Annex 18

Greenhouse gas emission reduced and assumptions under the ACCIÓN project

I. Methodology to calculate ex-ante greenhouse gas emission reduced and assumptions under ACCIÓN

The Methodology followed was:

1. Data from Hansen (2013) was obtained, which provides information on forest change patterns worldwide. Using this tool, deforestation was estimated for the period 2001 to 2024 in each of the selected ANP and ADVC for this analysis.

2. Landsat satellite data for 2018 processed by the Mexican National Commission of Biodiversity (CONABIO) was used to map land use in each Protected Area (PA) and determine the number of hectares in each land use category. This allowed to estimate the total carbon stocks that currently exist in natural areas. Among the 17 land use categories proposed by CONABIO, we identified 10 in the selected PAs: 1. Mangrove and Petén, 2. Wet forests, 3. Dry forests, 4. Minor aquatic vegetation, 5. Vegetation of sandy soils, 6. Grasslands, 7. Agricultural Land, 8. Urban and built, 9. Bare soil, and 10. Water. Since the analysis focused on forest carbon stocks, the categories of interest were 1, 2 and 3.

3. The PAs with vegetation type that could contribute to greenhouse gas emission mitigation trough reduction were selected.

4. The scenario for land use and vegetation will be calculated for 20 years was estimated for each of the ACCIÓN PAs. To make this estimate, the set of models from the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) software will be used, based on the average observed deforestation rate.

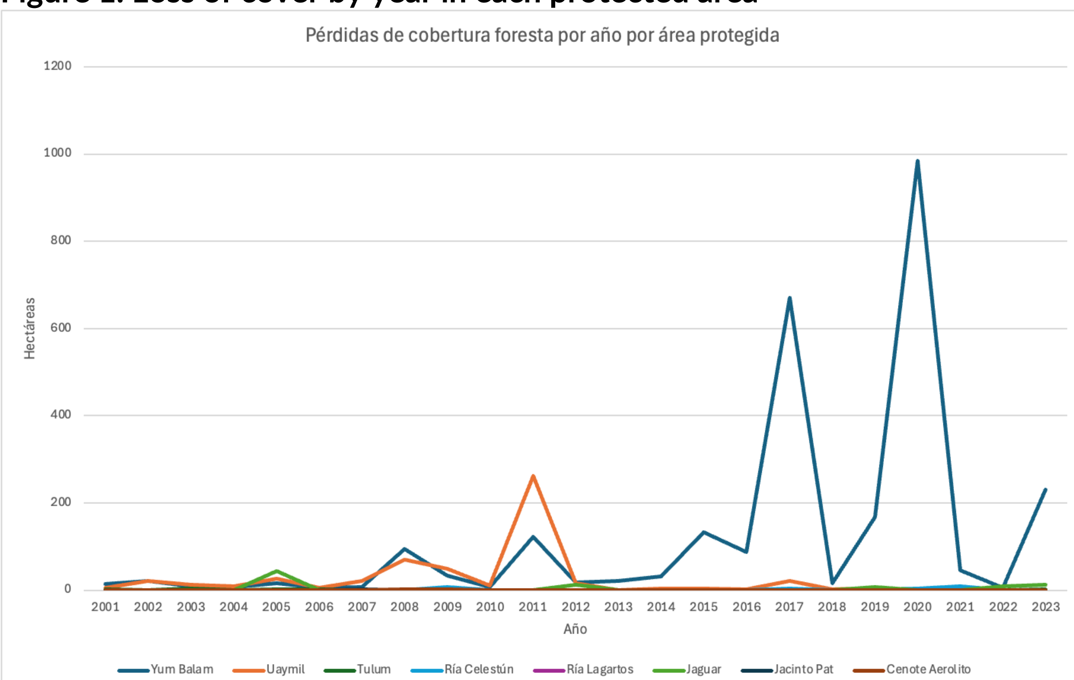
5. Using the InVEST scenarios, the ex-ante carbon balance tool (EX-ACT) from the Food and Agriculture Organization of the United Nations (FAO) was used to estimate carbon emissions that the assumed transitions would generate. Storage factors per hectare were also estimated for each type of soil, thus being able to calculate the current total stock of each ANP, and compare it with the estimated loss. It was assumed that:
   a. The deforestation rate from 2025 to 2045 is equal to the average deforestation rate observed from 2013 to 2022 according to information from Hansen (2013).
   b. Carbon growth parameters are proportional to the growth rate of mangroves estimated with information from Yin et al. (2003) and Song et al. (2023). These parameters imply that maximum carbon capture occurs in year 12.5.
   c. The expected deforestation would convert forests and rainforest to agriculture in the absence of the project.

d. Support for protected areas under ACCIÓN can protect up to 23% of the trend deforestation, derived from the GEF impact evaluation study for protected areas in Mexico (Hansen et al., 2015), and therefore the focus is on reduction of this expected deforestation.
e. The project lifespan is 20 years, with an implementation phase of 7.5 years financing Annual Operating Plans in PAs and a capitalization phase of 12.5 years.

