“DEVELOPMENT OF A SWAT-BASED SOIL PRODUCTIVITY INDEX”

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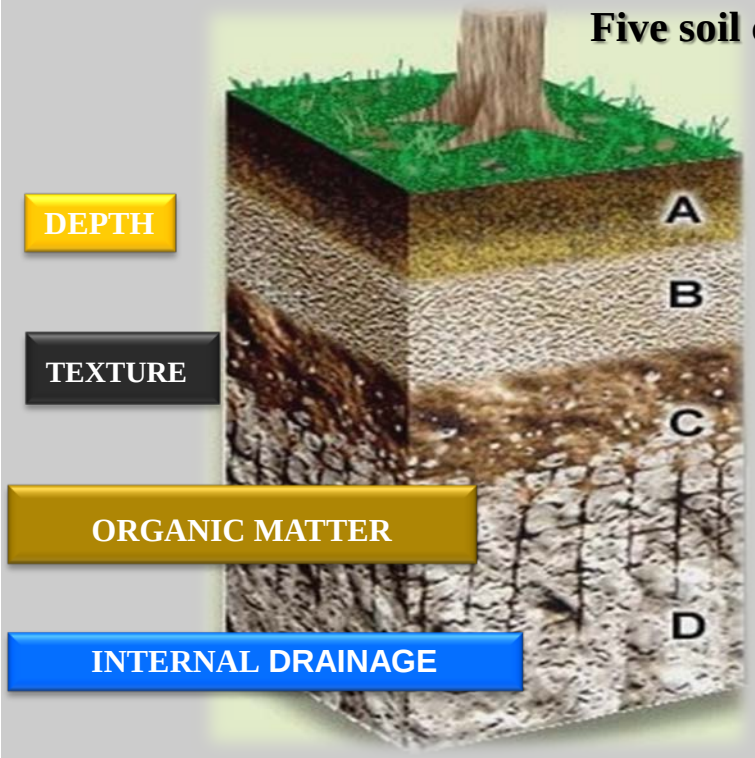
OBJECTIVE:

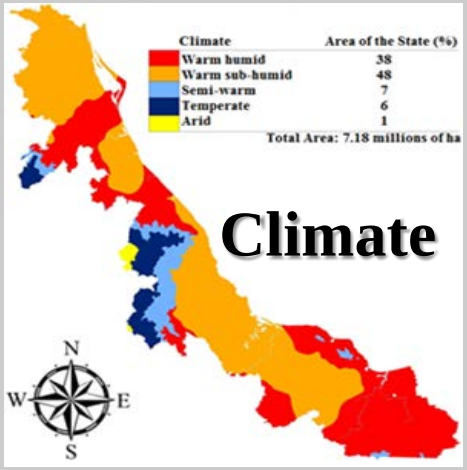
To develop and map a SWAT-based Soil Productivity Index (SPI) for the Sate of Veracruz, México.

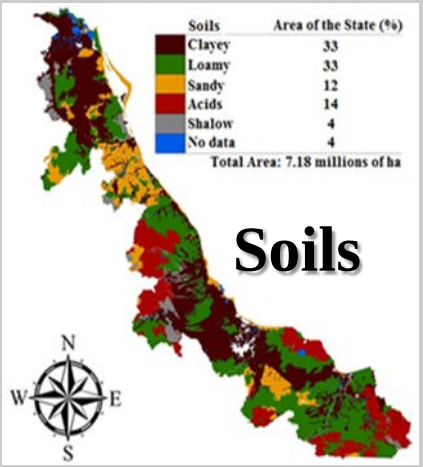
The grain yield of *Zea mays* was used as dependent variable.

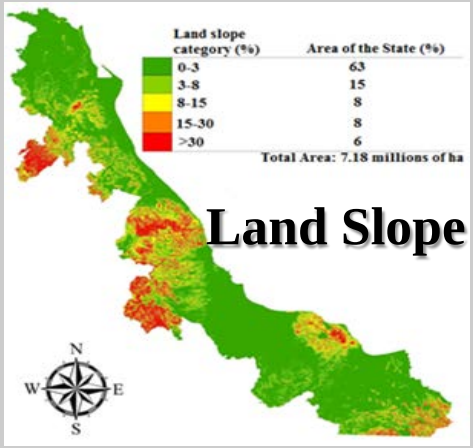
Five soil characteristics were considered.

