AIR QUALITY INDEXES IN MANIZALES: IMPLEMENTATION AND REPRESENTATION

Jade Alexandra Li Ramírez [2]

jalir@unal.edu.co

Ángela María Pérez Zapata [1]

Néstor Darío Duque Méndez [1]

Beatriz Helena Aristizabal Zulúaga [2]

[1] Grupo de trabajo en Ambientes Inteligentes Adaptativos (GAIA)

[2] Grupo de trabajo Académico en Ingeniería Hidráulica y Ambiental (GTA)

In Colombia about 6000 people die

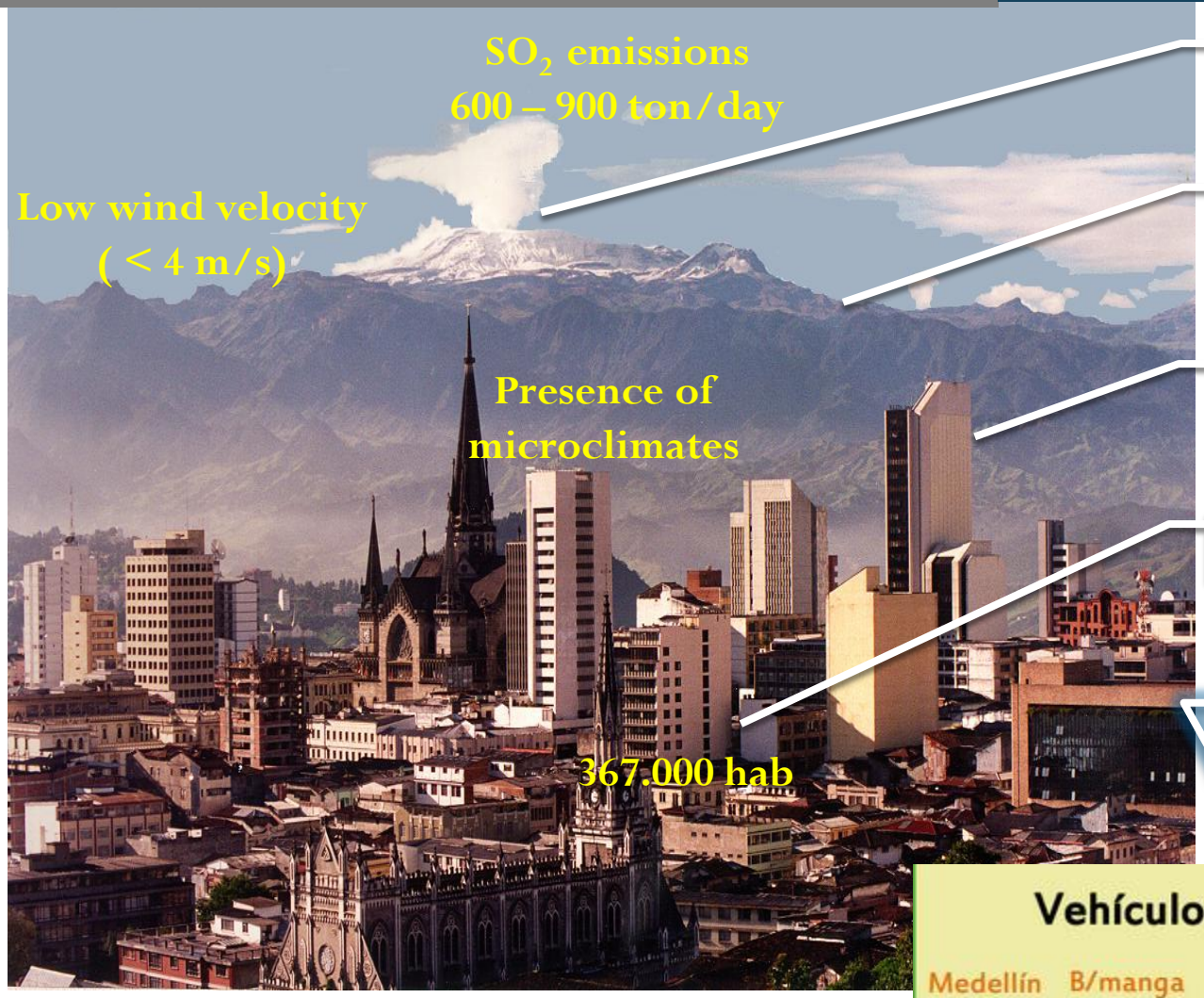
and there are 7400 new cases of chronic bronchitis

each year!

because air pollution!
(CONPES 3550, 2008)

