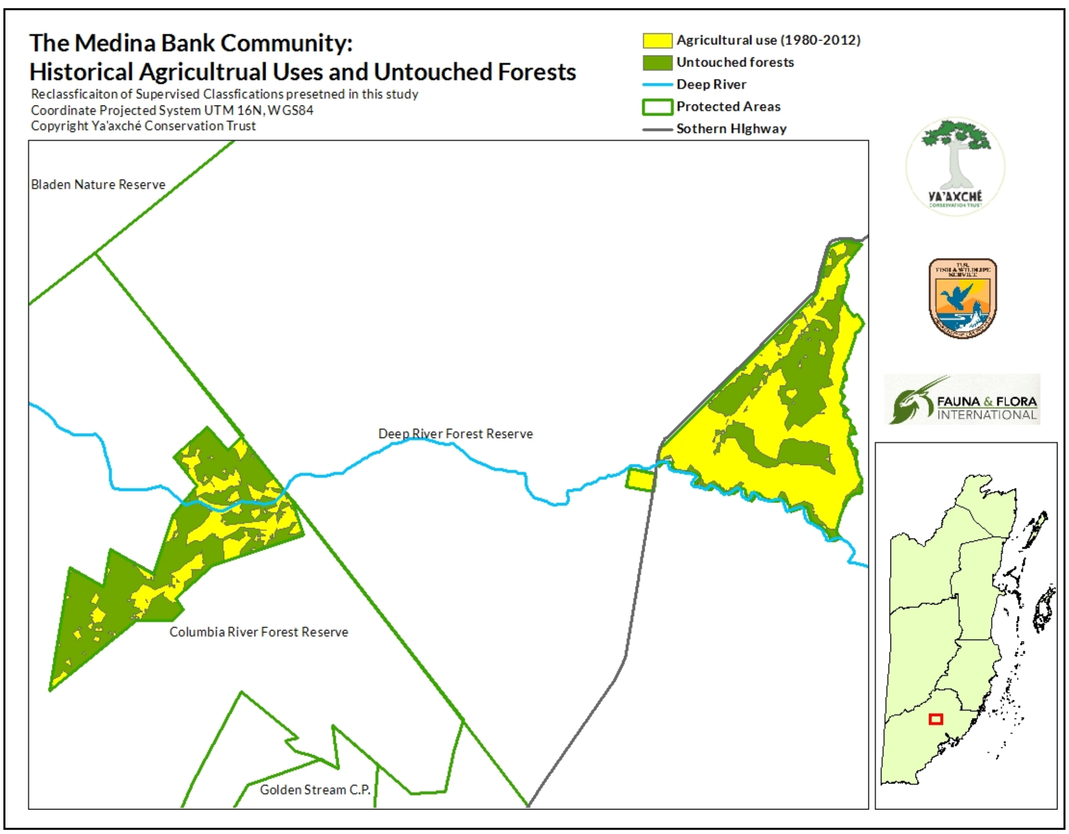

Figure 26. Cumulative Human Footprint in Medina Bank from 1980 to 2012.

The following charts show the evolution of human footprint in the villages community lands.

