UNIVERSIDAD NACIONAL DE COLOMBIA

Presentación #3
Análisis geoespacial

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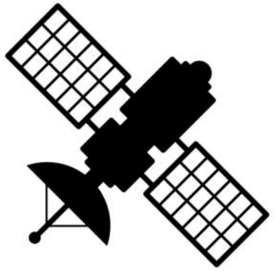
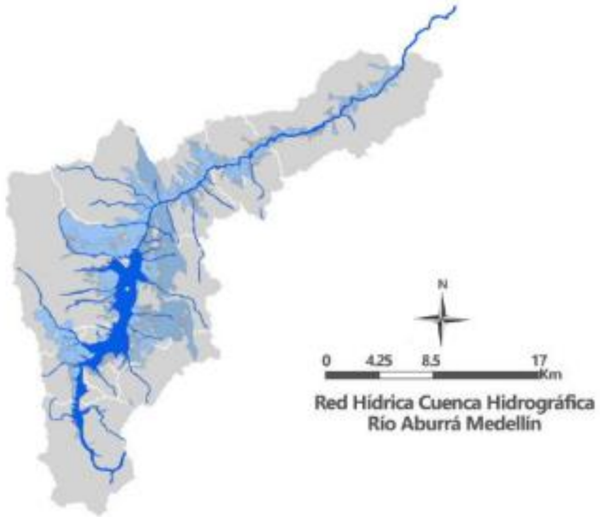


Contextualización E2

Problema:
Evolución de coberturas y su efecto en aportes de caudal durante eventos extremos.

Motivación:
Comprender desde una perspectiva geoespacial, las causas de inundación en entornos urbanos en escala de microcuenca.

Caso de estudio:
Cuenca Río Aburra



Fuente: portal área metropolitana

Fuente: El Colombiano, 29/04/2025

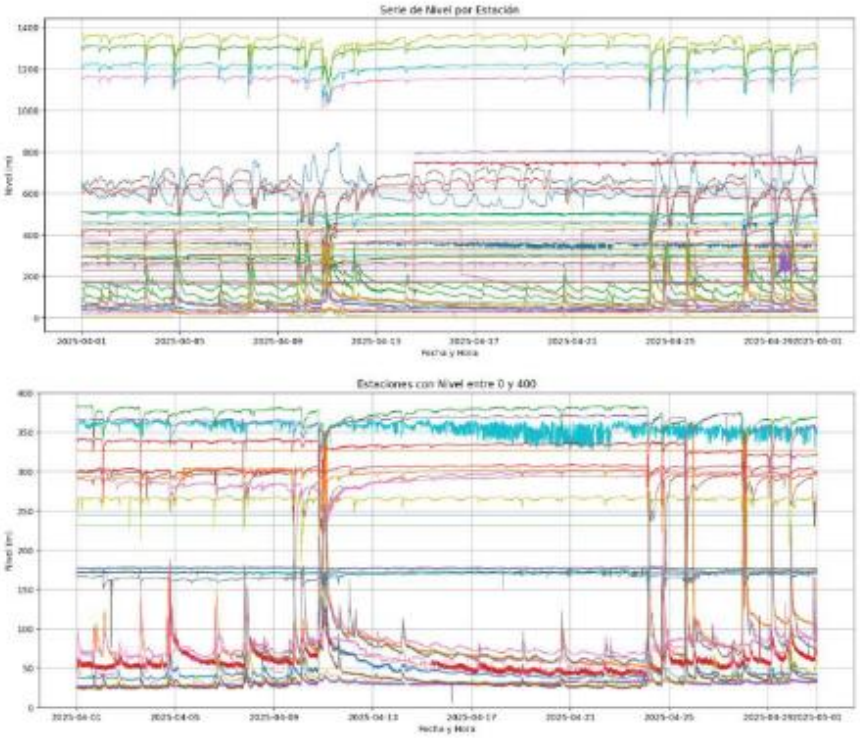
Fuente: infobae, 29/04/2025

Contextualización E2

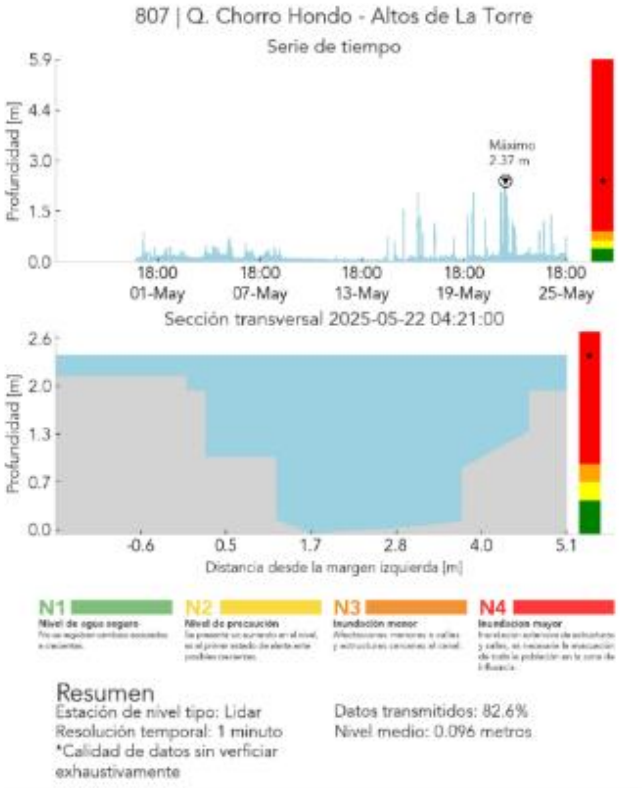
Fuentes de información:
SIATA (estaciones de nivel y precipitación),
ALOS PALSAR (MDT, 12.5m)
IDEAM (coberturas)
IGAC (capas vectoriales diversas)