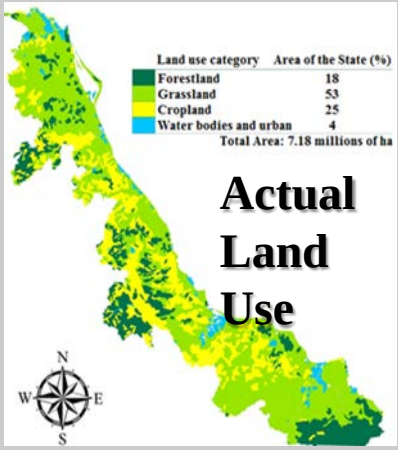


Localization of the state of Veracruz, México









Simulation of *Zea maiz* grow and biomass production

The Soil and Water Assessment Tool (SWAT) model was used
The entire area of the state of Veracruz was considered as the basin.

Maps used:
Digital elevation model (DEM) with 90x90m pixel size.
Soils (scale 1:250,000)
Actual land use
Surface drainage
90 sub-basins and 6,204 HRU's were created.

Data base used
Five land slope categories (0-3, 3-8, 8-15, 15-30 and >30%),
46 types of soils (described from 829 soil profile data set).
Climate data from 95 weather stations
***Zea mays* Physiological parameters**
***Zea mays* management**

Database Inputs

Soils

Example: Typical soil profile of the Acrisol humico

Horizon	Depth (mm)	Clay (%)	Silt (%)	Sand (%)	pH	O.C. (%)	albedo	K ($mmhr^{-1}$)	AWC	BD ($g\ cm^{-3}$)
A	157	28	27	45	4.80	3.55	0.05	3.7	0.12	1.37
B1	202	39	24	37	4.75	1.58	0.11	2.0	0.12	1.30
B2t	856	44	22	34	4.79	0.66	0.18	1.7	0.12	1.28

O.C.: Organic carbon, K: Saturated hydraulic conductivity, AWC: Available Water Capacity, BD: Bulk density.

Zea mays main physiological parameters fed to SWAT.

Species	RUE ($Kgha^{-1}/Mjm^{-2}$)	2nd point RUE	LAI	HI	Canopy Height (m)	Root depth (m)	Optimum temp. ^0C	Base temp. ^0C
Zea mays	35	42	3.5	0.45	2.5	1.0	25	10

Weather stations

- Weather data was taken from 95 weather stations.
- Each station has at least 20 years of records between1960-2008.
- Weather statistics were worked out using the EPIC weather generator.
- Daily maximum and minimum temperature and rainfall data from 1990 to 2008 were fed to SWAT.
- Solar radiation was left to be estimated by SWAT.

