MEGADAPT

Laboratorio Nacional de Ciencias de la Sostenibilidad

LANCIS

Arizona State University

Universidad Nacional Autónoma de México

November, 2017

Outline

1. Precipitation analysis

2. WRF baseline simulation : validation analysis

3. WRF-SLEUTH scenarios

Precipitation analysis

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Precipitation analysis

Data

- SACMEX precipitation data (observed total anual precipitation (mm) by weather station – 2007-2014)
- Reported frequency and volume of ponding by source or type at the borough level (2007-2014).

Precipitation analysis

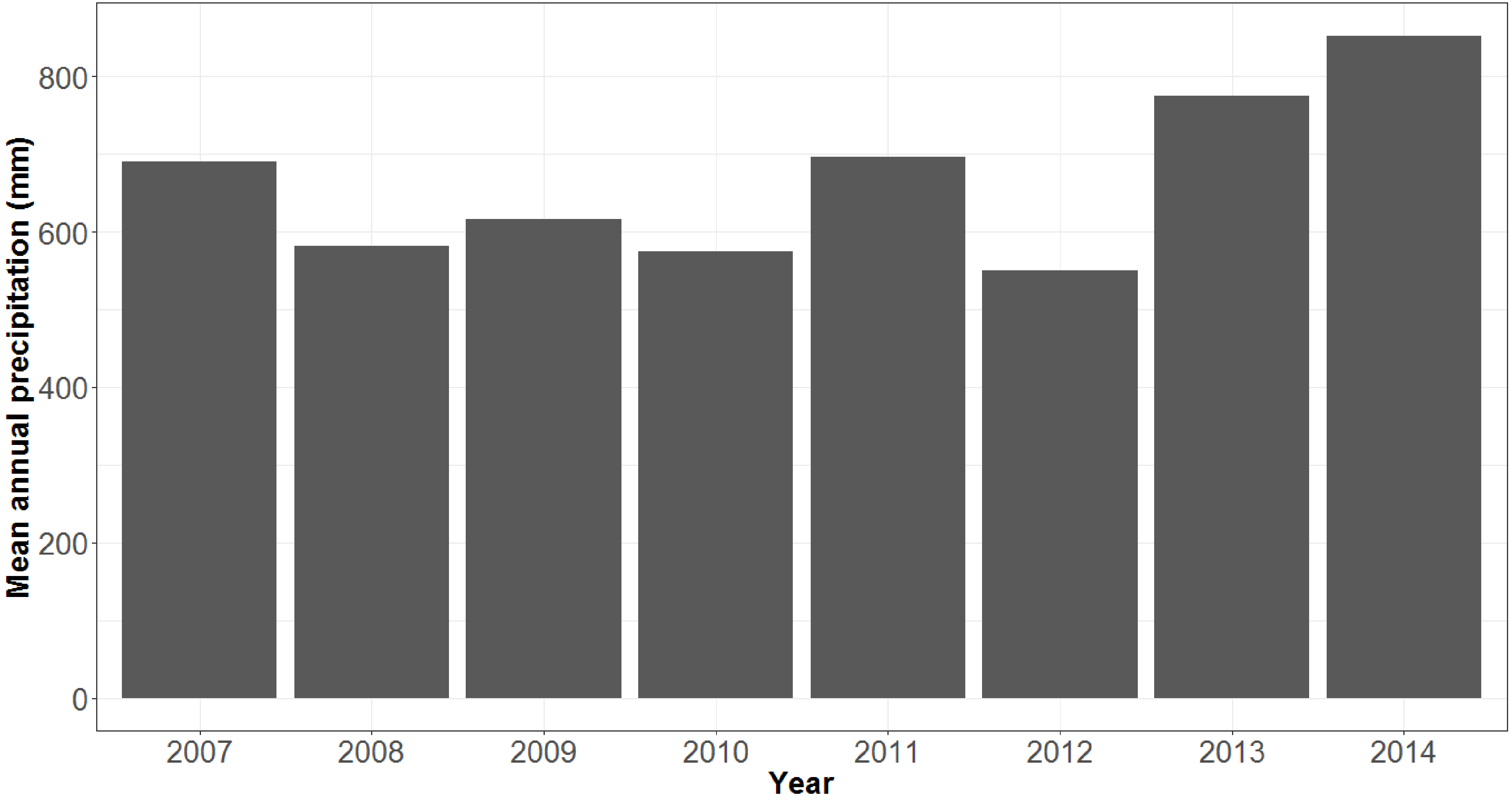


Figure 1. Observed mean annual precipitation (mm) calculated over 49 weather stations

Precipitation analysis

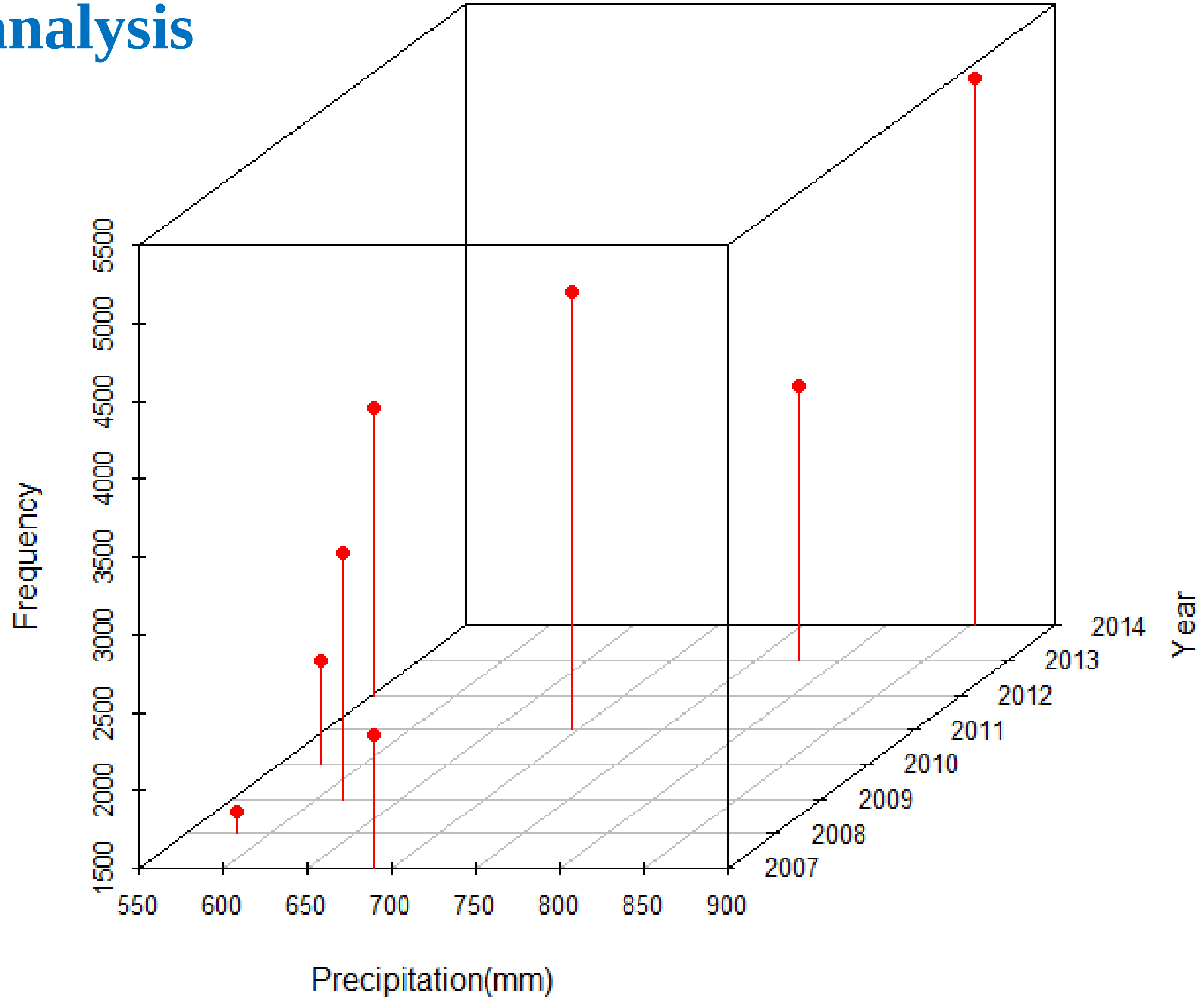


Figure 2. Frequency of reported ponding events as a function of the mean anual precipitation (mm)

