Remote sensing based products applicable to National Park monitoring in México

Dr. Rainer Ressl, Director of Geomatics

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Remote sensing based products applicable to National Park monitoring in México

1. Rapid fire detection program – Fire monitoring in ANPs
2. Future remote sensing based land cover monitoring for ANPs
3. Example applications for ANP monitoring in México
4. Satelite receiving station in Chetumal

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National commission for knowledge and use of biodiversity

Inter-secretarial advisory commission
headed by the President of Mexico

- Foreign Affairs (SRE)
- Department of Interior (SHCP)
- Energy (Sener)
- Economy (SE)
- Agr., Env. Dev. and Fisheries (Sagarpa)
- Public education (SEP)
- Health (SSA)
- Turism (Sectur)
- Social Development (Sedesol)
- Environment and Nat. Res. (Semarnat)

Main tasks / objectives

- Maintenance of the national biodiversity system (SNIB)
- Support biodiversity studies
- Release information on biological richness

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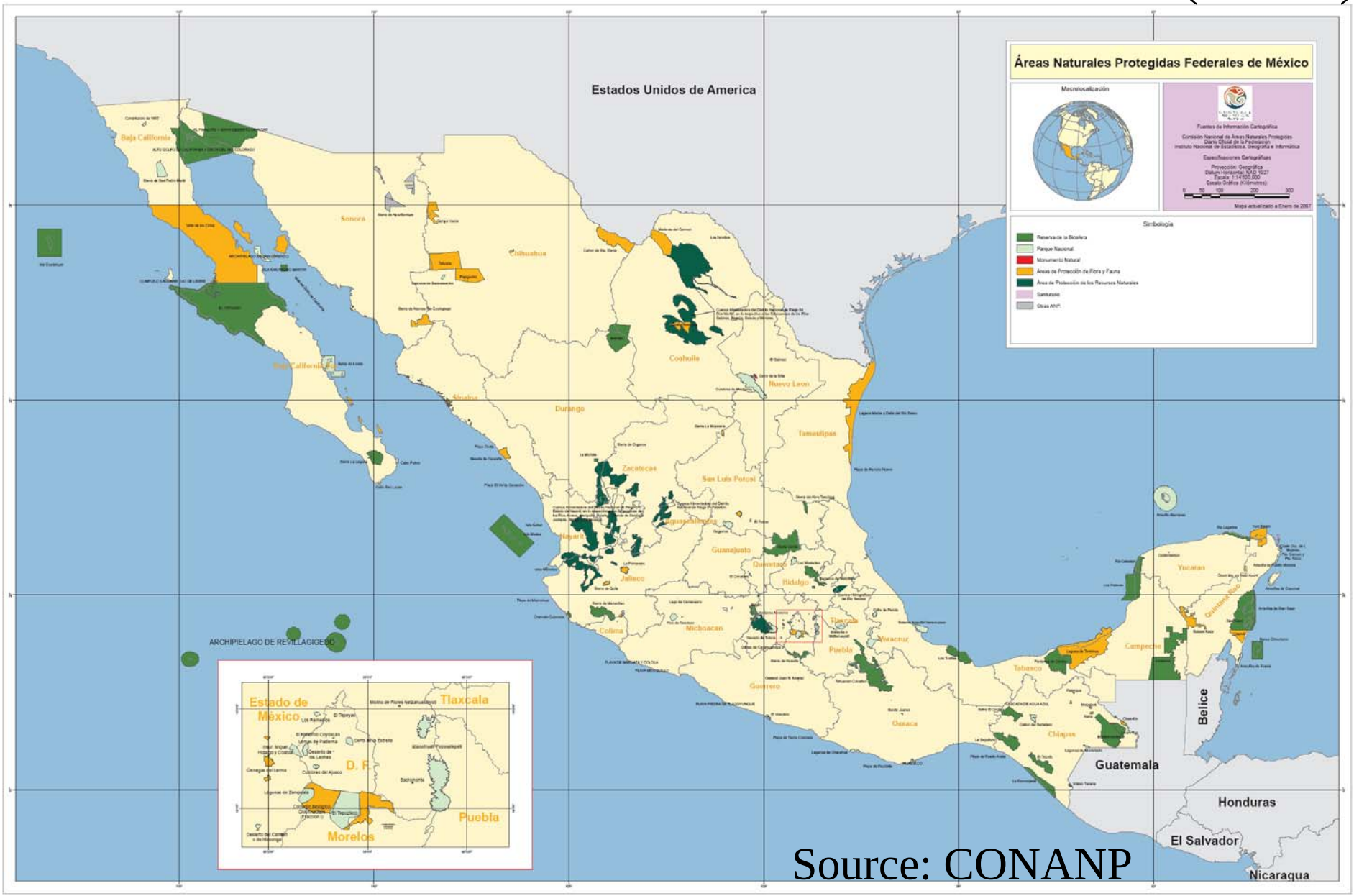
Federal Nature Protection Areas (ANP) in México

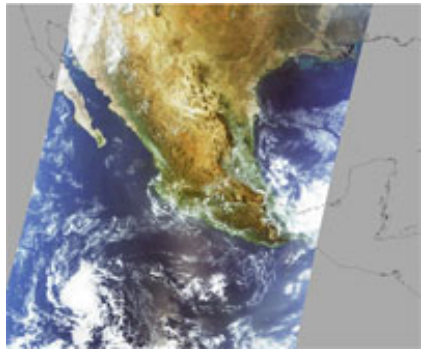
Area: 196.437.500 Mil. ha

ANP: 22.275.672 Mil. ha (11.34%)



Source: CONANP

Rapid fire detection program – Fire monitoring in ANPs



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Rapid fire detection program – Fire monitoring in ANPs

More than 80,000 hectares are affected by fires in Mexico every year.

Fires have a huge impact on global and local environmental processes

Identification and mapping of burned areas is critical for fire management

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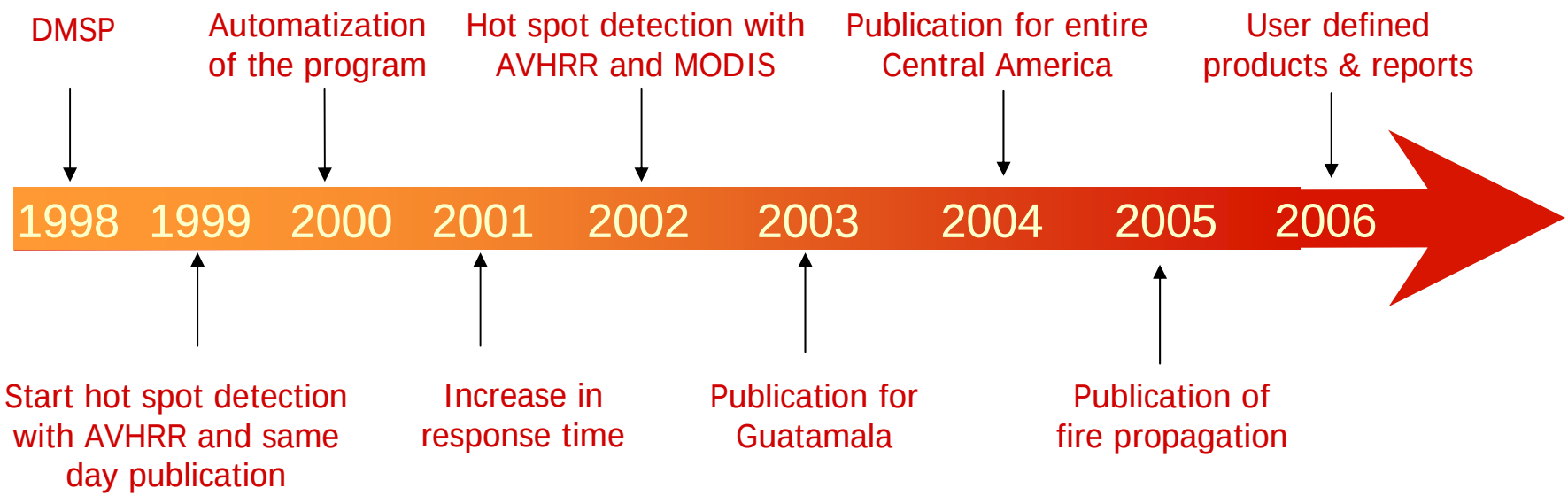
Photography by: Fulvio Eccardi

History of fire related activities at CONABIO



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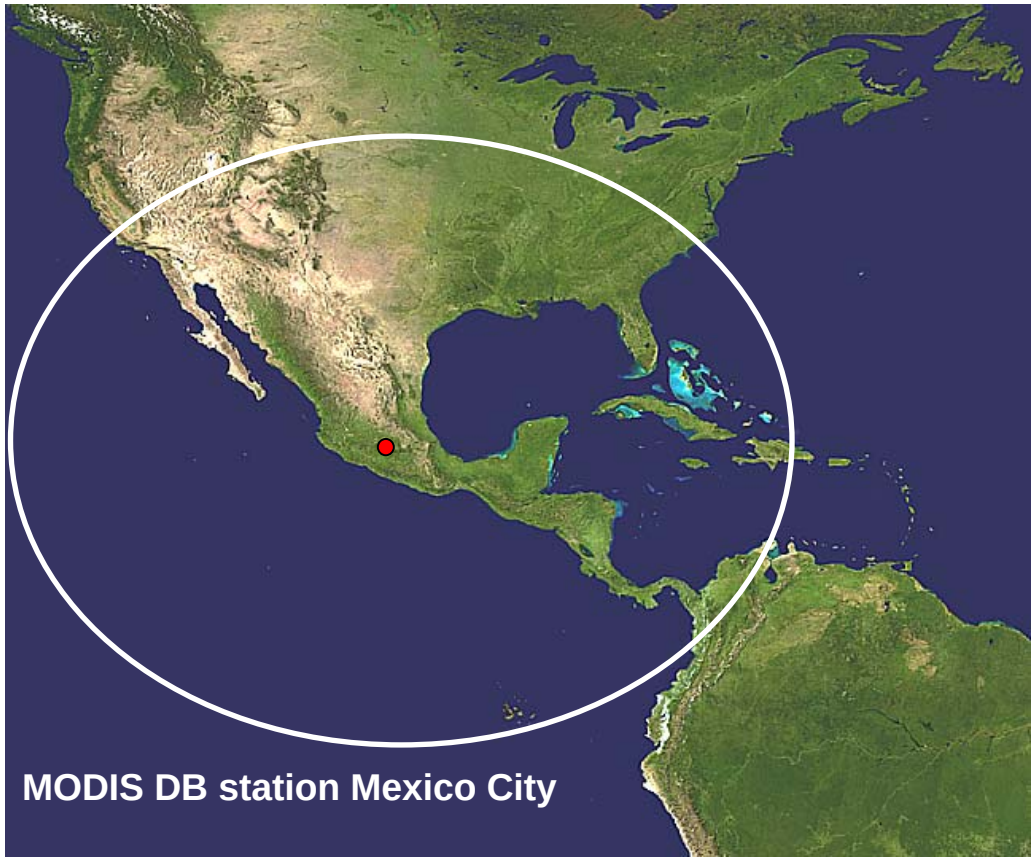
Rapid fire detection program

Continuous fire monitoring through complementary suite of satellites



MODIS DB station (X band antenna)

8 passes /day receiving MODIS Aqua / Terra

AVHRR (L band antenna)

Mainly NOAA 16 and 17

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Rapid fire detection program

Processing chain

Reception

AVHRR

MODIS

Pre-processing TeraScan

45 >> 15 min

MODIS and AVHRR images

MOD14 algorithm

Field information

Mask application

Elimination of points

- Volcanoes, mines
- Stable lights
- Water bodies

cloud masks

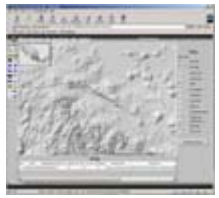
Detection of "Hot spots"

Aditional information

GIS

- States
- Municipalities
- Vegetation
- Protected areas

Daily Products



Web publication

- Information tables
- Fire maps
- Shape files
- e-mail chain

Total time between reception and publication

1.5 hours > 40 min

Fire processing

(45 min >> 20 min)