Taken from: Caracol radio

MANIZALES

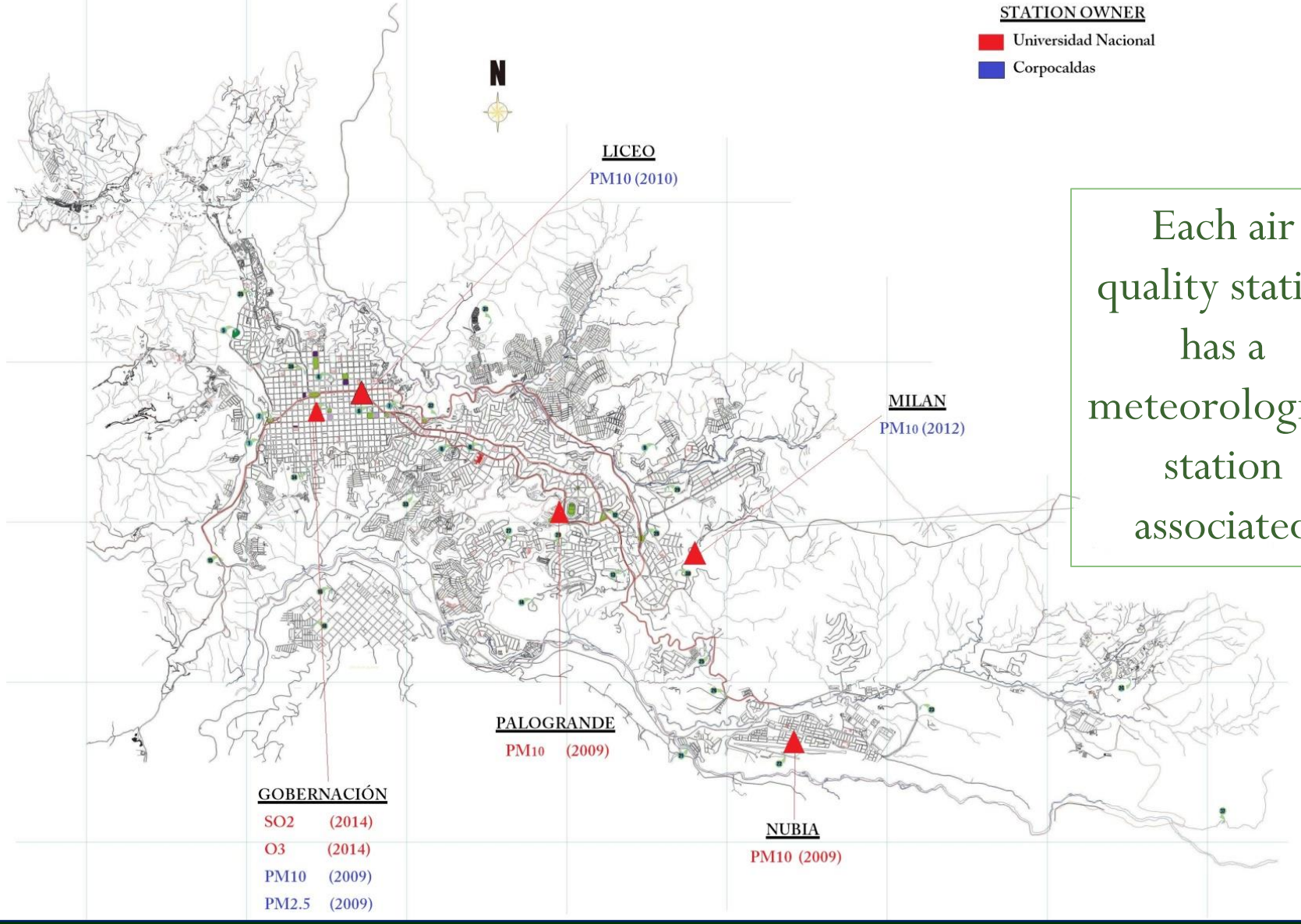


- Presence of volcanoes
- Biogenic sources
- Presence of industries
- Population
- Vehicular density

Taken from: La Patria Manizales

Taken from: http://manizalescomovamos.org

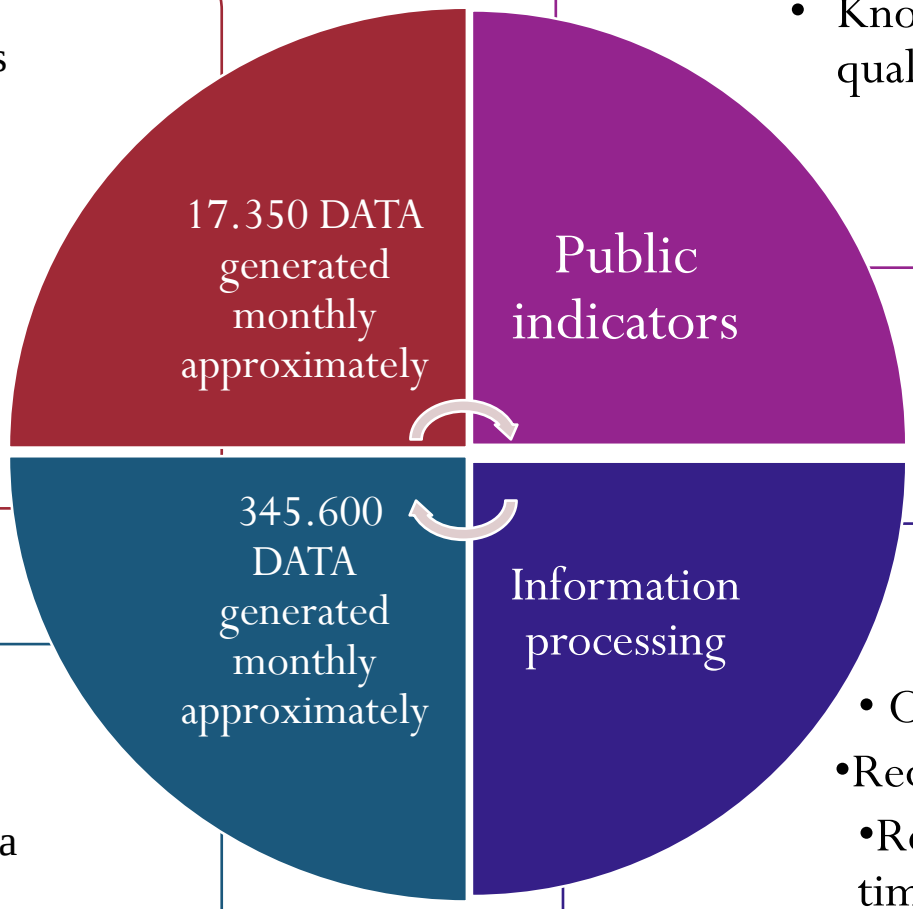
Pollutants analyzed



Each air quality station has a meteorological station associated

IMPORTANCE AND ADVANTAGES OF DATA WAREHOUSE

- **AIR**
- **Gases:** Continuous monitoring each 5 minutes
- **Particulate matter:** Monitoring each 3 days



- Knowledge of air quality information.

- **WEATHER**
- Meteorological data associated at each air quality station

- Organization
- Reduces handle errors
- Reduces processing time
- Safe storage
- Continuous updating

OBJECTIVES

TO GENERATE AIR QUALITY INDEXES FOR MANIZALES CITY.