Ponding analysis

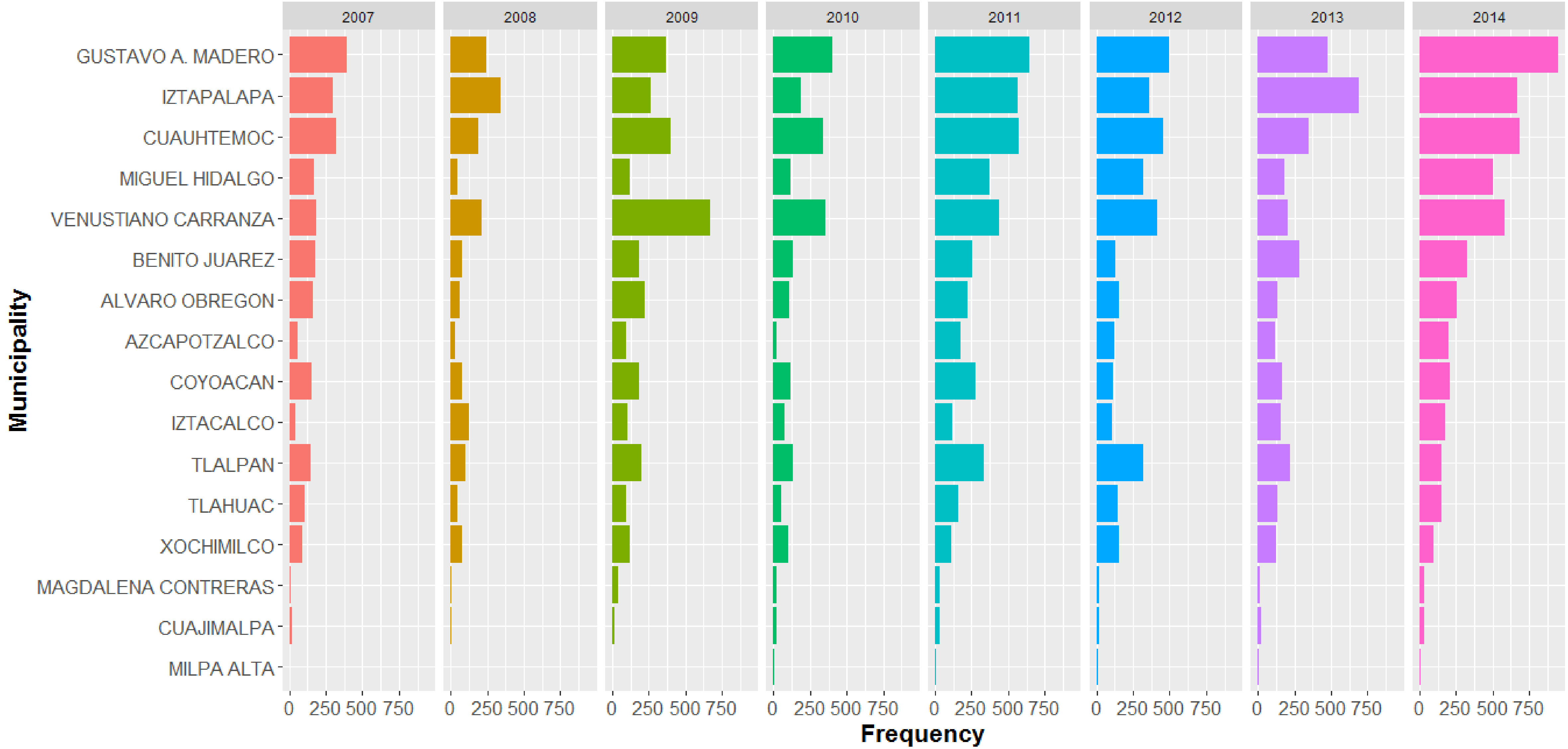


Figure 3. Reported ponding frequency by municipality and year

Ponding analysis

- Source of ponding :

a) inexistente (lacking)
b) hundimiento (sinking)
c) obstrucción (obstruction)
d) ruptura (breaking off)
e) falta de bombeo (pump failure)
f) insuficiencia-desconocida (undetermined)

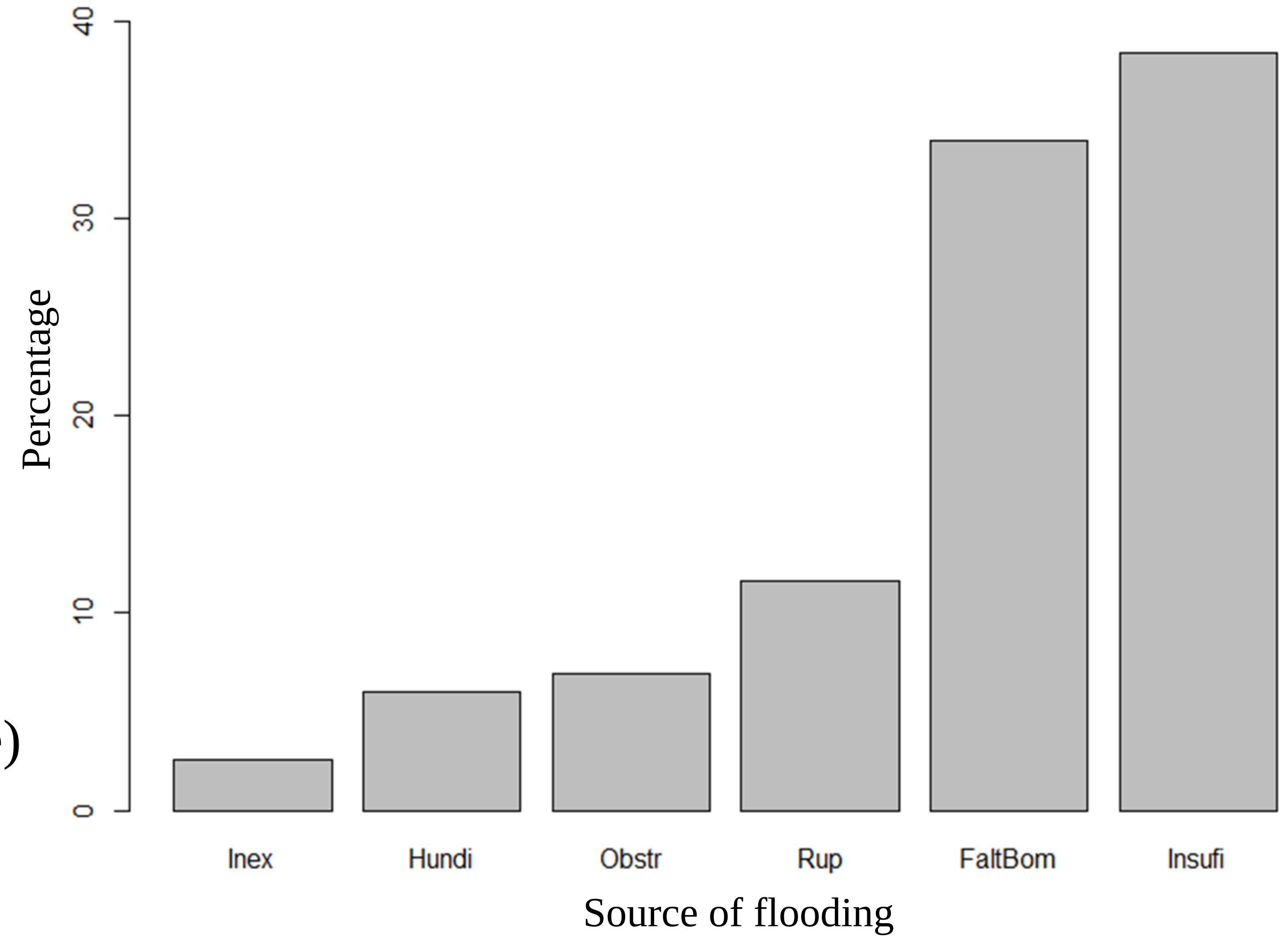


Figure 4. Relative contribution of each source of ponding to the total reported ponding events

