SER-301 - Análise Espacial de Dados Geográficos

Estimativa da emissão de gases e material particulado provenientes da queima da cana-de-açúcar através de dados de satélites

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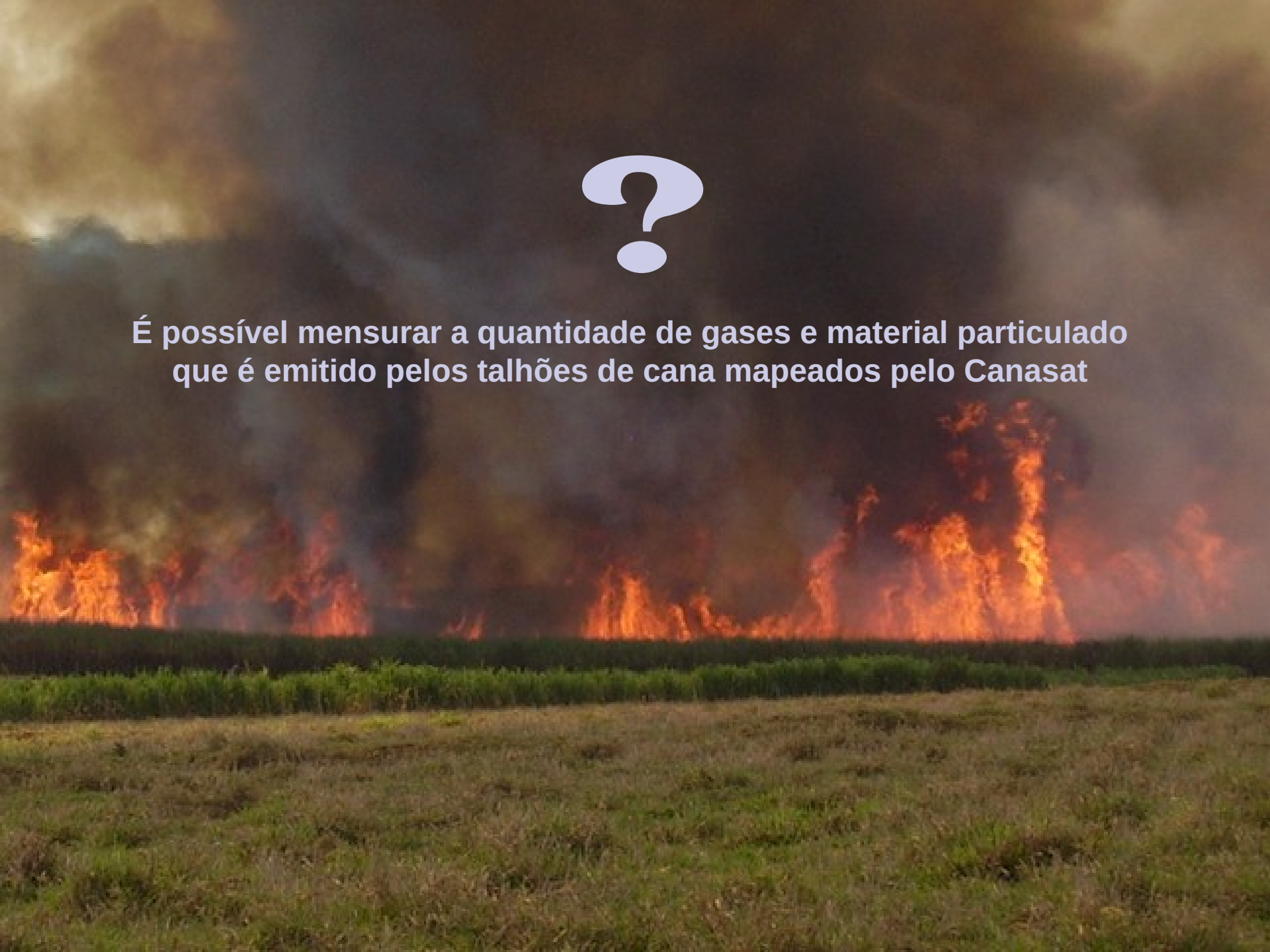
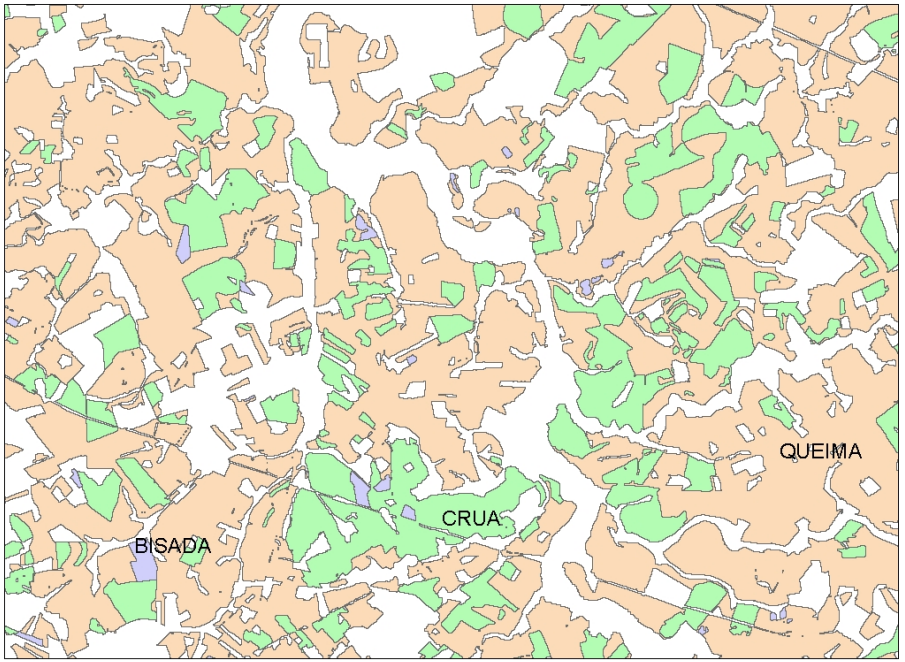
PROBLEMA



