Colegio de Postgraduados
Campus Tabasco

Bioenergy, land use change and Ecosystem Services in Tabasco, Mexico

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Outline

1. Oil palm: current and potential use.

2. Study case: Chontalpa region.

3. Building scenarios

Oil palm: current use
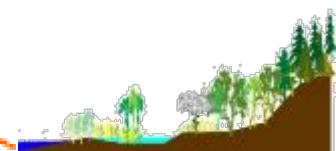
Oil palm: a food source

Mexico produces only 14.1% of palm oil consumption and 11.2% of palm kernel oil
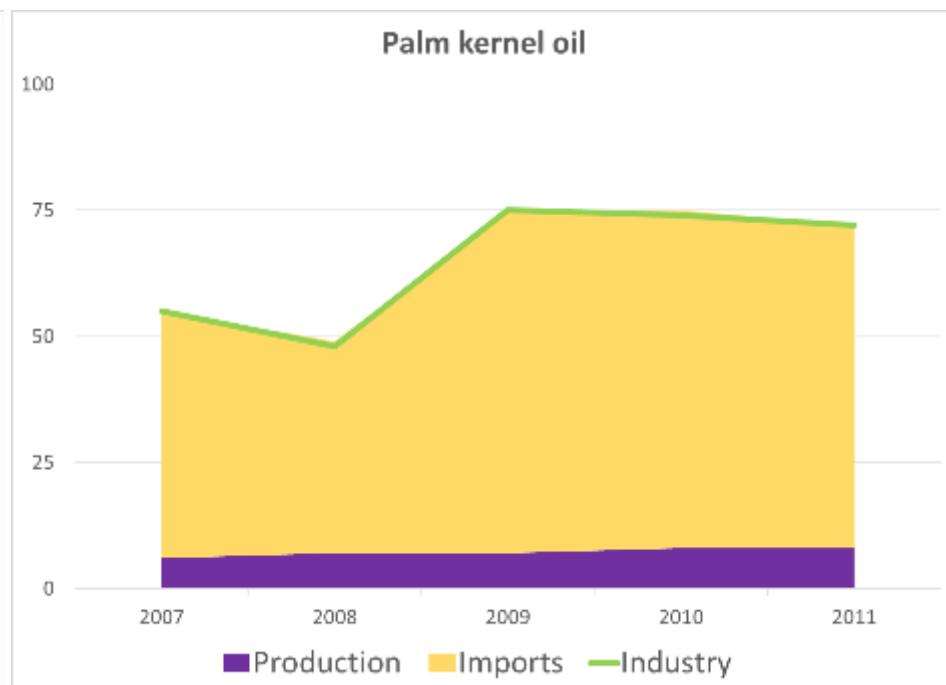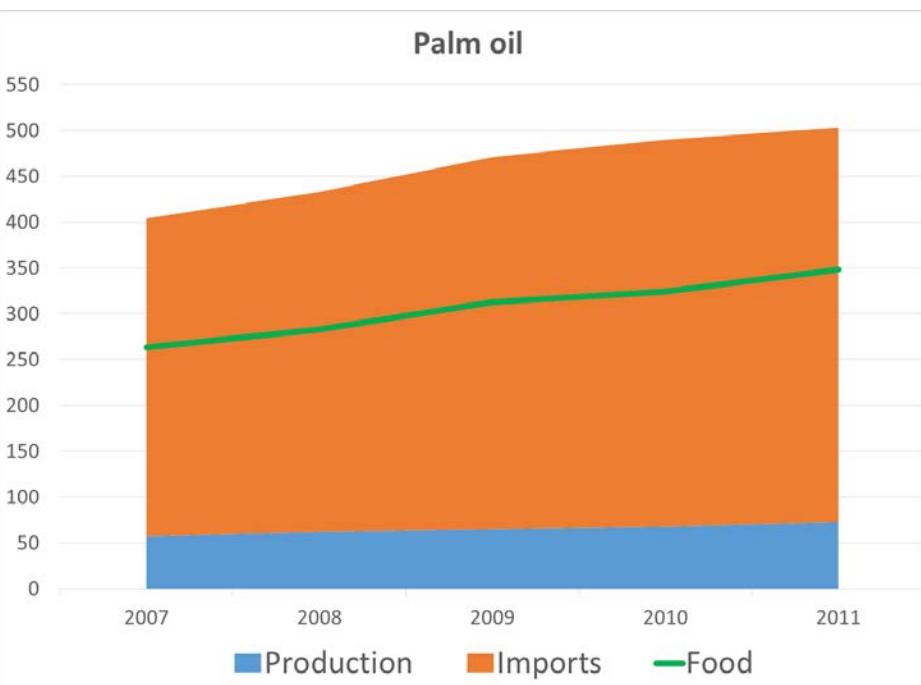
# Oil palm: potential use
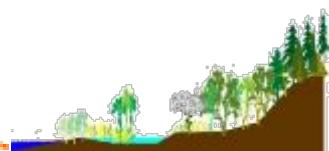
Oil palm: an energy source