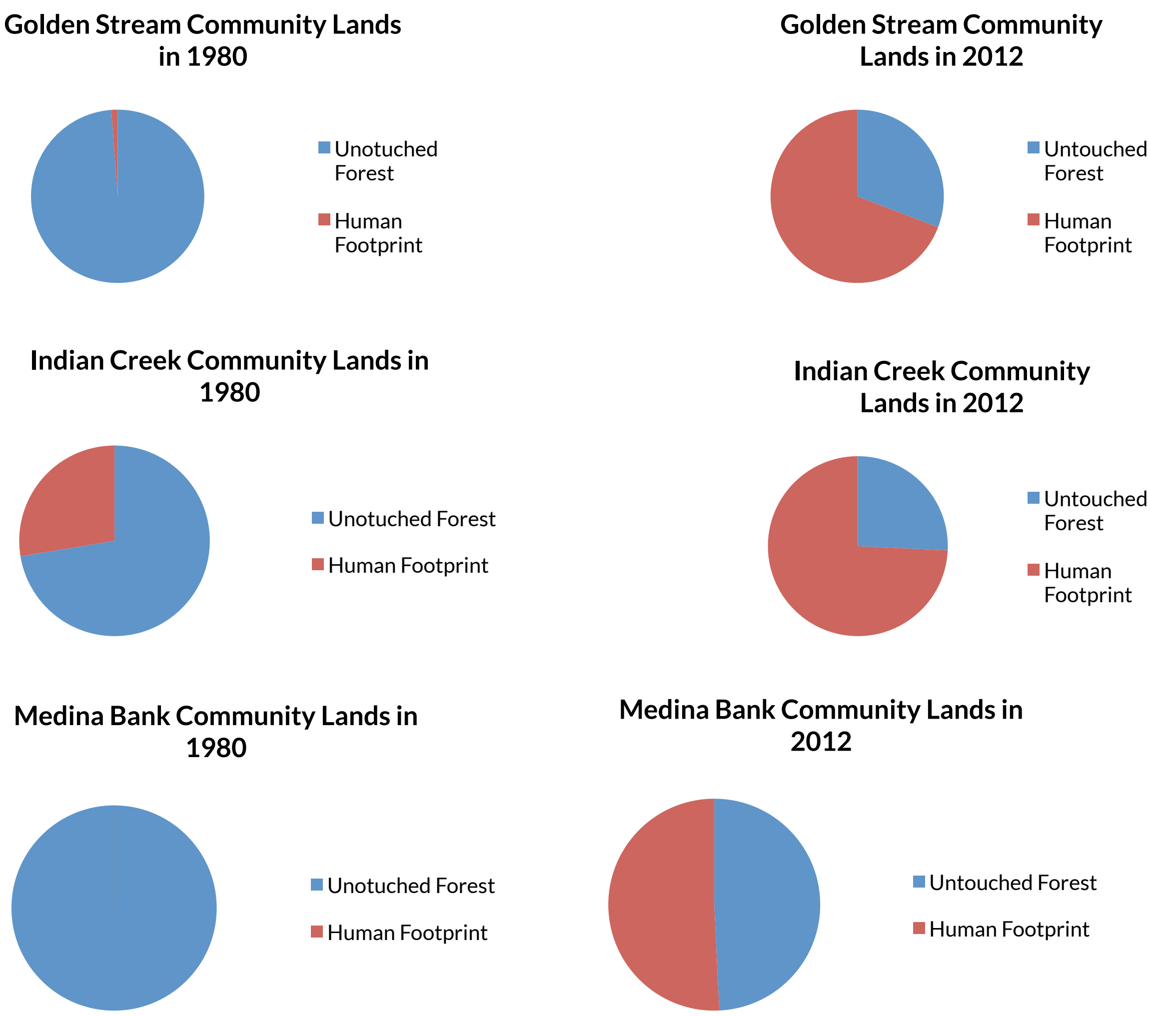

Figure 27. Human footprint and Untouched Forest in community in 1980 and 2012.

Table 5. Untouched Forest loss in community lands from 1980 to 2012

Community	Untouched Forest loss (%)
Golden Stream	68.8
Indian Creek	64.4
Medina Bank	50.8

Deforestation patterns

Figure 28 and Figure 29 show where and when has deforestation happened in the MGL in the last decades.