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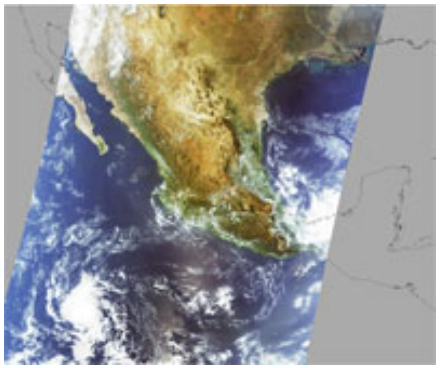
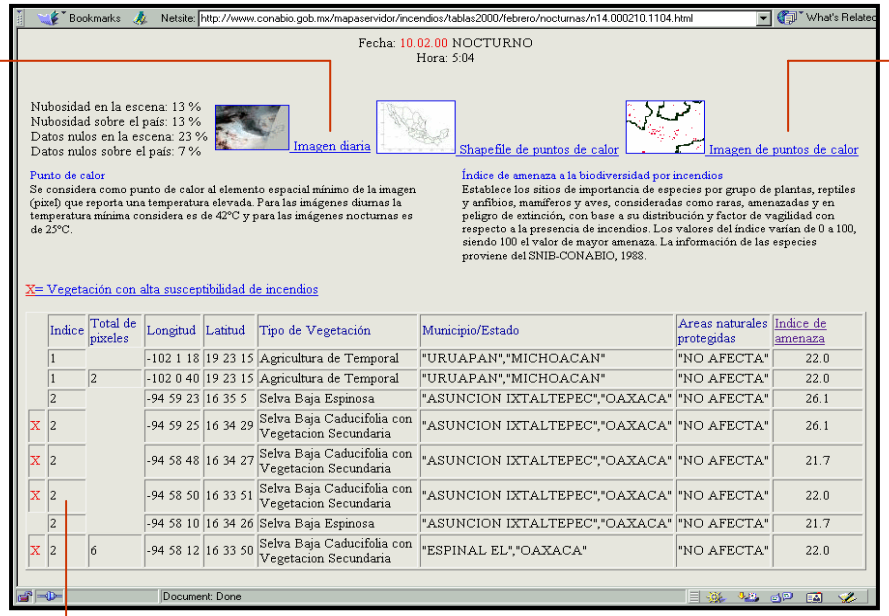
www.conabio.gob.mx

Rapid fire detection program

Quicklook





Bookmarks Netsite: http://www.conabio.gob.mx/mapaservidor/incendios/tablas2000/febrero/nocturnas/n14.000210.1104.html What's Related

Fecha: 10.02.00 NOCTURNO
Hora: 5:04

Nubosidad en la escena: 13 %
Nubosidad sobre el país: 13 %
Datos nulos en la escena: 23 %
Datos nulos sobre el país: 7 %

Imagen diaria Shapefile de puntos de calor Imagen de puntos de calor

Punto de calor
Se considera como punto de calor al elemento espacial mínimo de la imagen (pixel) que reporta una temperatura elevada. Para las imágenes diurnas la temperatura mínima considera es de 42°C y para las imágenes nocturnas es de 25°C.

Índice de amenaza a la biodiversidad por incendios
Establece los sitios de importancia de especies por grupo de plantas, reptiles y anfibios, mamíferos y aves, consideradas como raras, amenazadas y en peligro de extinción, con base a su distribución y factor de vagilidad con respecto a la presencia de incendios. Los valores del índice varían de 0 a 100, siendo 100 el valor de mayor amenaza. La información de las especies proviene del SNIB-CONABIO, 1988.

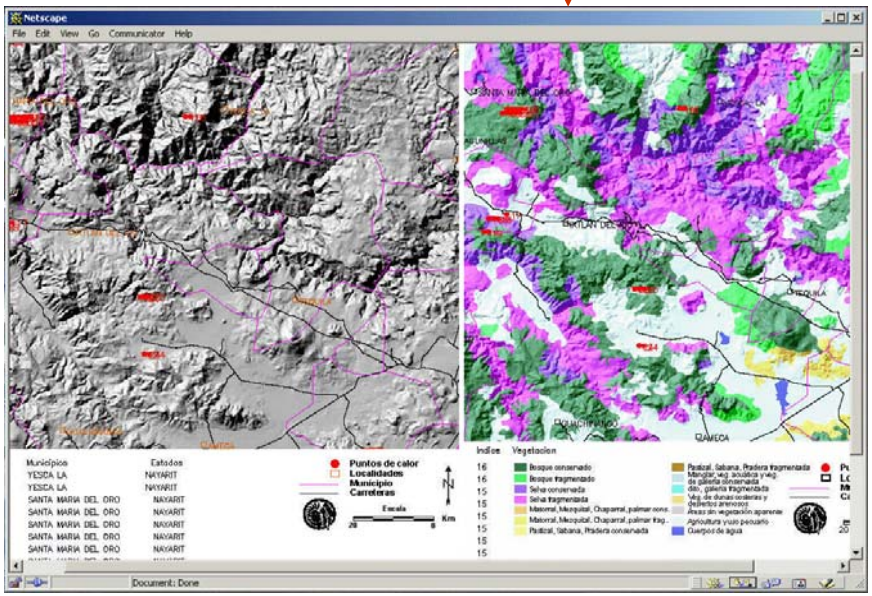
X= Vegetación con alta susceptibilidad de incendios

	Indice	Total de pixeles	Longitud	Latitud	Tipo de Vegetación	Municipio/Estado	Areas naturales protegidas	Indice de amenaza
	1		-102 1 18	19 23 15	Agricultura de Temporal	"URUAPAN","MICHOACAN"	"NO AFECTA"	22.0
	1	2	-102 0 40	19 23 15	Agricultura de Temporal	"URUAPAN","MICHOACAN"	"NO AFECTA"	22.0
	2		-94 59 23	16 35 5	Selva Baja Espinosa	"ASUNCION IXTALTEPEC","OAXACA"	"NO AFECTA"	26.1
X	2		-94 59 25	16 34 29	Selva Baja Caducifolia con Vegetacion Secundaria	"ASUNCION IXTALTEPEC","OAXACA"	"NO AFECTA"	26.1
X	2		-94 58 48	16 34 27	Selva Baja Caducifolia con Vegetacion Secundaria	"ASUNCION IXTALTEPEC","OAXACA"	"NO AFECTA"	21.7
X	2		-94 58 50	16 33 51	Selva Baja Caducifolia con Vegetacion Secundaria	"ASUNCION IXTALTEPEC","OAXACA"	"NO AFECTA"	22.0
	2		-94 58 10	16 34 26	Selva Baja Espinosa	"ASUNCION IXTALTEPEC","OAXACA"	"NO AFECTA"	21.7
X	2	6	-94 58 12	16 33 50	Selva Baja Caducifolia con Vegetacion Secundaria	"ESPINAL EL","OAXACA"	"NO AFECTA"	22.0

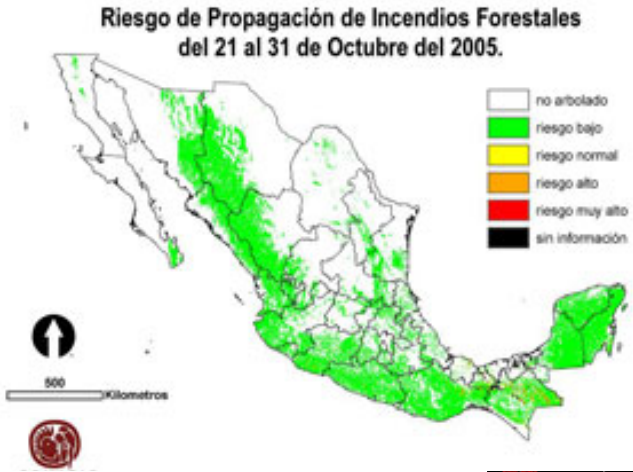
Document: Done

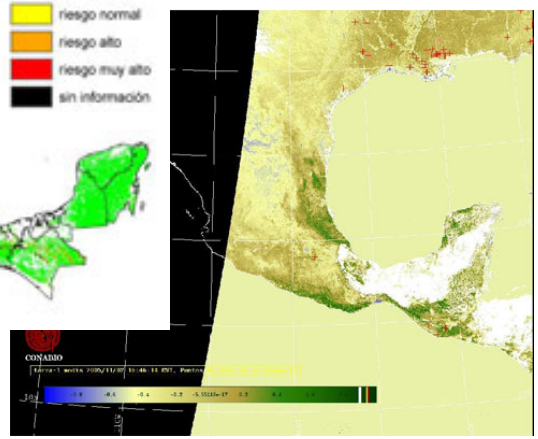
"Hot Spot"- Map

DEM and Vegetation



Value added products





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Statistics of the operational fire detection program at CONABIO

- Approx. 350.000 hits on fire page every month
- Average response time from satellite overpass to end user less than 50 min.
- 4606“hot spots” (night) and 43327 “hot spots” (day) detected, classified and reported in the year of 2006
- 330 user defined e-mails with fire related products sent out daily to méxican and central american end users (currently 48 institutions)

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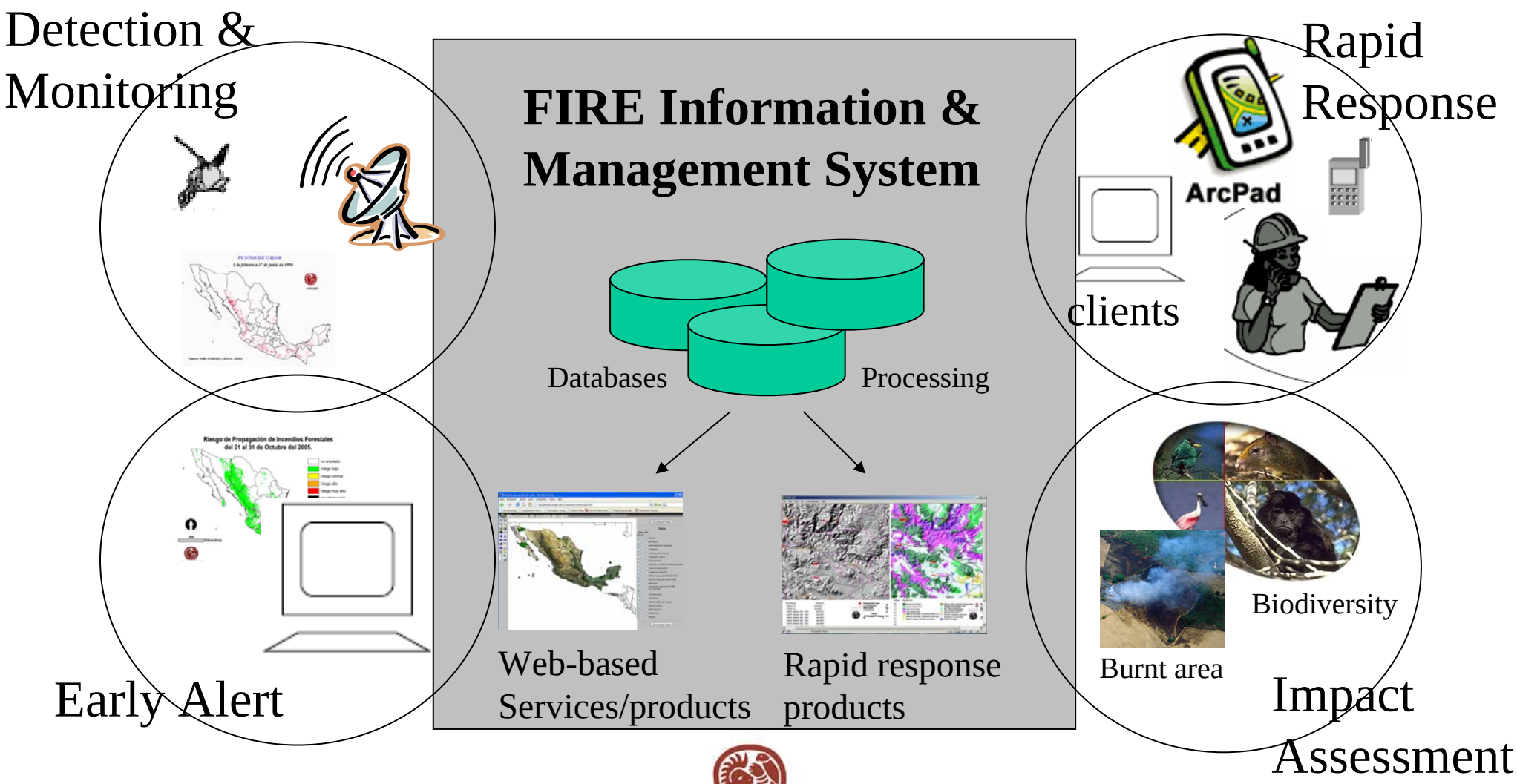
Rapid fire detection program – Future components

Early Alert, Monitoring and Impact Assessment System for Forest Fires in Mexico and Central America



