EVALUATION OF THE THREAT BY WILDFIRES IN THE STATE OF YUCATAN, MEXICO.

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- **Introduction**

- **Background**

- **Target**

- **Working Methods**

- **Results**

- **Conclusions**

- **Recommendations**

- **In the Yucatan Peninsula, forest fires are annually one of the main impacts of environmental degradation.**

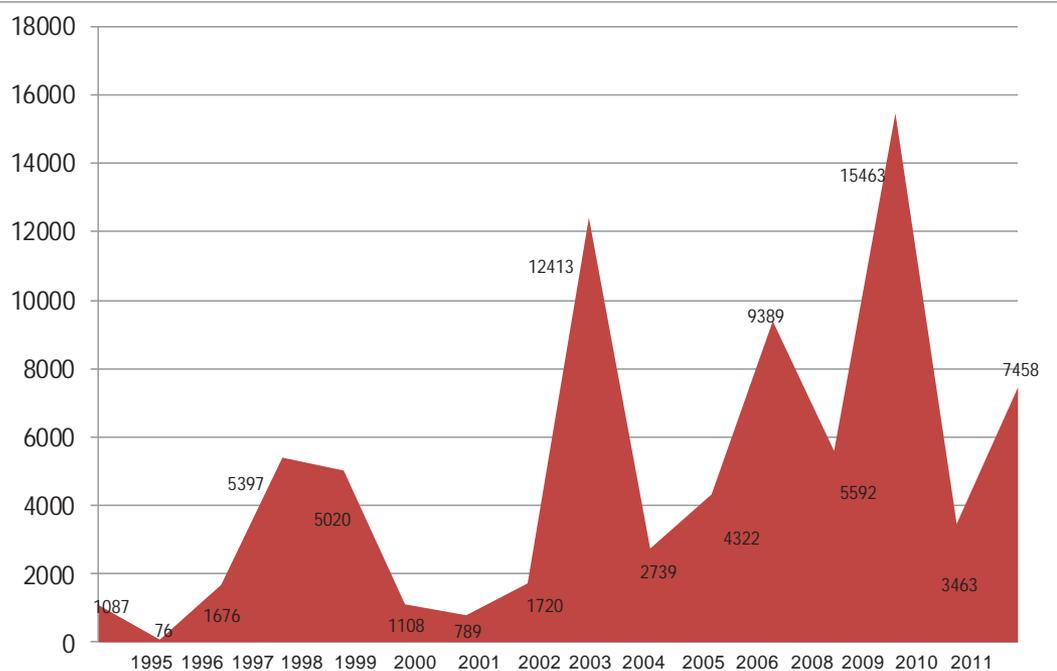- **Every year we lose 7,178 ha (CONAFOR, 2012), representing a slow regeneration and growing impact on our society.**

- **95% of fires are caused by man-made activities, as well as by the passage of tropical storms.**

The following chart shows the area affected in ha. in the last years

Entidades federativas con menor número de incendios, superficie afectada y sup/inc

Forest fires recorded from January to November 2012 14 fires in 461 ha (CONAFOR, 2012).

Forest fires in the years 1995 -2011. Annual average of 40 fires in an area of 4,857 ha = 13% Yucatán (CONAFOR, 2012).

Chart data (area affected in ha):
1995: 1087, 1996: 76, 1997: 1676, 1998: 5397, 1999: 5020, 2000: 1108, 2001: 789, 2002: 1720, 2003: 12413, 2004: 2739, 2005: 4322, 2006: 9389, 2008: 5592, 2009: 15463, 2010: 3463, 2011: 7458

MAPA DE PELIGRO DE OCUERRENCIA DE INCENDIOS FORESTALES PARA 2013

SIMBOLOGÍA
REPUBLICA MEXICANA
PELIGRO POR INCENDIO

- PELIGRO BAJO
- PELIGRO MEDIO
- PELIGRO ALTO
- PELIGRO EXTREMO

CONAFOR (National Forest Commission) has presented the National Bushfire 2013 which shows the hazard map for forest fires.

Identify and quantify the areas susceptible and Wildfire threat by the method of Hierarchical Analysis Process (AHP) using ArcGIS 10.1 as an analytical tool.

WORKING METHOD

Working Field
- Verification and Data Collection
- Fuel type map
  Incidence Hot Spot Map
  Map of Hot Spot Frequency
  Map of horizon thickness soil O
- Multicriteria Evaluation
- Susceptibility map

Paperwork
- Data collection and analysis preexisting informatio (Reports, databases, images, maps, etc.).
- RGB SPOT Image, Topographic Maps Using land and vegetation, data bases heat Points Recidivism and Frequency
- Base Map Generation
- Meteorological Component Analysis temperature and precipitation — Drought index, Frequency Tropical Cyclones
- Fuel Type Analysis
- Statistical analysis Wildfire frequency
- Exposed Systems Analysis (Population, roads, agricultural and forest)

Map of threat of forest fires

According to data that have been CONAFOR and Civil Protection and the state of Yucatan, was analyzed within the period of the years 2005-2013. Of the 106 municipalities in the state, 78 of them had some type of fire less than 100 ha, 23 municipalities reported less than 1000 ha and only 28 exceeded 1000 ha. The most affected municipalities were Mérida, Dzidzantún, Motul, Sinanche, Uman, Tekax Tixkokob, Conkal, Izamal, Valladolid, Telchac Pueblo, Chemax and Tizimín, whose area affected ranged between 2500 and 33,863 ha respectively.