Discretización de eventos: cuando el sensor registre nivel de emergencia en estación de nivel fija

Estaciones meteorológicas AMVA
Fuente: portal SIATA

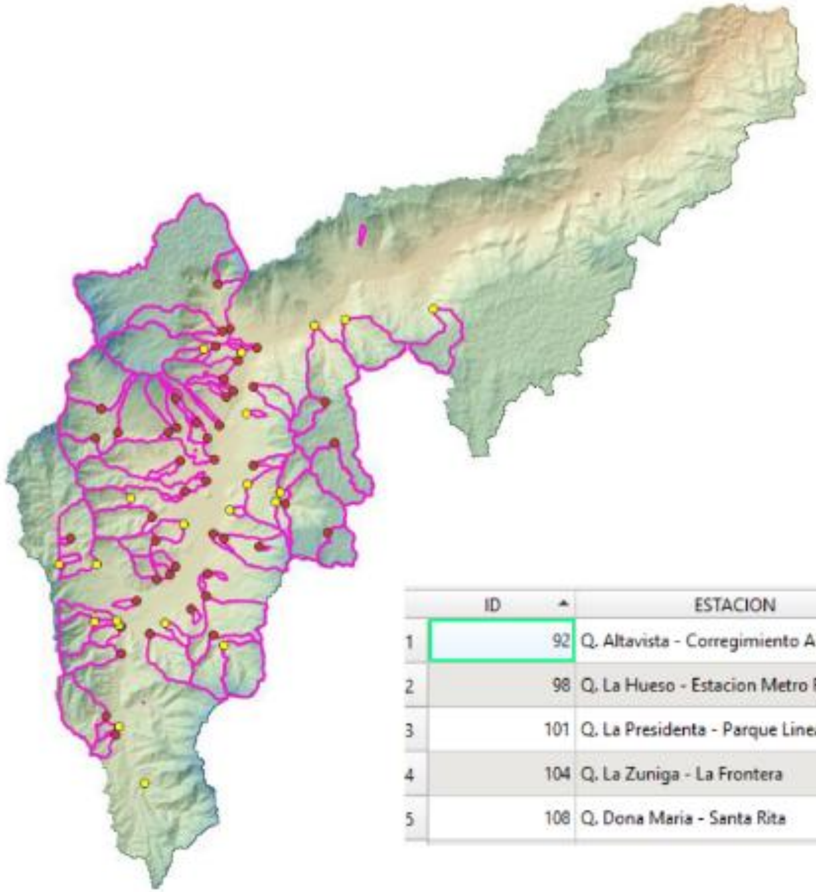


Serie de niveles (abril, 2025), en 87 estaciones red SIATA



Umbral de riesgo, descripción SIATA.

Contextualización E2



20 estaciones (amarillo) de 68 con reporte de riesgo y sus cuencas (rojo). AMVA

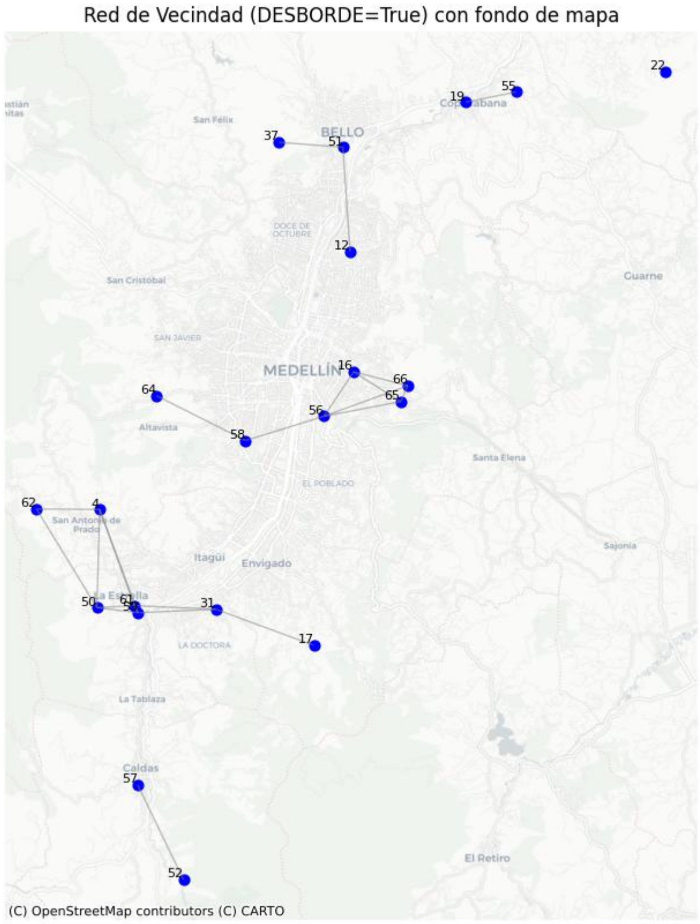
Atributos:

- ID: código estación
- ESTACION: Drenaje al que pertenece
- DESBORDE: Si presento crecientes en el mes (1), sino (0)
- AREA: área de la cuenca aportante [km2]
- TIA: área impermeable / área total [%]
- PPT: precipitación promedio diaria [mm/día]
- COTA: elevación de terreno [m.s.n.m.]