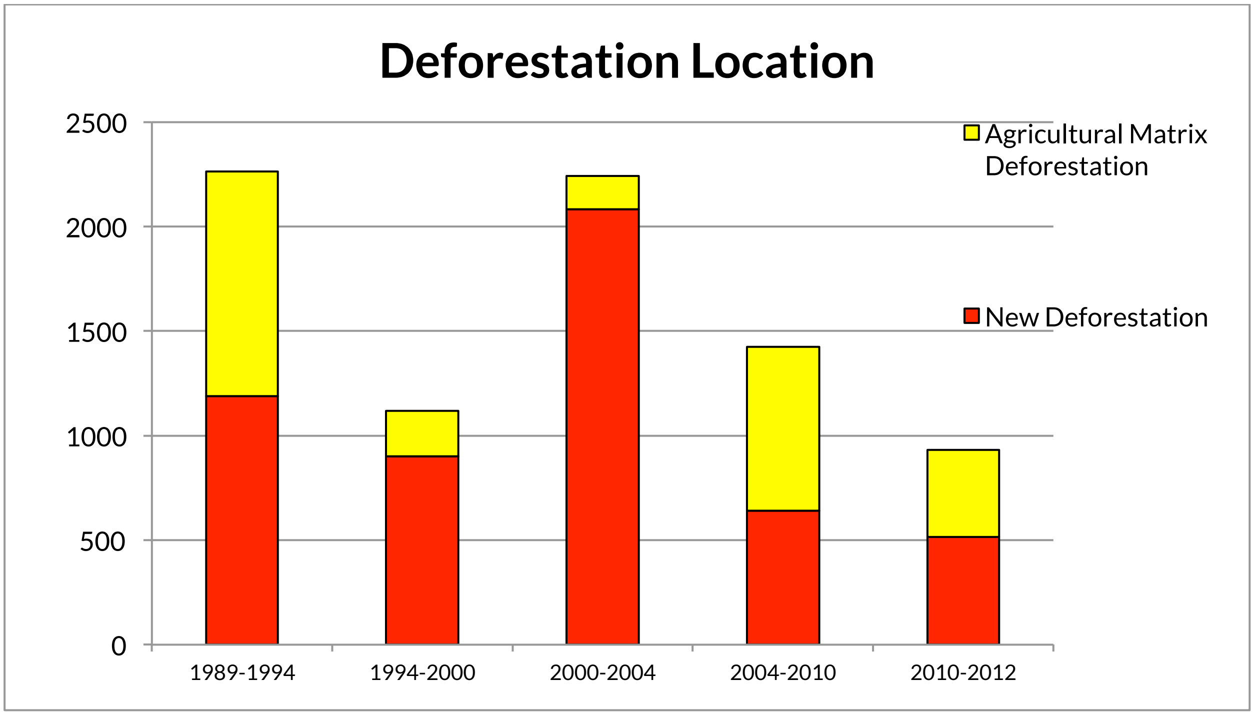

Figure 28. Deforestation location in the MGL from 1989 to 2012 (y-axis in hectares)

New Deforestation accounts for clearings that have happened in the category forest, inlcuding the change from *forest* to *recent deforestation* and from *forest* to *older deforestation*. Agricultural Matrix Deforestation accounts for clearings that happened in areas that were included in the categories *shrubland*, *regrowth* and *older deforestation*