Fuel models

Heat frequency points

Components To determine the susceptibility of Fire

Horizon Thickness of Soil O

Heat Points Recidivism

Drought Index

Tropical Cyclone Frequency
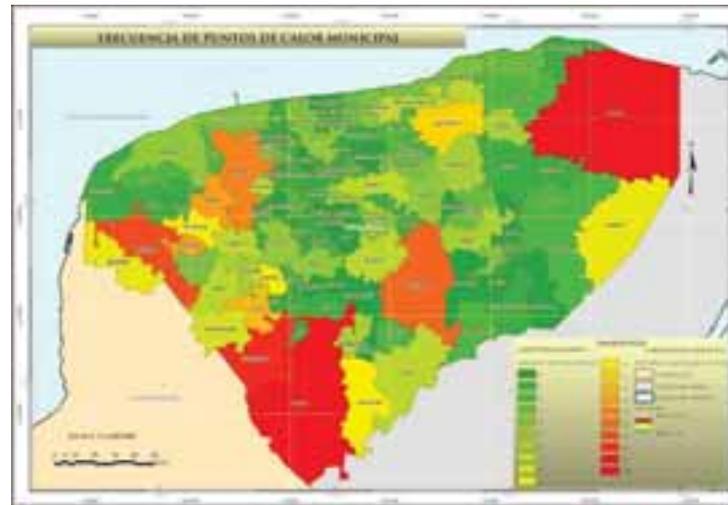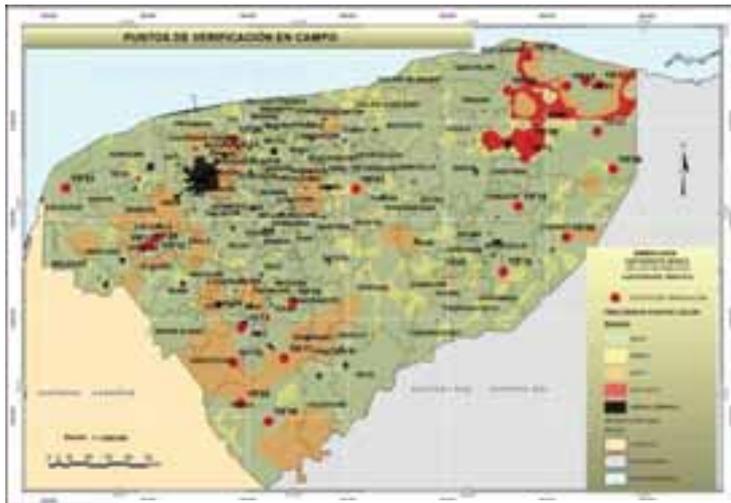
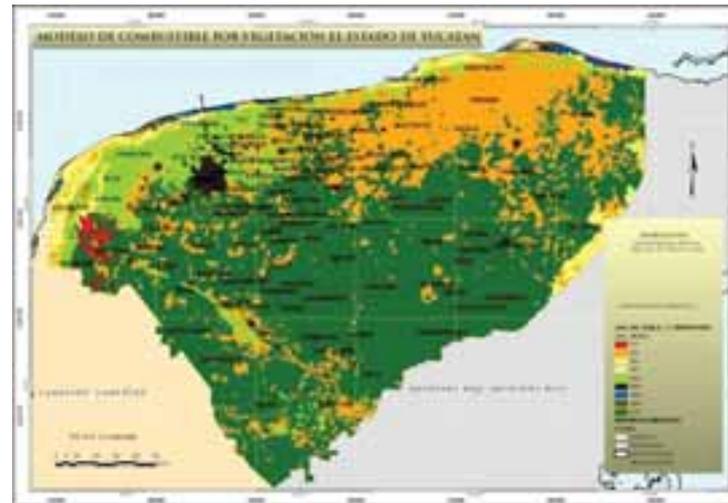**Structure Attributes**

Frequency of hot spots (Conabio, 2012)

Density of heat by town

Checkpoints in field

Fuel model (Anderson, 1982, PRONATURA, 2009)

The state of Yucatan is made up of 106 municipalities, of which 88 reported at least one hot spot in the period 2000-2012, with an average calorific influence of 20 municipalities per year.

ANALYSIS MULTICRITERIA

- IDENTIFICATION OF ENVIRONMENTAL VARIABLES.

- RECOGNIZE THE WEIGHT OF VARIABLES.

- IDENTIFY THE LINKS BETWEEN THE VARIABLES.

- OBJECTIVE PROPOSE A SOLUTION.

SUPPORT INFORMATION MODEL
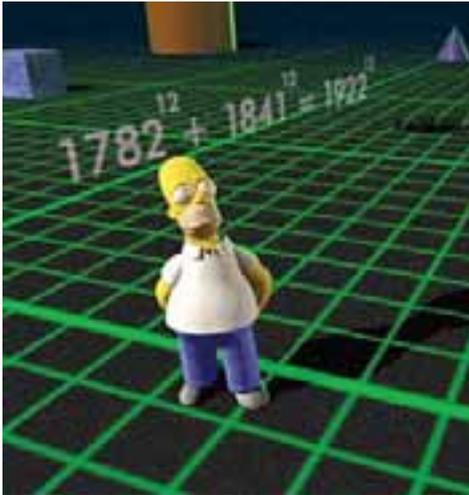
Step 1.-Matrix AHP hierarchical structure with paired comparisons.