II. Background

Figure 1 shows the observed loss of cover by year for each protected area from 2013 to 2022. Figure 2 presents the same information but expressed in percentage terms.

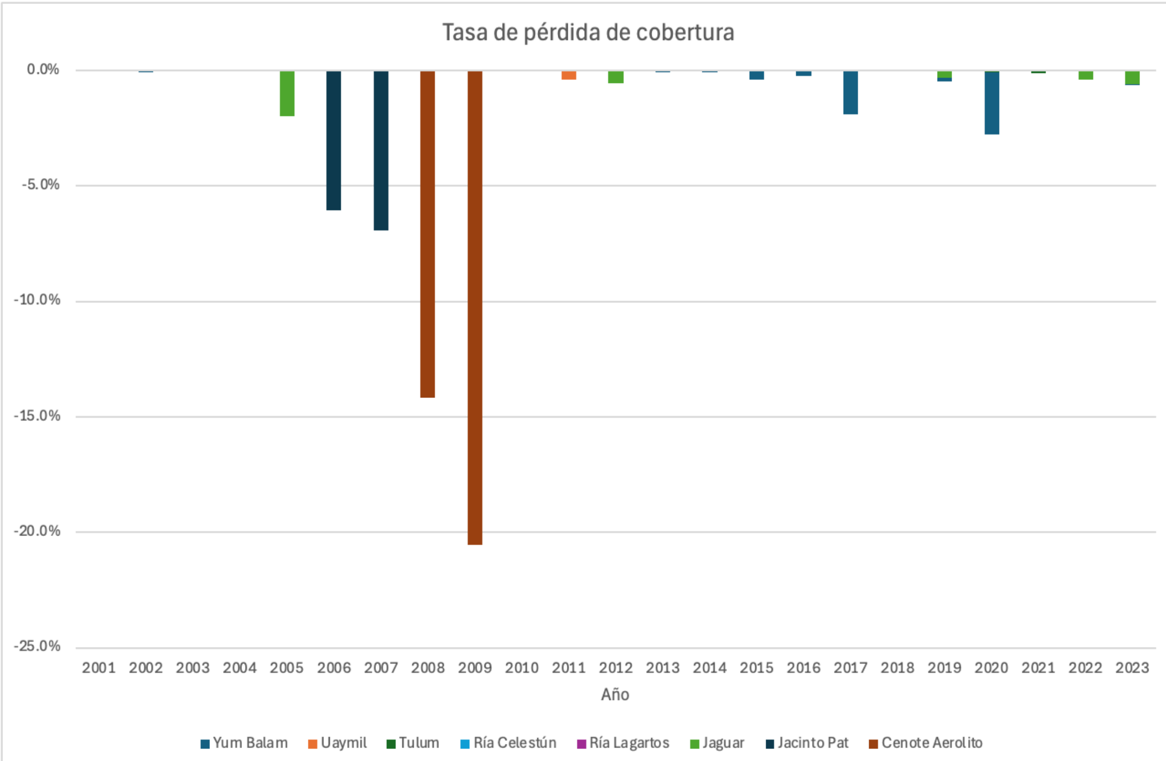
Figure 1. Loss of cover by year in each protected area



Fuente: Elaboración propia con información de Hansen (2013).

Source: Own elaboration with information from Hansen (2013).

Figure 2. Loss of cover by year in each protected area



Source: Own elaboration with information from Hansen (2013).

Table 1 shows each site's average deforestation per year and the projected hectares to be deforested in 2025-2045.

Table 1. Projected rates and hectares of deforestation for 2025-2045

Área	Tasa anual de deforestación promedio	Hectáreas deforestadas totales (2025-2045)
Arrecife Alacranes	0.000%	0
Arrecifes de Sian Ka'an	0.000%	0
Cenote Aerolito	1.400%	3.26
Costa Occ. de I. Mujeres, Pta. Cancún y Pta. Nizuc	0.000%	0
Jacinto Pat	0.550%	1.9
Jaguar	0.170%	77
Manglares de Puerto Morelos	-0.026%	0
Playa Chenkan	0.000%	0