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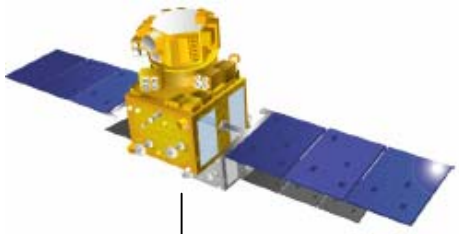
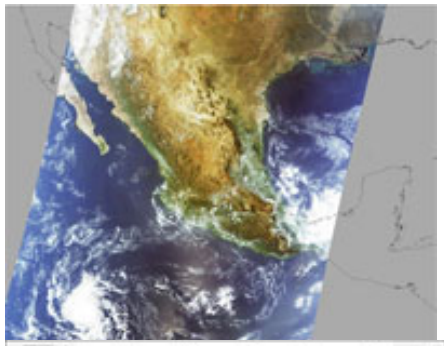
Forest Fire monitoring in CONABIO – Potential future components

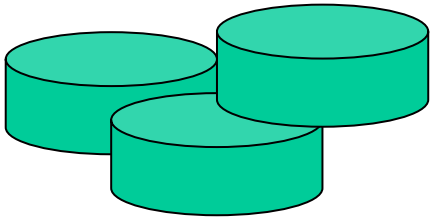
National surveillance by satellite





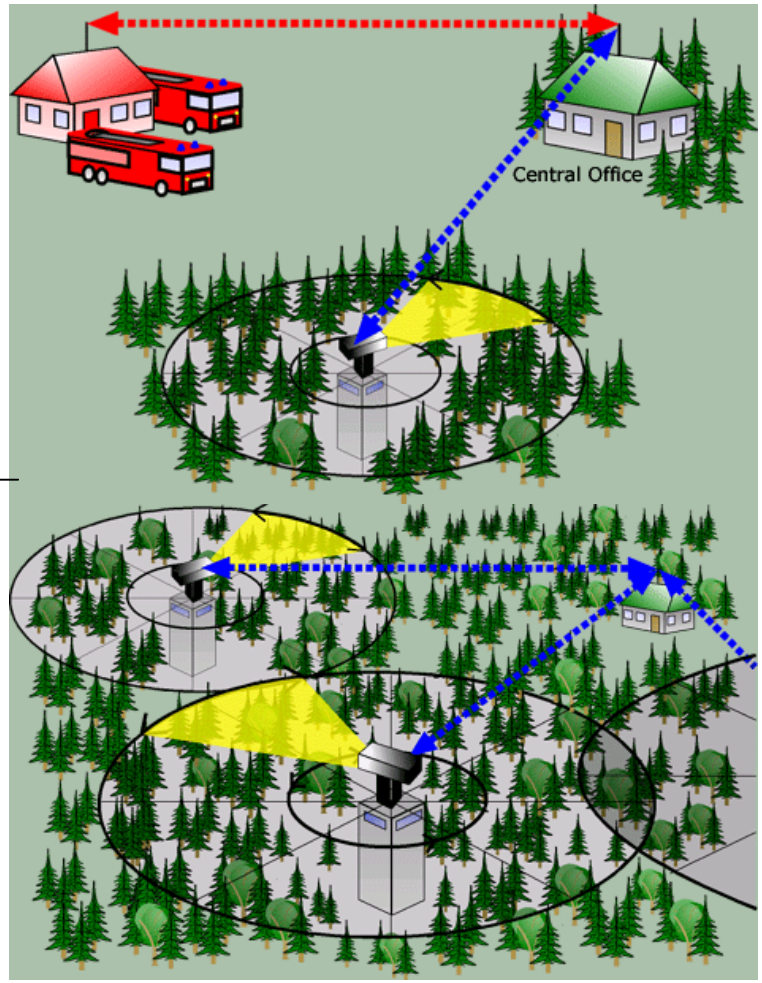
•8-10 surveys / day
•2300 km coverage

Central Information System for Wildfire Monitoring



•Multi-scale
•Multi-temporal
•Complementary

ANP Surveillance by terrestrial camera systems



•Surveys every 10 min
•20 km Radius

Quelle: IQ Wireless - Firewatch

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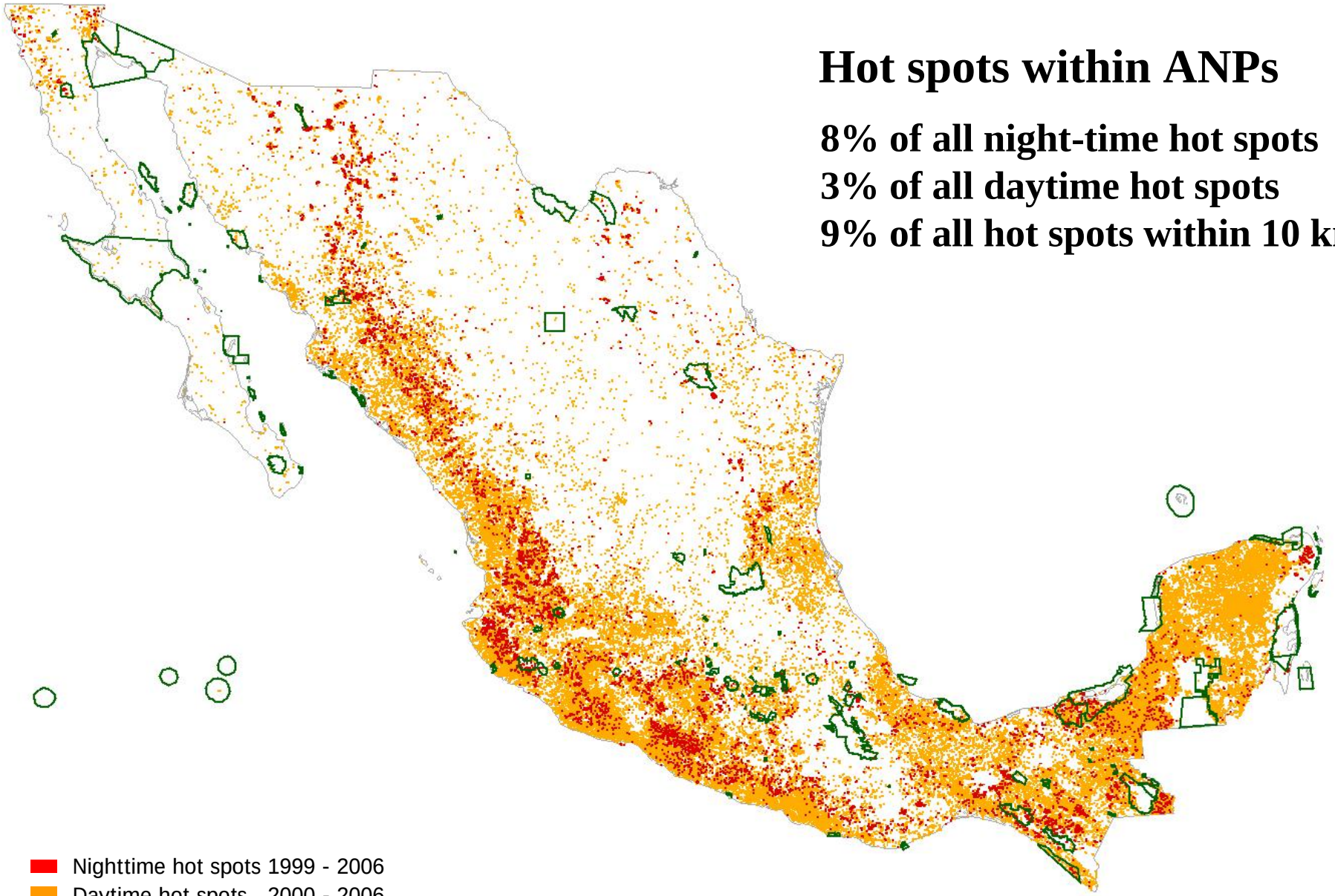
Detected hot spots in ANPs between 1999 - 2006



Hot spots within ANPs

8% of all night-time hot spots
3% of all daytime hot spots
9% of all hot spots within 10 km buffer

Nighttime hot spots 1999 - 2006
Daytime hot spots 2000 - 2006

Area Natural Protegida

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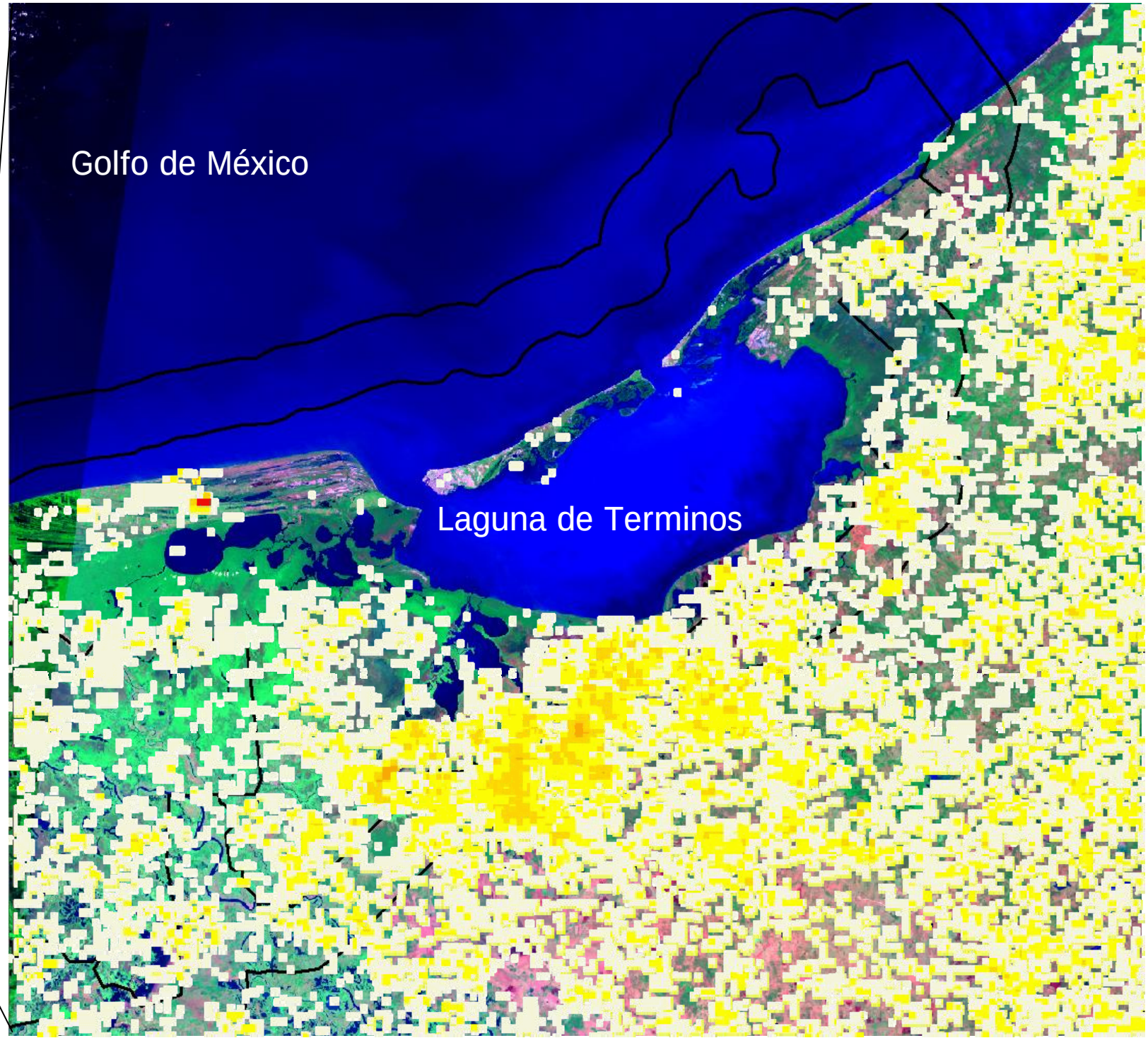
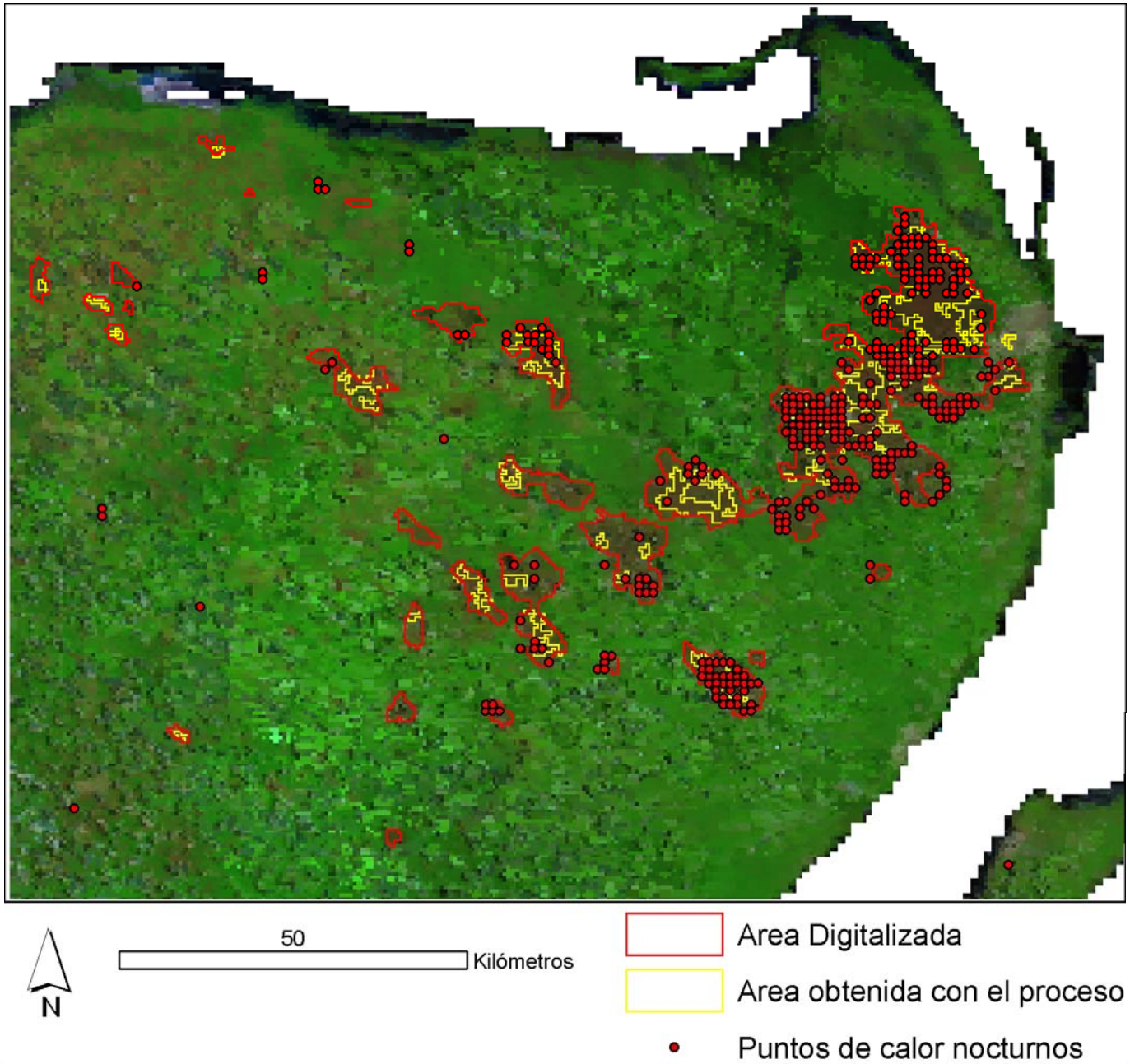
ANP
Laguna de Terminos