PAIRED COMPARISON MATRIX						
Criteria	Fuel model	Heat frequency points	Heat Points Recidivism	Tropical Cyclone Frequency	Horizon Thickness of Soil O	Drought Index
Fuel model	1	2	3	4	5	6
Heat frequency points	1/2	1	2	3	4	5
Heat Points Recidivism	1/3	1/2	1	2	3	4
Tropical Cyclone Frequency	1/4	1/3	1/2	1	2	3
Horizon Thickness of Soil O	1/5	1/4	1/3	1/2	1	2
Drought Index	1/6	1/5	1/4	1/3	1/2	1

The consistency vector values

VECTOR OF THE WEIGHTED SUM						
Criteria	Fuel model	Heat frequency points	Heat Points Recidivism	Tropical Cyclone Frequency	Horizon Thickness of Soil O	Drought Index
Fuel model	0.379	0.498	0.481	0.410	0.327	0.261
Heat frequency points	0.190	0.249	0.321	0.307	0.262	0.217
Heat Points Recidivism	0.126	0.124	0.160	0.205	0.196	0.174
Tropical Cyclone Frequency	0.095	0.083	0.080	0.102	0.131	0.130
Horizon Thickness of Soil O	0.076	0.062	0.053	0.051	0.065	0.087
Drought Index	0.063	0.050	0.040	0.034	0.033	0.043
l	6.211	6.213	6.149	6.069	6.033	6.064

2.- Step obtaining results weights AHP matrix.

CALCULATION OF WEIGHTS IN PAIRED COMPARISON MATRIX	
Promedio	
Weigh	Criterio
0.379	Fuel model
0.249	Heat frequency points
0.160	Heat Points Recidivism
0.102	Tropical Cyclone Frequency
0.065	Horizon Thickness of Soil O
0.043	Drought Index
1.000	

Step 3. - Is the consistency vector estimation. Is obtained by dividing the vector sum of weight between the weights of the attributes determined based on results using the following formula

$\lambda = (\lambda+n)/(n-6).$

$\lambda =$ Vector sum consistency

$n =$ Number of attributes

$\lambda = (\lambda + n) / (n - 6) = (6.211+6.213+6.149+6.069+6.033+6.064) / (6) = 6.123$

Step 4. - Calculate the consistency ratio (CR)

Where IA is the index or Inconsistency Random Randomness, which is obtained from tables and depends on the number of elements (n). A PC value <0.10 indicates a reasonable level of consistency in pairwise comparisons, PC> 0.1, indicating inconsistency in judgments, in this case, you should review and revise the original values in the matrix

$PC = IC / IA$

$PC = IC / IA = -0.25 / 1.24 = -0.020$

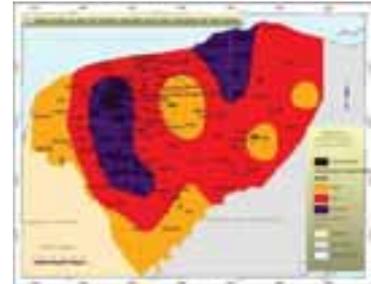**AHP extension application, to collate AHP matrix values.**

Fuel model map (INEGI,2008).

Heat frequency points model map (CONABIO, 2009).

Heat Points Recidivis model map (CONABIO, 2009).

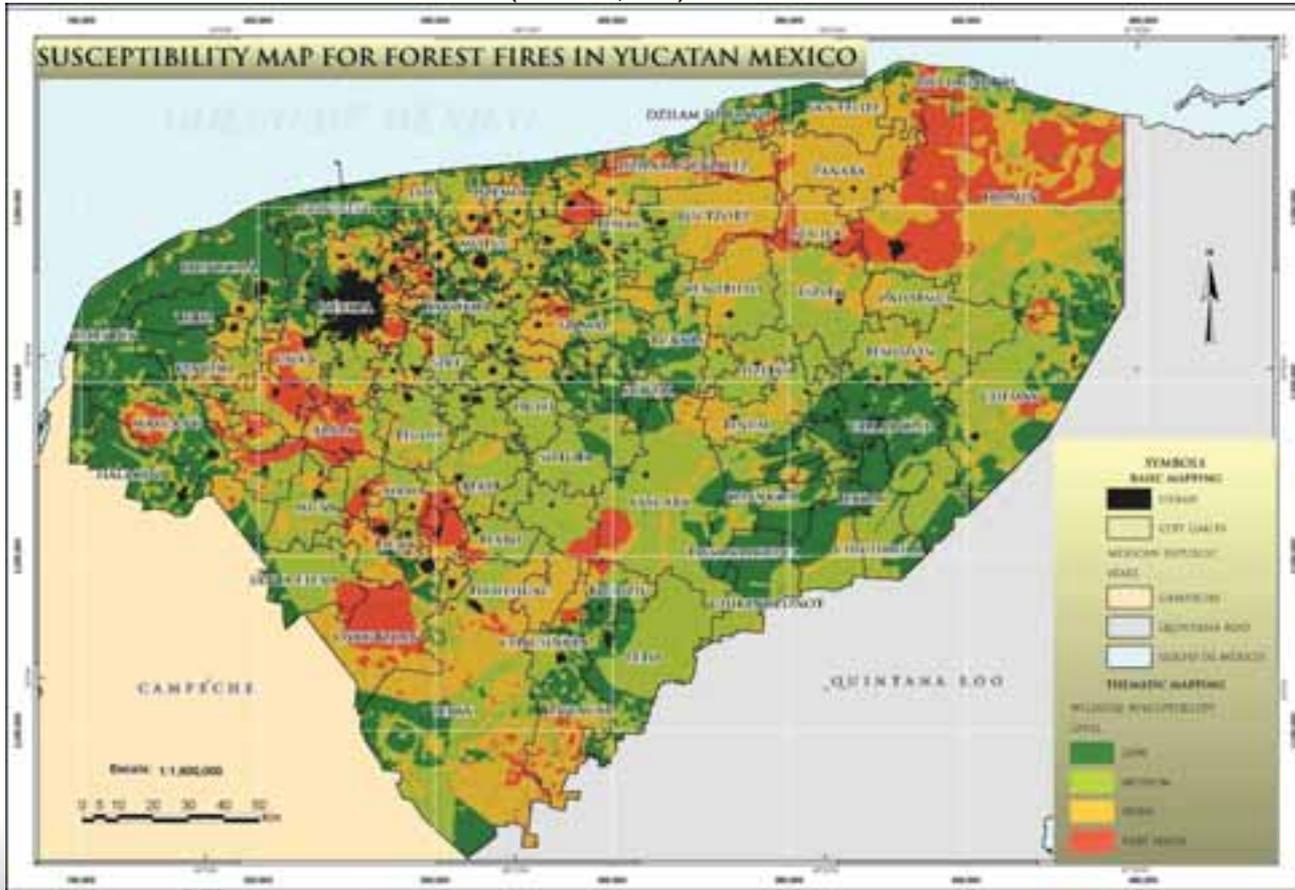**Tropical Cyclone Frequency mapl model, (SGM,2012)**