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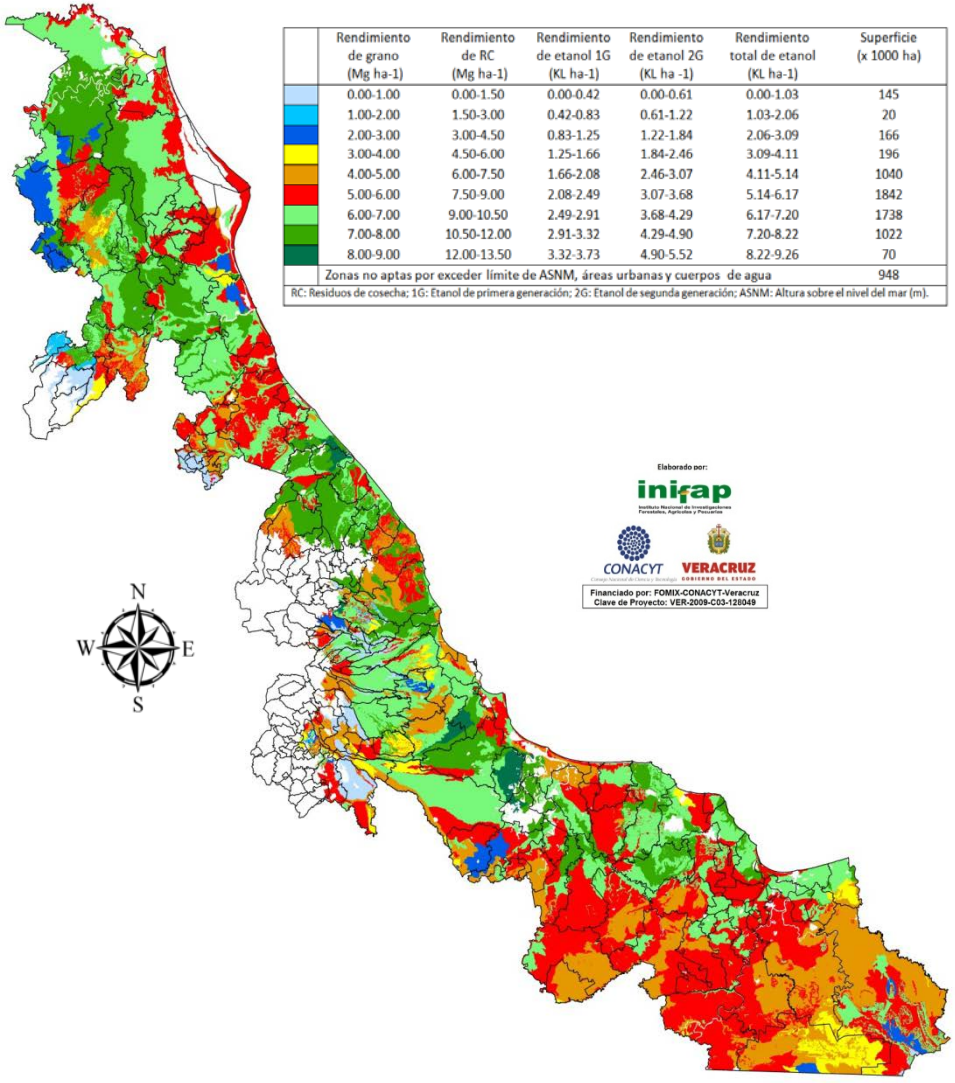
	Rendimiento de grano (Mg ha-1)	Rendimiento de RC (Mg ha-1)	Rendimiento de etanol 1G (KL ha-1)	Rendimiento de etanol 2G (KL ha -1)	Rendimiento total de etanol (KL ha-1)	Superficie (x 1000 ha)
	0.00-1.00	0.00-1.50	0.00-0.42	0.00-0.61	0.00-1.03	145
	1.00-2.00	1.50-3.00	0.42-0.83	0.61-1.22	1.03-2.06	20
	2.00-3.00	3.00-4.50	0.83-1.25	1.22-1.84	2.06-3.09	166
	3.00-4.00	4.50-6.00	1.25-1.66	1.84-2.46	3.09-4.11	196
	4.00-5.00	6.00-7.50	1.66-2.08	2.46-3.07	4.11-5.14	1040
	5.00-6.00	7.50-9.00	2.08-2.49	3.07-3.68	5.14-6.17	1842
	6.00-7.00	9.00-10.50	2.49-2.91	3.68-4.29	6.17-7.20	1738
	7.00-8.00	10.50-12.00	2.91-3.32	4.29-4.90	7.20-8.22	1022
	8.00-9.00	12.00-13.50	3.32-3.73	4.90-5.52	8.22-9.26	70
	Zonas no aptas por exceder límite de ASNM, áreas urbanas y cuerpos de agua					948

RC: Residuos de cosecha; 1G: Etanol de primera generación; 2G: Etanol de segunda generación; ASNM: Altura sobre el nivel del mar (m).