Nighttime fire
1999-2006

Daytime fire
2000-2006



Post fire impact assessment – Automated Burnt Area estimation



MODIS BA product

Validation with high resolution satelite data (SPOT)

Problems:

- Still large omissions of BA
- Cloud border contamination

Future remote sensing based land cover monitoring in ANPs

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MODIS – Potential products for monitoring in ANP

Deforestation monitoring , change detection:

- **Vegetation / land cover fraction:**
  - **Percent Tree Cover,**
  - **Non-tree Cover,**
  - **Percent Bare Cover**
- **Vegetation Cover Conversion (VCC) → Change detection: "hot spots"**
- **16-Day 250m Composite NDVI/EVI → Vegetation presence/ Changes**
- **Burnt areas (BA) → Monitoring of changes related to fires**
- **Net Primary Production (NPP)**

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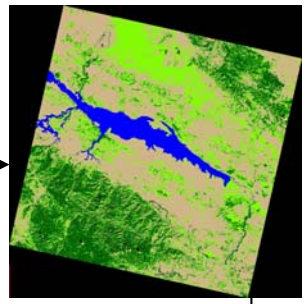
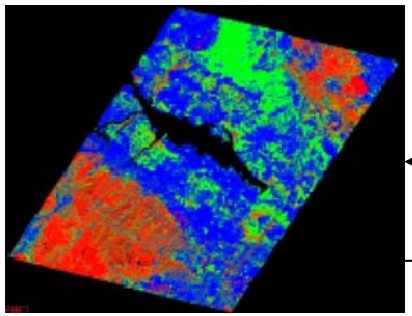
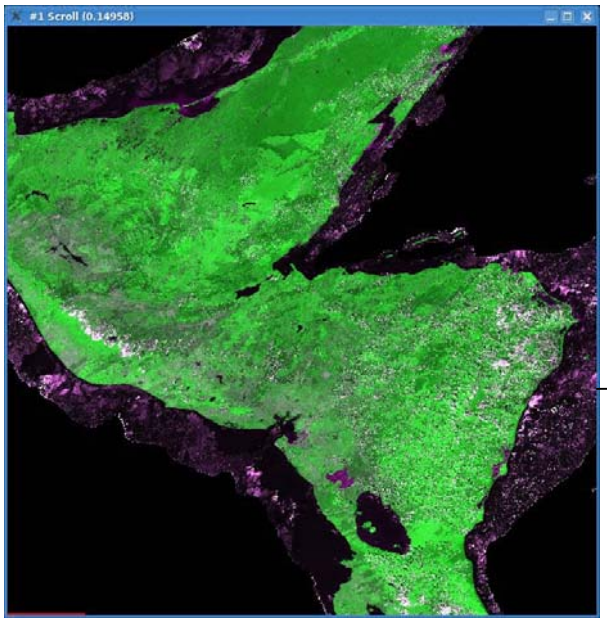
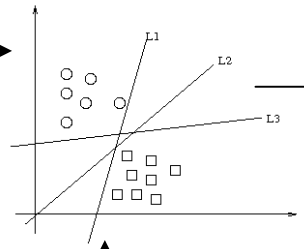
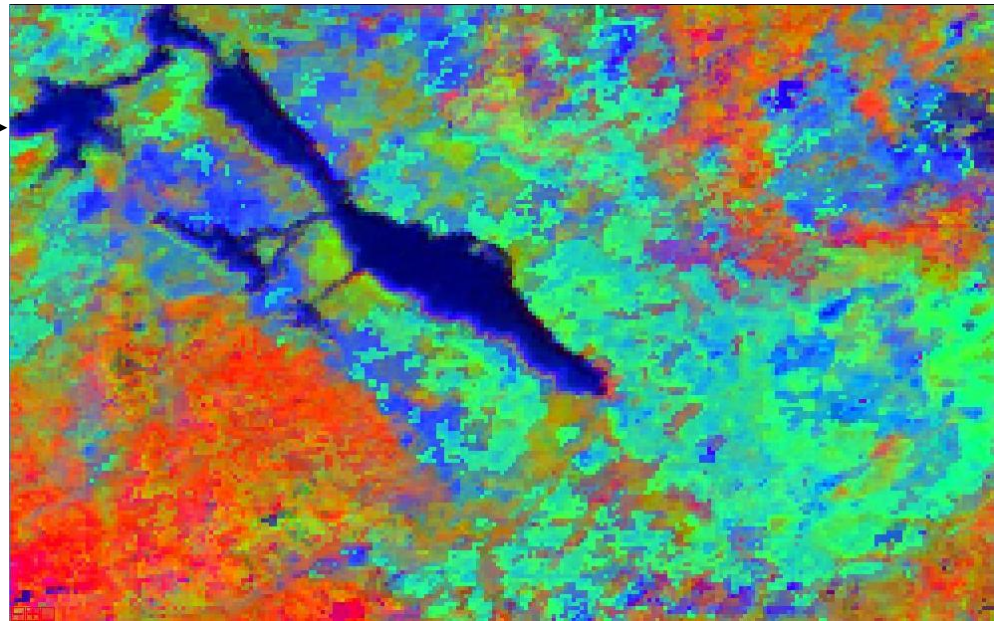
Land cover monitoring in ANPs - vegetation fraction / MODIS











Estimation of fractional vegetation and land cover:

- Tree vegetation
- Non-tree vegetation
- Bare soil

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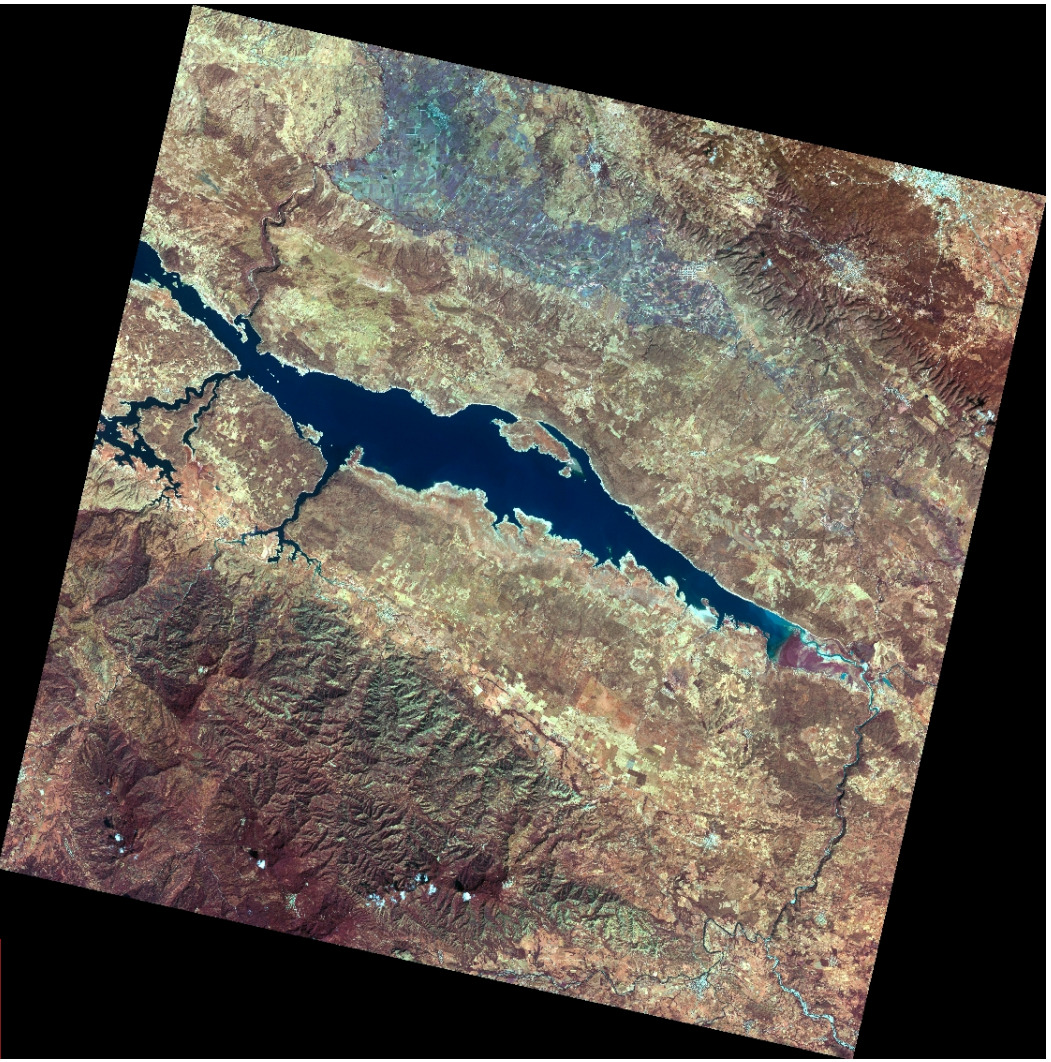
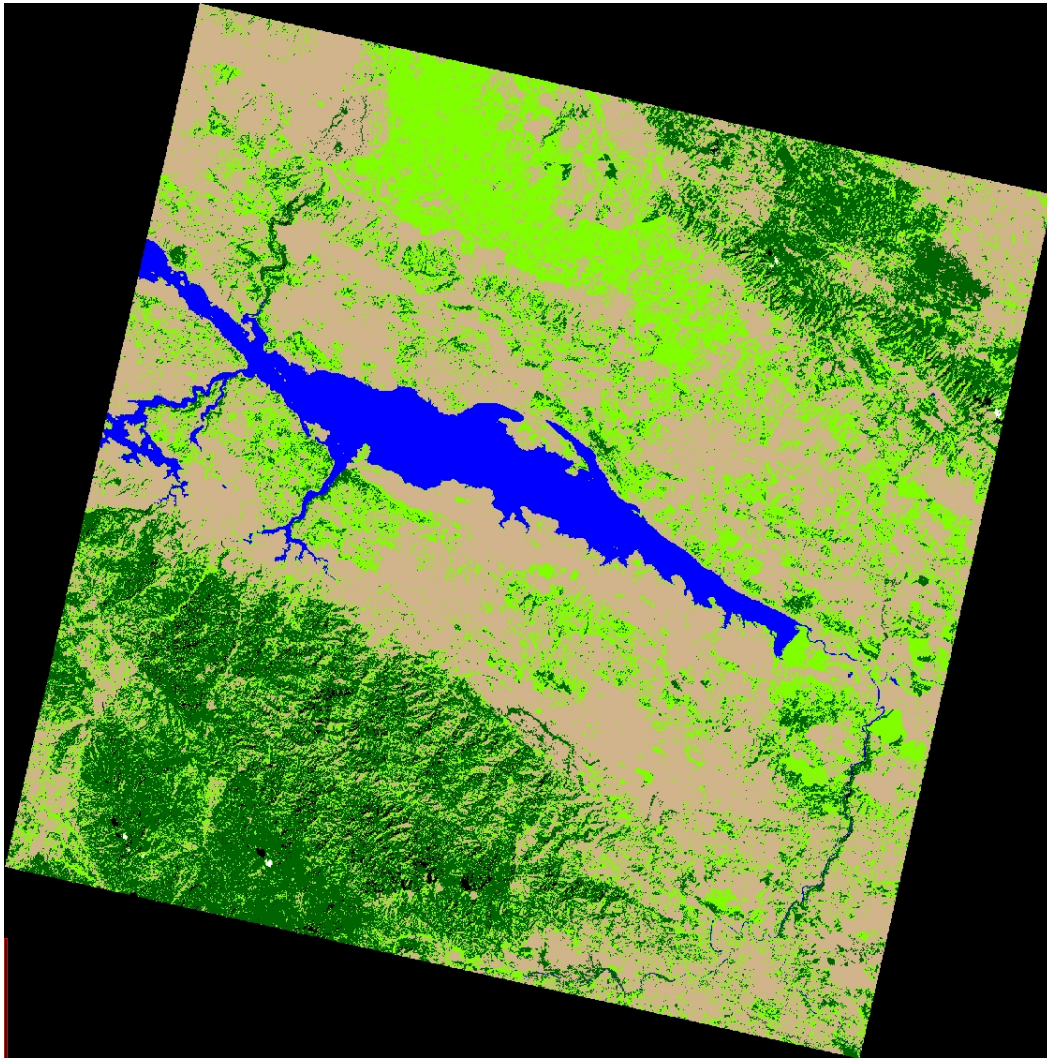
Land cover monitoring in ANPs - vegetation fraction / MODIS