Horizon Thickness of Soil O map model (SGM,2012)

Drought Index (SGM,2012)

SUSCEPTIBILITY MAP FOR FOREST FIRES IN YUCATAN MEXICO

Map of susceptibility for wildfire gives us as a result of the analysis of the variables of the components of biotic and Hidrometerologicals which identifies likely areas to be affected by this phenomenon

YIF04. Fire near the town San Salvador

MUNICIPALITIES WITH HIGH AND VERY HIGH SUCEPTIBILITY					
Municipality	**VERU HIGH**	**HIGH**	**MEDIUM**	**LOW**	**TOTAL SURFACE**
BUCTZOTZ	17.78	480.01	94,22	9.17	506.96
CENOTILLO	8.93	748.67	307.34		1064.94
DZÁN	45.67	31.97	4.36		82
DZILAM DE BRAVO	4.33	412.07	145.72		562.12
DZILAM	29.78	486.85	43.18	3.61	563.42
ESPITA	40.01	871.54			911.55
KANASÍN	37.53	64.85			102.38
MUNA	5.4	209.39	241.98		456.77
OPICHÉN	6.68	257.11	32.96		296.75
RIO LAGARTOS	27.77	170.65	291.95		490.37
SUCILA	48.64	448.39	1.38		498.41
TIZIMÍN	107.73	2640.6	2312.6	12.74	5073.67
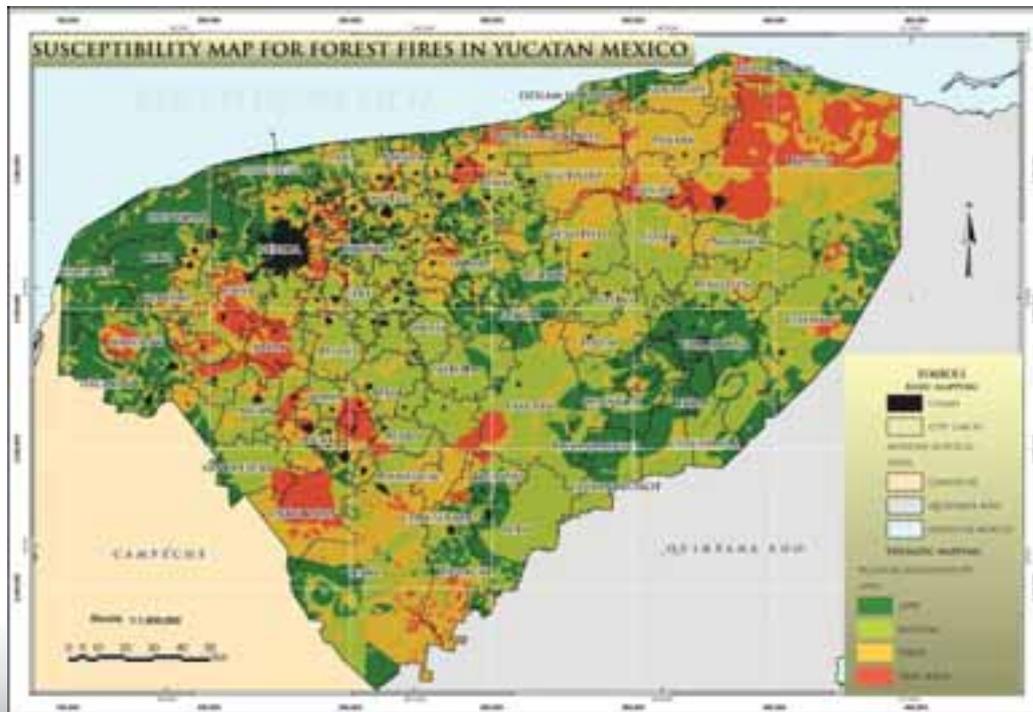
YIF07. Fire in the locality of the Ruins
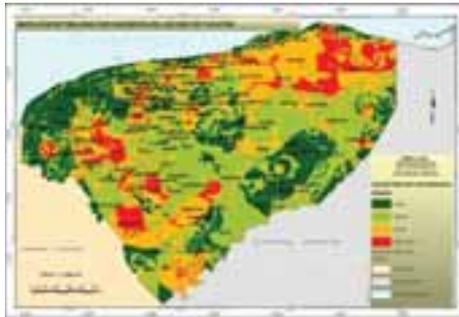
Susceptibility map fires.