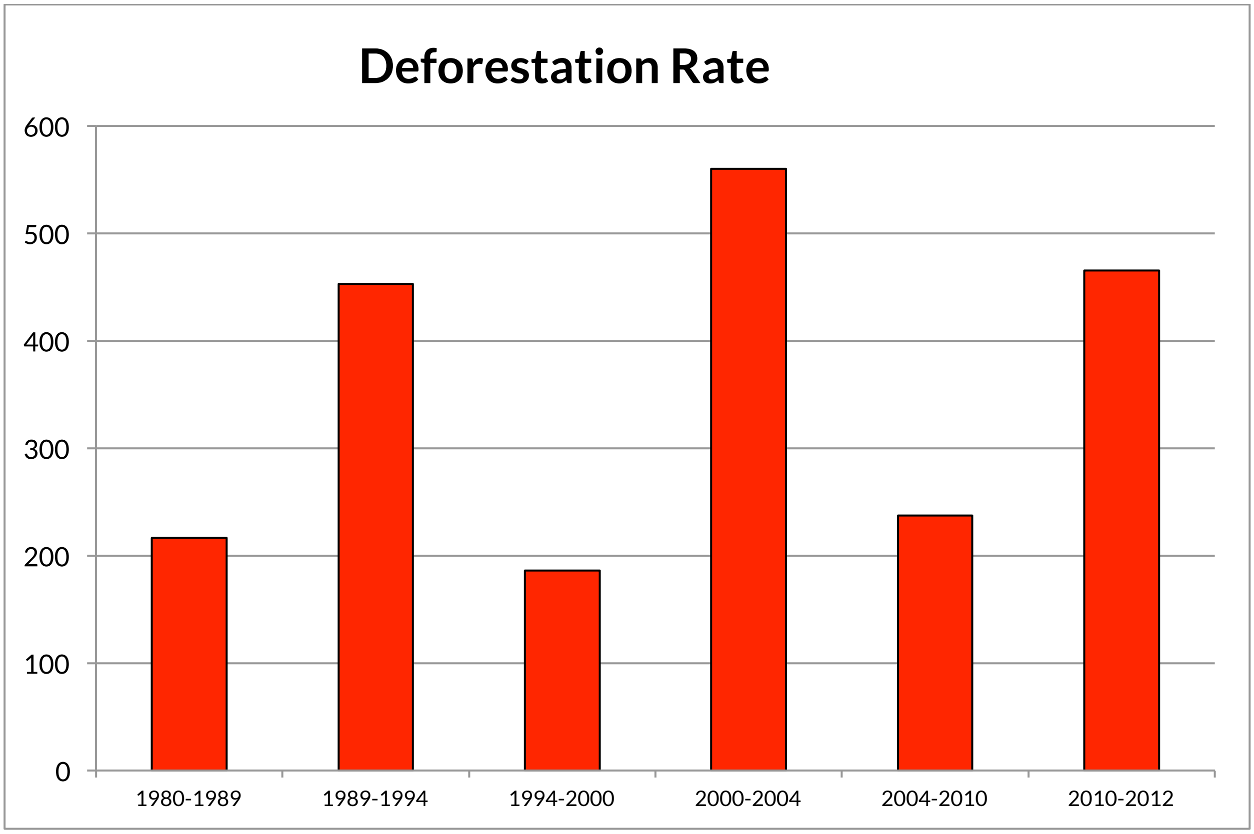

Figure 29. Deforestation rates in the MGL from 1980 to 2012 (y-axis in ha/year)

Discussion

Land Tenure

Looking at the overall numbers shown in figure 2, the Forest Department appears to be the key player in the MGL, as it has authority over more than 70% of its total area. Bladen Nature REserves holds the highest level of protection, but CRFR and DRFR could be desereserved in the future for exploitations, though forestry or agroforestry. The descisions mde in the Forest Department about this will determine how much of the MGL remains covered by forests. However, and in terms of connectivity related issues, privately owned lands (17% of the total MGL area) and community lands (7.5% of the total MGL area) will play a key role in maintaining ecological and structural connectivity between the Maya Mountains, the low plain forests and the costal areas.

Currently, the Panthera Corporation is assessing land tenure in southern Belize in a more especific basis for the delimitation of the Southern Belize Biological Corridor.

Community boundaries

Community boundaries (shown in figure 3) are a very sensible issue in the communities of the MGL. As of today, Ya'axché Conservation Trust has played a minor role in helping communities define their boundaries, as there were other prioritary issues that needed to be addressed. However, in the near future, it will be important to address the communities about this issue, especially if they want to put in practice community development plans that involve spatial planning and land use allocations. All of the conflict areas shown in the map will need to be studied through ground truthing, topographic features and past agreements.

Classifications

This study presents a classification legend that reflects dynamics in Modern Mayan agriculture. In this sense, categories like *regrowth*, *shrubland* (understood as a secondary state of broadleaf forest) and *recent* and *older deforestation* have not been mapped before. This could jeopardize the validity of the validation process, where these categories had to be reclassified to forest (*regrowth*) and non-forest (*shrubland* and *older* and *recent deforestation*) in order to be validated with previous studies (for all classifications presented previous to 2004). In this sense, in many areas the shrubland category appears as vegetation recovery in previously deforested areas, which makes sense as it would be an initial regrowth of grasses and low bushes, whereas the regrowth category (as pointed out previously) is classified in areas where the fallow period is longer and vegetation has acquired higher density and altitude.

For the 2004-20010 and the 2010-2012 classification, however, ground truthing points acquired through GPS field campaigns in spring and summer of 2012 show that this classes make sense radiometrically, in accordance with the high separability shown by the Jeffries-Matusita and the Transformed Divergence indexes obtained during the design of the training areas for the supervised classification. This process has highlighted the importance of ground truthing, if possible with presence of a local farmer that knows the recent history of the studied landscape and the causes of its evolution to its current state. This has also helped come up with the described categories in this study. Further study of more recent satellite images accompanied with its ground truthing will help us refine our understanding of Mayan Modern agriculture and the LULC change associated to it.