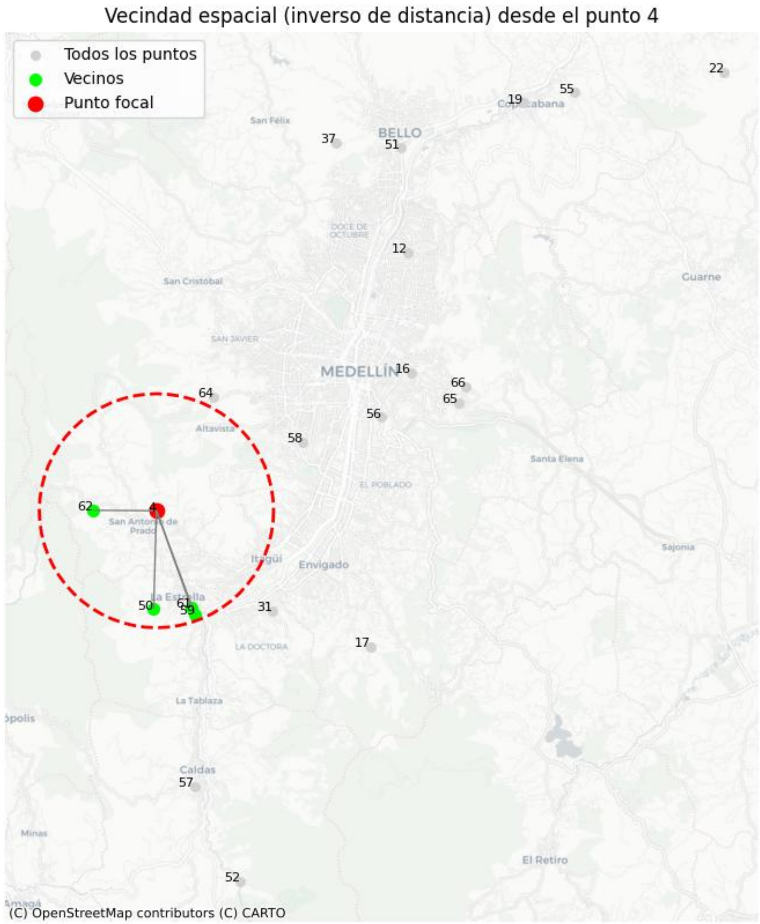
	ID	ESTACION	DESBORDE	LONGITUD	LATITUD	AREA	AREA IMP	AREA PERM	TIA	PPT	COTA
1	92	Q. Altavista - Corregimiento Altavista	0	-75.6160200000...	6.221850000000...	7.790150588000...	1.050364173000...	6.739786415000...	13.48323323000...	320.6816101074...	1619.000000000...
2	98	Q. La Hueso - Estacion Metro Floresta	0	-75.5974300000...	6.258590000000...	1.162763574000...	1.076476571000...	0.086287003	92.57914463999...	289.2758789062...	1517.000000000...
3	101	Q. La Presidenta - Parque Lineal La Pr...	0	-75.5693799999...	6.207790000000...	8.646379494000...	3.865673624000...	4.780705870000...	44.70858151000...	260.5184936523...	1565.000000000...
4	104	Q. La Zuniga - La Frontera	0	-75.5798199999...	6.185110000000...	0.327368253	0.231352579	0.096015674	70.67043821999...	296.5843505859...	1555.000000000...
5	108	Q. Dona Maria - Santa Rita	1	-75.6514999999...	6.190590000000...	11.01758285000...	0.591719081	10.42586376000...	5.502340950000...	460.2601318359...	1761.000000000...