Ponding analysis

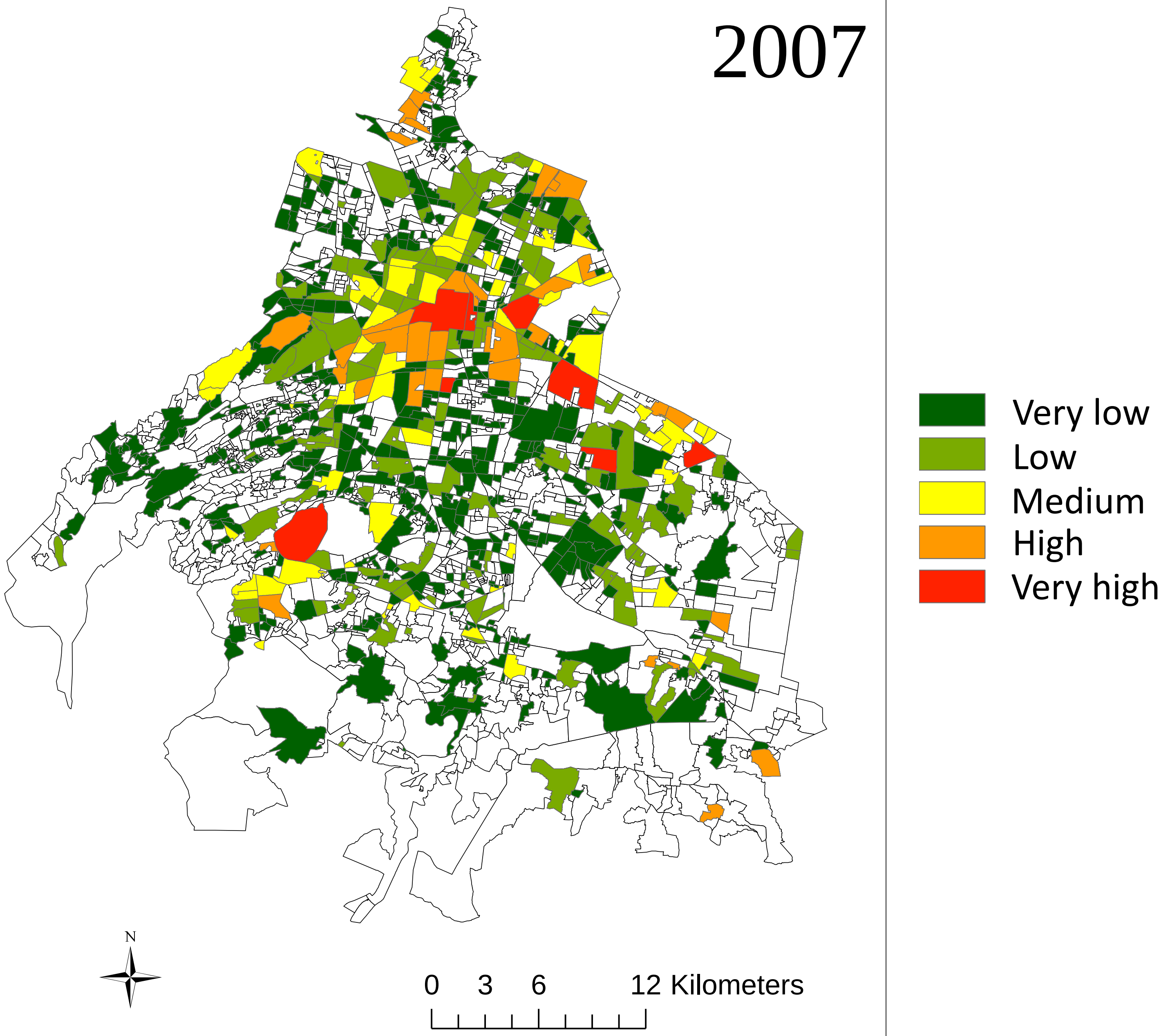
Severity Index

- An annual severity index was calculated using a weighted lineal combination that included both the normalized volumen and frequency of the reported pondings.

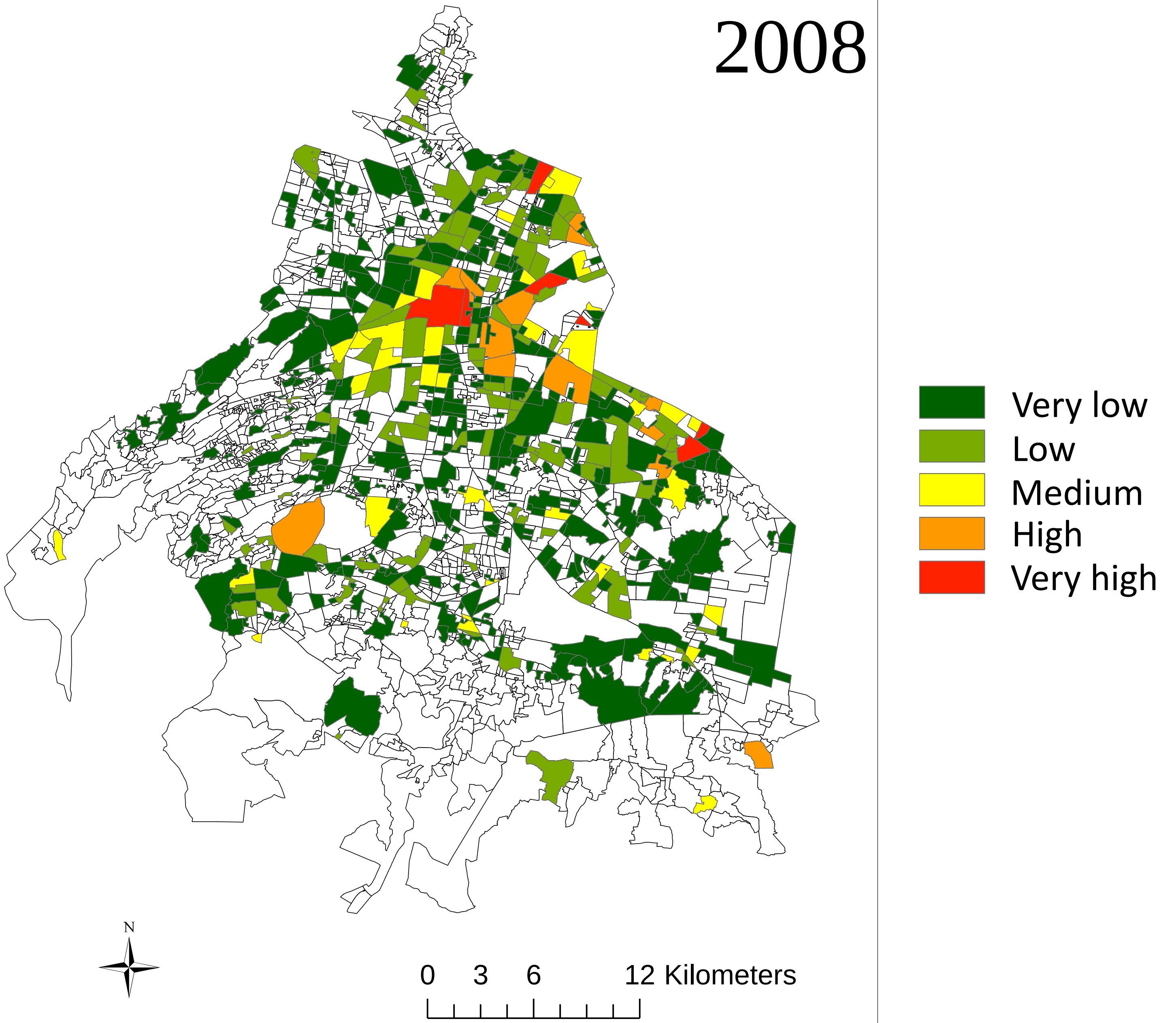
- We mapped the results over the study region.

- We plotted the severity index as a function of the source or type of pondings.