Spatial high resolution training data – SPOT 10 m





5 classes: bush/non tree vegetation, tree vegetation, bare soil, water y clouds/shadows

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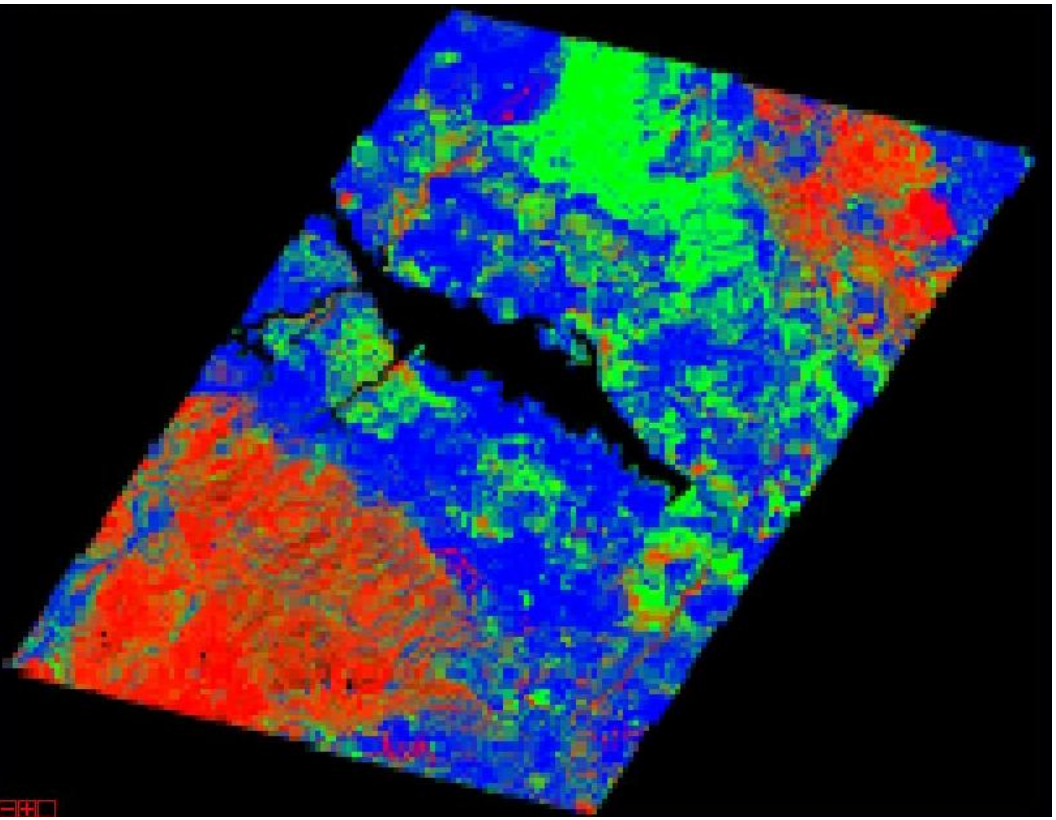
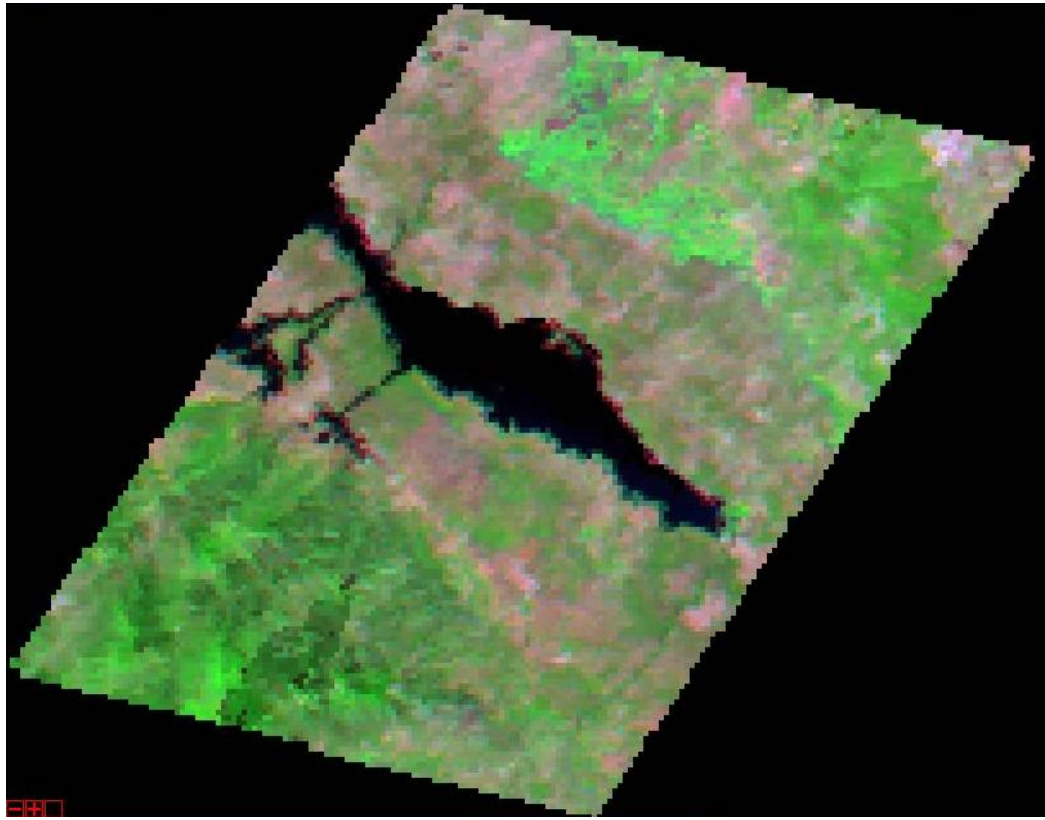
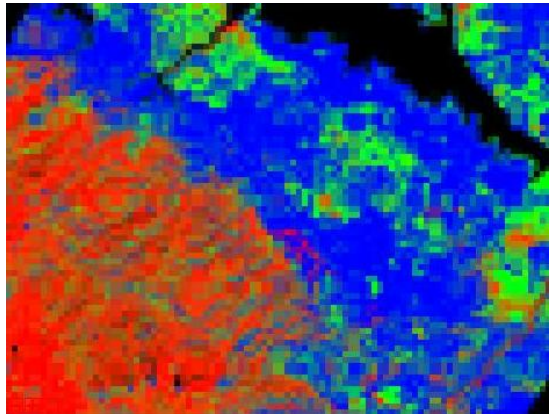
MODIS Vegetation Continuous Fields - VCF

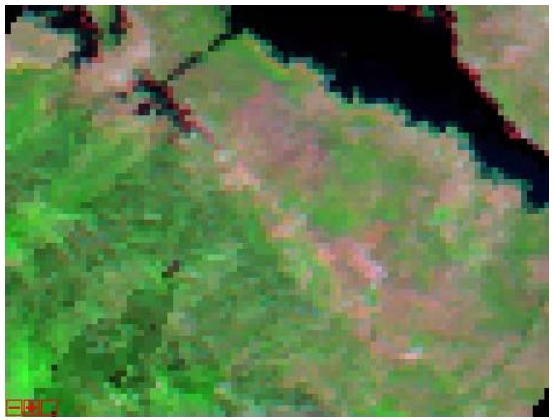
Classification algorithm – Support Vector Machine "SVM"





Training data (SPOT)