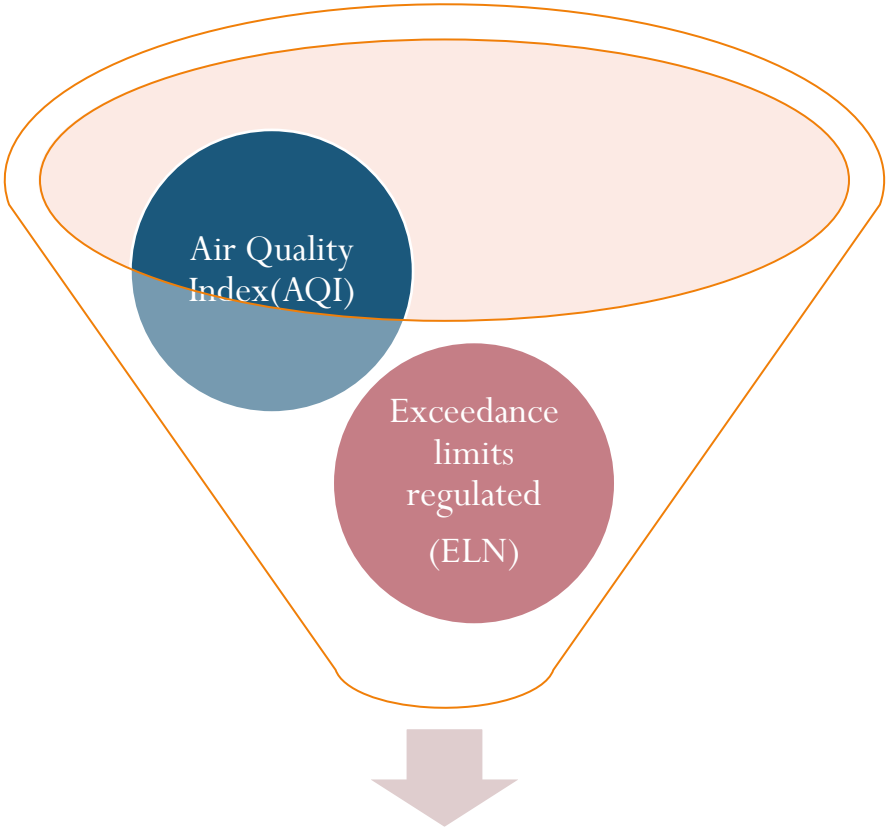
Show the indexes through systematic calculation tool (data warehouse) that allows to storage, to process, to graph and to update constantly the dates.

Analyze air quality in the city by indexes and graphic it.

AIR QUALITY INDEXES IN MANIZALES: IMPLEMENTATION AND REPRESENTATION

MATERIALS AND METHODS

Indexes selected



INDEXES

METHODOLOGY

"Protocolo para el Monitoreo y Seguimiento de la Calidad del Aire" published in 2010 for MAVDT and "Manual de Operación de Sistemas de Vigilancia de Calidad del Aire"(MAVDT, 2010)

EPA methodology

AQI	COLOR	LEVEL	O_3 8h ppm	PM_{10} 24h $\mu g/m^3$	$PM_{2.5}$ 24h $\mu g/m^3$	SO_2 24h ppm
0-50	Green	Good	0.000 0.059	0 54	0.0 15.4	0.000 0.034
51-100	Yellow	Moderate	0.060 0.075	55 154	15.5 40.4	0.053 0.144
101-150	Orange	Unhealthy for sensitive groups	0.076 0.095	155 254	40.5 65.4	0.145 0.224
151-200	Red	Unhealthy	0.096 0.115	255 354	65.5 150.4	0.225 0.304
201-300	Purple	Very unhealthy	0.116 0.373 (0.155 0.404) (4)	355 424	150.5 250.4	0.305 0.604
301-500	Brown	Hazardous	(3)	425 604	250.5 500.4	0.605 1.004

$$I_{cont} = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}} (C_{cont} - BP_{Lo}) + I_{Lo}$$

Where:

I_{cont} = Index for the pollutant

C_{cont} = Concentration measurement for the pollutant

BP_{Hi} = Cutpoint greater or iqual to C_{cont}

BP_{Lo} = Cutpoint less or iqual to C_{cont}

I_{Hi} = Air quality index value corresponding to BP_{Hi}

I_{Lo} = Air quality index value corresponding to BP_{Lo}

Exceedance limits regulated (ELN)

Pollutant	Maximum permissible levels (µg/m³)	Time
PM_{10}	50	Anual
	100	24 horas
$PM_{2.5}$	25	Anual
	50	24 horas
SO_2	80	Anual
	250	24 horas
	750	3 horas
O_3	80	8 horas
	120	1 hora

Maximum permissible levels for criteria pollutants

In accordance with Colombian law

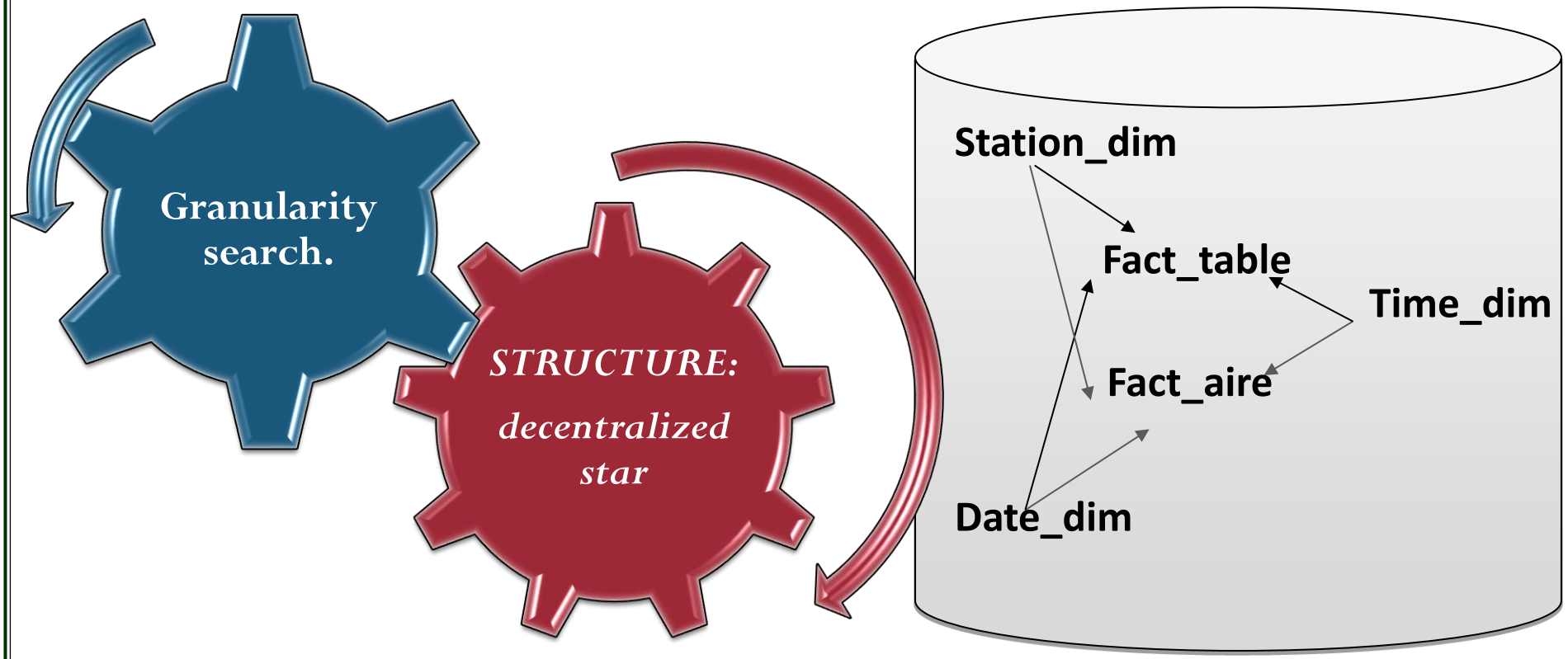
Resolution 610 from 2010 (MAVDT, 2010)