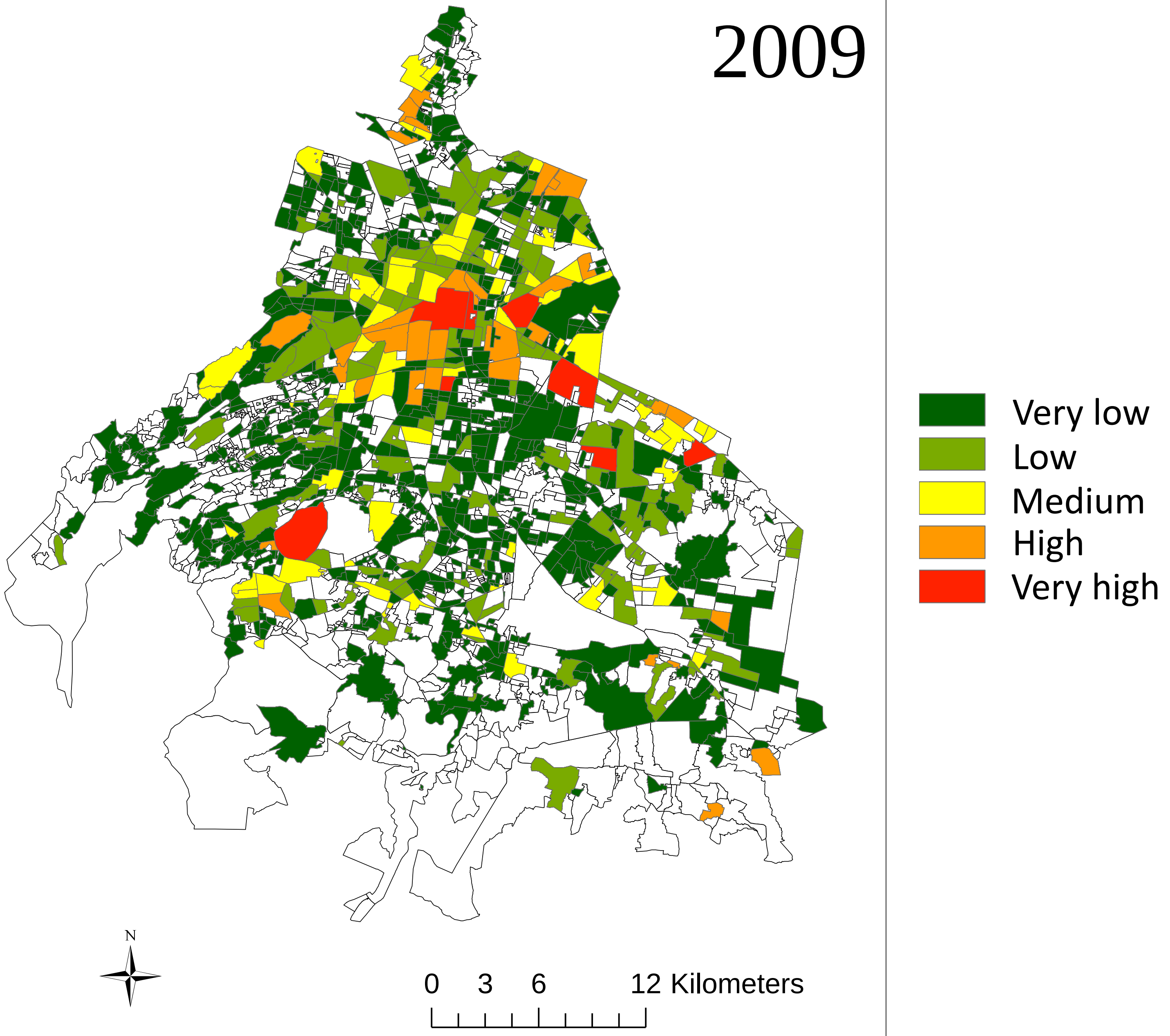
Severity index



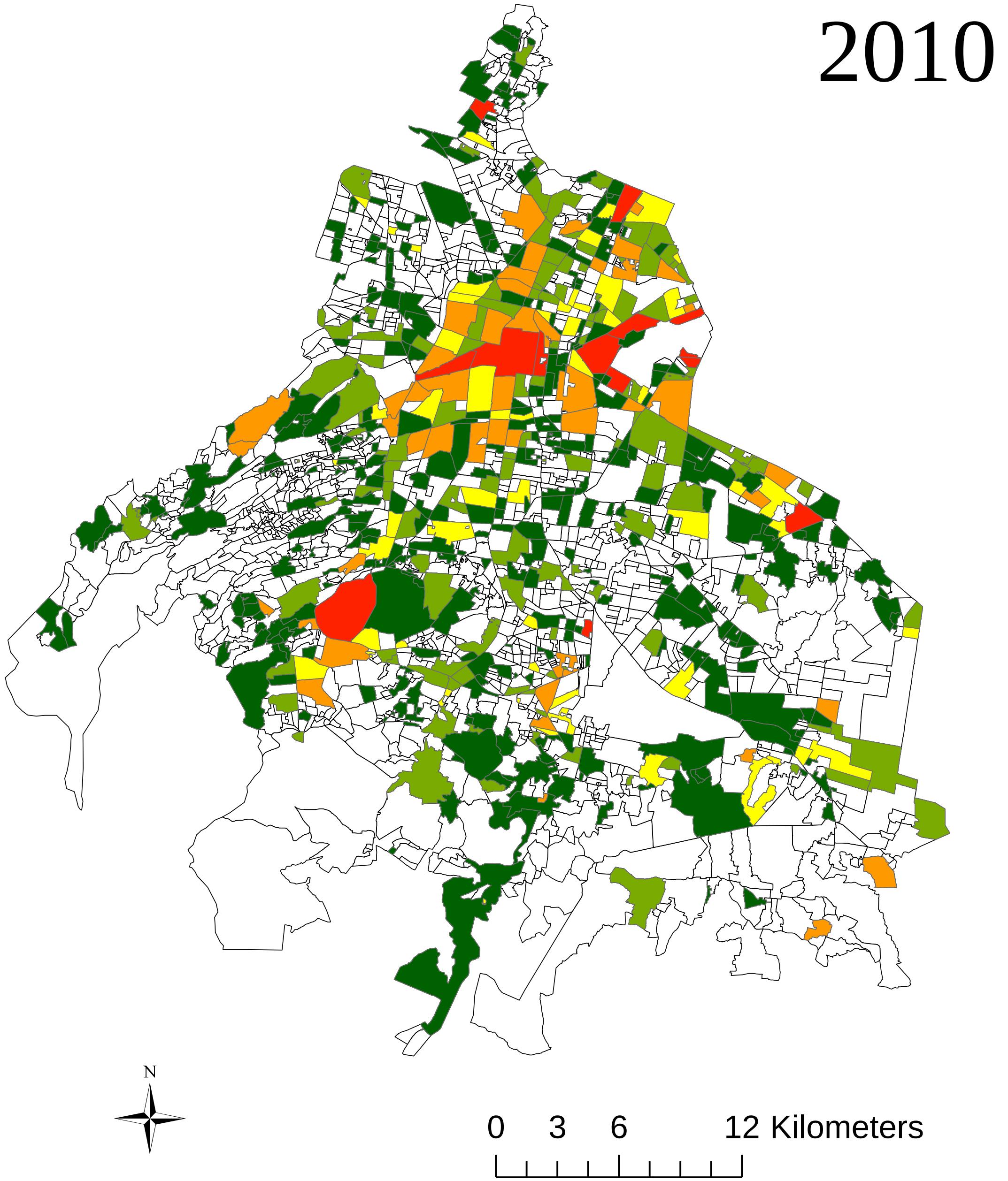
Severity index



Severity index

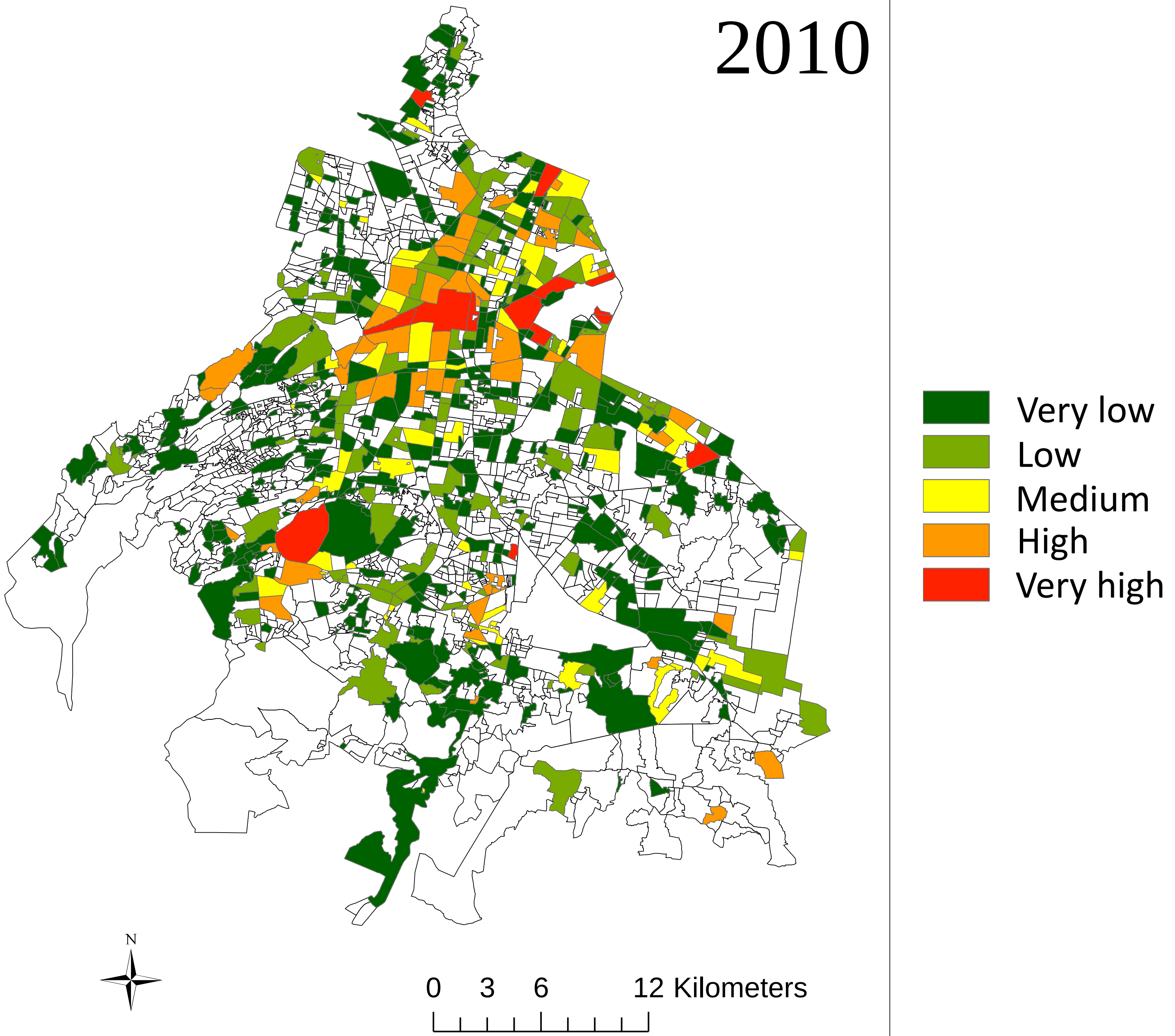


Severity index



- Very low
- Low
- Medium