Dataframe de puntos

Matriz de vecindad

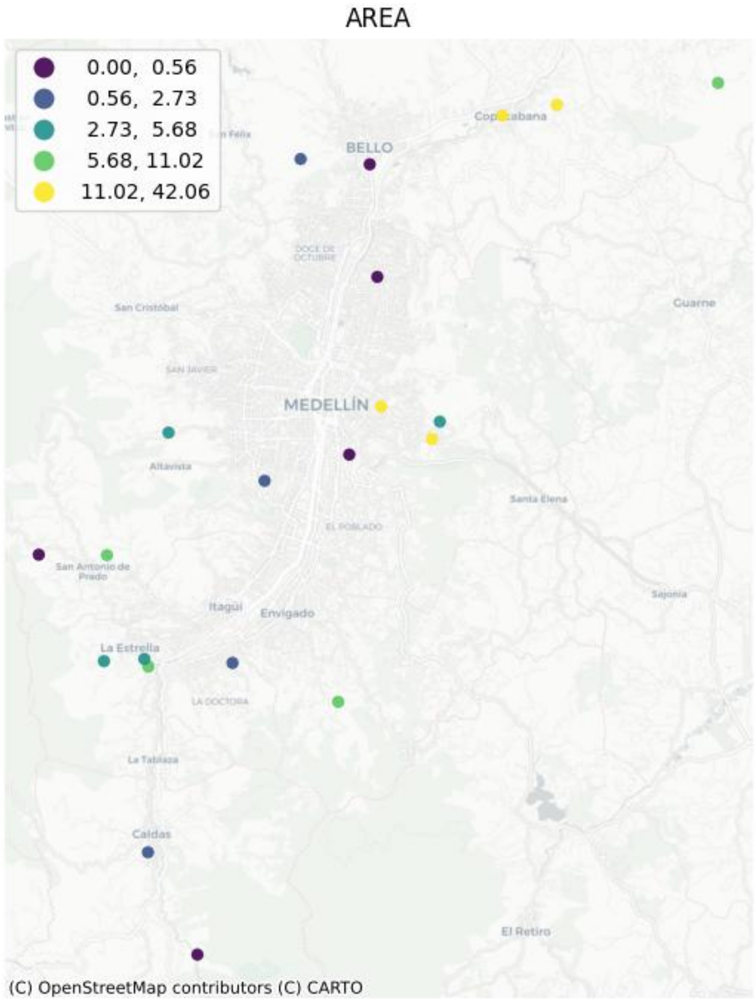


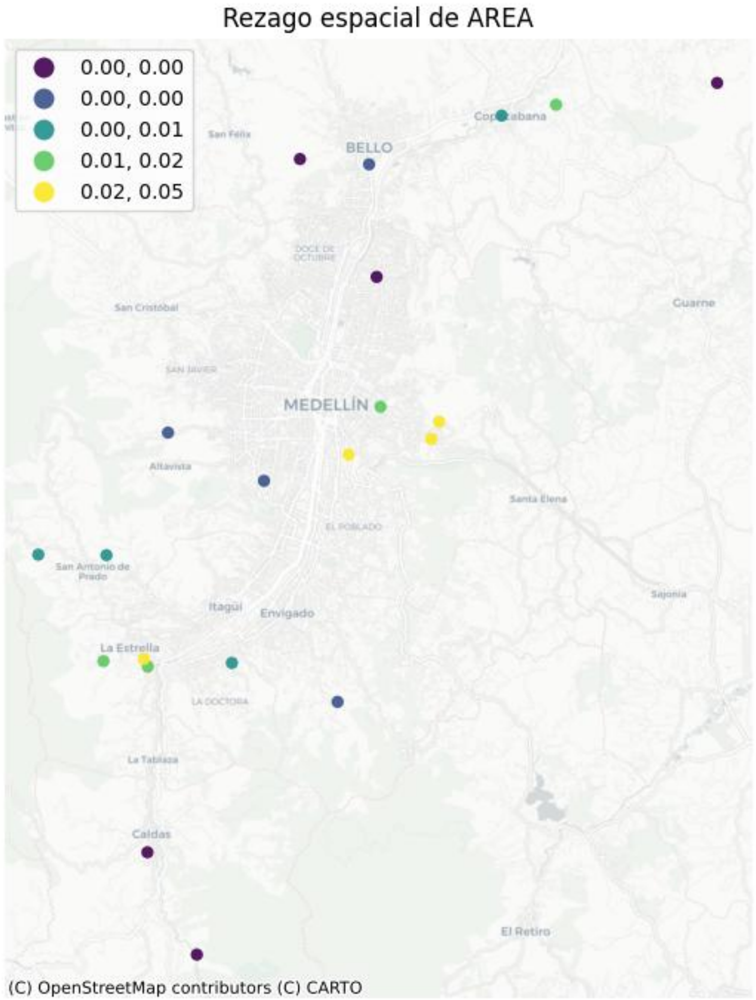
Matriz de vecindad por distancias, D = 5 km



Inverso de la distancia. Punto 4

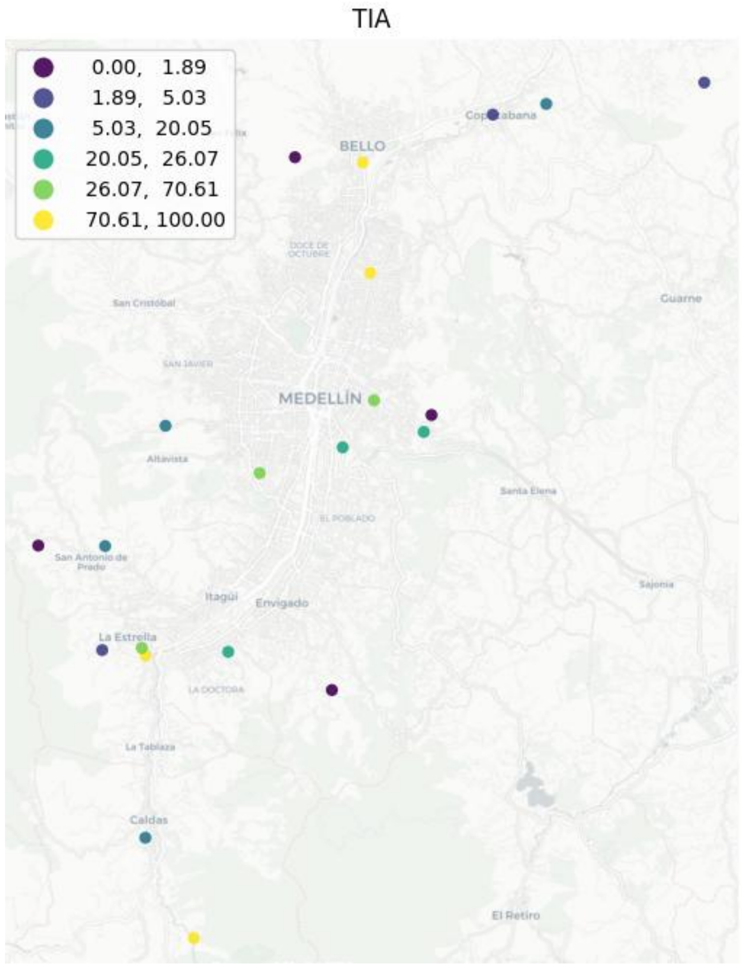
Rezago espacial (área)