Mexico produces 85% of its energy from oil and gas products. Almost half of the renovable energy comes from bioenergy (wood and sugar cane).
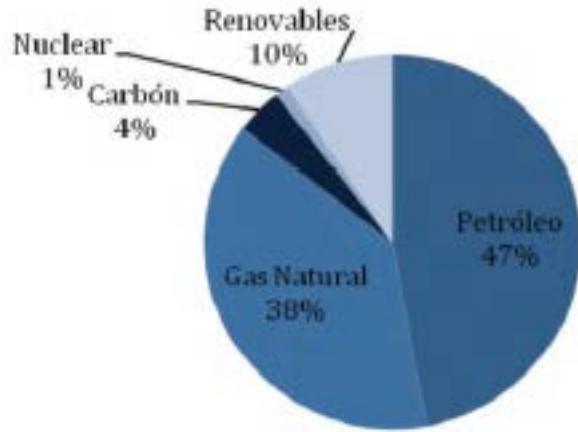
Bioenergy potential
(petajouls per year)
3,569 PJ/a, 42% Total consumption

Sener 2009
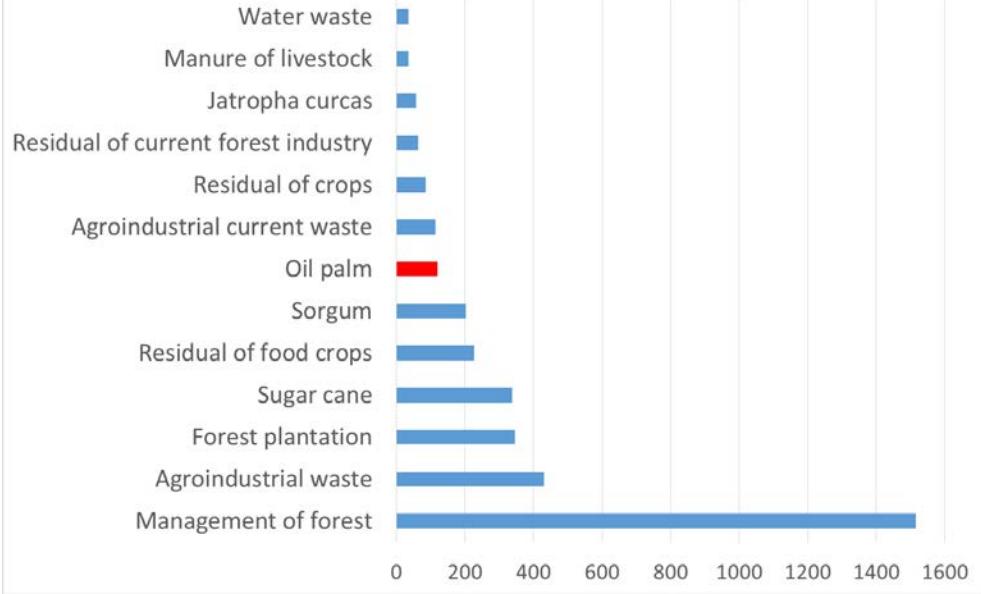
Johnson et al., 2009

Oil palm: potential use
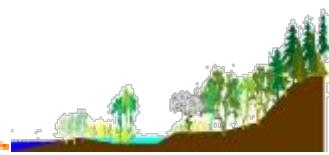
Oil palm: an energy source

Most of the bioenergy crop potential can establish in low and flat land of Gulf Of Mexico, where precipitation is high and there are land without any agricultural use.