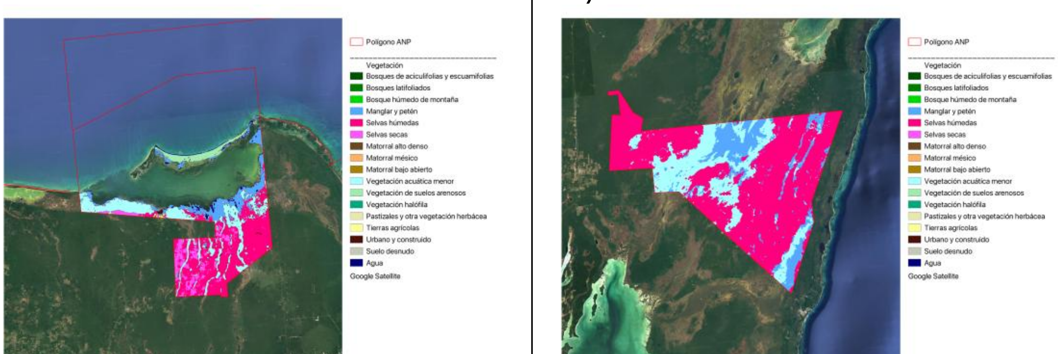
Playa Delfines	0.000%	0
Playa Ría Lagartos	0.000%	0.06
Playas de Isla Contoy	0.000%	0
Ría Celestún	0.014%	24
San Buenaventura	-1.880%	0
Tulum	0.015%	21
Uaymil	0.030%	476
Yum Balam	0.330%	2450

Source: Own elaboration based on Hansen (2013).

With this information, a trend scenario for 2045 was generated (see Figure 3). This was done with the InVEST software package, using the *Scenario Proximity* module. As parameters, it was established that forests and jungles are converted to agriculture in a magnitude in hectares, as shown in Table 1.

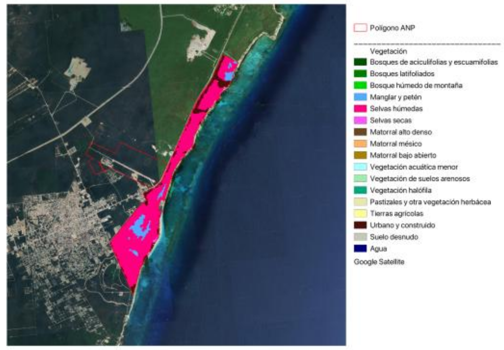
Figure 3. Deforestation trend scenarios

Yum Balam | *Uaymil*

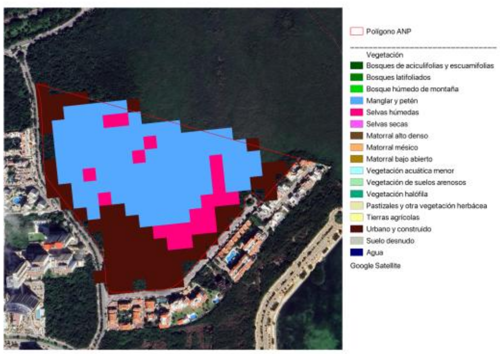


Jaguar

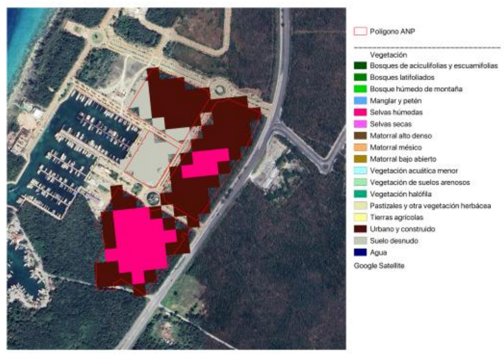
Tulum



Jacinto Pat

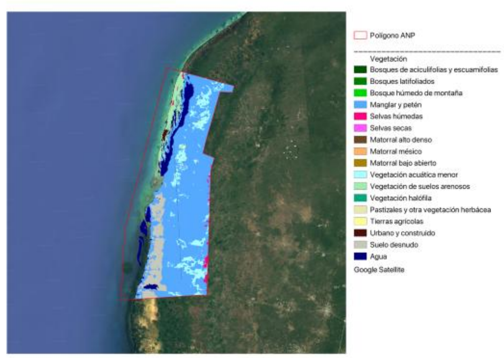


Aerolito Cenote



Ría Lagartos Beach

Celestun Estuary



Source: Own elaboration.

Once the scenarios were generated, carbon storage factors were established for each vegetation type and land use. These parameters were obtained from the EX-ACT tool (FAO, 2022). Table 2 shows the factors used for each land use and vegetation and this link includes all the EX-ACT sheets.

Table 2. Carbon storage factors.