Property type model
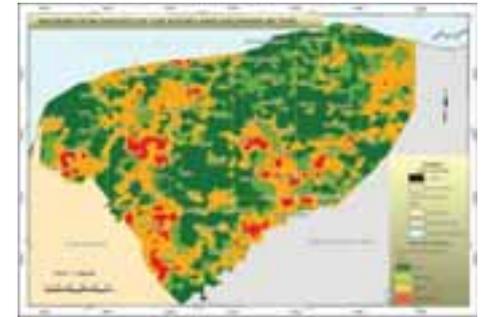
Model Type of roads

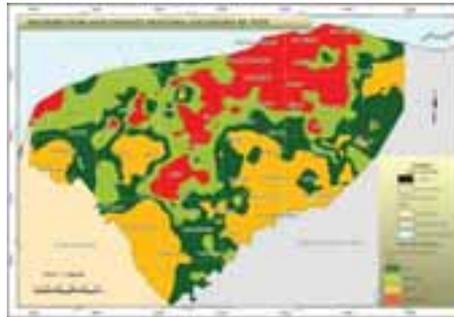Map of threat fire

According to the estimated areas: Low Threat, 255,316 ha, represents 6.40 %. Medium Threat, 192,507.40, equivalent to 48.26 %. High Threat 153,865.80, which means 38%, and very high Threat 24,848.70., corresponding to 6.23
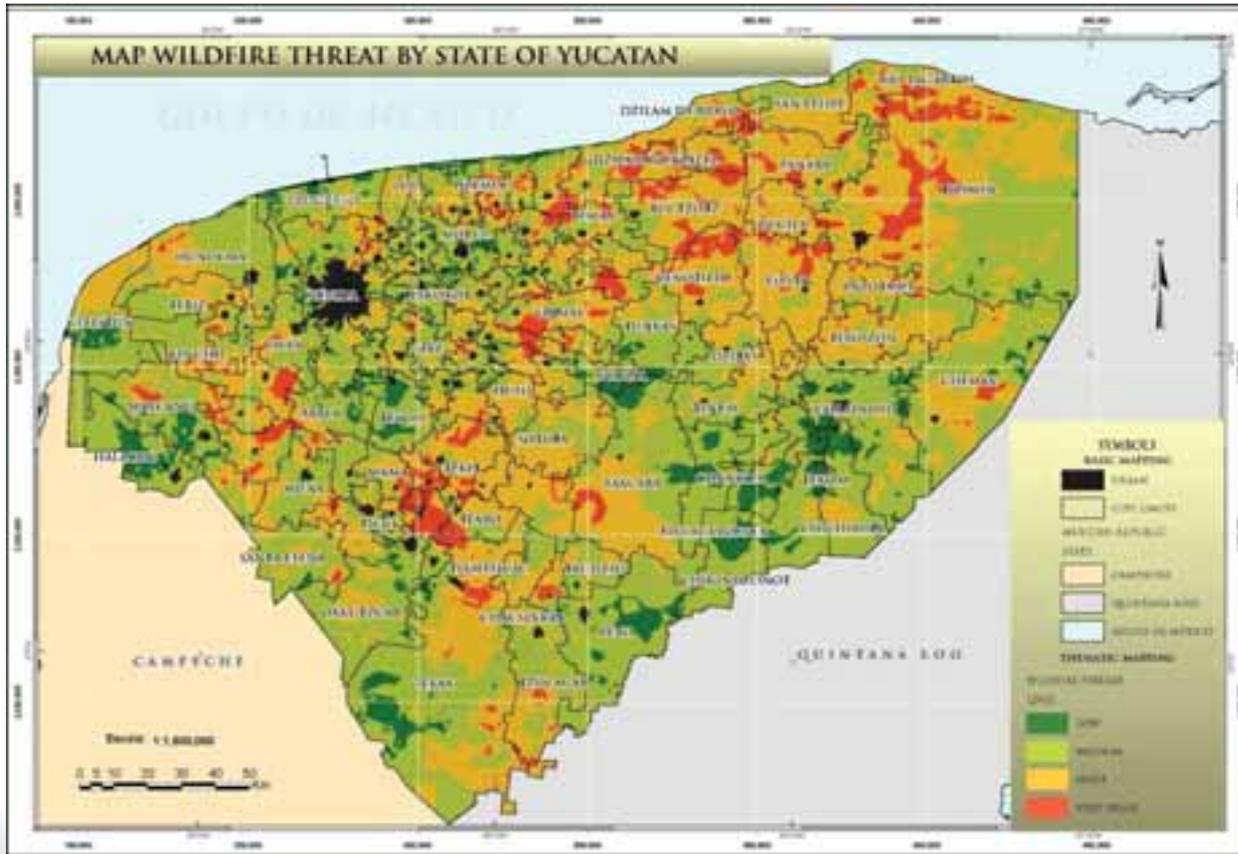
DETERMINATION OF SURFACE LEVEL ACRES

THREAT LEVEL	SUPERFACE	PORCENT	STATE SUPERFACE	MUNICIPALITIES	LOCATIONS
LOW	255316	6.40		61	162
MEDIUM	1925074	48.26		105	1242
HIGH	1538658	38.57	3988780	104	1010
VERY HIGH	248487	6.23		77	168