Zea Mays Grain Yield as simulated by SWAT in the State of Veracruz México

Description of the soil variables considered

Soil Variable	Categories of the soil variables		
	Low	Medium	High
Depth	Shallow: < 30 cm	Medium: 30 –70 cm	Deep: > 70 cm
Texture	Coarse	Loamy	Clayey
Organic Matter	< 1.5 %	1.5 - 3.5 %	> 3.5 %
Internal Drainage	Slow	Medium	Fast
Land Slope	> 15 %	8 – 15 %	< 8 %

Values of each soil variable category where obtained from the «SOIL_CODE» and «SLOPE_CODE» fields of each HRU in the Attribute table

Attributes of MAIZFINAL3

FID	Shape *	OBJECTID	GRIDCODE	SHAPE_LENG	SHAPE_AREA	SUBBASIN	LU_NUM	LU_CODE	SOIL_NU	SOIL_CODE	SLOPE_NU	SLOPE_CODE	MEAN_SLOPE	AREA
2268	Polygon	196	196	6660	656100	2	1	AGRL	7	Re	1	0-3	0.611051	604358.051343
2193	Polygon	86	86	89460	31509000	11	1	AGRL	3	Bg	1	0-3	0.363309	30938005.5694
2200	Polygon	100	100	900	32400	11	1	AGRL	3	Bg	2	3-8	3.211666	32400.000001
2202	Polygon	102	102	73440	112492800	11	1	AGRL	2	Vp	1	0-3	0.531433	112390812.955
2209	Polygon	110	110	3600	186300	11	1	AGRL	2	Vp	2	3-8	3.439571	186299.999999
2194	Polygon	91	91	33840	6779700	12	1	AGRL		Bk		0-3	0.859213	5751866.606812

SOIL_CODE

DEPTH

TEXTURE

INTERNAL DRAINAGE

ORGANIC MATTER

SLOPE_CODE

SLOPE

SPI dependent on (Depth-Texture) overlay

Average grain yield of *Zea mays* (t ha^{-1}) as dependent variable

Soil Variables		Soil Depth		
		< 30 cm	30 – 70 cm	> 70 cm
Soil Texture	Coarse	ND	3.83	5.73
	Loamy	0.68	ND	5.86
	Clayey	2.53	4.74	6.10

Description of SPI dependent on (Depth-Texture)

SPI	Description of soil variables
High	Soil depth > 70 cm
	Any level of Texture
Medium	Soil depth 30 - 70 cm
	Any level of Texture
Low	Soil depth < 30 cm
	Any level of Texture

SPI dependent on (Depth-Texture) – (Organic Matter) overlay

Average grain yield of *Zea mays* (t ha^{-1}) as dependent variable

Soil Variables		Depth – Texture		
		Low	Medium	High
Organic Matter	< 1.5 %	ND	4.77	5.91
	1.5 .3.5 %	ND	4.23	5.91
	> 3.5 %	1.41	5.24	6.42

Description of SPI dependent on Depth –Texture - Organic Matter

SPI	Description of soil variables
High	Soil depth > 70 cm
	Any level of Texture
	Any organic matter content
Medium	Soil depth 30 - 70 cm
	Any level of Texture
	Any organic matter content
Low	Soil depth < 30 cm
	Any level of Texture
	Any organic matter content

SPI dependent on (Depth-Texture–Organic Matter) – (Drainage) overlay

Average grain yield of *Zea mays* (t ha^{-1}) as dependent variable

Soil Variables		Depth – Texture – Organic matter		
		Low	Medium	High
Internal Drainage	Slow	ND	5.63	6.39
	Medium	ND	4.36	5.70
	Fast	1.41	4.45	5.75

Description of SPI dependent on Depth - Texture - Organic Matter – Drainage

SPI	Description of soil variables
High	Soil depth > 70 cm
	Any level of Texture
	Any organic matter content
	Any Internal drainage
Medium	Soil depth 30 - 70 cm
	Any level of Texture
	Any organic matter content
	Any Internal drainage
Low	Soil depth < 30 cm
	Any level of Texture
	Any organic matter content
	Any Internal Drainage