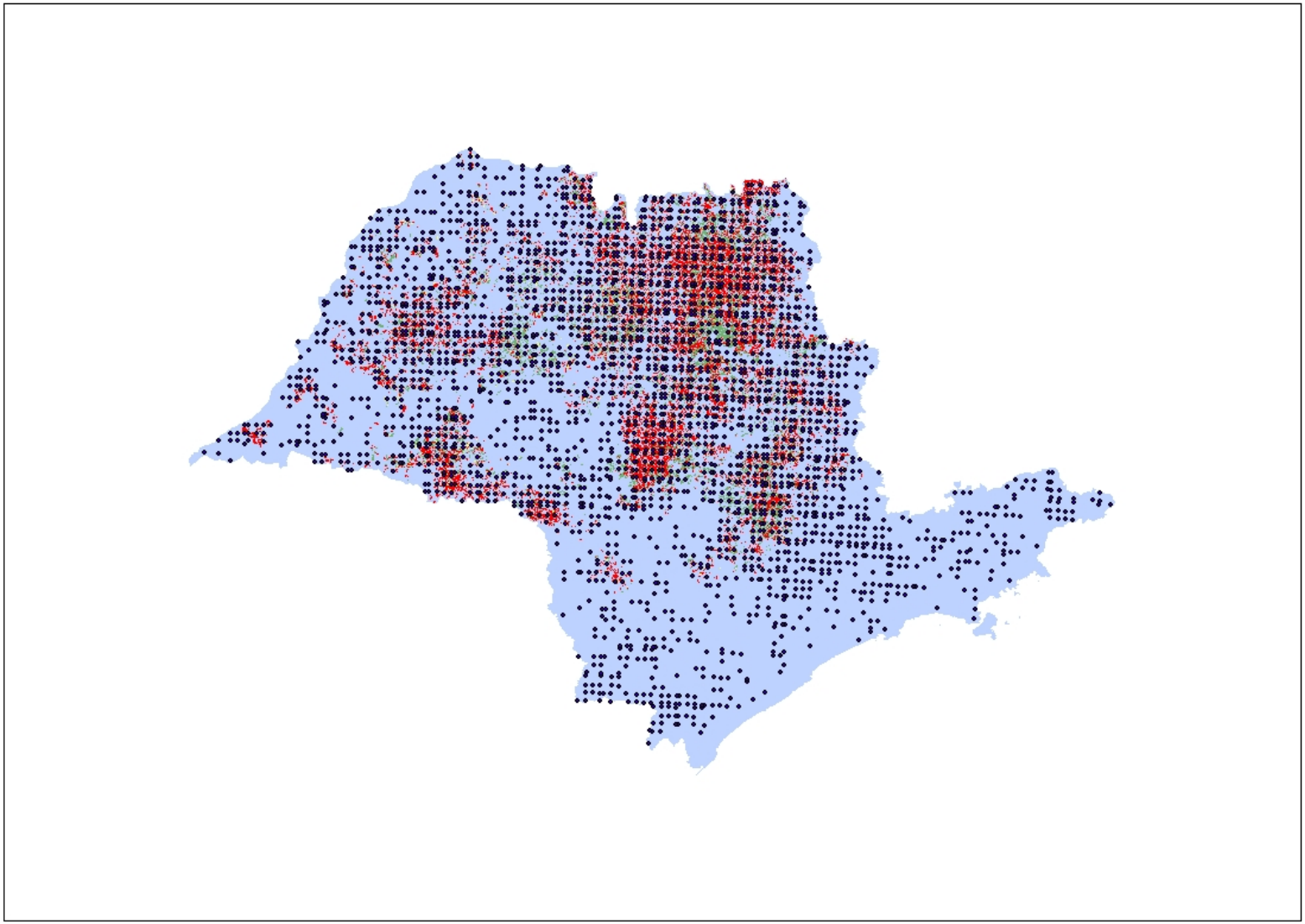
É possível mensurar a quantidade de gases e material particulado que é emitido pelos talhões de cana mapeados pelo Canasat