Air Quality standard or level Immission

Data warehouse

DEVELOPING

http://froac.manizales.unal.edu.co/cube/IDEA/index.php



Analysis of indexes

Software

(R Core Team , 2015)

Tools used

Library

(Carslaw, D.C. and K. Ropkins, 2012)

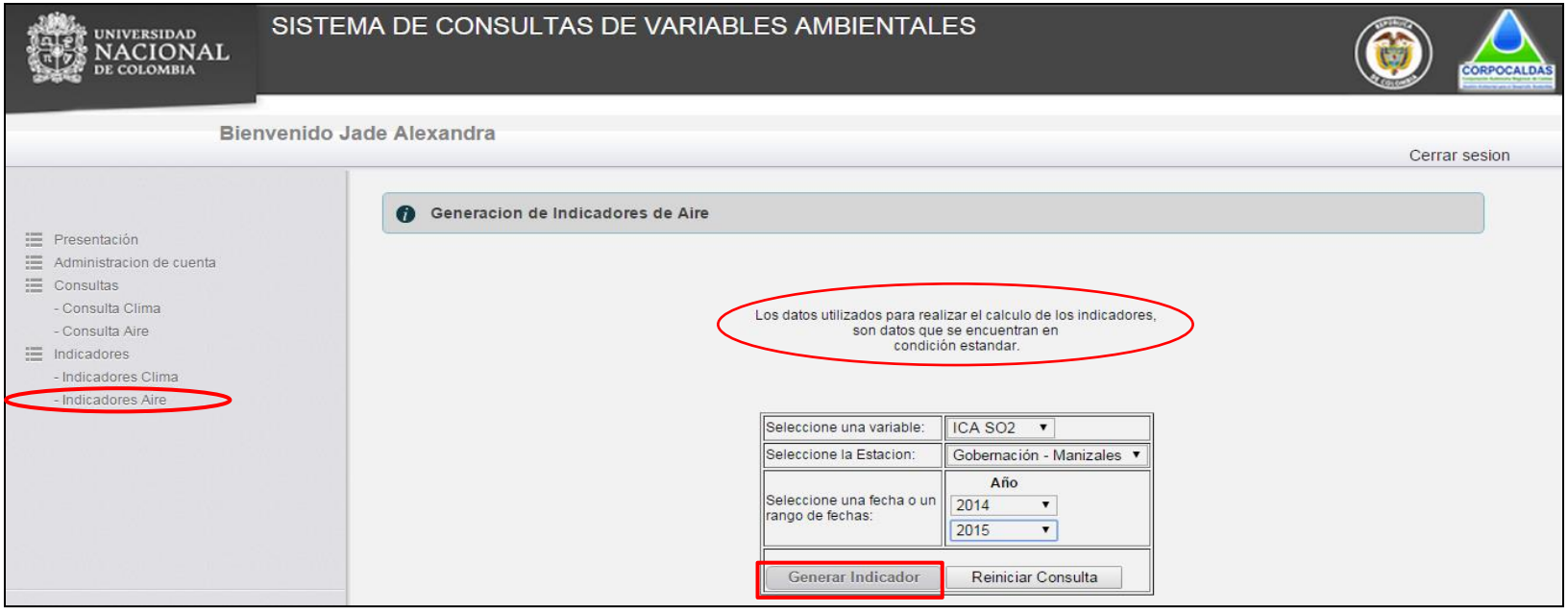
Graphics with both AQI and ELN

AIR QUALITY INDEXES IN MANIZALES: IMPLEMENTATION AND REPRESENTATION

RESULTS

Homepage

Information about project

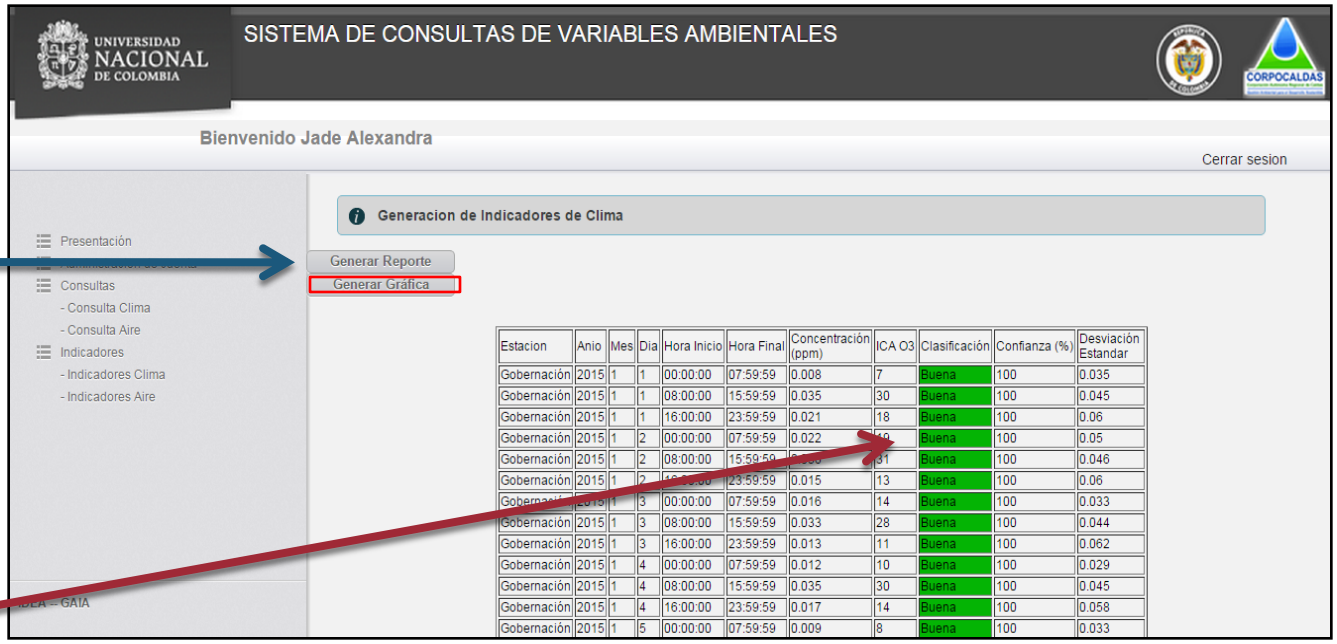


Data warehouse

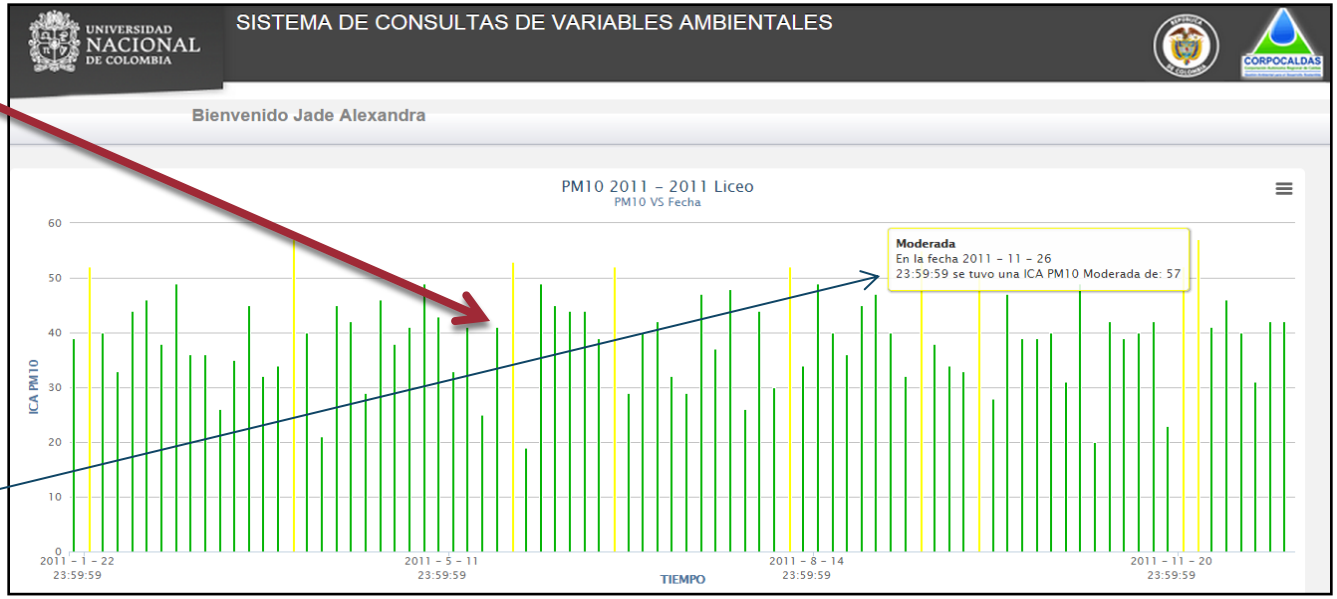
Download table generated. Files format .csv