Human footprint has seen a very significant rise around the southern highway and in the villages community lands as can be seen in figures 18 to 24 . This is coherent with the fact that deforestation has been happening both inside and outside of the agricultural matrix (figure 25), implying this latter case the expansion of agricultural influenced areas. This means that much of the forest that appears in the community lands in the latest classification (2010-2012) corresponds to regrowth forest, also known as wamil, a non structured broadleaf forest. It remains a challenge for remote sensing techniques to be able to distinguish old growth forest from wamil in single date classification. In this study we inferred the presence of wamil through the multi-temporal approach, as it is found in places fallow periods are longer.

Deforestation has happened both in newly deforested areas as well as in the already existing agricultural matrix. Different periods of time present different proportions of these 2 deforestation types. The 1989-1994 deforestation pattern indicates that most of it happened in the non-forest category of the 1980-1989 classification, a category that had to be created due to radiometric characteristics of the 1980 image. Similar patterns are observed in the 2004-2010 and the 2010-2012 classifications, which respond to the fact that Hurricane Iris and its aftermath fires created large regrowth category areas that were subsequently cleared for agriculture. The high amount of new deforestation on the 2000-2004 classification responds to the aftermath fires of Hurricane Iris in mountainous regions in the back of the community lands. However, the similar trend observed in the 1994-2000 classification, responds to large agricultural clearings that happened in the previously forested Golden Stream community lands.

Deforestation rates are variable, as can be seen in figure 26. The peak in the 1989-1994 period corresponds, as commented in the previous paragraph, to the large clearing that happened in this period in the Golden Stream community lands. High rates in the 2000-2004 period correspond to the aftermath fires of Hurricane Iris. More significant, for their spatial and circumstantial characteristics, is the high deforestation rate in the period 2010-2012. Both small and large patches of forests have been cleared during this period, especially in Golden Stream and Indian Creek communities. Some of the small clearings appear inside the CRFR on the Golden Stream boundary with this protected area. In the Indian Creek village, it is significant that the clearings happen near the highway, but also in a significant way in lands closer to the CRFR border, staging the expansion of human footprint due to fertility loss that has been pointed out has one of the main processes happening in the MGL communities.

Conclusions

Increase of population (in the Toledo district, from 11495 inhabitants in 2000 to 18968 in 2010, a 65% increase in 10 years) and the associated rise in agricultural demand have led to a decrease in soil fertility, which has led to an expansion of the agricultural matrix in the villages community lands, in the search of more fertile soils. Highly variable fallow periods and shifting agricultural techniques have created a complex landscape dominated by a young secondary forest, which remains unused for a few years before it is cut down again after the fallow period, as well as shrubs and grasslands. The search of new fertile lands for Modern Mayan agriculture has been one of the main trends identified in this study, and in this sense, there is the risk that in the Golden Stream and Indian Creek communities new plots will be cleared outside of the community lands, in the Columbia River Forest Reserve.

It is assumed that BNR and private lands managed by local NGO's will remain highly forested and well conserved in the following years. Therefore, the actions and decisions of the Forest Department concerning the use or CRFR and DRFR will be key in the maintenance of a predominant forest cover in the MGL. Community lands will play an important role in keeping functional and structural connectivity of the MGL's forests. In this sense, community councils will have to decide if they want to stabilize LULC change rates by applying different agricultural techniques that allow the appearance of a more structured forest type in the community lands, which could be achieved through agroforestry practices and slash and mulch. This techniques are not especially popular right now, as they imply a significantly higher work charge and a higher initial financial charge. The definition of community boundaries wherever there is a conflict will be key for the elaboration of Community Development Plans that include Land Use planning concerning agrcultural practices.

Forest health and cover is very directly related to agricultural practices in the MGL, so it is everybody's responsibility to promote more sustainable agricultural practices as well as deal with other factors that have an obvious impact on it, like population growth, to help conserve a predominant forest cover in southern Belize.

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