GOES
WFABBA
FRP
MOD 14 & MYD 14- Thermail Anomalies, Fires & Biomass Burning
...E O MODIS

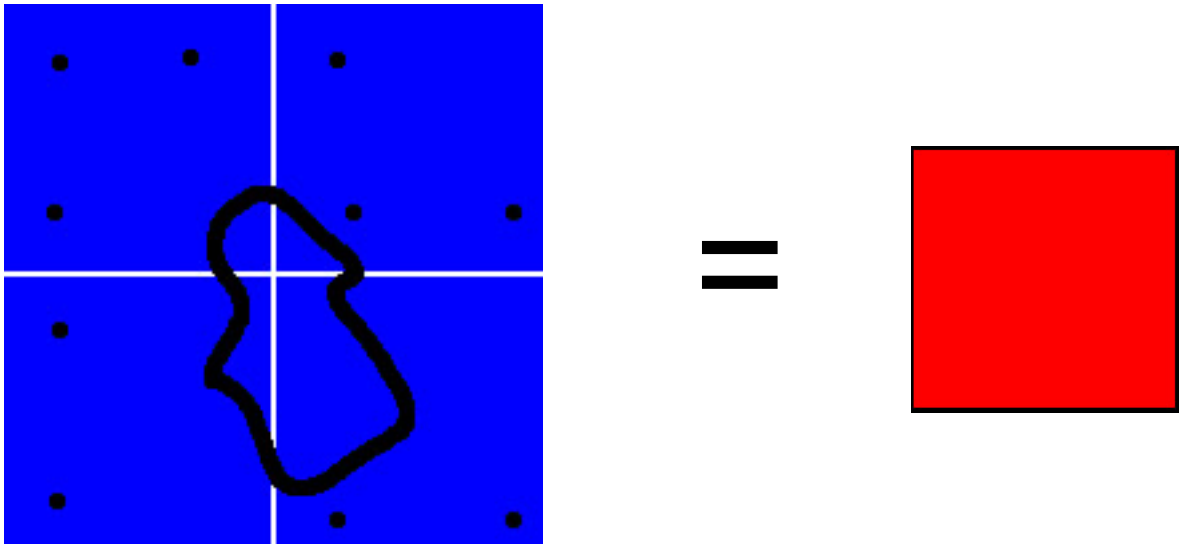
Mapeados com base em imagens TM



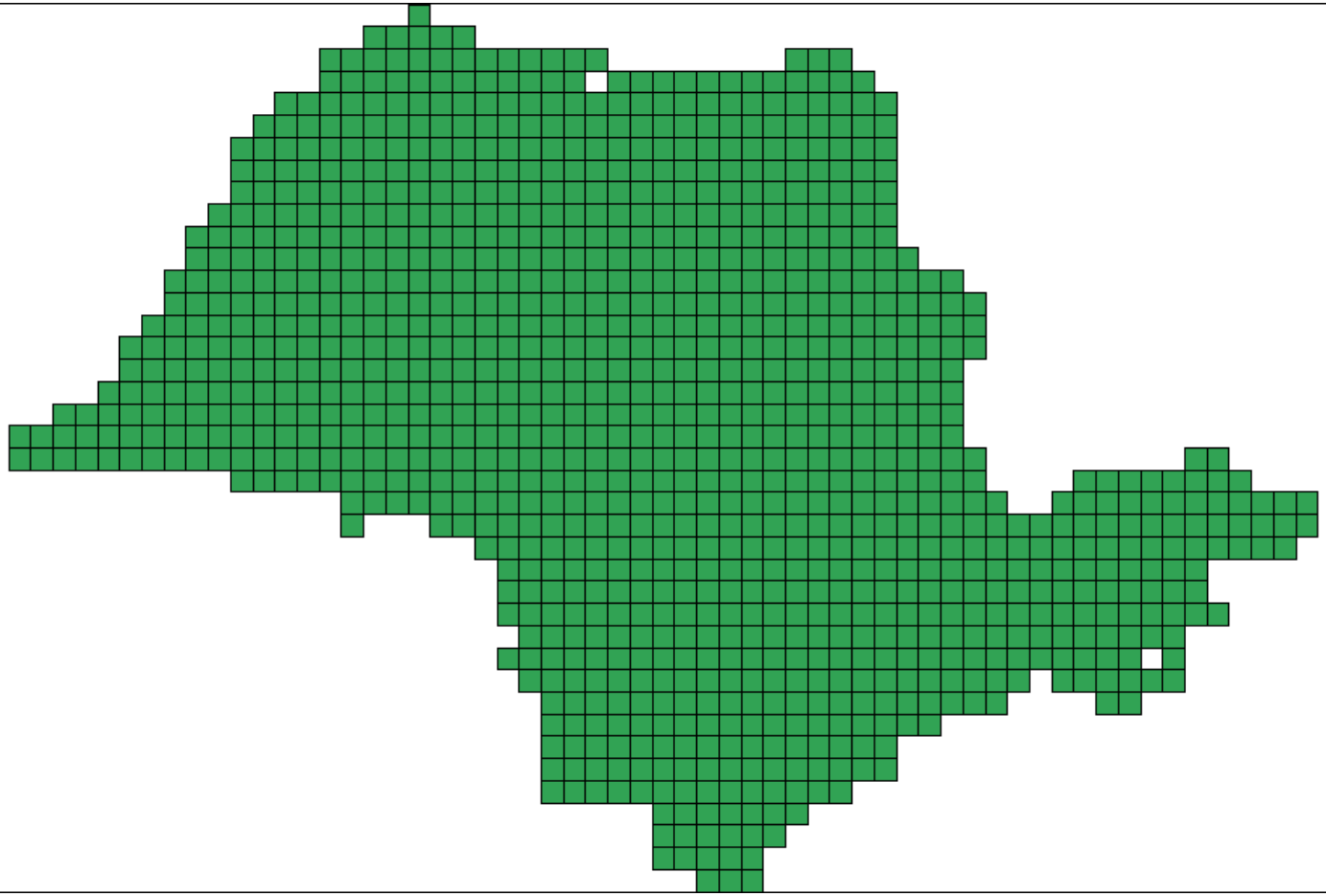
Área de Estudo



Para fazer as análises...



Para fazer as análises...



Regressão Simples

$Y = X\beta + \varepsilon$, $\varepsilon \sim N(0,\sigma^2)$,

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REGRESSION
SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set            : cells_sp.shp_pol
Dependent Variable  :  CANAQUEIMA  Number of Observations: 1102
Mean dependent var  :    0.239335  Number of Variables   :    2