Color code as showes in the EPA methodology

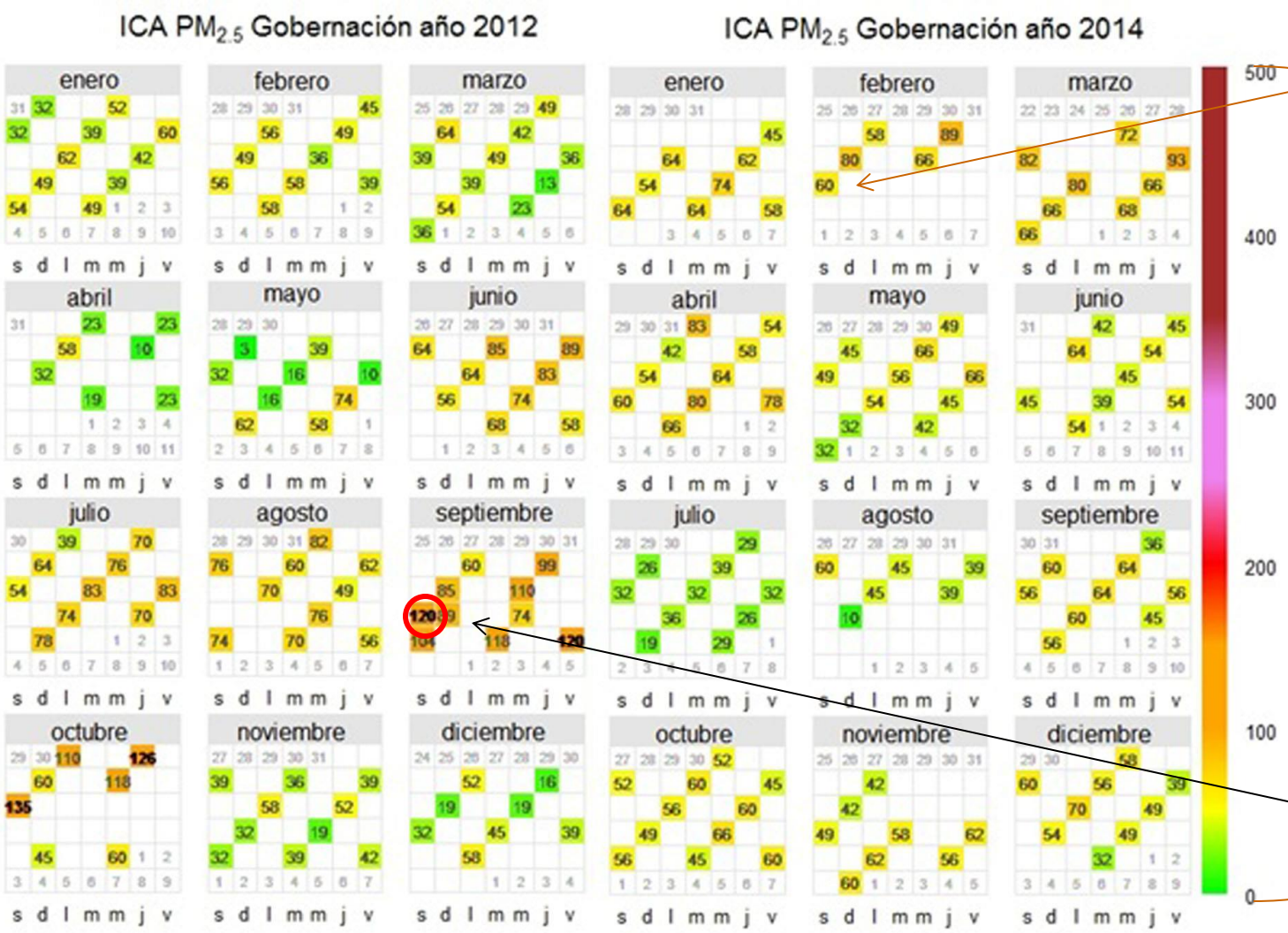
Info box



Estacion	Anio	Mes	Dia	Hora Inicio	Hora Final	Concentración (ppm)	ICA O3	Clasificación	Confianza (%)	Desviación Estandar
Gobernación	2015	1	1	00:00:00	07:59:59	0.008	7	Buena	100	0.035
Gobernación	2015	1	1	08:00:00	15:59:59	0.035	30	Buena	100	0.045
Gobernación	2015	1	1	16:00:00	23:59:59	0.021	18	Buena	100	0.06
Gobernación	2015	1	2	00:00:00	07:59:59	0.022	19	Buena	100	0.05
Gobernación	2015	1	2	08:00:00	15:59:59	0.036	31	Buena	100	0.046
Gobernación	2015	1	2	16:00:00	23:59:59	0.015	13	Buena	100	0.06
Gobernación	2015	1	3	00:00:00	07:59:59	0.016	14	Buena	100	0.033
Gobernación	2015	1	3	08:00:00	15:59:59	0.033	28	Buena	100	0.044
Gobernación	2015	1	3	16:00:00	23:59:59	0.013	11	Buena	100	0.062
Gobernación	2015	1	4	00:00:00	07:59:59	0.012	10	Buena	100	0.029
Gobernación	2015	1	4	08:00:00	15:59:59	0.035	30	Buena	100	0.045
Gobernación	2015	1	4	16:00:00	23:59:59	0.017	14	Buena	100	0.058
Gobernación	2015	1	5	00:00:00	07:59:59	0.009	8	Buena	100	0.033