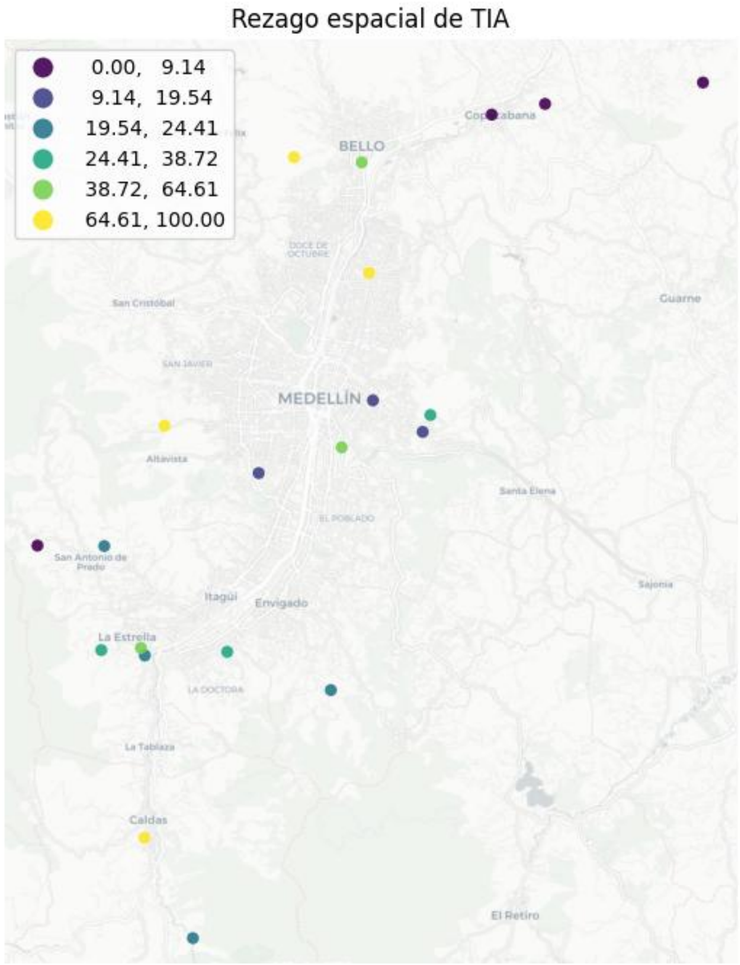




Comparación rezago área de cuenca km^2

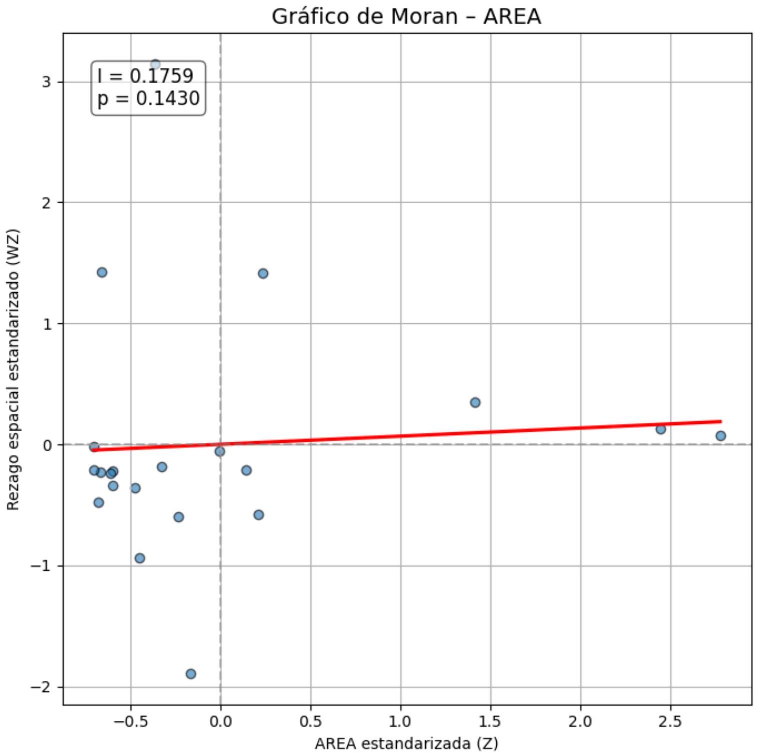
Rezago espacial (TIA)