- High
- Very high

Severity index



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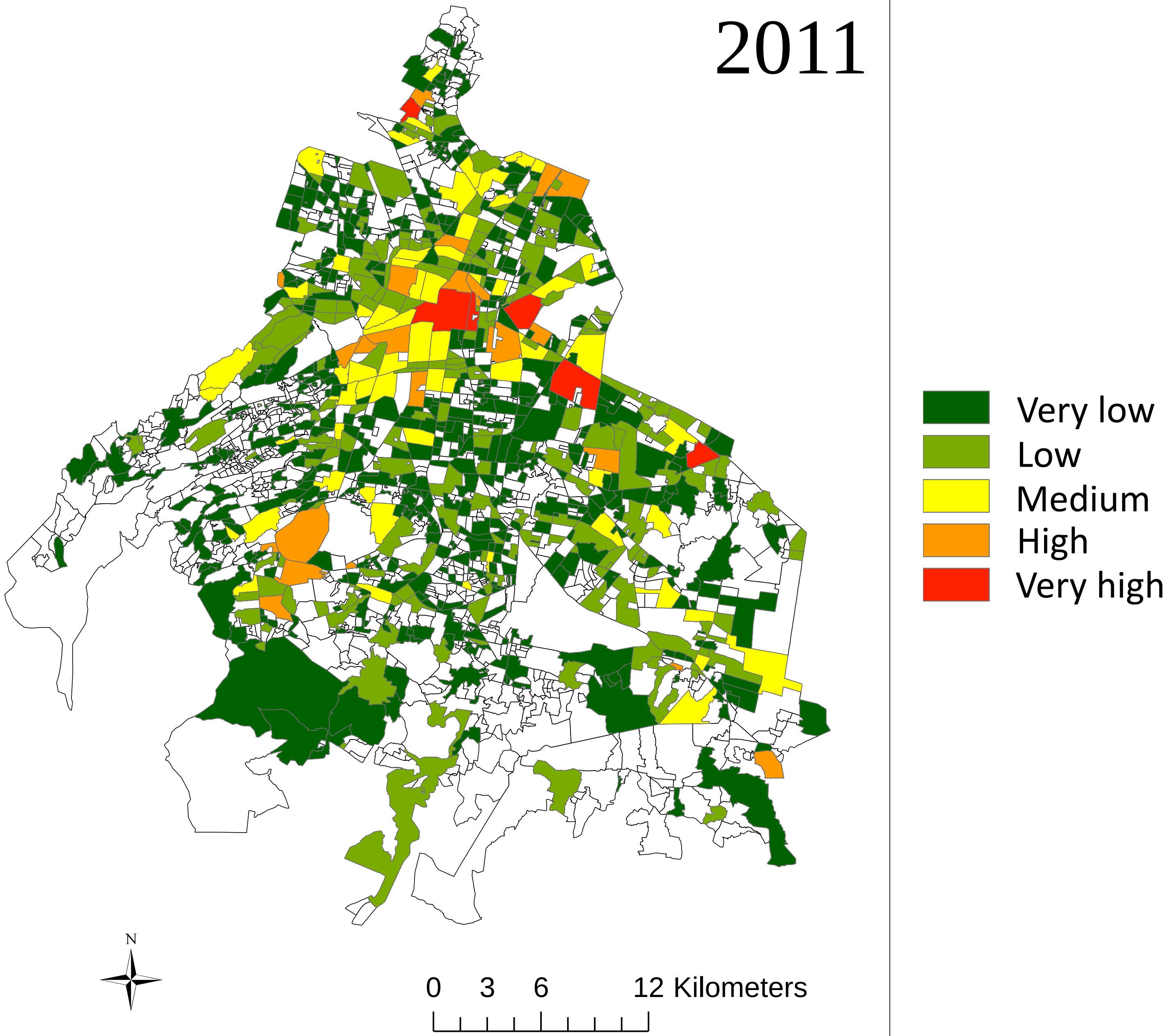

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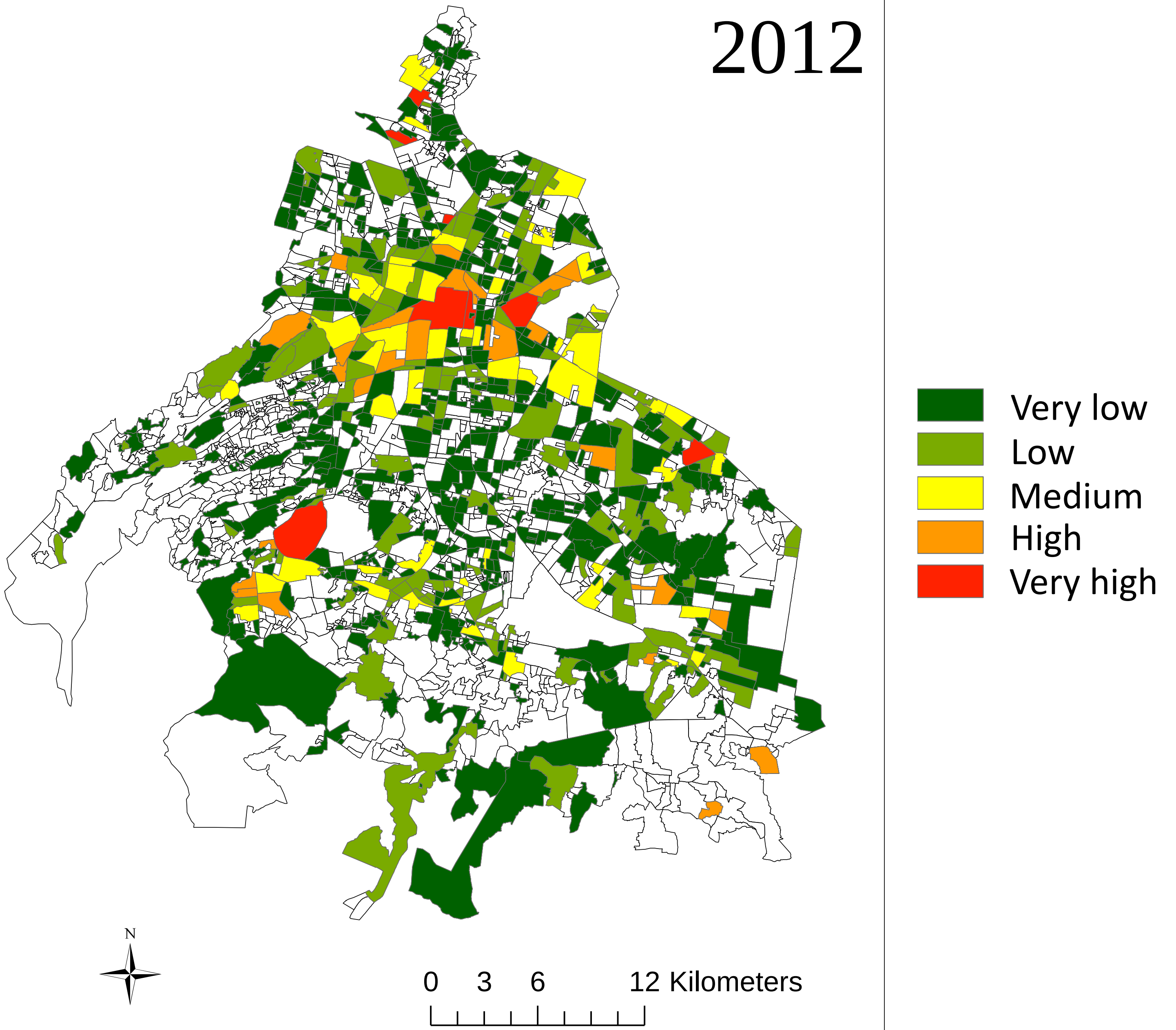