S.D. dependent var  :    0.273988  Degrees of Freedom    : 1100

R-squared           :    0.220265  F-statistic           :  310.735
Adjusted R-squared  :    0.219556  Prob(F-statistic)     :        0
Sum squared residual:     64.5049  Log likelihood        :  0.145733
Sigma-square        :   0.0586408  Akaike info criterion :  3.70853
S.E. of regression  :    0.242159  Schwarz criterion     :  13.7183
Sigma-square ML     :   0.0585343
S.E of regression ML:    0.241939

------------------------------------------------------------------------------
    Variable     Coefficient       Std.Error     t-Statistic     Probability
------------------------------------------------------------------------------
    CONSTANT       0.1544877      0.00873961        17.67673       0.0000000
       ENERG  0.0001100082   6.240653e-006        17.62767       0.0000000
------------------------------------------------------------------------------

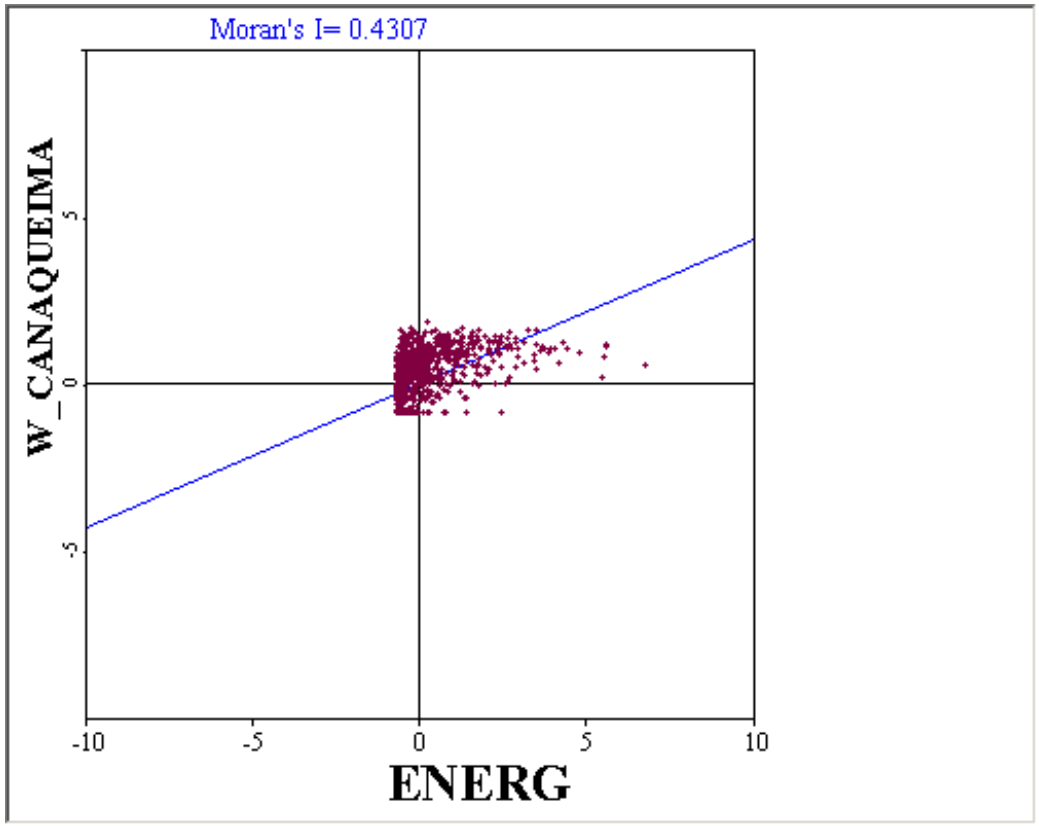
REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER    1.857903
TEST ON NORMALITY OF ERRORS
TEST                     DF          VALUE              PROB
Jarque-Bera               2          83.73283           0.0000000

DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                     DF          VALUE              PROB
Breusch-Pagan test        1          18.87477           0.0000140
Koenker-Bassett test      1          24.51749           0.0000007
SPECIFICATION ROBUST TEST
TEST                     DF          VALUE              PROB
White                     2          28.03494           0.0000008

DIAGNOSTICS FOR SPATIAL DEPENDENCE
FOR WEIGHT MATRIX : sp_weight.GAL   (row-standardized weights)
TEST                              MI/DF       VALUE           PROB
Moran's I (error)              0.471576    21.4235587      0.0000000
Lagrange Multiplier (lag)             1   585.5864930      0.0000000
Robust LM (lag)                       1   143.8682450      0.0000000
Lagrange Multiplier (error)           1   454.1431399      0.0000000
Robust LM (error)                     1    12.4248918      0.0004236
Lagrange Multiplier (SARMA)           2   598.0113849      0.0000000
```

Forte dependência espacial

Análise exploratória

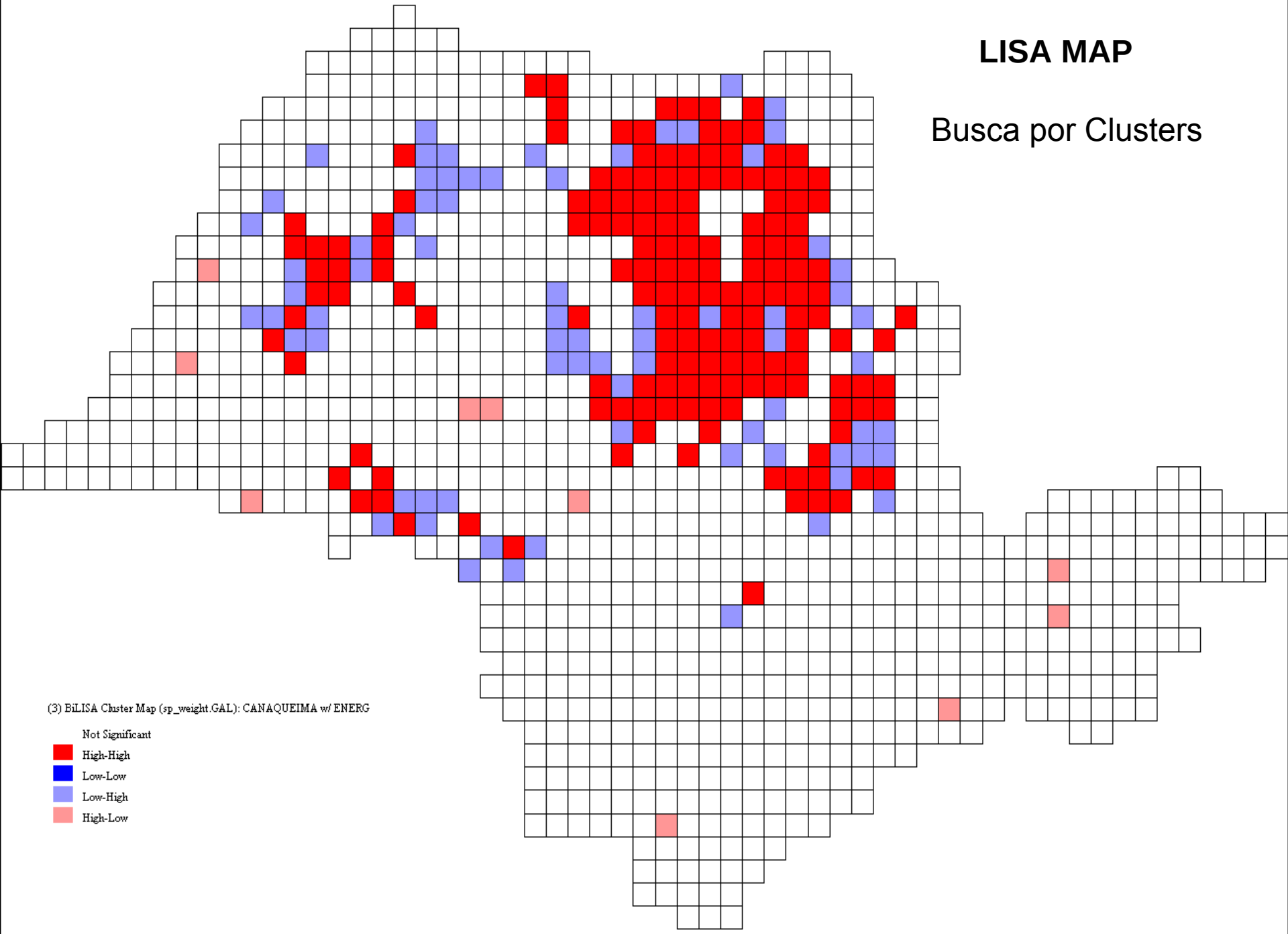


Índice de Moran Global

Índice > 0 , há correlação direta
Índice< 0 , há correlação inversa
Índice = 0 , não apresenta correlação

LISA MAP

Busca por Clusters