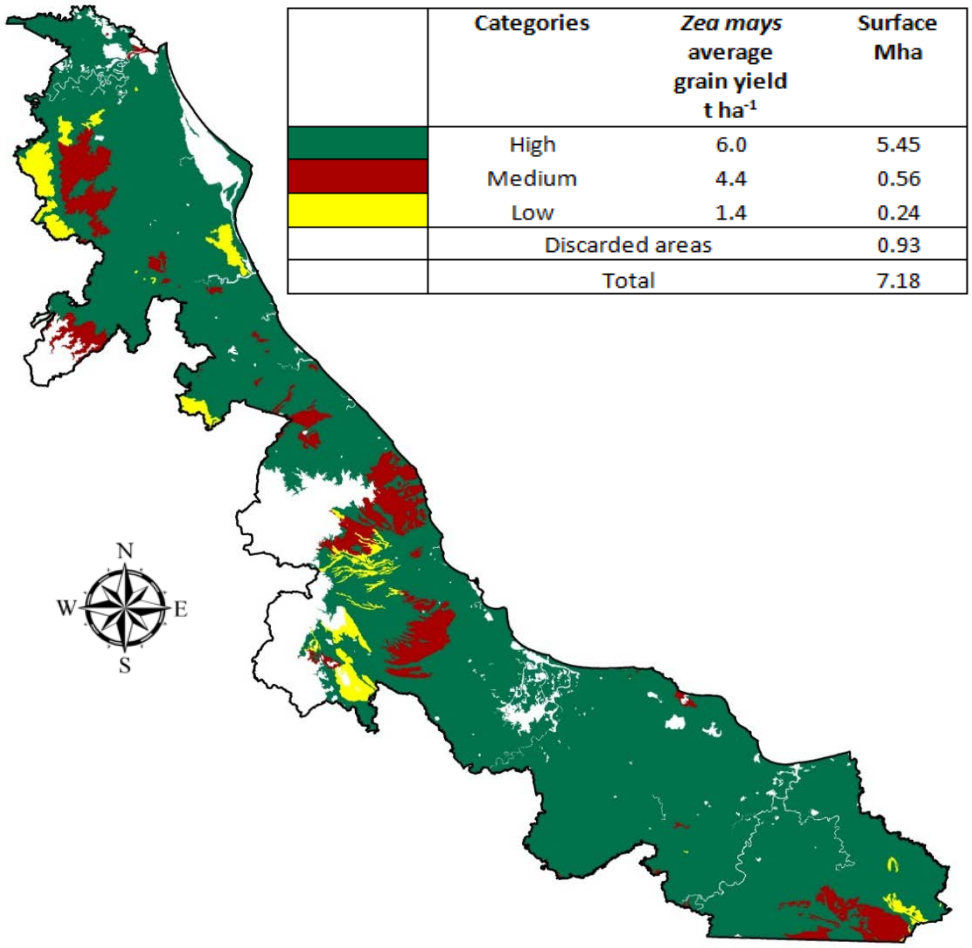
SPI dependent on (Depth-Texture–Organic Matter–Drainage) - Land slope overlay

Average grain yield of *Zea mays* (t ha^{-1}) as dependent variable

Soil Variables		Depth – Texture – Organic matter - Drainage		
		Low	Medium	High
Land Slope	0 -8 %	1.50	4.40	5.84
	8 – 15 %	1.34	4.43	5.96
	> 15 %	1.33	4.36	6.21

Description of SPI dependent on Depth - Texture - Organic Matter – Drainage – Slope

SPI	Description of soil variables
High	Soil depth > 70 cm
	Any level of Texture
	Any organic matter content
	Any Internal drainage
	Any Land slope
Medium	Soil depth 30 - 70 cm
	Any level of Texture
	Any organic matter content
	Any Internal drainage
	Any Land slope
Low	Soil depth < 30 cm
	Any level of Texture
	Any organic matter content
	Any Internal Drainage
	Any Land slope



	Categories	*Zea mays* average grain yield t ha^{-1}	Surface Mha
	High	6.0	5.45
	Medium	4.4	0.56
	Low	1.4	0.24
	Discarded areas		0.93
	Total		7.18

CONCLUSIONS

The SPI developed mostly depended on soil depth, followed by organic matter content and internal drainage

Acknowledgements

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