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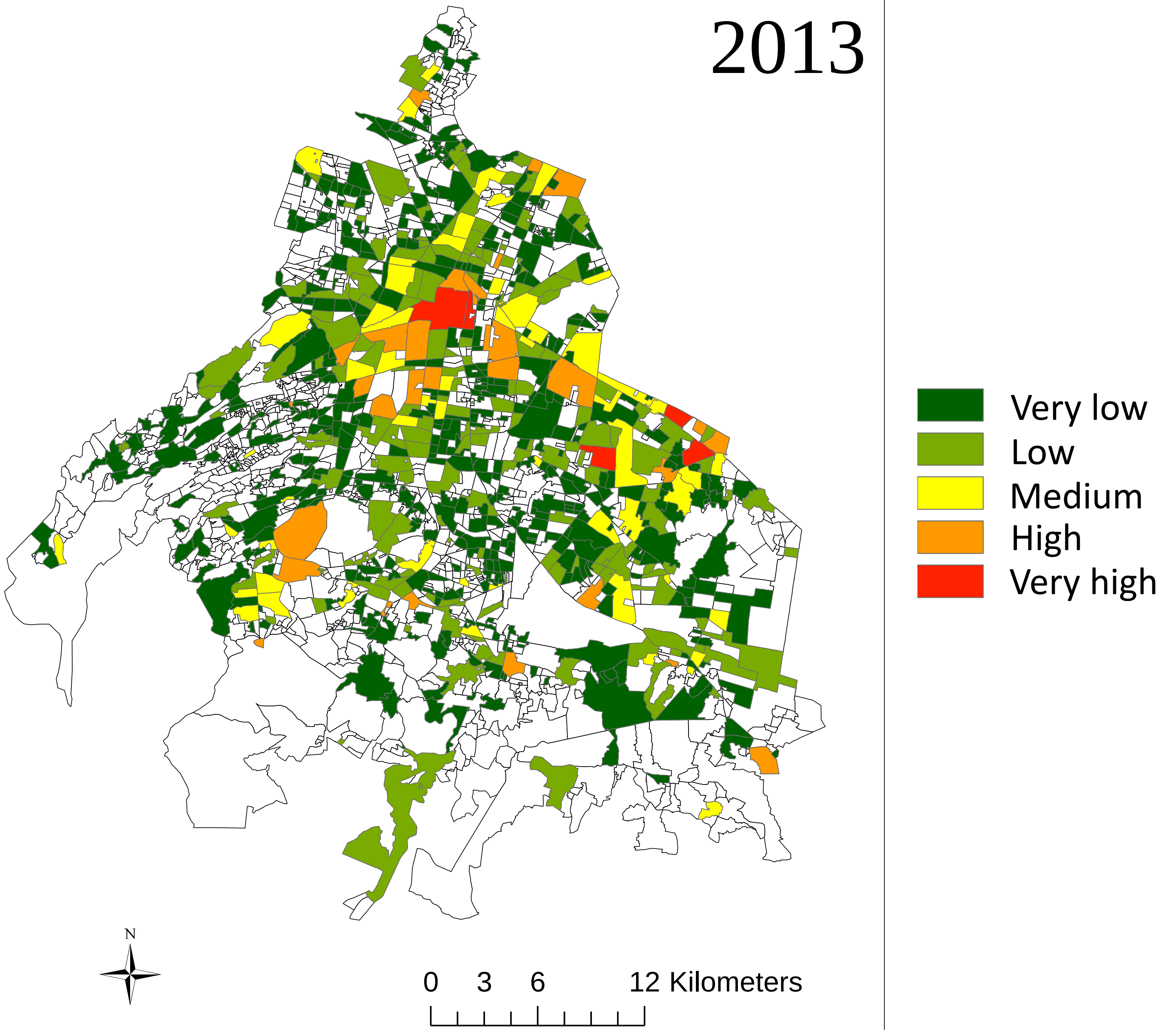
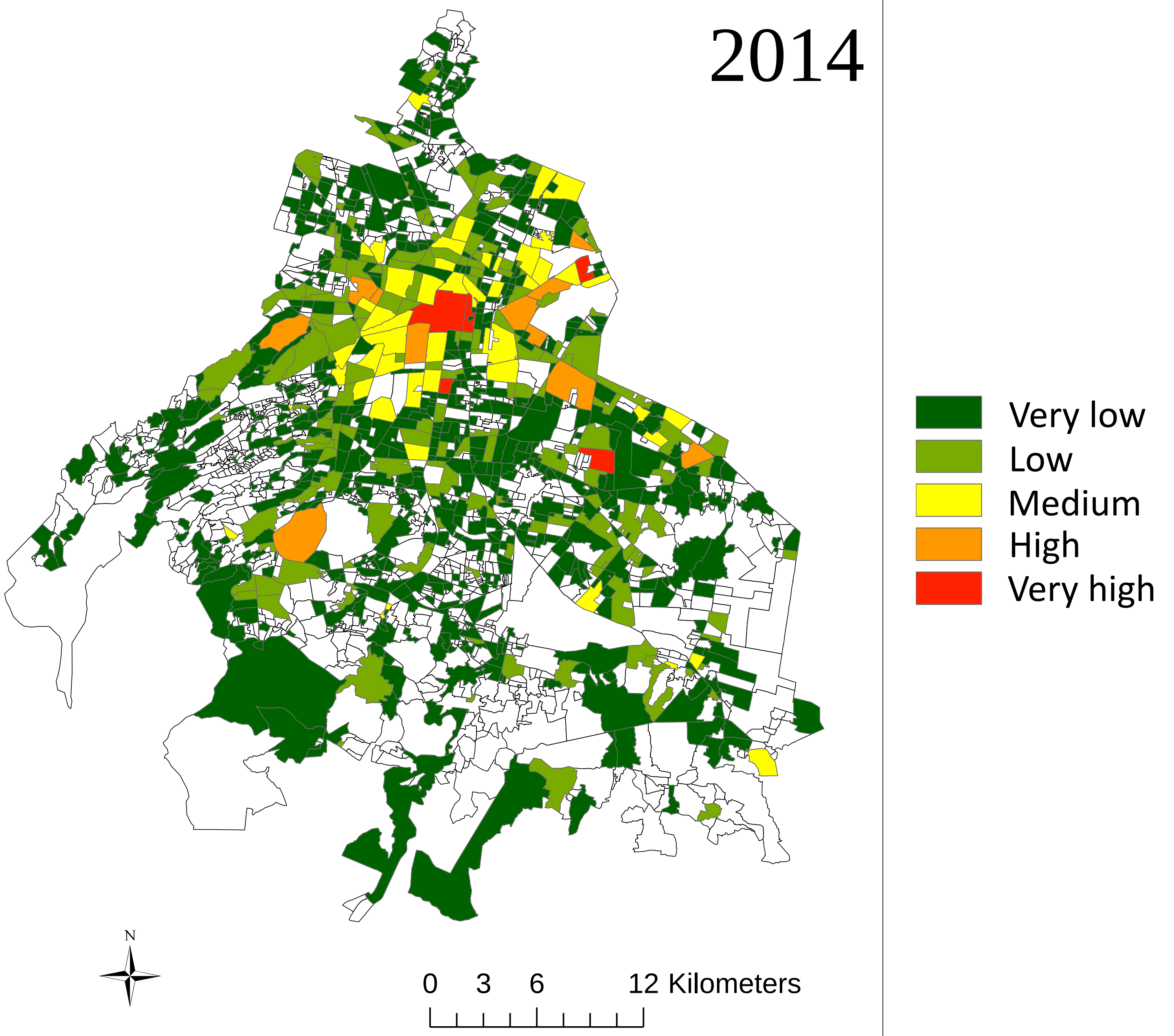