LOCATIONS AND NUMBER OF PEOPLE WITH VERY HIGH THREAT

STATE	MUNICIPALITY	POPULATION	POBTOT	POBMAS	POBFEM	VIVTOT	TVIVHAB	TIPO_DE_VI	COST_UNIT	COTS	AREA	SUP_HA	THREAT
YUCATÁN	HOCTÚN	SAN JOSÉ ORIENTE	990	499	491	219	211	1	12500.00	2737500.00	31.05	3,105.00	VERY HIGH
	MANÍ	TIPIKAL	951	470	481	247	220	2		12350000.00	87.36	8,736.00	
	TEKAX	MANUEL CEPEDA PERAZA	573	268	305	163	138	2		8150000.00	117.23	11,723.00	
	ESPITA	HOLCÁ	552	273	279	144	134	2		7200000.00	93.22	9,322.00	
	TZUCACAB	CORRAL	336	161	175	104	74	2	50000.00	5200000.00	22.92	2,292.00	
		SACBECÁN	236	128	108	56	49	2		2800000.00			
	CANSAHCAB	SANTA MARÍA	209	111	98	68	57	2		3400000.00	23.98	2,398.00	
	TAHMEK	XTABAY	110	62	48	40	35	2		2000000.00	2.66	266.00	
	TIZIMÍN	DZONOT BOX	84	39	45	23	20	2		1150000.00	467.51	46,751.00	
	SEYÉ	BOLONIXÁN	40	21	19	10	9	2		500000.00	4.74	474.00	
	CHACSINKÍN	XNO-HUAYAB	38	19	19	7	7	1	12500.00	87500.00	21.40	2,140.00	
	TEKAL DE VENEGAS	SAN FELIPE	33	16	17	8	8	2	50000.00	400000.00	48.50	4,850.00	
	TEKAX	PLAN CHAC POZO UNO	22	11	11	17	7	1		212500.00	117.23	11,723.00	
	ESPITA	DZADZ PICHÍ	19	8	11	4	4	1		50000.00	93.22	9,322.00	
	TIZIMÍN	EL RAMONAL	18	15	3	7	7	1		87500.00			
		EL CERRITO	13	5	8	6	5	1		75000.00			
		BUENAVISTA	13	9	4	5	4	1	12500.00	62500.00			
		DZADZ MAHAS	12	0	0	2	2	1		25000.00	467.51	46,751.00	
		DZIDZILÁ	11	5	6	3	3	1		37500.00			
		SAN ÁNGEL	11	0	0	1	1	1		12500.00			
		DZODZIL	10	0	0	2	1	1		25000.00			
		SAN LUIS	10	5	5	4	4	1		50000.00			
	CONKAL	SAN DIEGO CUTZ	10	6	4	3	3	3	150500.00	451500.00	5.60	560.00	
			4301	2131	2137	1143	1003	35		47064000			

23 communities with more than 10 inhabitants were identified, which represent a higher risk in terms of their location. The trend exhibited by the municipalities that are more affected with regard to their population includes Hoctún, Maní, Tekax, Espita, Tzucacab, Cansahcab, Tizimín, Tahmek, Seyé y Conkal
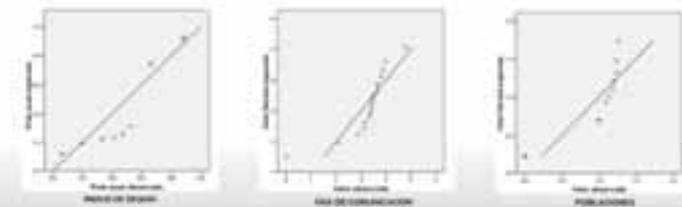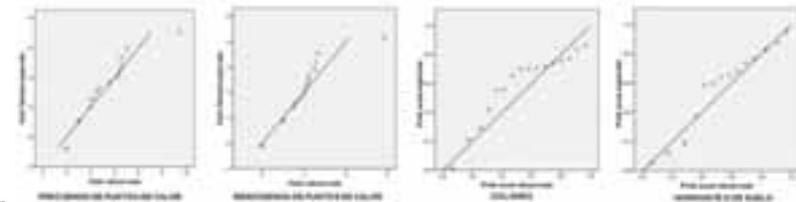

Agricultural Burning

Data Analysis Statistical Method Pearson

Correlation between variables used Pearson coefficient

	REINCIDENCIA PUNTOS DE CALOR	ÍNDICE DE SEQUIA	CICLONES	HORIZONTE O SUELO	VÍAS DE COMUNICACIÓN	POBLACIONES	REINCIDENCIA PUNTOS DE CALOR
REINCIDENCIA Correlación de Pearson	1	-0.087	0.537	0.367	0.341	0.57	0.946
Sig. (Bilateral)		0.731	0.022	0.134	0.166	0.013	0
N	18	18	18	18	18	18	18
ÍNDICE DE SEQUIA Correlación de Pearson	-0.087	1	0.189	-0.131	0.322	0.031	-0.024
Sig. (Bilateral)	0.731		0.453	0.603	0.192	0.902	0.926
N	18	18	18	18	18	18	18
CICLONES Correlación de Pearson	0.537	0.189	1	0.328	0.545	0.717	0.511
Sig. (Bilateral)	0.022	0.453		0.184	0.019	0.001	0.3
N	18	18	18	18	18	18	18
HORIZONTE O DE SUELO Correlación de Pearson	0.367	-0.131	0.328	1	0.119	0.586	0.393
Sig. (Bilateral)	0.134	0.603	0.184		0.639	0.011	0.106
N	18	18	18	18	18	18	18
VÍAS DE COMUNICACIÓN Correlación de Pearson	0.341	0.322	0.545	0.119	1	1	0.3
Sig. (Bilateral)	0.166	0.902	0.019	0.639			0.227
N	18	18	18	18	18	18	18
POBLACIONES Correlación de Pearson	0.57	0.31	0.717	0.586	0.259	1	0.597
Sig. (Bilateral)	0.013	0.902	0.001	0.011	0.3		0.009
N	18	18	18	18	18	18	18
FRECUENCIA Correlación de Pearson	0.946	-0.024	0.511	0.511	0.3	0.597	1
Sig. (Bilateral)	0	0.926	0.03	0.03	0.227	0.009	
N	18	18	18	18	18	18	18

To confirm the direct relationship between the variables that were used to determine the forest fire hazard map and to ensure the trustworthiness of the data, a model of correlation by Pearson was used, through the software SPSS (*Statistical Package for the Social*).