MODIS data

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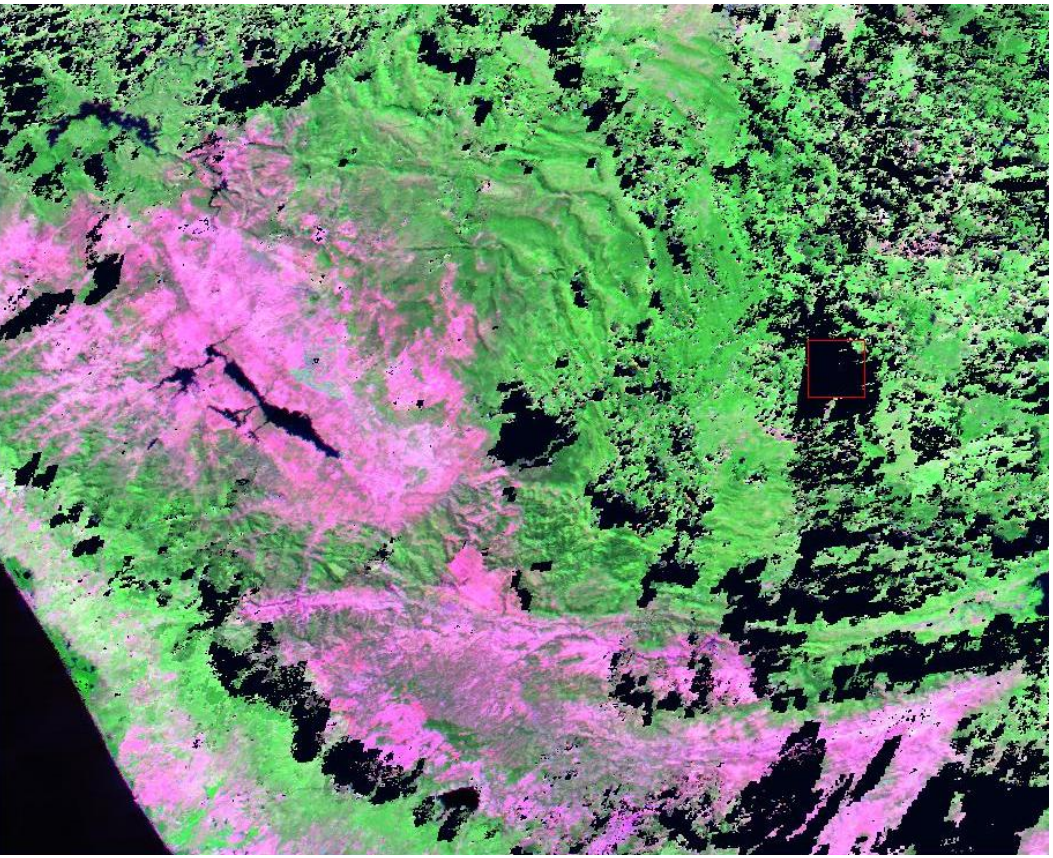
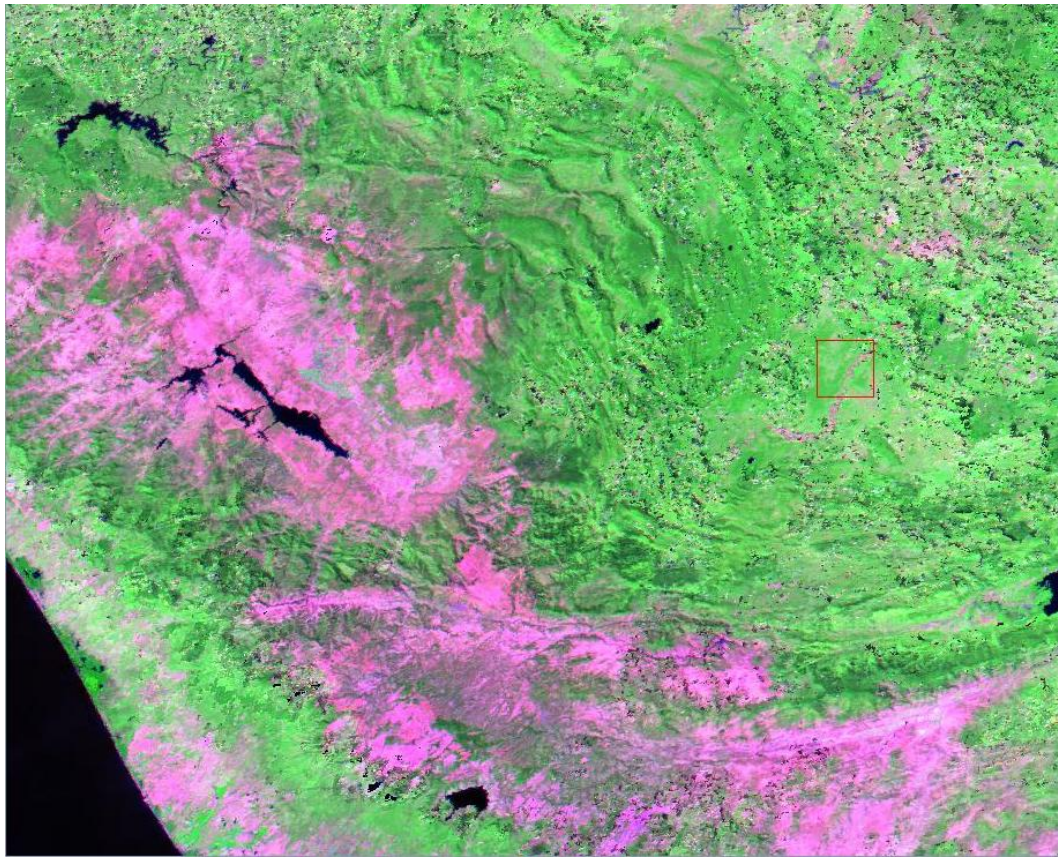
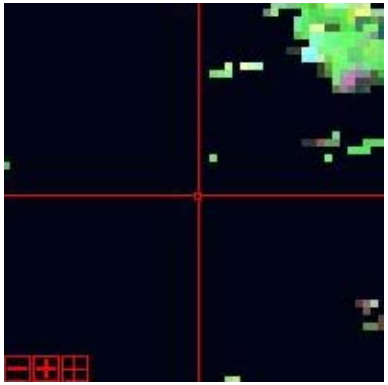
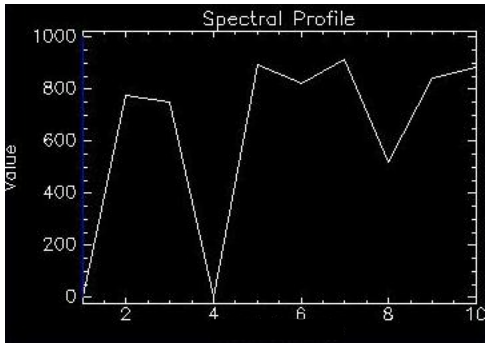
Land cover monitoring in ANPs - vegetation fraction / MODIS

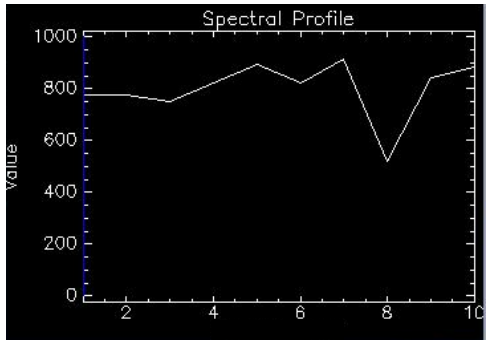
Data gap interpolation – simple SPLINE

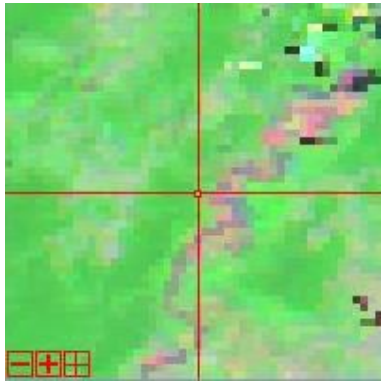












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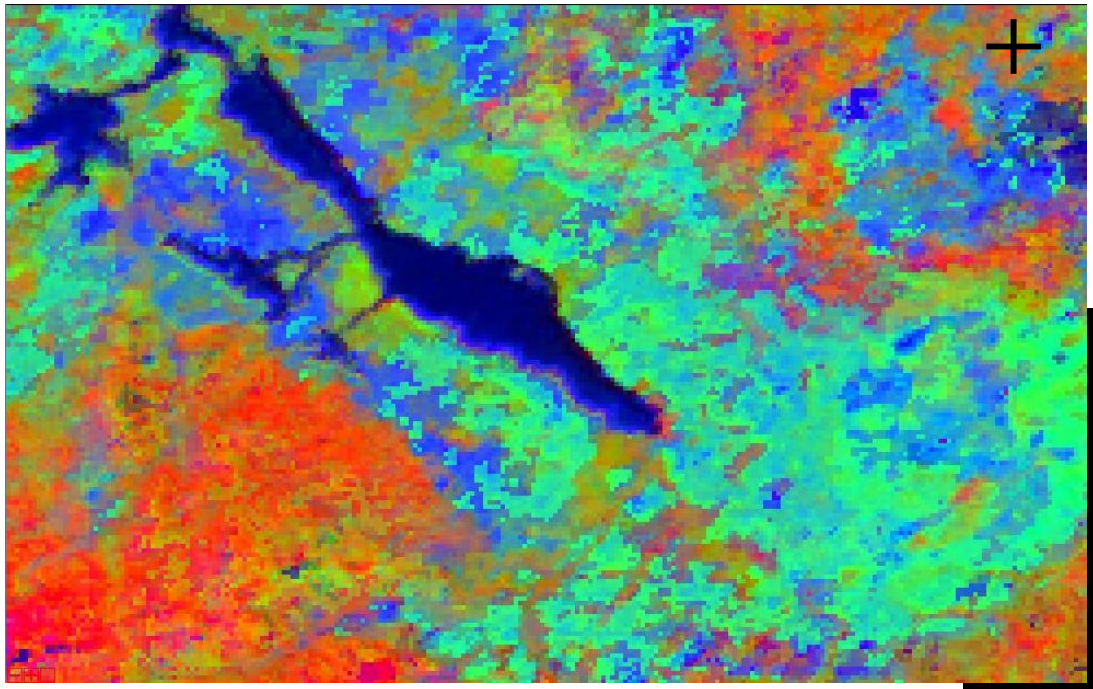
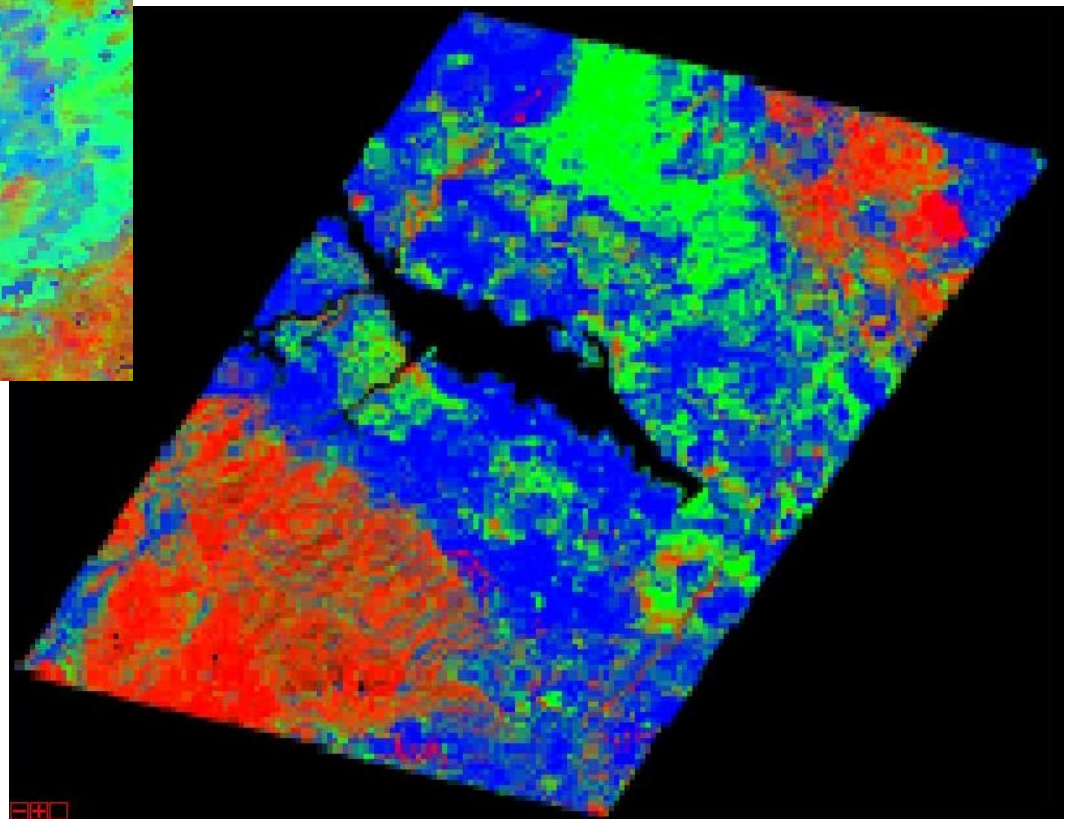
Land cover monitoring in ANPs - vegetation fraction / MODIS

Results – alfa version!





Next steps

- Testing in different ecosystems
- Describing spectral and temporal behaviour of core clases
- Validation with selected users (e.g. ANP)
- Application: “environmental services”

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Example applications for ANP monitoring in México

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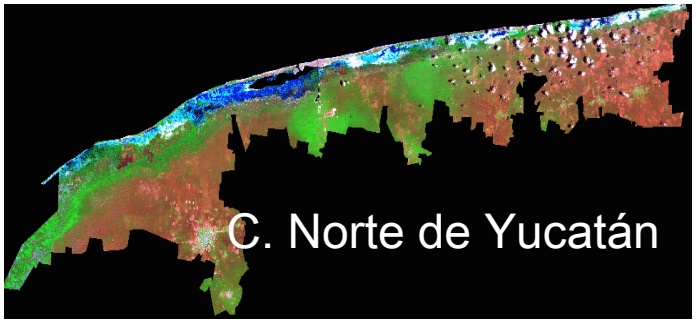
Selected Remote sensing applications for ANPs in México – Mesoamerican Biological Corridor