Dedicated energy crops
- Non suitable
- Oil palm
- Sugarcane
- Jatropha
- Sorghum
- Eucalyptus
- State boundaries

Energy content

African Oil Palm   121 PJ/year
Sugarcane   338 PJ/year
Jatropha curcas 57 PJ/year
Sorghum bicolor 202 PJ/year
Eucalyptus sp 345 PJ/year

Technical potential for dedicated energy crops in Mexico - 2008
Edafo-climatic conditions suitable for each crop. No increased area due to potential irrigation. Suistainibility criteria: natural forest and agriculture areas remain inaccesible.
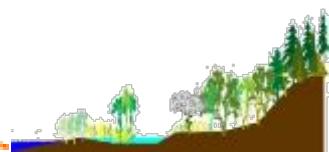
1:12,409,505

Source: REMBIO 2008, INEGI 1995, 2000, 2002
Created in ArcGIS 9.2 using ArcMap
Author: Guerrero G. & Ghilardi A. April 2008

Albers Equal Area Conic Projection
North American Datum 1927

Region of the Chontalpa

Tabasco has a potential for food oil and bionergy production
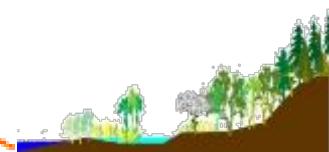
Tabasco has a potential for food oil and bionergy production

RLCh is located on the west part of Tabasco, including 4 municipalities: Cardenas, Huimanguillo, Paraiso and Cunducan. Total surface is 6,938 km^2 (25% of Tabasco's state).

RLCh comprises of 60% of agriculture land (cocoa, coconut, sugarcane, pineapple, cattle, maize, rubber, eucalyptus) and 40% of ecosystems (mangrove, hydrophytes, rainforest, swamps, acahual, water bodies) Economy is based on oil industry and agriculture.
There are 500,000 inhabitants distributed across 140 localities.