Severity index



Severity index

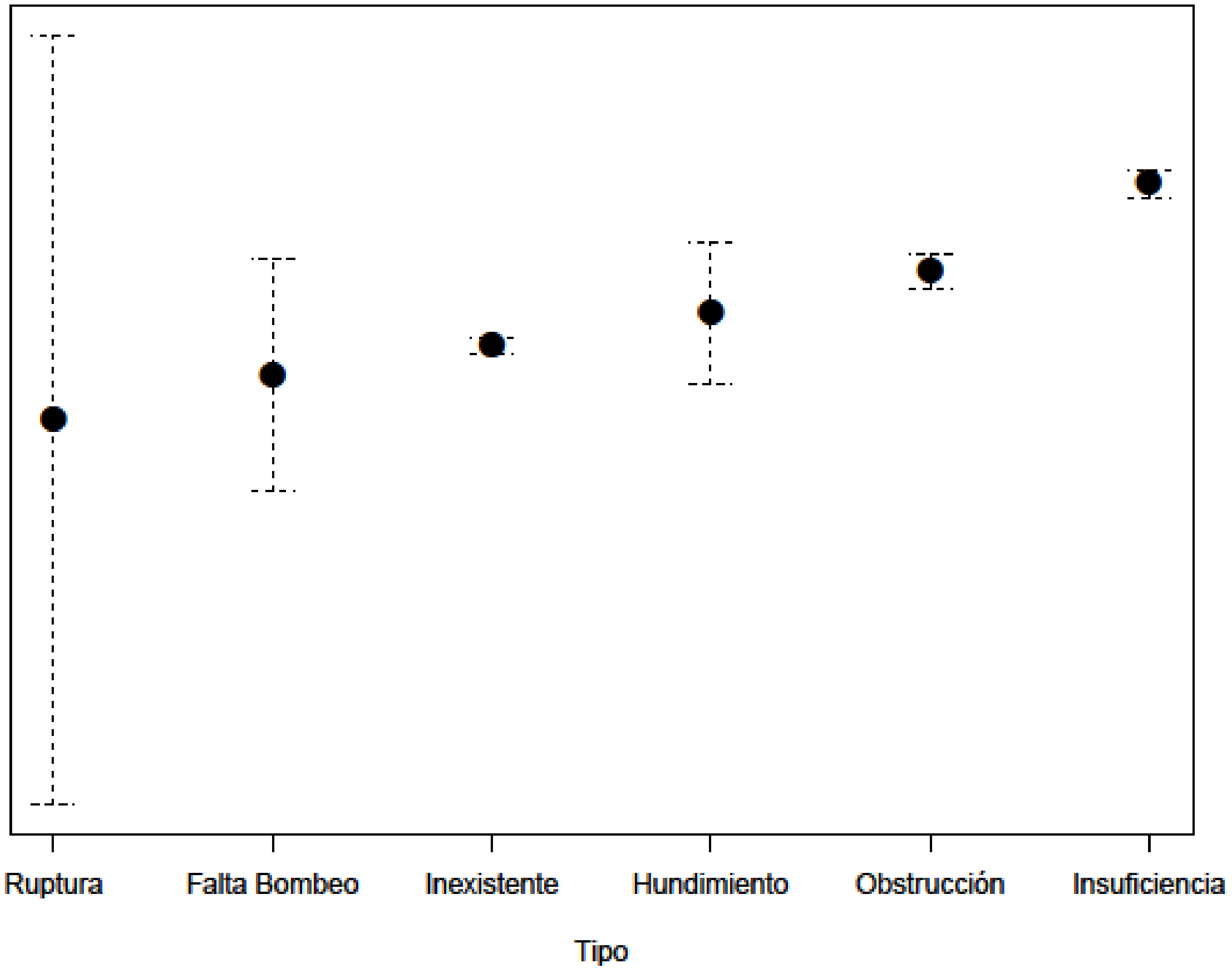
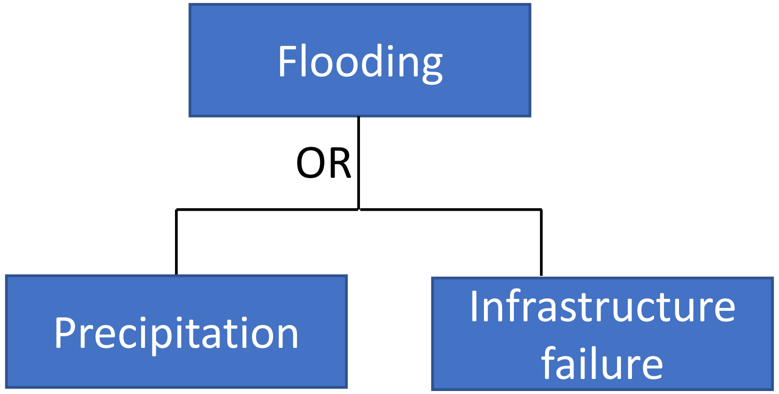


Figure 5. Severity index as a function of source or type of ponding

Bayesian approach



Bayesian approach

- We estimated the likelihood of a ponding event to occur in each census block given a precipitation input. This information will feed a Fault and Event Tree Analysis (Ferdous et al. 2011).

1) Total mean precipitation (TMP 2007-2014) at the census-block level was estimated by interpolation by regularized spline with tensión (Hofierka et al. 2002) of the TMP observed in each weather station.
2) We categorized the precipitation and frequency data using the 25th,50th,75th percentiles.
3) Counted the census blocks within each precipitation-frequency category.
4) Obtained the conditional probability $p(F|P)$ for each census block.

Bayesian approach

Bayesian approach

Table. 1 Number of census blocks within each Frequency-Precipitation category

	Precipitation			
Frequency	**1**	**2**	**3**	**4**
1	79	118	110	155
2	155	177	169	175
3	170	140	122	108
4	109	77	112	76
Total	**513**	**512**	**513**	**514**

Precipitation	Frequency
1: 472 – 571	**1:** 1 - 5
2: 571 - 638	**2:** 5 - 17
3: 638 - 725	**3:** 17 - 50
4: 725 - 1145	**4:** 50 - 70

Bayesian approach

Bayesian approach

Table. 2 Proportion of census blocks within each Frequency-Precipitation category

	Precipitation			
Frequency	**1**	**2**	**3**	**4**
1	0.15	0.23	0.21	0.30
2	0.30	0.34	0.32	0.34
3	0.33	0.27	0.23	0.21
4	0.21	0.15	0.21	0.14
Total	**1**	**1**	**1**	**1**

To evaluate whether a census block will experience flooding during a given model iteration, these probabilities will be compared to a probability derived from a stochastic number generator (e.g. if(runif(1) < p) { then flooding occurs })

WRF baseline simulation : validation analysis

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Miquelajauregui, Y – LANCIS, UNAM

WRF baseline simulation analysis

- We defined the baseline simulation year – 2013- based on monthly data availability provided by the Servicio Meteorológico Nacional (SMN), and the percentage of missing values within a given year.

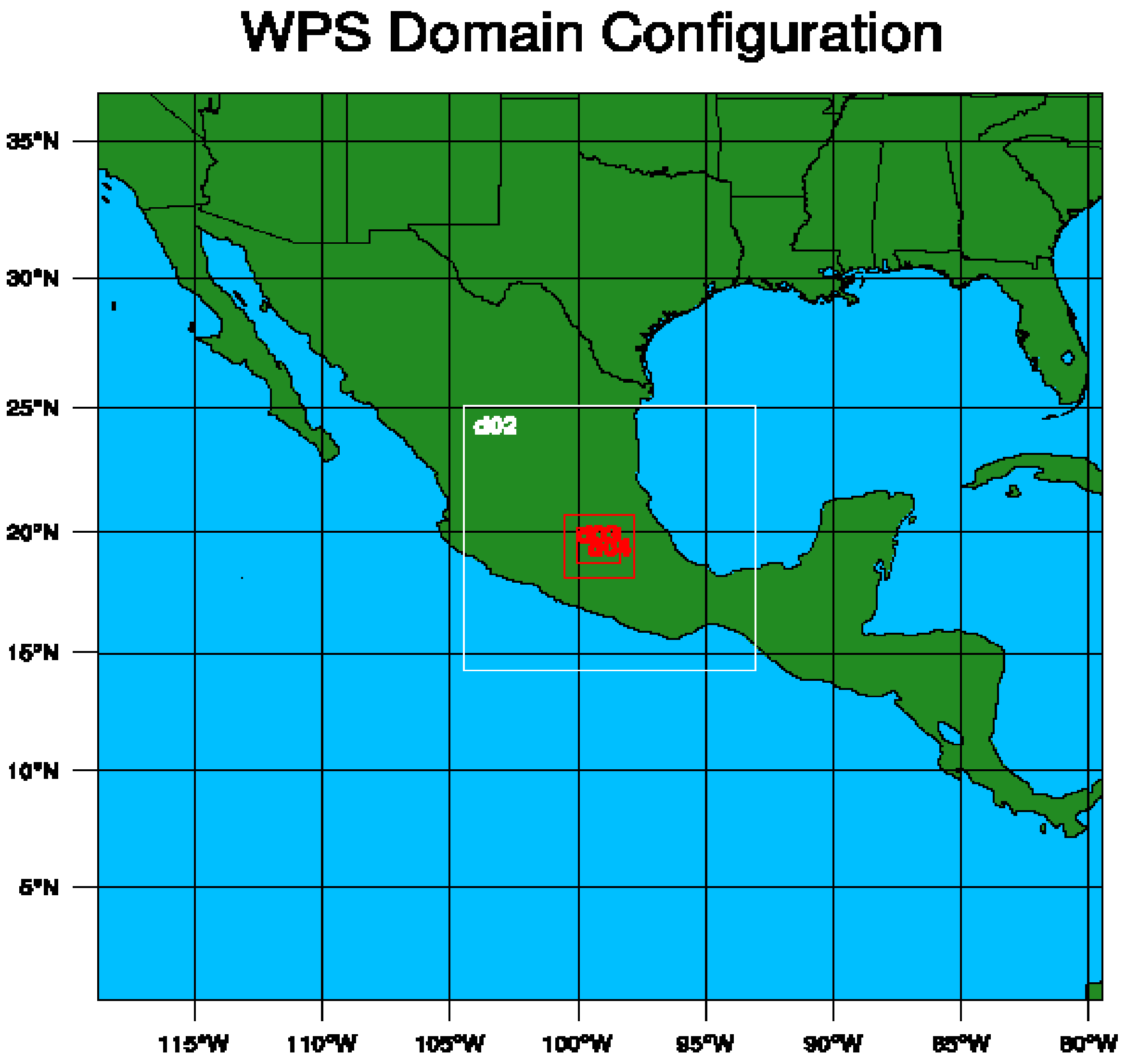
Table. 3 Meteorological station name, geographic location, altitude and percentage of missing values over the 12-month period of record (January-December) for the three years evaluated (2012-2014).