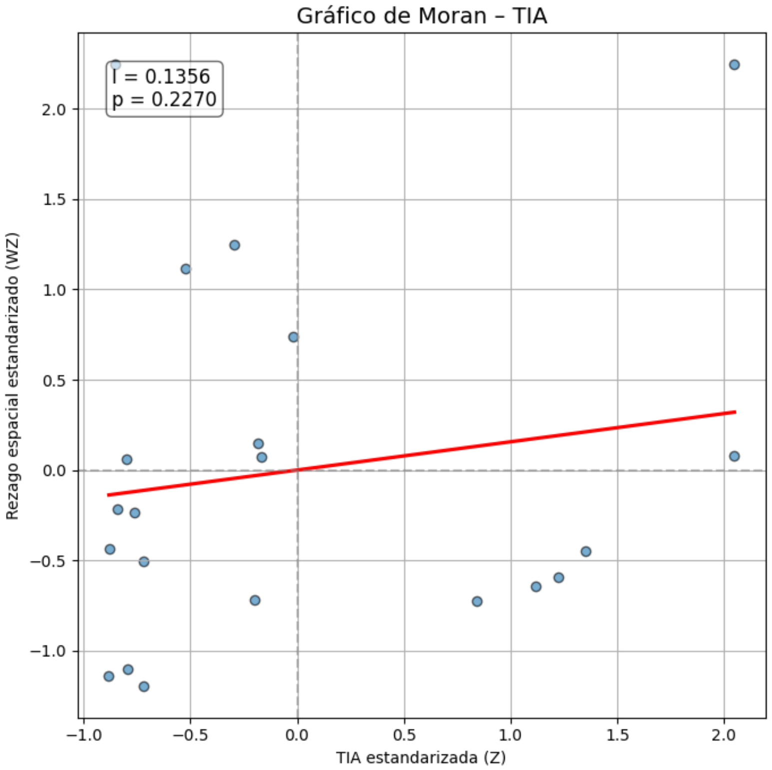


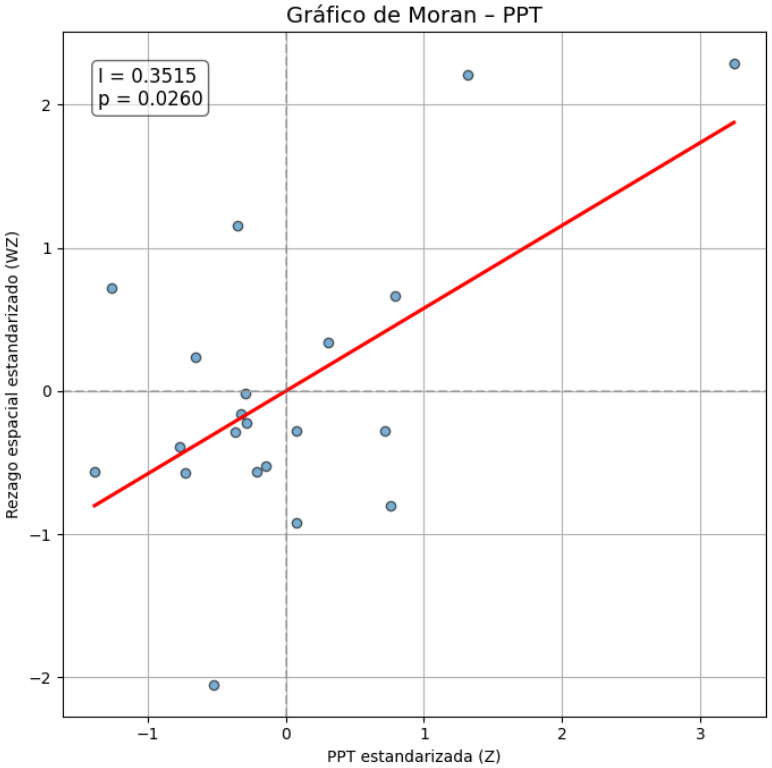


Comparación rezago % TIA de cuenca (total impervious area)