Region of the Chontalpa

Vegetación hidrófila

Selva mediana perennifolia

Selva baja inundable

Selva alta perennifolia

Palmar inundable

Matorrales

Manglar

Acahuales

Region of the Chontalpa

Cuerpos de agua

Pastizales

Forestal
- Eucalipto en asociación
- Hule

Cultivos
- Cacao
- Caña
- Plátano
- Cítricos
- Coco
- Piña
- Arroz
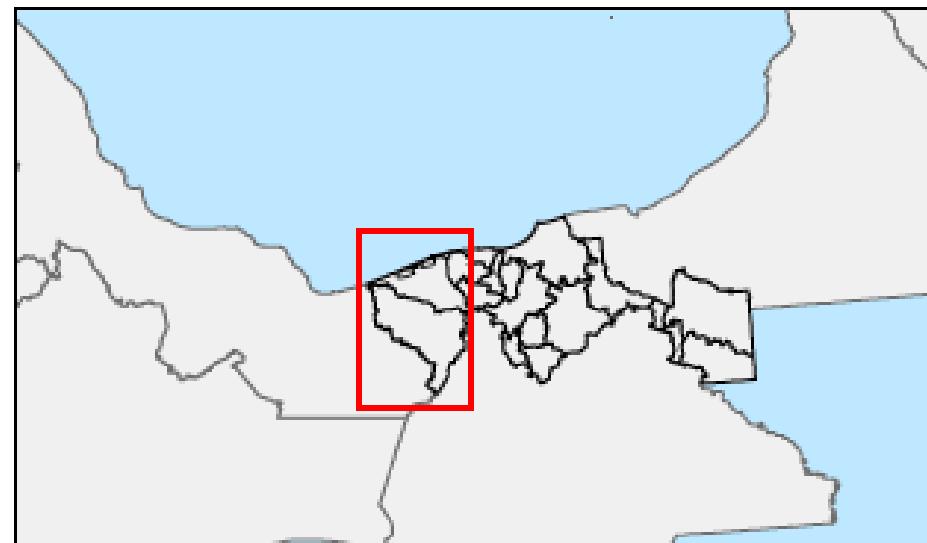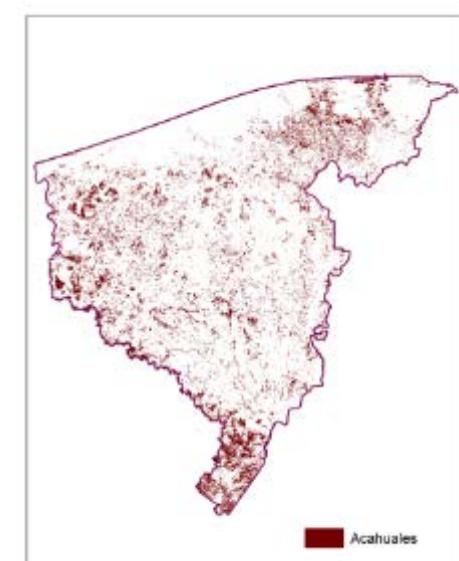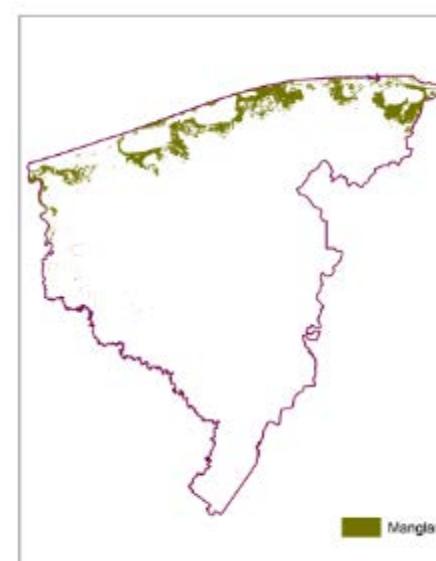