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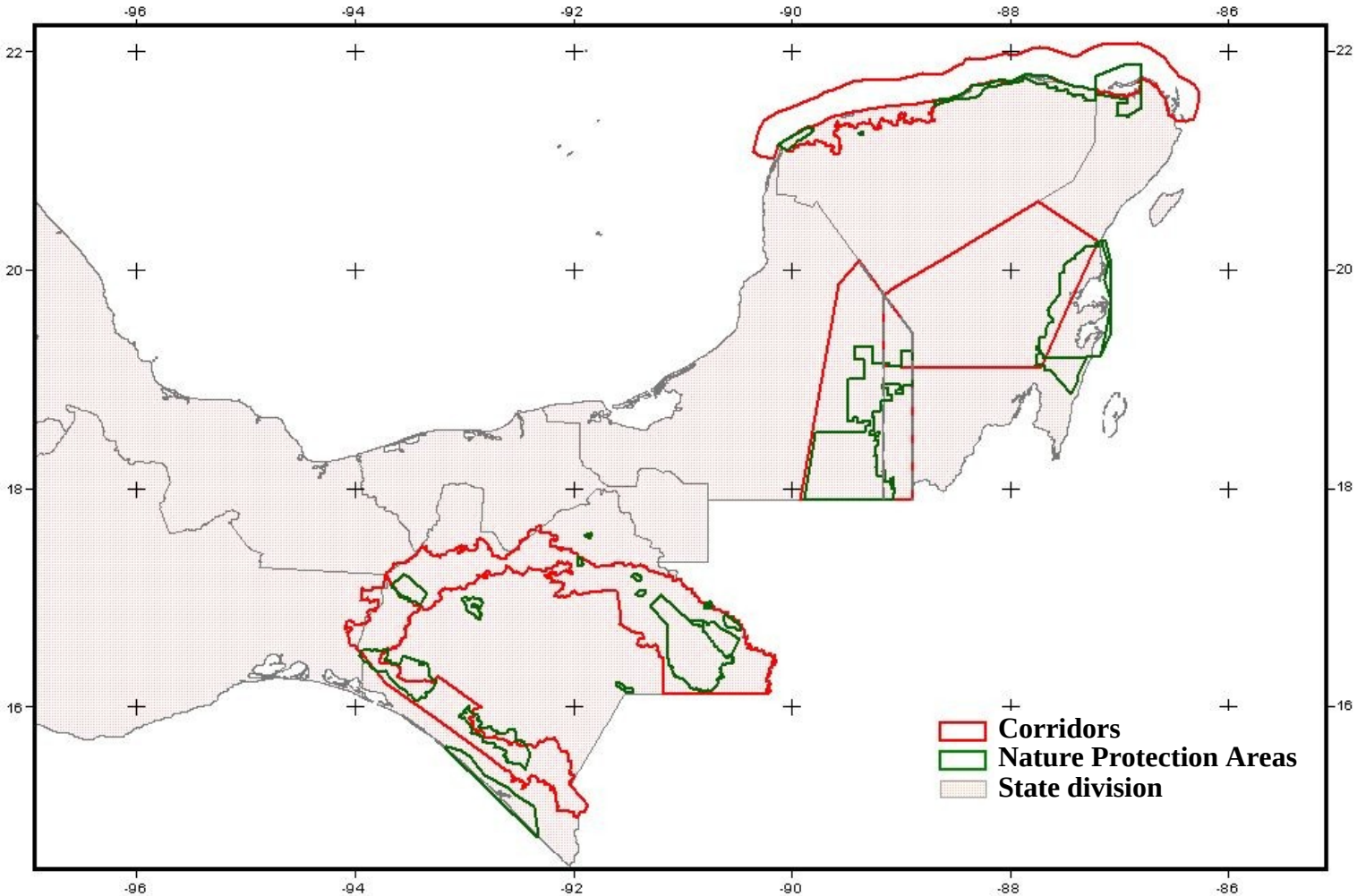
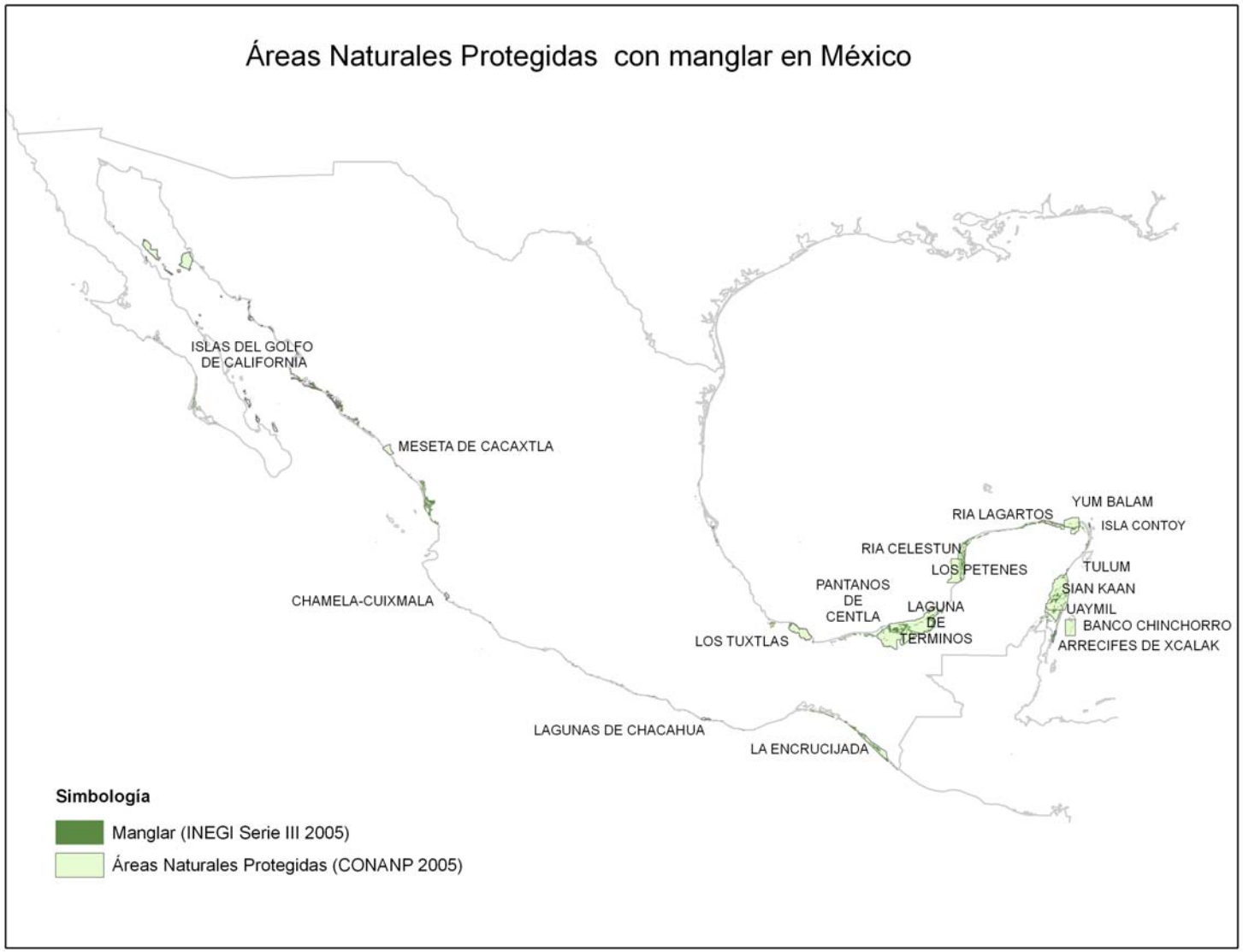
Automated monitoring of land cover change in ANPs – Test case: Mesoamerican Biological Corridor



- Land cover change (Landsat) - > Modeling
- Phenology Monitoring (MODIS – EVI)
- Fire monitoring and BA
- Landscape pattern analysis
- Vegetation Indicators (Fragmentation)
- Biodiversity indicators (species richness, habitat changes)

Monitoring of mangrove forests in Mexico in ANPs



Stages

1. Nationwide inventory
2. Characterization through biophysical variables
3. Monitoring

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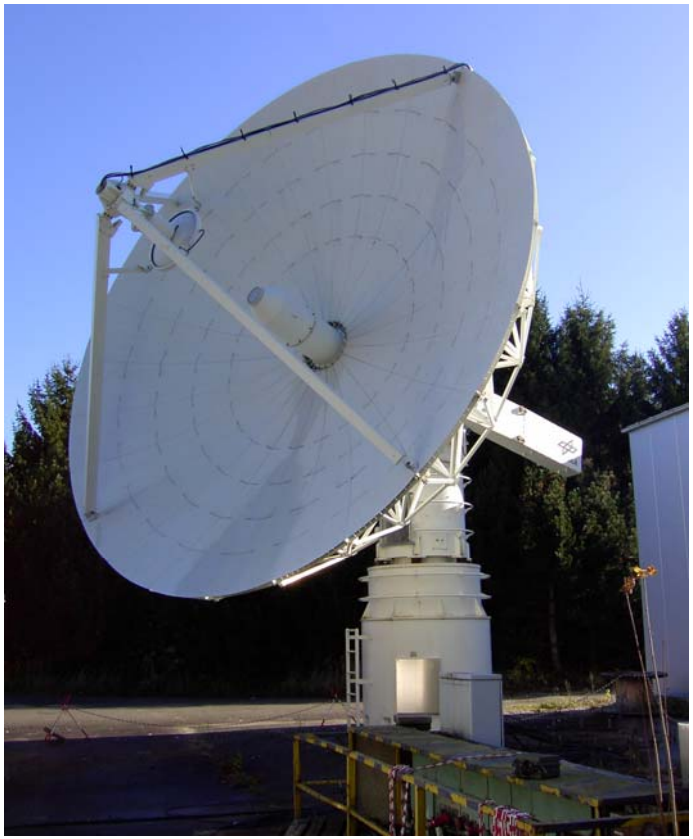
Future satellite receiving antena in Chetumal / México (DLR / México)

Chetumal antenna LSX-band, 8.0m



Assured and potential data reception at the „Chetumal Station“

assured
planned
To be confirmed
Under negotiation

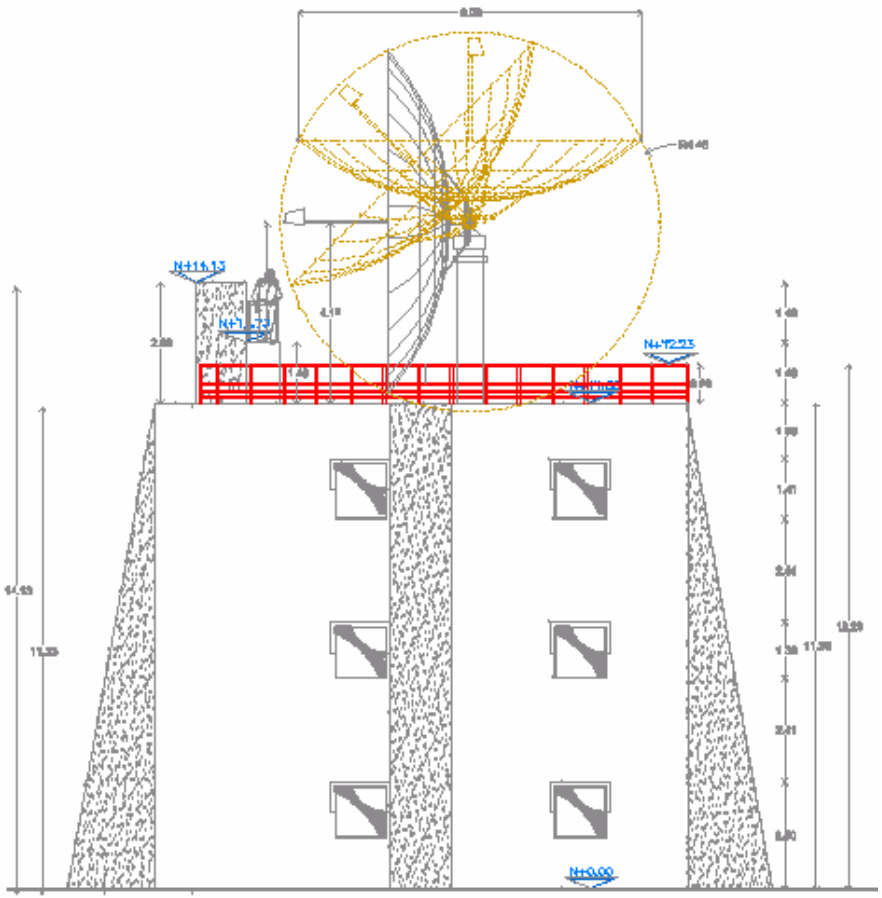
Satellite	Owner	Sensor	Chetumal	HL Proc	Access
ERS-2	ESA	SAR	Acq,Lvl-0	Mexico City	Sc: Cat-1
ERS-2	ESA	LBR	Acq, Lvl-2	DLR	free
Envisat	ESA	ASAR	Acq, Lvl-1b	DLR	Sc: Cat-1
Landsat-5	USGS	TM	Acq, lvl-0	USGS	Sc: free
Terra	NASA	MODIS	Acq, Lvl-1	Mexico City	Free
Aqua	NASA	MODIS	Acq, Lvl-1	Mexico City	free
IRS-P6	ISRO	AWIFS, LISS-3,4	Acq, Lvl-0	Mexico City	Com: Geoeye
TerraSAR-X	DLR	SAR	Acq, Lvl-0	DLR	Sc: DLR
RapidEYE	RapidEye	Optical	Acq, Lvl-0	RapidEye	Com: RE