$PM_{2.5}$



CALENDAR

Measuring days

AQI value

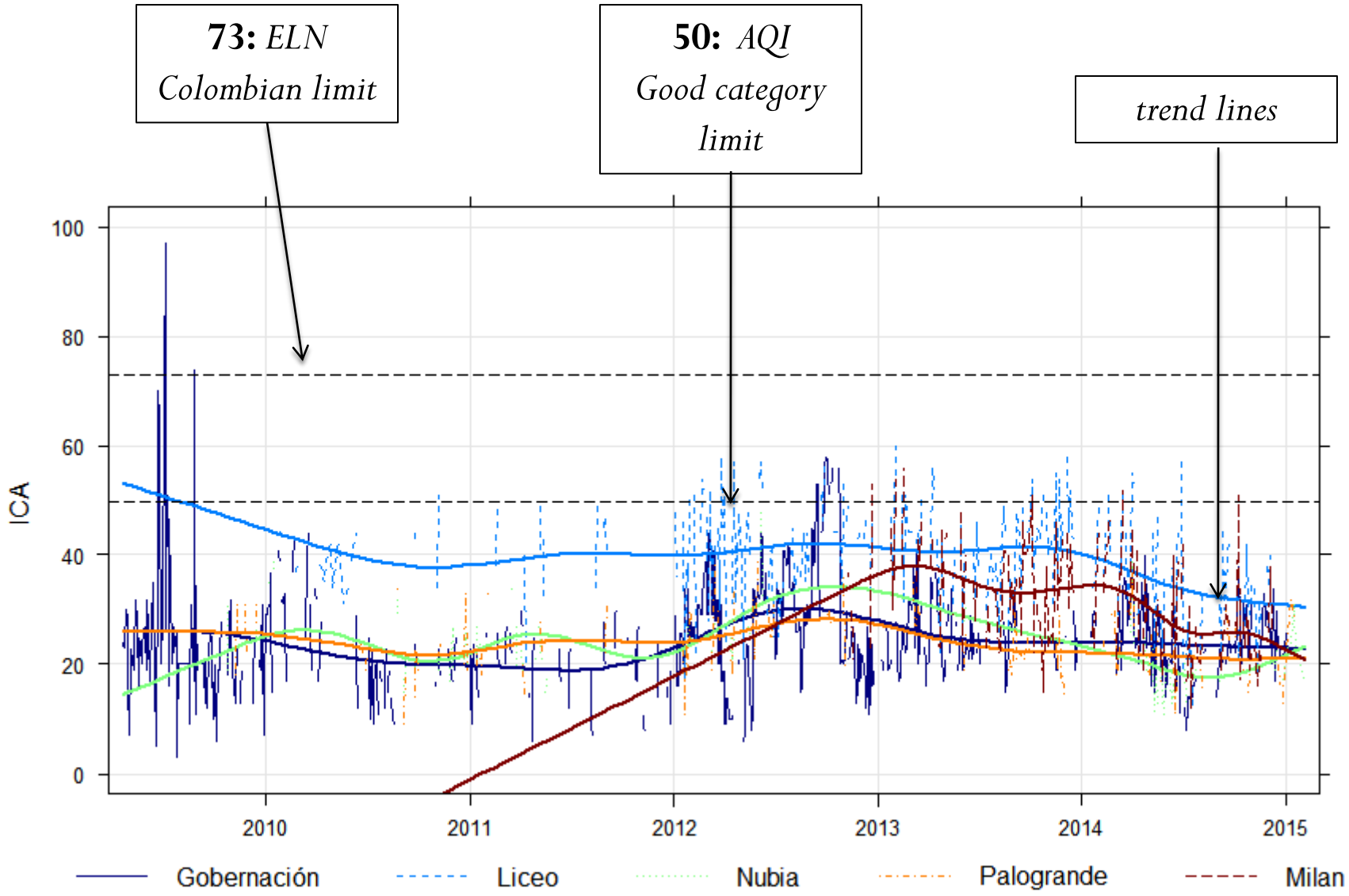
Category by color

Ranges and colors scale as showed in the EPA methodology

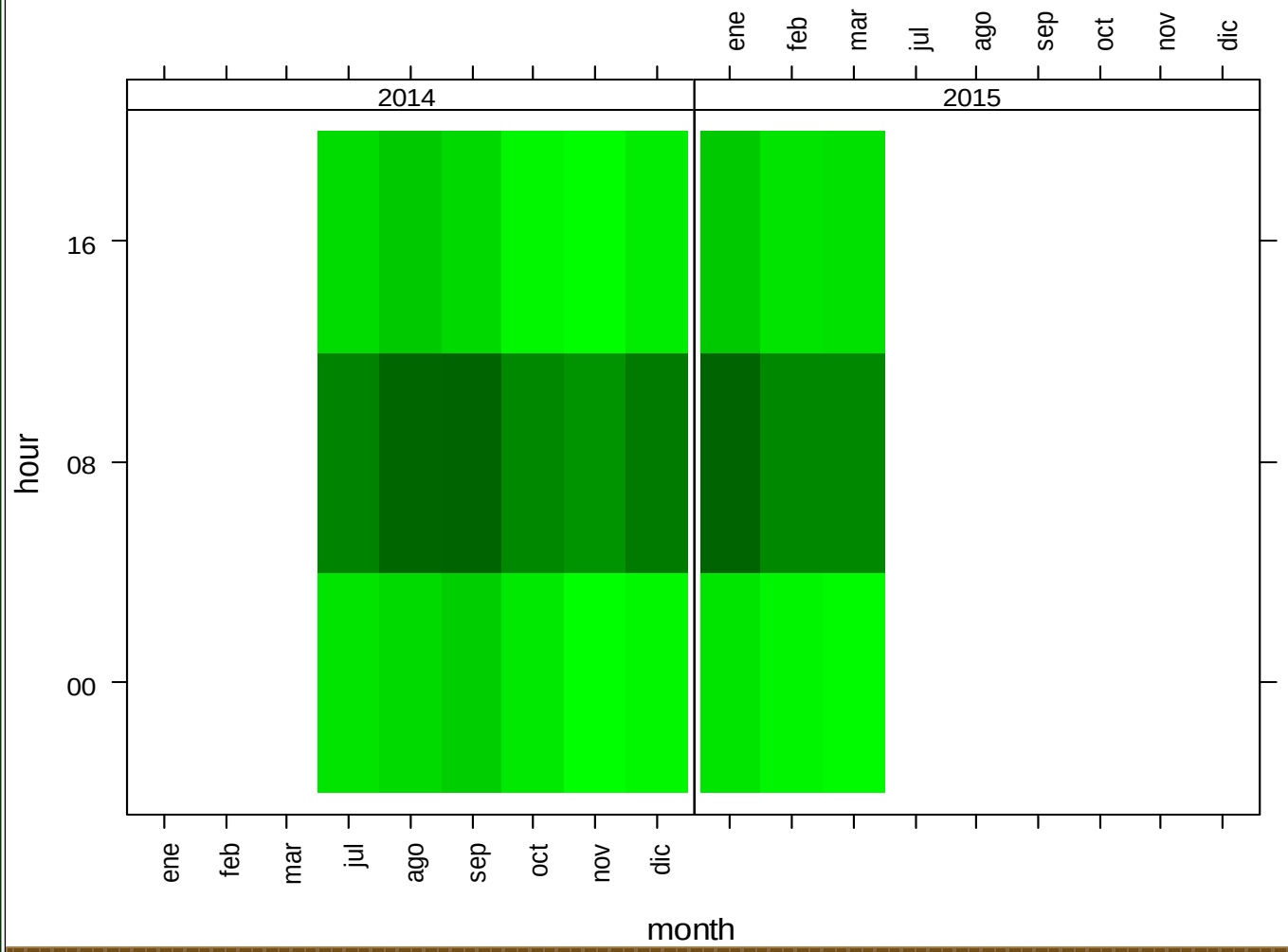
Bold

Days exceeding Colombian limit (120)

PM_{10}


73: ELN
Colombian limit
50: AQI
Good category
limit