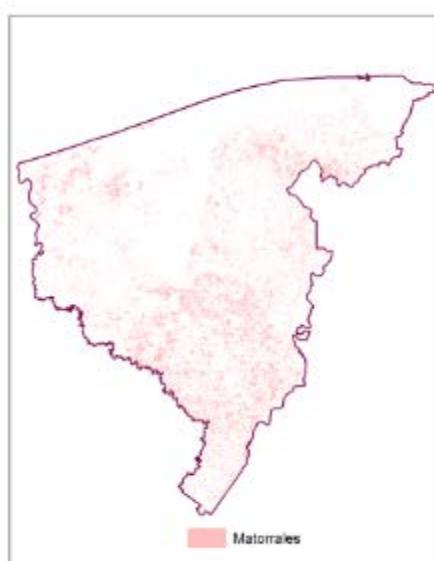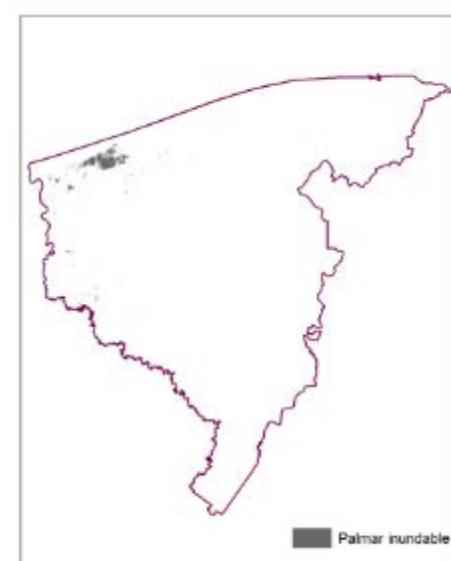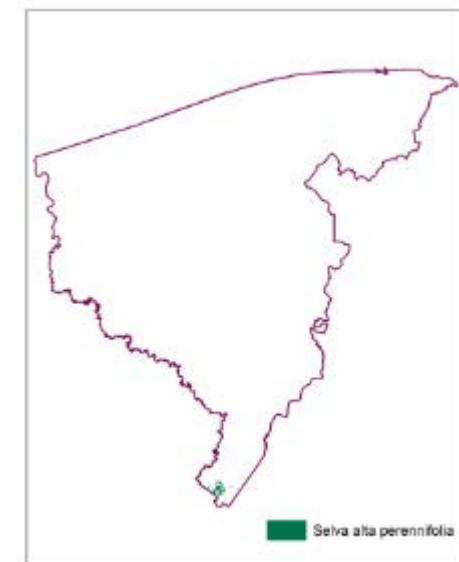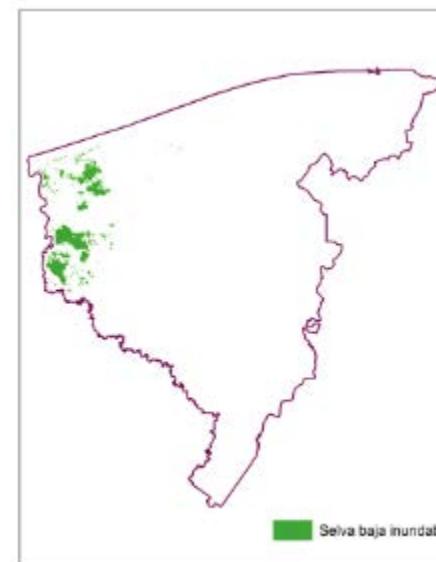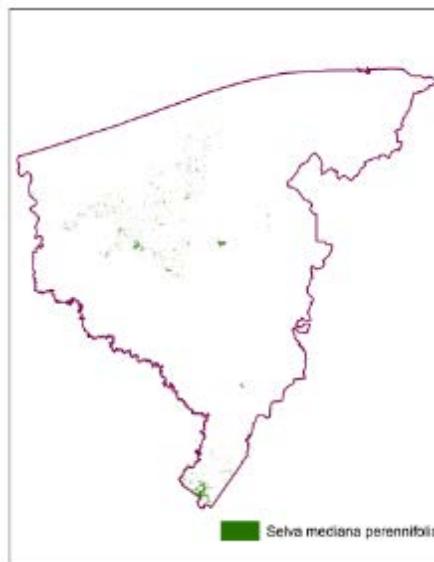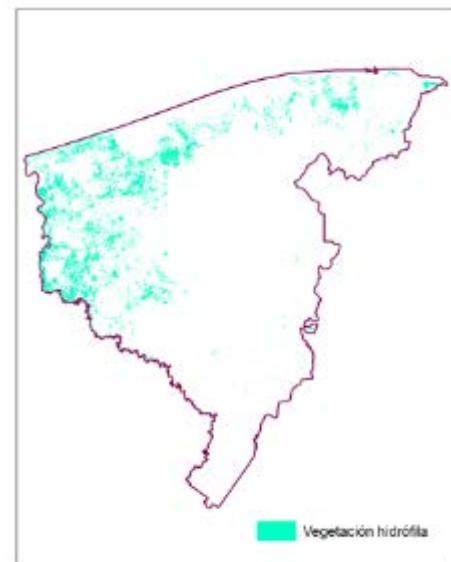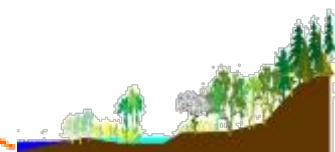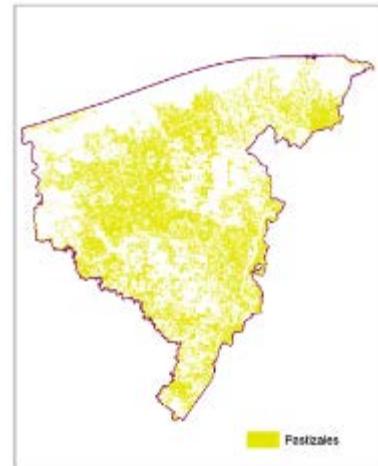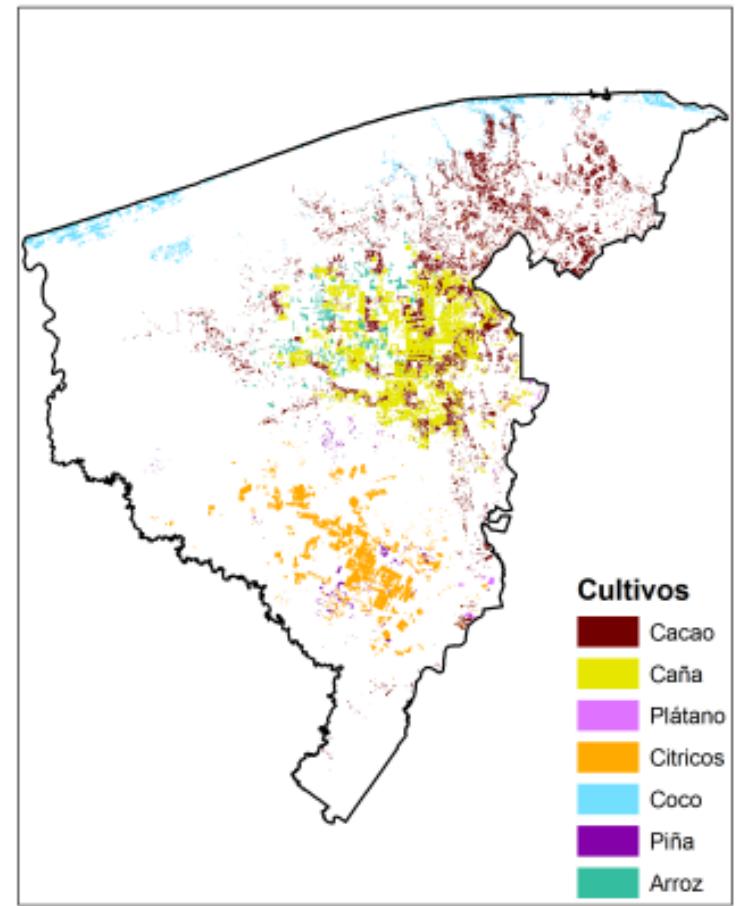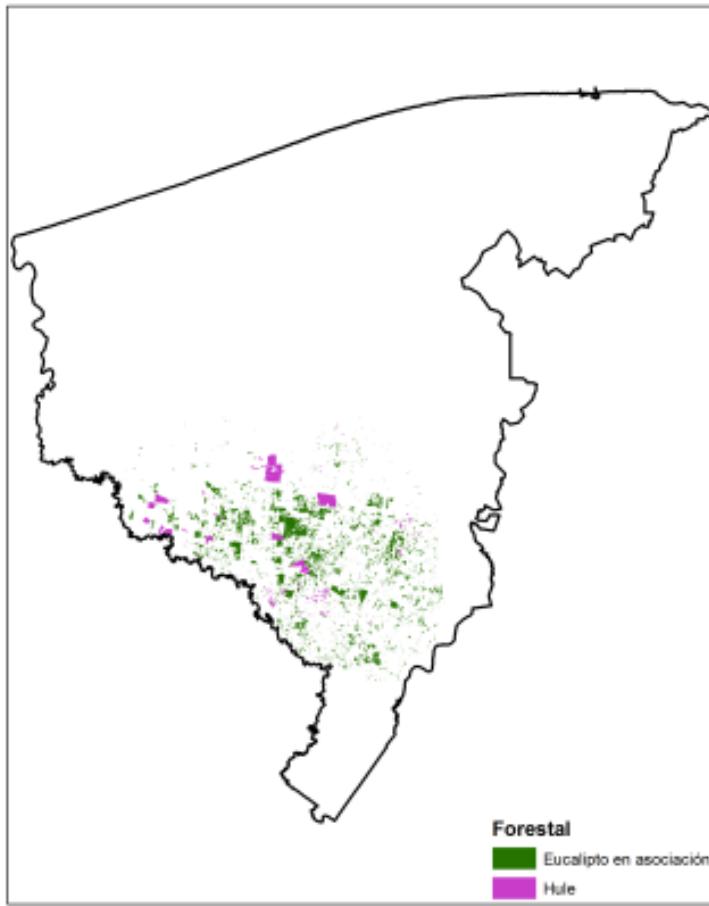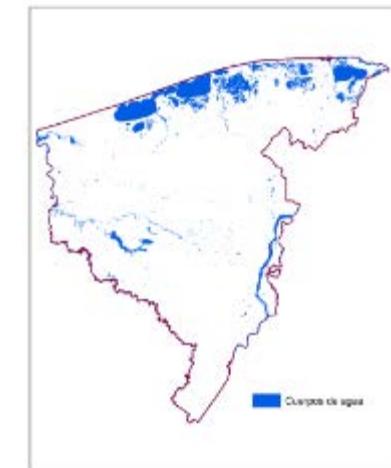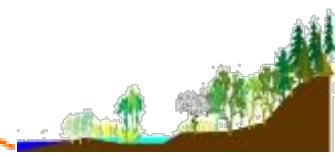
Objective