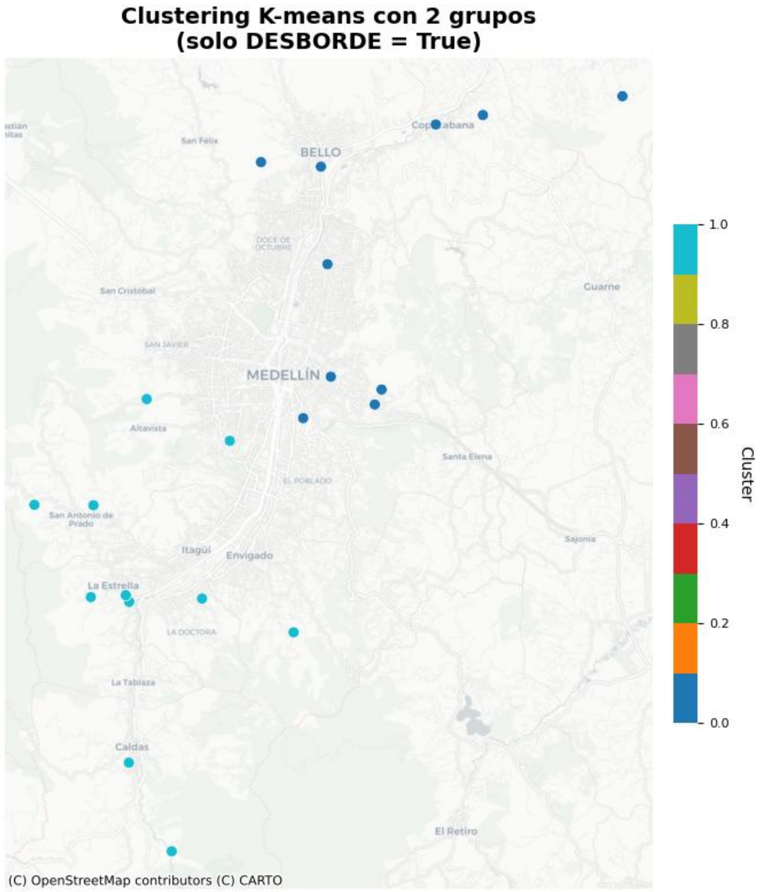
Índice de MORAN

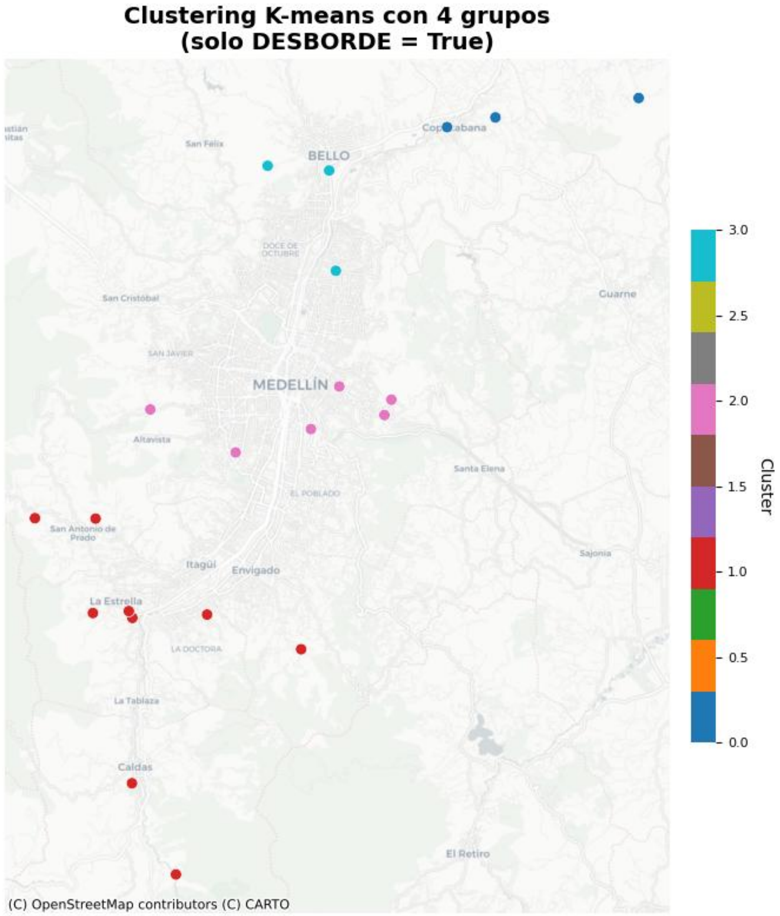


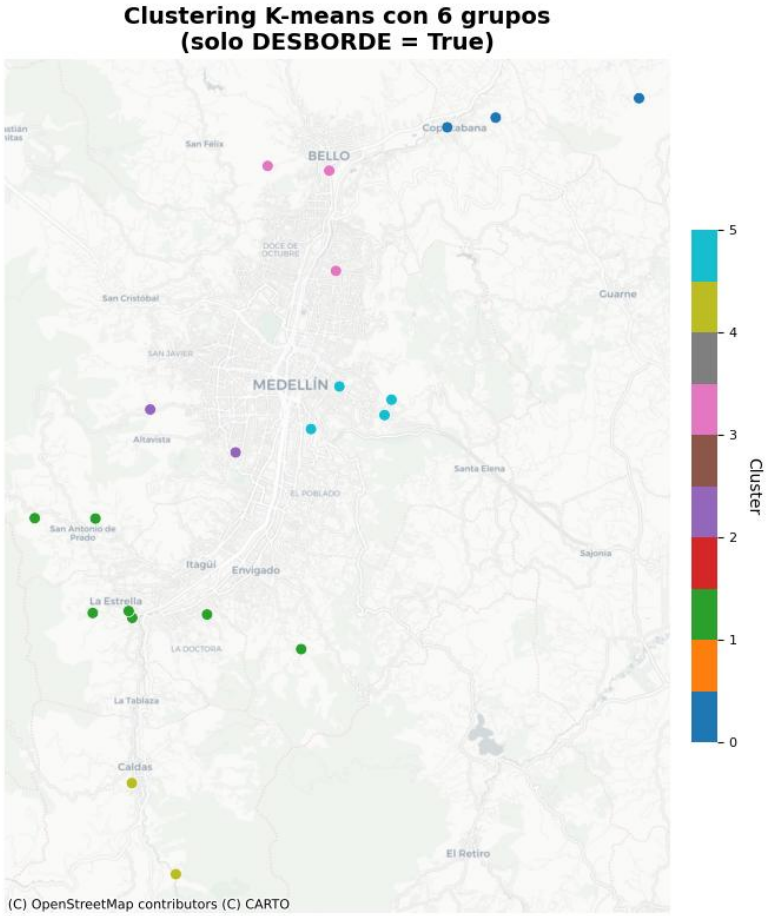




Clasificación K means







Modelo OLS

R^2= 2.8%

AIC = 99.98

```
SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES
-----------------------------------------
Data set            :     unknown
Weights matrix      :        None
Dependent Variable  :DESBORDE_BIN                Number of Observations:          68
Mean dependent var  :      0.3088                Number of Variables   :           7
S.D. dependent var  :      0.4654                Degrees of Freedom    :          61
R-squared           :      0.0288
Adjusted R-squared  :     -0.0668
Sum squared residual:     14.0971                F-statistic           :      1.1546
Sigma-square        :       0.231                Prob(F-statistic)     :      0.3424
S.E. of regression  :       0.481                Log likelihood        :     -42.988
Sigma-square ML     :       0.207                Akaike info criterion :      99.975
S.E of regression ML:      0.4553                Schwarz criterion     :     115.512

------------------------------------------------------------------------------------
            Variable     Coefficient       Std.Error     t-Statistic     Probability
------------------------------------------------------------------------------------
            CONSTANT         0.33993         0.68069         0.49939         0.61930
                AREA     -3467.30164    160158.87635        -0.02165         0.98280
            AREA IMP      3467.26366    160158.87641         0.02165         0.98280
           AREA PERM      3467.29857    160158.87634         0.02165         0.98280
                 TIA        -0.00005         0.00250        -0.02180         0.98268
                 PPT         0.00149         0.00108         1.38204         0.17200
                COTA        -0.00031         0.00032        -0.96428         0.33871
------------------------------------------------------------------------------------
```