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Analysis of variance

| Value			
Component	Total	% de la variance	% accumulated
1	2.329	30.30	70.55
2	1.277	16.62	21.22
3	1.324	17.22	22.79
4	0.686	8.92	6.12
5	0.543	7.07	3.84
6	0.982	12.77	12.54
7	0.547	7.11	3.89

Dispersion of points of 7 variables

Test of Kolmogorov-Smirnov

| PRUEBA	FRECUENCIA PUNTOS DE CALOR	REINCIDENCIA PUNTOS DE CALOR	ÍNDICE DE SEQUIA	CICLONES	ESPESOR O DE SUELO	VIAS DE COMUNICACIÓN	POBLACIONES
N	18	18	18	18	18	18	18
Parámetros normales Media	2.8328	1.8322	2.13	2.5611	1.8844	3.2994	0.7417
Desviación típica	2.32864	1.27712	1.324	0.68563	0.54327	0.98160	0.54664
Diferencias más extremas Absoluta	0.140	0.203	0.242	0.218	0.195	0.261	0.348
Positiva	0.140	0.203	0.242	0.134	0.147	0.182	0.246
Negativa	-0.112	-0.146	-0.189	-0.218	-0.195	-0.261	-0.348
Z de Kolmogorov -Smirnov	0.593	0.861	1.025	0.926	0.829	1.107	1.478
Sig. asintót. (Bilateral)	0.874	0.449	0.245	0.358	0.498	0.173	0.025

Mapa de Riesgo por Incendios Temporada 2011

Comité Estatal de Prevención y Combate de Incendios
GOBIERNO DEL ESTADO DE YUCATÁN