To study changes of land use by including oil palm production in the Region of La Chontalpa.
To measure economic benefits/disbenefits for such change by building different scenarios

Assumptions

Public policy program uses the study of the oil palm potential in Tabasco state.
Ecosystem services values are considered for payment environmental program.
Simulation is based on production value rather than profit value.
Mangrove and water bodies are not considered in the simulation
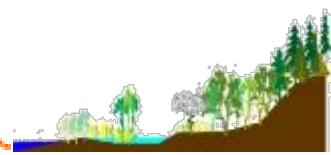
Methods

- Identification of potential área of oil palm
- Measurement of value of agricultural production
- Measurement of value of ecosystem services
- Building scenarios

Building scenarios

Identification of potential area of oil palm

Legend:
- Manglar (blue)
- Cuerpo de agua (light blue)
- Acahual (dark green)
- Matorral (dark green)
- Palmar inundable (green)
- Selva alta perennifolia (green)
- Selva baja inundable (green)
- Selva mediana perennifolia (light green)
- Vegetación hidrófita (pale green)
- Pastizal (orange)
- Cultivo de arroz (orange-yellow)
- Cultivo de cacao (yellow)
- Cultivo de caña (yellow)
- Cultivo de coco (yellow)
- Cultivo de cítricos (yellow)
- Cultivo de hule (yellow)
- Cultivo de piña (yellow)
- Cultivo de plátano (yellow)
- Plantaciones de eucalipto+Acahual (yellow)