Meteorological Station	Location	Latitude (°N)	Longitude (°W)	Altitude (m)	% missing values (2012)	% missing values (2013)	% missing values (2014)
Atlacomulco	Estado de México	19.475	-99.523	2600	2.20	0.33	0.04
Cerro Catedral	Estado de México	19.323	-99.318	3754	12.9	2.70	7.89
Ecoguardas	CDMX	19.161	-99.121	2200	11.9	0.94	4.62
El Chico	Hidalgo	20.118	-98.425	3004	-	1.10	-
Huamantla	Tlaxcala	19.239	-97.575	2222	6.19	1.75	0.06
Huejutla	Hidalgo	21.917	-98.226	115	4.67	2.17	0.11
Huichapan	Hidalgo	20.231	-99.395	2189	3.46	0.24	0.05
Itza-Popo	Estado de México	19.543	-98.383	3682	0.86	0.51	11.3
Nevado Toluca	Estado de México	19.732	-99.461	4139	3.04	0.46	0.13
Presa Madín	Estado de México	19.312	-99.164	2364	0.78	0.26	0.02
Valle de Bravo	Estado de México	19.223	-100.54	2476	-	1.35	3.37
Zimapán	Hidalgo	20.442	-99.232	1788	0.87	3.37	0.72

WRF baseline simulation analysis

- Observational data were recorded with a temporal frequency of 10 min.
- To replace missing values in the dataset, a linear interpolation using the nearest non-missing value was performed.
- To enable direct comparison to WRF simulation results, temperature (°C) records were averaged to represent a single hourly value.
- As with temperature, the cumulative rainfall (mm) was calculated on an hourly basis.

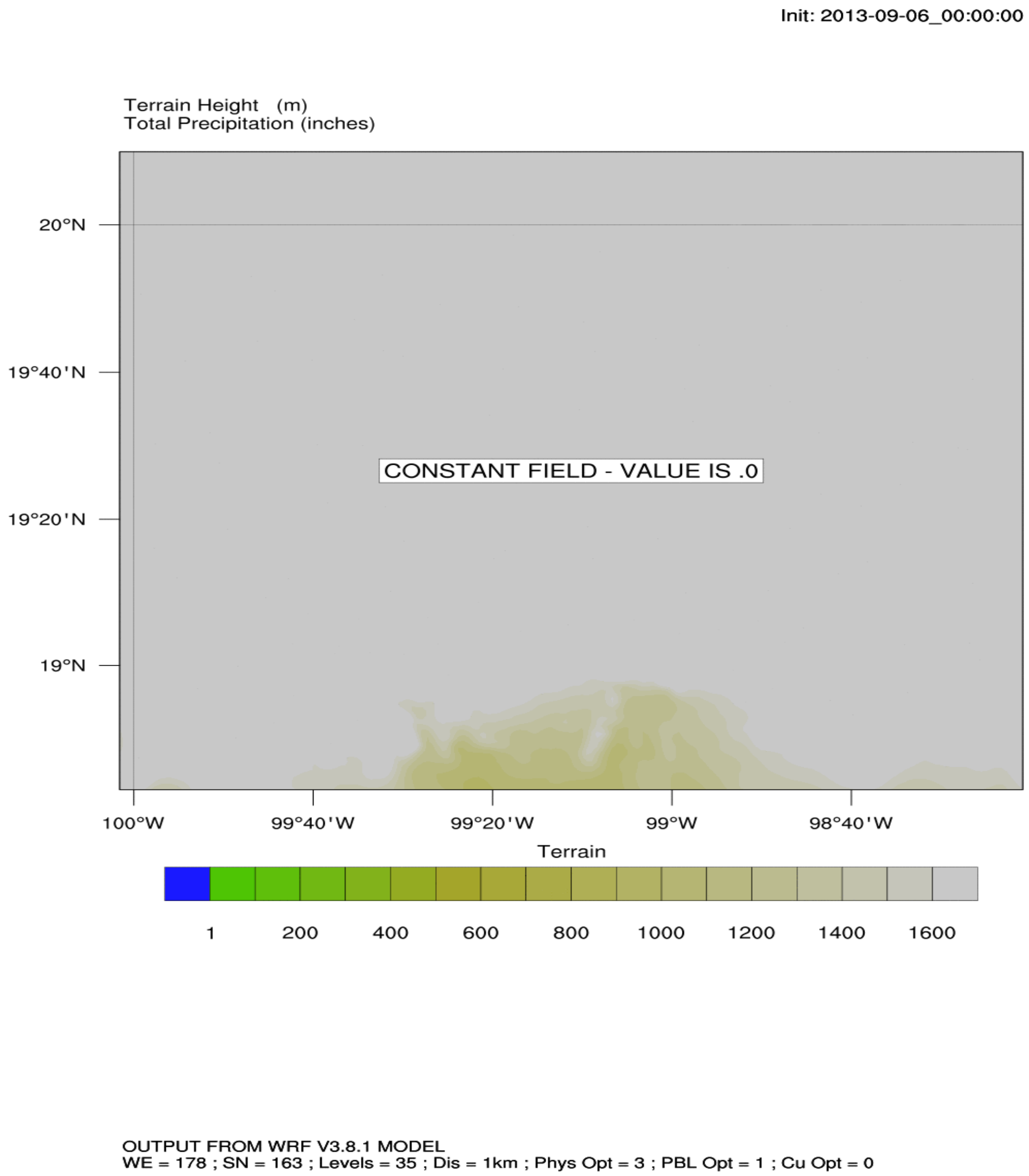
WRF baseline simulation analysis



WRF baseline simulation analysis

September 6th and 7th 2013

Each image represents one simulated hour



WRF baseline simulation analysis

Proposed validation methodology:

1. Extract WRF simulated results on a sation-by-station basis.

2. To assess model accuracy, we will compare observed and predicted values.

The statistical model evaluation will be based on three goodness-of-fit (GOF) statistics :

1. Correlation tests – assess the degree of association between modelled and measured estimates
2. Mean difference and the percent relative error (E) - to assess model bias.
3. Theil´s inequality coefficient *U* – ranges from 0 (lack of fit) to 1 (perfect fit)

WRF-SLEUTH scenarios

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Serrano-Candela, F – LANCIS, UNAM
Gómez, P – LANCIS, UNAM
Jiménez, M – LANCIS, UNAM
….and everyone else on LANCIS working on generating layers and performing excellent work

WRF-SLEUTH scenarios…still under construction

- WRF is fed by land cover information.

- SLEUTH outputs will be used to create land cover change scenarios in WRF and to evaluate its effects on atmospheric phenomena.

- SLEUTH generates data for 2011-2060. The scenarios explored so far are:

    1. Control run

    2. Regionalization based on Flores, S (pers.comm.)

    3. Agricultural fields favors urban growth