Conabio Code	Land use and vegetation	Stock CO2e/ha
4	Mangrove and petén	515
5	Rainforests	718
6	Dry forests	345
10	Minor aquatic vegetation	166
11	Vegetation of sandy soils	166
12	Halophytic vegetation	166
13	Grasslands and other herbaceous vegetation	35
14	Agricultural land	15
15	Urban and built	0
16	Bare soil	0
17	Water	0
0	Unknown	0

Source: Own elaboration with the EX-ACT tool (FAO, 2022).

With this information, the FAO EX-ACT tool (2022) was used to quantify the carbon content in the current and trend scenarios for NPAs whose deforestation rate is greater than zero.

Table 3. Carbon results in the baseline scenario

Area	Stored carbon (tCO_2 e)	Trend carbon loss to 2044 (tCO_2 e)	% carbon loss (2025 to 2045)
Yum Balam	270,416,623	-1,895,852	0.7%
Selva húmeda		-654,476	
Selva seca		-117,747	
Manglar y petén		-1,123,629	
Uaymil	566,564,121	-943,552	-0.16%
Selva húmeda		-87,593	
Manglar y petén		-855,959	
Jaguar	17,349,099	-56,560	-0.32%
Selva húmeda		-48,686	
Selva seca		-58	
Manglar y petén		-7,816	
Tulum	4,672,877	-13,689	-0.29%
Selva húmeda		-13,391	

Selva seca		-174	
Manglar y petén		-124	
Jacinto Pat	83,637	-2,119	-2.5%
Selva húmeda		-709	
Manglar y petén		-1,410	
Cenote Aerolito	45,234	-2,169	-4.8%
Selva húmeda		-2,169	
Playa Ría Lagartos	285,362	-258	-0.09%
Manglar y petén		-258	
Ría Celestún	254,785,393	-42,340	-0.01%
Selva húmeda		-470	
Selva seca		-233	
Manglar y petén		-41,637	
Total	**1,114,202,346**	**-2,956,539**	**-0.27%**

Source: Own elaboration

The estimate of trend carbon loss is a maximum conservation potential under a scenario of zero deforestation. To consider a conservative perspective, we consider the results of the Global Environmental Facility (GEF) (2015), which presents evidence that the GEF's support in Mexico prevented 23% of deforestation between 2000 and 2012, comparing protected areas that received support from this organization and those that did not. In this sense, we assume that support for protected areas in Mexico can protect up to 23% of trend deforestation. Table 10 presents this scenario of carbon stock protection.

Table 3. Results of carbon sequestration in a conservative scenario

Area	Conservation of carbon stocks to 2045 (tCO_2 e)
Yum Balam	-436,045
Uaymil	-217,017
Jaguar	-13,009
Tulum	-3,148
Jacinto Pat	-487
Aerolito Cenote	-499
Ría Lagartos Beach	-59
Celestun Estuary	-9,738
Total	**-680,004**

Source: Own elaboration

Other pathways for carbon sequestration/avoidance

There are other activities under Component 1 that are expected to have positive mitigation co-benefits, but they are marginal and therefore not quantified. For example:

(i) Ecotourism. Without the project, the degradation of mangroves, seagrasses, and marshes remains constant. With the implementation of ecotourism, degradation rates are expected to decrease by 4.4% based on literature, resulting in increased biomass over the 20-year project lifespan.

(ii) Small-scale fisheries. In the absence of the project, the degradation of mangroves, seagrasses, and marshes remains constant annually. By introducing sustainable fishing practices through "Fishing Refuge Zones," these rates are anticipated to drop trough livelihoods diversification by improving fisheries growth and avoiding changing to agricultural practices, leading to ecosystem health improvements and mangroves, seagrasses, and marshes biomass growth over the 20-year project lifespan.

(iii) Beekeeping. Under the no-project scenario, mangroves, seagrasses, and marshes experience constant degradation. Sustainable beekeeping practices are projected to reduce mangrove degradation, given its low environmental impact and negligible emissions. While this intervention does not affect seagrasses or marshes, it will contribute to increased biomass project lifespan over the 20-year project lifespan.

III. Conclusions

Based on the analysis, it is estimated that reversing the trend of 23% deforestation in the deforestation rate in the selected PAs would reduce **the emission of 680,004 tCO_2 e of forest carbon** by 2045. In addition, the project will influence the health of PAs with low deforestation rates, so the quantity and quality of carbon stocks in these areas may also increase. Finally, it is worth noting that most of the selected PAs have important extensions of coastal-marine ecosystems with a high carbon absorption capacity, such as reefs, seagrasses, and oceans. Therefore, forest carbon sequestration through avoided deforestation is only significant of the many carbon sequestration/avoidance pathways of the project.

IV. Sources

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