Aceves et al 2012

Building scenarios

Identification of potential area of oil palm

CATEGORÍAS	Uso de suelo	SUPERFICIE (Hectáreas)
Cultivos	Cultivo de arroz	509
	Cultivo de cacao	2894
	Cultivo de caña	4939
	Cultivo de cítricos	534
	Cultivo de coco	27
	Cultivo de hule	26
	Cultivo de piña	43
	Cultivo de plátano	319
	Pastizal	32077
	Plantaciones de eucalipto	860
	Superficie de Agroecosistemas	**42228** (65%)
Ecosistema	Acahual	6669
	Cuerpo de agua	732
	Manglar	3269
	Matorral	8053
	Palmar inundable	37
	Selva alta perennifolia	114
	Selva baja inundable	19
	Selva mediana perennifolia	398
	Vegetación hidrófila	2784
	Superficie de ecosistemas	**22075** (35%)
	Superficie total del área de estudio	**64303** (100%)
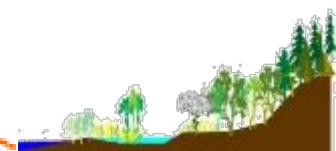
Measurement of value of agricultural production

Production yield · Price payed to producer = value of production per hectare

TIPO	VALOR DE LA PRODUCCIÓN POR UNIDAD DE SUPERFICIE [USD hectárea^{-1}]	RENDIMIENTO [toneladas ha^{-1}]	PRECIO [USD tonelada^{-1}]
Arroz palay (milagro filipino)	707.40	2.846	248.56
Cacao seco	1127.51	0.429	2628.24
Caña de azúcar (industrial)	1973.59	52.996	37.24
Cítricos (limón persa)	2173.58	11.885	182.88
Copra	372.24	0.776	479.70
Hule hevea	1388.73	2.198	631.82
Piña (sin clasificar)	7365.31	32.314	227.93
Plátano (enano gigante)	12957.45	58.655	220.91
Palma de aceite (o africana)	1199.85	12.382	96.90
Bovino en pie (en pastizal)	429.39	0.329	1.30
Eucalipto (celulosa y corte a 10 años)	480.96	29.160	16.49

Measurement of value of ecosystem services

Σ Quantification of ecosystem services· Price of ES = value of ES per hectare

$$VET_{i_{xyz}} = \sum_{x=1}^{x=n} ES_{i_{xy}} \cdot V_{i_z}$$

Servicio de provisión

Servicio de regulación

Servicio de sustento

Servicio cultural
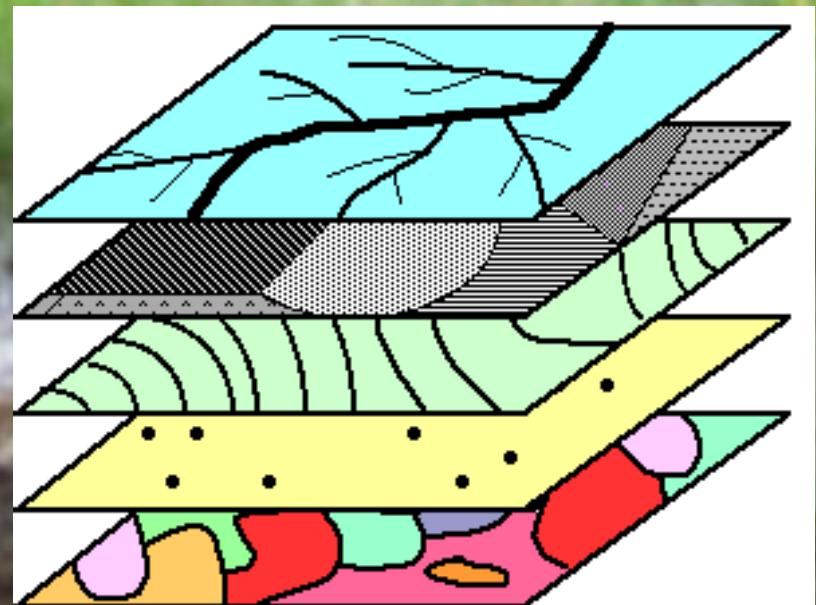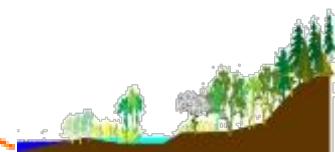
Measurement of value of ecosystem services