Modelo SAR

R^2= 6.76%
AIC = 100.64

```
SUMMARY OF OUTPUT: MAXIMUM LIKELIHOOD SPATIAL LAG (METHOD = FULL)
------------------------------------------------------------------
Data set             :     unknown
Weights matrix       :     unknown
Dependent Variable   :DESBORDE_BIN              Number of Observations:        68
Mean dependent var   :      0.3088              Number of Variables   :         8
S.D. dependent var   :      0.4654              Degrees of Freedom    :        60
Pseudo R-squared     :      0.0676
Spatial Pseudo R-squared:   0.0463
Log likelihood       :    -42.3193
Sigma-square ML      :      0.2018              Akaike info criterion :     100.639
S.E of regression    :      0.4492              Schwarz criterion     :     118.395

-------------------------------------------------------------------------------------
            Variable     Coefficient       Std.Error     z-Statistic     Probability
-------------------------------------------------------------------------------------
            CONSTANT         0.26118         0.63608         0.41060         0.68136
                AREA     -3580.78676    263183.87253        -0.01361         0.98914
            AREA IMP      3580.75190    263183.87263         0.01361         0.98914
           AREA PERM      3580.78450    263183.87252         0.01361         0.98914
                 TIA         0.00044         0.00234         0.18793         0.85093
                 PPT         0.00163         0.00102         1.59325         0.11110
                COTA        -0.00033         0.00030        -1.10124         0.27079
      W_DESBORDE_BIN         0.16681         0.14344         1.16290         0.24487
-------------------------------------------------------------------------------------

SPATIAL LAG MODEL IMPACTS
Impacts computed using the 'simple' method.
            Variable           Direct        Indirect           Total
                AREA       -3580.7868       -716.8914      -4297.6782
            AREA IMP        3580.7519        716.8844       4297.6363
           AREA PERM        3580.7845        716.8910       4297.6755
                 TIA           0.0004          0.0001          0.0005
                 PPT           0.0016          0.0003          0.0020
                COTA          -0.0003         -0.0001         -0.0004
```

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Modelo SLX

R^2= 13%

AIC = 104.49

```
REGRESSION RESULTS
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SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES
-----------------------------------------
Data set            :     unknown
Weights matrix      :        None
Dependent Variable  :DESBORDE_BIN                Number of Observations:          68
Mean dependent var  :      0.3088                Number of Variables   :          13
S.D. dependent var  :      0.4654                Degrees of Freedom    :          55
R-squared           :      0.1300
Adjusted R-squared  :     -0.0598
Sum squared residual:     12.6279                F-statistic           :      1.9025
Sigma-square        :       0.230                Prob(F-statistic)     :      0.0542
S.E. of regression  :       0.479                Log likelihood        :     -39.246
Sigma-square ML     :       0.186                Akaike info criterion :     104.491
S.E of regression ML:      0.4309                Schwarz criterion     :     133.345

-----------------------------------------------------------------------------------
            Variable     Coefficient       Std.Error     t-Statistic     Probability
-----------------------------------------------------------------------------------
            CONSTANT         2.18705         2.15800         1.01346         0.31528
                AREA   4567269.54256    260995.01519        17.49945         0.00000
            AREA IMP  -4567269.55029    260995.00949       -17.49945         0.00000
           AREA PERM  -4567269.55288    260995.00775       -17.49945         0.00000
                 TIA         0.00300         0.00262         1.14334         0.25785
                 PPT         0.00378         0.00142         2.66626         0.01005
                COTA        -0.00064         0.00039        -1.62650         0.10956
              W_AREA     -2807.98762    393630.43056        -0.00713         0.99433
          W_AREA IMP      2807.82670    393630.43075         0.00713         0.99433
         W_AREA PERM      2807.98924    393630.43059         0.00713         0.99433
               W_TIA        -0.00825         0.00674        -1.22435         0.22604
               W_PPT        -0.00731         0.00275        -2.65744         0.01029
              W_COTA         0.00056         0.00116         0.48142         0.63213
-----------------------------------------------------------------------------------
```

Modelo SEM

$R^2 = 6.31\%$

```
Data set            :      unknown
Weights matrix      :      unknown
Dependent Variable  :DESBORDE_BIN                Number of Observations:         68
Mean dependent var  :       0.3088               Number of Variables   :          7
S.D. dependent var  :       0.4654               Degrees of Freedom    :         61
Pseudo R-squared    :       0.0631
N. of iterations    :            1               Step1c computed       :         No

------------------------------------------------------------------------------------
            Variable     Coefficient       Std.Error     z-Statistic     Probability
------------------------------------------------------------------------------------
            CONSTANT         0.32222         0.51412         0.62674         0.53083
                AREA      7907.38013
            AREA IMP     -7907.41345
           AREA PERM     -7907.37803
                 TIA         0.00073         0.00240         0.30509         0.76030
                 PPT         0.00184         0.00097         1.89351         0.05829
                COTA        -0.00035         0.00024        -1.47690         0.13970
              lambda         0.20922         0.18220         1.14832         0.25083
------------------------------------------------------------------------------------
```

Referencias:

- Han Chen, Yizhao Wei, Jinhui Jeanne Huang. (2023). Altered landscape pattern dominates the declined urban evapotranspiration trend.
- Guzman G. (2018). Análisis de la influencia del diseño urbano en la meteorología del Valle de Aburra
- Osorio D. (2019). Vulnerabilidad de la disponibilidad actual y futura del recurso hídrico en el valle de Aburra y sus cuencas abastecedoras.