Sc: DLR

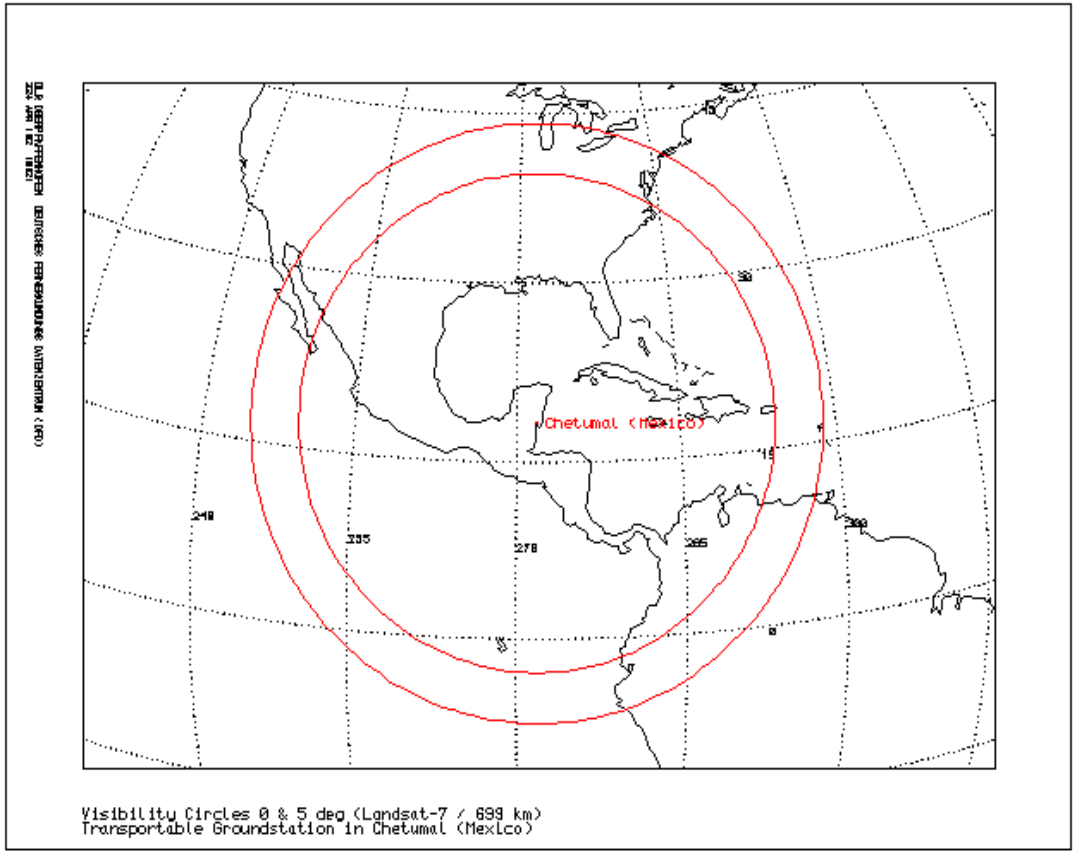
CONABIO

Satellite receiving station Chetumal

Infrastructure preparation



Data reception circle of „Chetumal“



CONABIO

Mexico City - October 10-11, 2007

Direct broadcast/direct readout technologies provide near real-time access to imagery and derivative land and vegetation data products integral to numerous applications worldwide. The Land and Vegetation Direct Readout Workshop will be an opportunity to discuss current and future direct readout programmatic and technical issues regarding high temporal, moderate resolution sensors. The two-day workshop will focus specifically on land and vegetation applications based on MODIS, AVHRR, VIIRS and other moderate resolution environmental sensors that support direct readout.

The Land and Vegetation Direct Readout Workshop is co-sponsored by NASA, the Global Observations of Forest Cover and Land Cover Dynamics (GOFC/GOLD), the Comisión nacional para el conocimiento y uso de la biodiversidad (CONABIO) and the USDA Forest Service Remote Sensing Applications Center. The workshop is primarily intended for scientists and data producers from direct readout facilities, land/vegetation product scientists for MODIS, AVHRR, VIIRS and similar environmental sensors, and members of academia.

The workshop is hosted by CONABIO at the Unidad de Seminarios — Universidad Nacional Autónomia de México (UNAM) University Campus, Mexico City. The workshop will follow the International Seaspace Remote Sensing Conference to be held at the same venue October 8-9, 2007

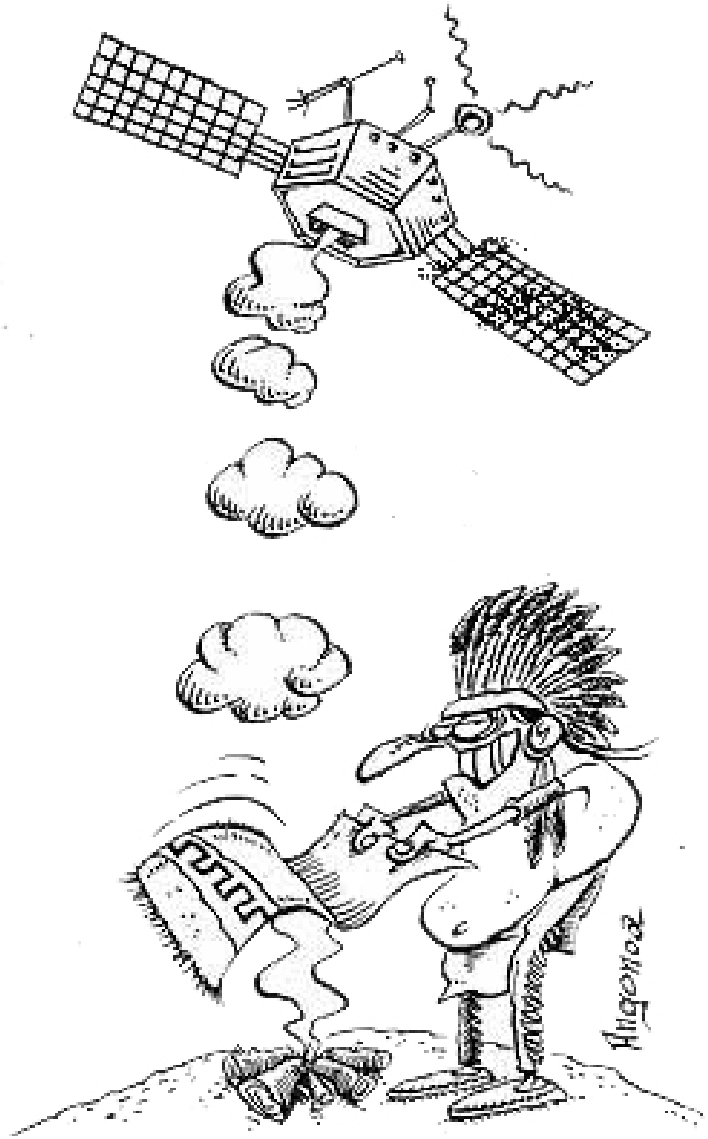
Workshop Goals

Primary goals of the workshop will include:

- Discussion of the current state of direct readout technologies
- Continuity of current technologies with future missions
- A forum for technical exchange between direct readout data producers and scientists on land/vegetation science algorithms and applications
- Formation of regional/continental direct readout data integration networks

Hotel and venue information will be provided soon.

NASA CONABIO USDA GOFC-GOLD

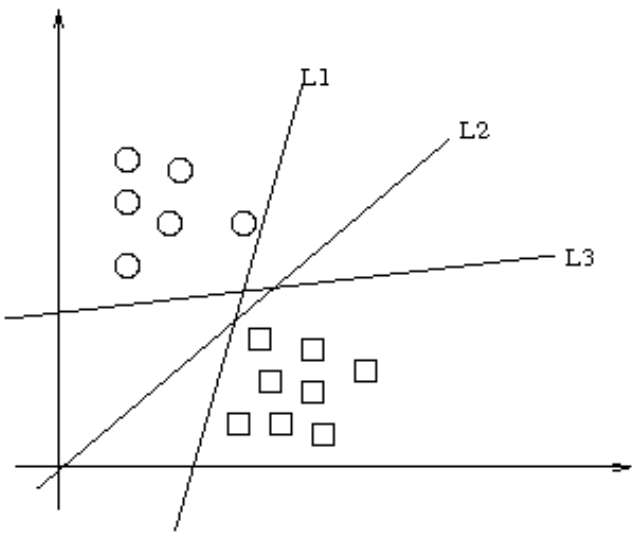


CONABIO

Algoritmo de clasificación - SVMs

Support Vector Machines – Método de aprendizaje supervisado para la clasificación y regresión multivariada, se considera un clasificador lineal aunque es posible usar clasificación no lineal aplicando *kernel trick* para maximizar el margen de los hiperplanos.

LIBSVM – Libreria open-source para SVMs. Chih-Chung Chang and Chih-Jen Lin



$$\{(\mathbf{x}_1, c_1), (\mathbf{x}_2, c_2), \ldots, (\mathbf{x}_n, c_n)\}$$

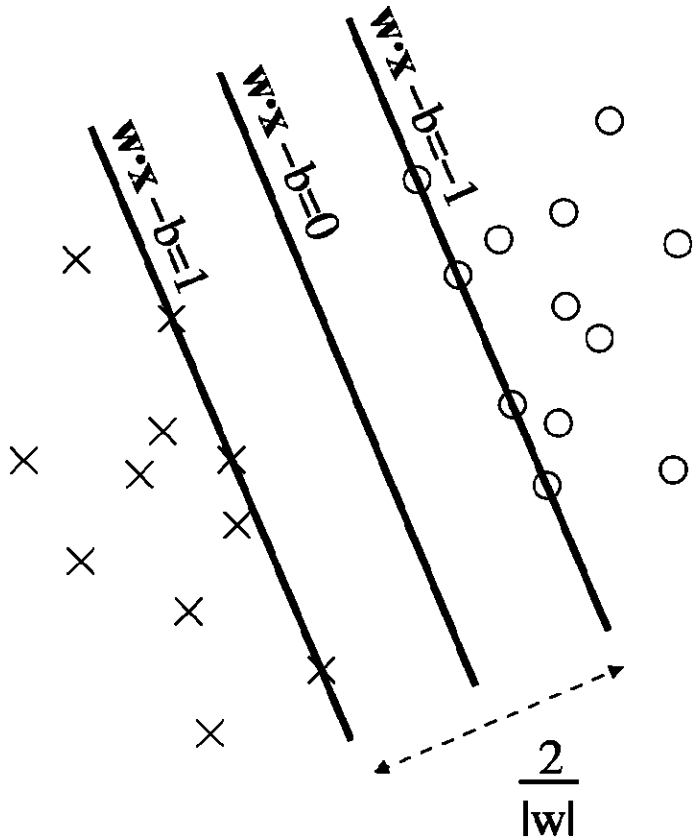
Hiperplano

$$\mathbf{w} \cdot \mathbf{x} - b = 0.$$

El vector **w** apunta de forma perpendicular al hiperplano que separa las clases

Si los datos de entrenamiento son linealmente separables es posible seleccionar estos y tratar de maximizar la distancia entre ellos, $2/|w|$, por lo tanto se desea minimizar $|w|$

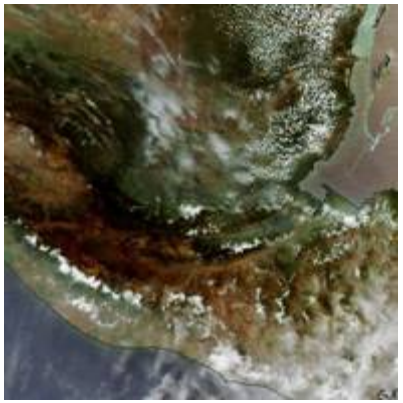
$$\mathbf{w} \cdot \mathbf{x_i} - b \geq 1 \qquad \text{or}$$
$$\mathbf{w} \cdot \mathbf{x_i} - b \leq -1$$



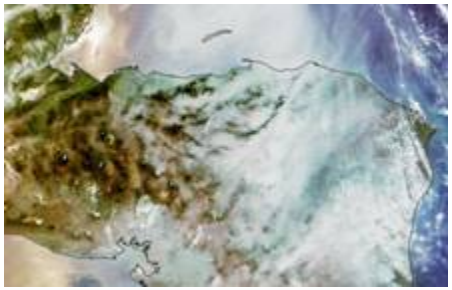
CONABIO

Rapid fire detection program

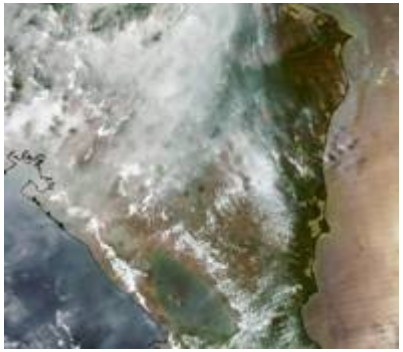
Near-realtime fire detection program for México and Central America



Guatemala



Honduras



Nicaragua

Time from reception to information release:

- **Currently ~ 1.5 hours**
- **April 2006 < 40 min**

•Suite of products

Low >> High tech

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