trend lines
ICA
100
80
60
40
20
0
2010
2011
2012
2013
2014
2015
Gobernación
Liceo
Nubia
Palogrande
Milan

O_3



Colombian limit:
35
Doesn't exceed

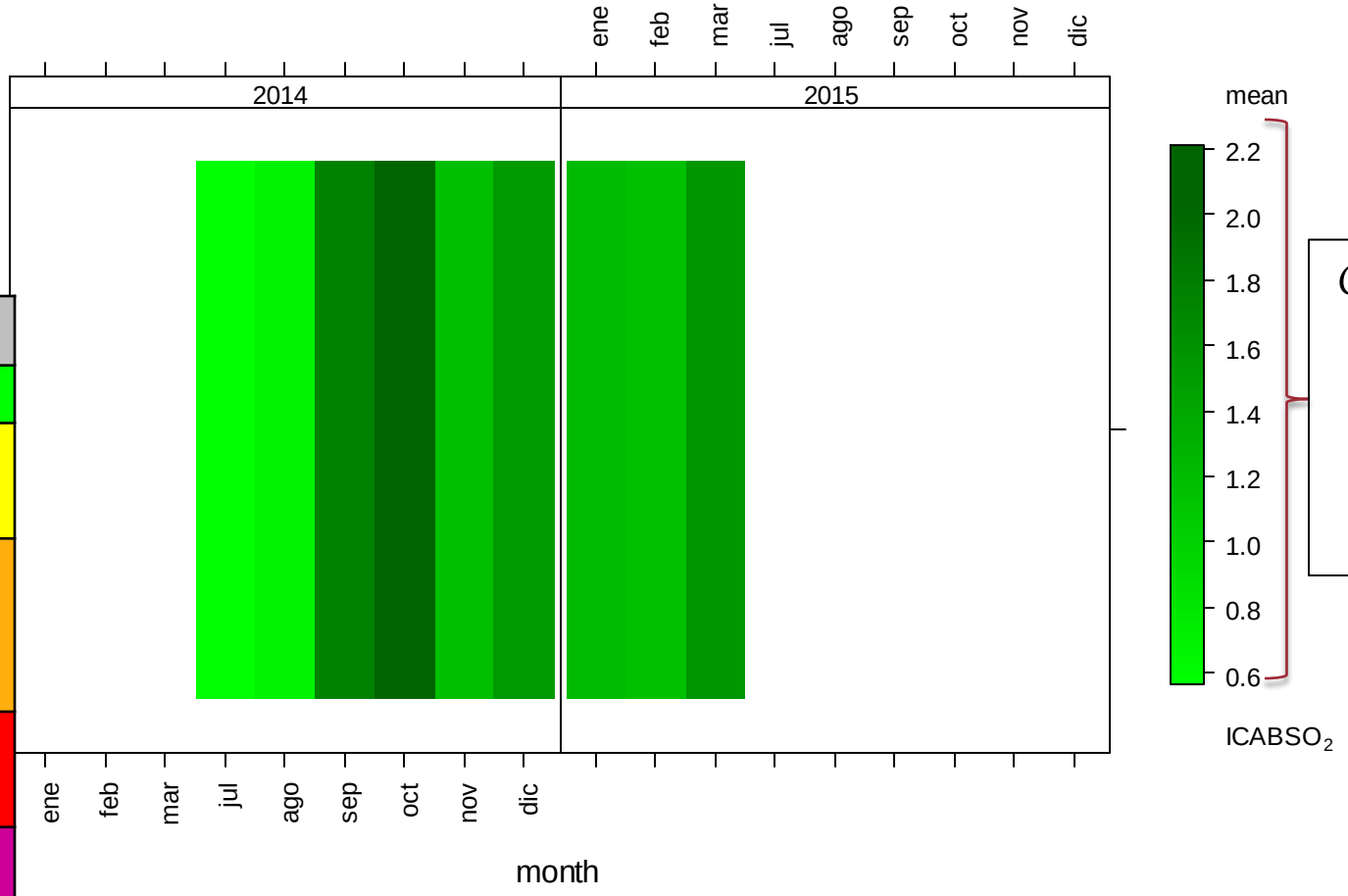
AQI	LEVEL
0-50	Good
51-100	Moderate
101-150	Unhealthy for sensitive groups
151-200	Unhealthy
201-300	Very unhealthy
301-500	Hazardous