Legend:
- ALTO
- MEDIO
- BAJO
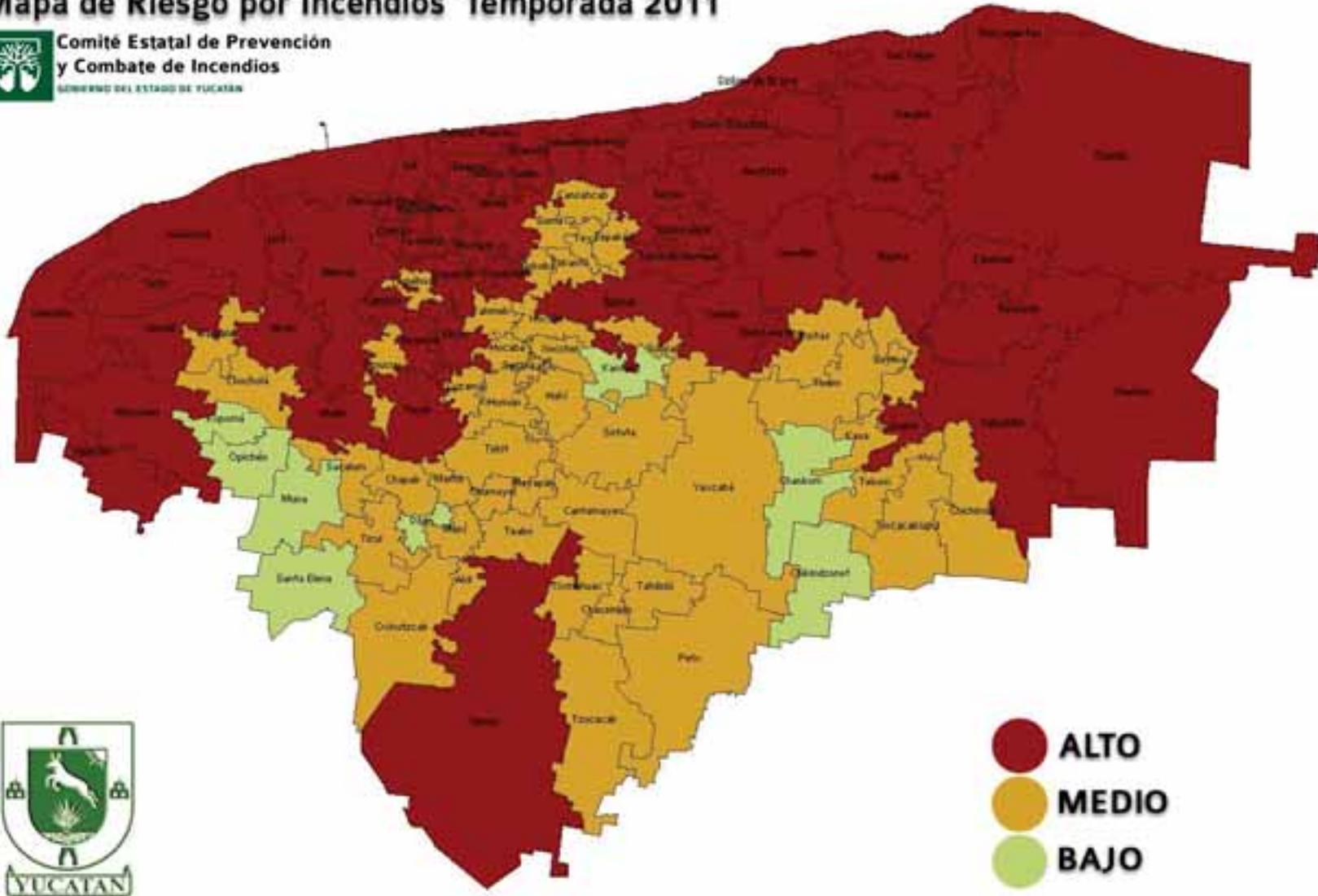
State Civil Protection Unit presented for fire prevention Season (2012). 53 municipalities in High risk level, 45 medium and 8 under.
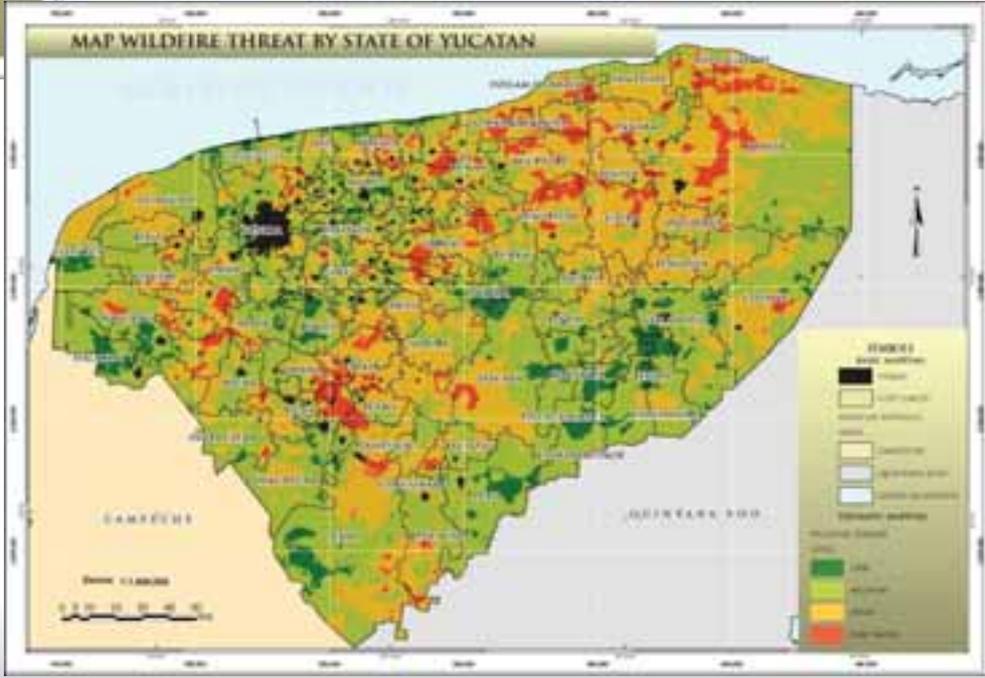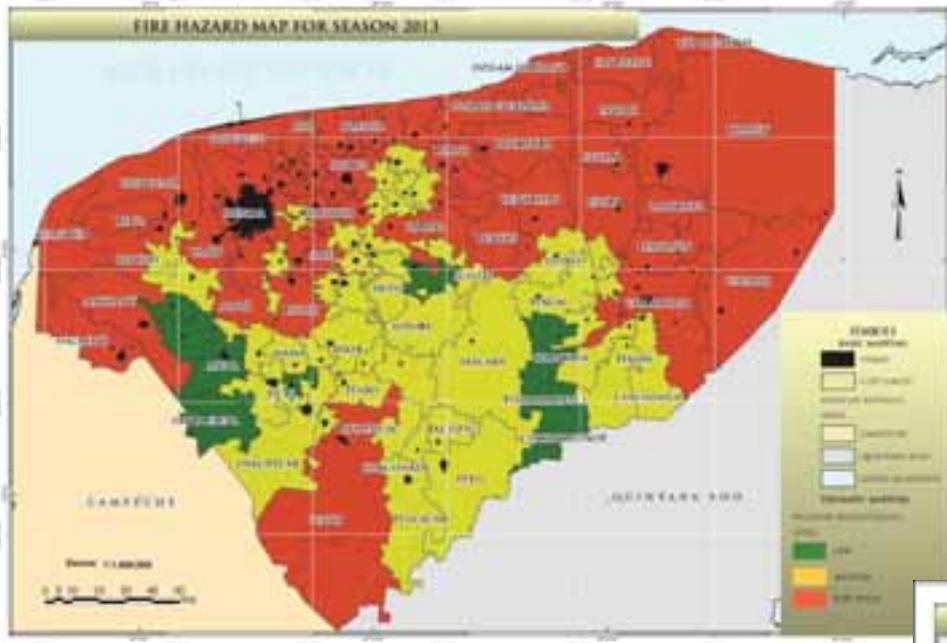
Threat high = 38%
Threat very high = 6.23

Geographic information systems together with other statistical models enable us to develop predictive maps to determine:

- degree of susceptibility,
- danger,
- vulnerability and,
- wildfire risk

Scenarios to determine the risk of forest fires generally are based on statistical models and predictive probability, we must consider more physical and biotic parameters.

NOM-015-SEMARNAP/SAGAR-1997, regulating the use of fire in forest land suitable for forestry, on land adjacent to forest land as well as agricultural and livestock use.

Establish working groups with the forestry sector (CENAPRED) and SGM to approve criteria defining these scenarios.

Gracias por su atención