Regulación de gases

Regulación del clima

Regulación de contingencias

Regulación del flujo de agua


Regulación de erosión

Ciclo de nutrientes

Purificación de agua y tratamiento de residuos

Suministro de agua
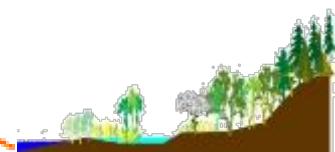
Measurement of value of ecosystem services

Provisión de alimentos

Provisión de materia prima

Provisión de material genético

Formación de suelos

Servicio de polinización

Control biológico

Hábitat

Servicios recreativos, educativos y culturales
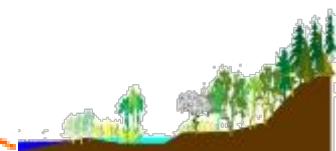
Measurement of value of ecosystem services

| TIPO	VALOR ECONÓMICO POR UNIDAD DE SUPERFICIE [USD hectárea^{-1}]
Acahual	3597.00
Cuerpo de agua	6149.00
Manglar	7832.00
Palmar inundable	7559.30
Matorral	2585.00
Selva alta perennifolia	7356.33
Selva baja inundable	3236.33
Selva mediana perennifolia	4365.33
Vegetación hidrófila	15118.60

Building scenarios

Oil palm scenarios

Current land use

Oil palm production

Oil palm scenarios

		EFECTO	
ESCENARIO	**DESCRIPCIÓN**	**AGROECOSISTEMAS**	**ECOSISTEMAS**
0	v_{ae} v_{en}	*	*
I	$v_{pa} > v_{ae}$ $v_{pa} > v_{en}$	arroz palay, cacao seco, copra y bovino en pie	*
II	$1.5 \cdot v_{pa} > v_{ae}$ $1.5 \cdot v_{pa} > v_{en}$	arroz palay, cacao seco, copra, bovino en pie y hule hevea	*
III	$2 \cdot v_{pa} > v_{ae}$ $2 \cdot v_{pa} > v_{en}$	arroz palay, cacao seco, copra, bovino en pie, hule hevea, caña de azúcar y cítricos,	*
IV	v_{pa}	arroz palay, cacao seco, caña de azúcar cítricos, copra, hule hevea, piña, plátano, bovino en pie y eucalipto	acahual, palmar inundable, matorral, selva alta perennifolia, selva baja inundable, selva mediana perennifolia y vegetación hidrófila

Building scenarios

## Oil palm scenarios

ESCENARIO	CAMBIO DE USO DE SUELO (hectáreas)		
	AGROECOSISTEMAS	ECOSISTEMAS	TOTAL
0	42 228	22 075	64 303
I	- 36 366 (86.1%)	0	- 36 366
II	- 36 392 (86.2%)	0	- 36 392
III	- 41 866 (99.1%)	0	- 41 866
IV	- 42 228 (100 %)	- 18 073 (81.8%)	- 60 301

Building scenarios
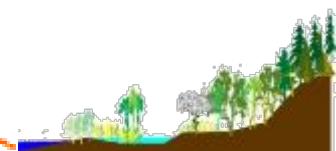
Oil palm scenarios

ESCENARIO	CAMBIO DE USO DE SUELO (millones de dólares)		
	AGROECOSISTEMAS	ECOSISTEMAS	TOTAL
0	33.210	119.910	153.119
I	+59.031 (178%)	119.910	+178.941
II	+80.859 (243%)	119.910	+200.769
III	+104.917 (316%)	119.910	+224.827
IV	+50.667 (153%)	-51.794 (43%)	-102.461

Summary

Oil palm has an agronomic and economic potential in the Region of La Chontalpa, and this could change the land use.

Farmers probably improve their income by producing oil palm. However, establishment of plantation is an important issue.

Cattle production is one of the most vulnerable land use.

Converting ecosystems into oil palm has a negative economic effect.

The potential study of oil palm should consider other environmental factors, such as ecosystem services.

Ecosystem services approach can help decision makers to develop conservation and guardianship programs for particular ecosystems.

Muito Obrigado!
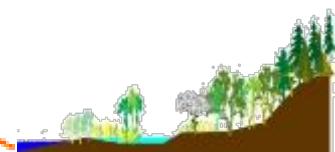
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