Ozone levels are higher when there is solar radiation

SO_2

Hours:

24 hours



AQI	LEVEL
0-50	Good
51-100	Moderate
101-150	Unhealthy for sensitive groups
151-200	Unhealthy
201-300	Very unhealthy
301-500	Hazardous

Colombian limit : **78** ***Doesn't exceed***

CONCLUSIONS

A **data warehouse is a useful tool** that allows to store information and use it for to realize calculations and graph systematically. Thus **reducing processing time and avoiding handling errors.**

Results of indexes have shown **logical dynamics** of pollutants according to its **chemical reactivity and the events** occurred in Manizales by mobile sources, volcanic activity and industrial activity.

The indexes are **a conceptual basis to know the air quality in the region and help the generation of laws**, strategies and prevention plans of atmospheric pollutants.

This is the beginning of a **base line** of pollutants in order to develop a **complete air quality knowledge** in Manizales.

ACKNOWLEDGMENT

Project: “Implementación de indicadores de línea base ambiental y construcción de una bodega de datos para apoyar la generación y análisis de los mismos como parte de la Fase III del proyecto de estructuración de la Línea Base Ambiental del Departamento de Caldas” (LB3)

Corporación autónoma de Caldas, CORPOCALDAS – Universidad Nacional de Colombia Sede Manizales

REFERENCES

Carslaw, D.C. and K. Ropkins, (2012) openair an R package for air quality data analysis. Environmental Modelling & Software. Volume 27-28, 52-61.

(Conpes), C.N. de P.E. y S., 2005. *Lineamientos para la formulación de la politica de prevencion y control de la contaminación del aire*, Bogota D. C, Colombia.

Aristizabal, B.H. et al., 2014. Linea Base Ambiental de Caldas: indicadores de clima y aire. In *Definición de los indicadores de la línea base ambiental de caldas*. Manizales: Universidad Nacional de Colombia, pp. 57–68.

Clench-Aas, J., Guerreiro, C. & Bartonova, A., 1998. *Air quality indicators*, Kjeller- Norway: Norsk institutt for luftforskning. Available at: www.epa.gov.

IDEAM, 2005. *Documento soporte norma calidad del aire*, Bogotá, Colombia: Ley 610 del 2010.

INEEC & SEMARNAT, 2013. Contaminantes criterio. Available at: http://www.inecc.gob.mx/calaire-indicadores/523-calaire-cont-criterio.

Jaramillo, M., González, D.E. & Núñez, M.E., 2009. Índice integrado de calidad del aire para ciudades colombianas. *Revista Facultad de Ingeniería Universidad de Antioquia*, 48, pp.97–106.

De Leeuw, F. a. a. M., 2002. A set of emission indicators for long-range transboundary air pollution. *Environmental Science & Policy*, 5(2), pp.135–145. Available at: http://linkinghub.elsevier.com/retrieve/pii/S1462901101000429.

Li, S.-T. & Shue, L.-Y., 2004. Data mining to aid policy making in air pollution management.pdf. *Expert Systems with Applications*, 27(3), pp.331–340. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0957417404000375.

Ministerio de Ambiente Vivienda y desarrollo Territorial (MAVDT), 2010. *Resolución 610*, Colombia: Resolución 601 del 4 de abril del 2066.

Ministerio de Ambiente, Vivienda y Desarrollo Territorial (MAVDT), 2010. Protocolo para el monitoreo y seguimiento de la calidad del aire - Manual de diseño de Sistemas de Vigilancia de la Calidad del Aire. Bogotá, D.C., Colombia.

OPS/OMS, 2012. *Protocolo para la vigilancia sanitaria y ambiental de los efectos en salud relacionados con la contaminación del aire en Colombia*, Colombia.

Purves, D.W. et al., 2004. Human-induced changes in US biogenic volatile organic compound emissions: evidence from long-term forest inventory data. *Global Change Biology*, 10(10), pp.1737–1755. Available at: http://doi.wiley.com/10.1111/j.1365-2486.2004.00844.x [Accessed June 10, 2015].

R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Sánchez, E., Ahmed, K. & Awe, Y., 2006. *Prioridades ambientales para la reducción de la pobreza en Colombia. Un análisis ambiental del país para Colombia*, Bogota D. C: The International Bank for Reconstruction and Development/The World Bank.

SGC, 2014. *Boletín Mensual No. 2869, Octubre de 2014.* Available at: http://www2.sgc.gov.co/Manizales/Publicaciones/Reportes-de-actividad/Reportes-Mensuales---Boletines-Informativos/2014/ [Accessed July30, 2015].

AIR QUALITY INDEXES IN MANIZALES: IMPLEMENTATION AND REPRESENTATION

THANK YOU!

Jade Alexandra Li Ramírez
jalir@unal.edu.co

Beatriz Helena Aristizabal Zulúaga
bharistizabalz@unal.edu.co