Dois modelos de regressão foram ajustados para examinar a relação entre os dados:

Spatial Error

$\boldsymbol{Y} = \boldsymbol{X\beta} + \varepsilon\ ,\ \varepsilon = \lambda \boldsymbol{W} + \xi$

$\boldsymbol{W}\varepsilon$ é a componente do erro com efeitos espaciais

λ é o coeficiente autoregressivo

ξ é a componente do erro

Spatial Lag

$\boldsymbol{Y} = \rho \boldsymbol{WY} + \boldsymbol{X\beta} + \varepsilon$

$\boldsymbol{W}$ é a matriz de proximidade espacial

$\boldsymbol{WY}$ expressa a dependência espacial em $\boldsymbol{Y}$

ρ é o *coeficiente espacial autoregressivo*

REGRESSION
SUMMARY OF OUTPUT: SPATIAL ERROR MODEL - MAXIMUM LIKELIHOOD ESTIMATION

Data set	: cells_sp.shp_pol		
Spatial Weight	: sp_weight.GAL		
Dependent Variable	: CANAQUEIMA	Number of Observations:	1102
Mean dependent var	: 0.239335	Number of Variables :	2
S.D. dependent var	: 0.273988	Degree of Freedom :	1100
Lag coeff. (Lambda)	: 0.748512		
R-squared	: 0.605750	R-squared (BUSE) :	-
Sq. Correlation	: -	Log likelihood :	274.810913
Sigma-square	: 0.029596	Akaike info criterion :	-545.622
S.E of regression	: 0.172035	Schwarz criterion :	-535.612062

Variable	Coefficient	Std.Error	z-value	Probability
CONSTANT	0.207237	0.02115408	9.796551	0.0000000
ENERG	2.871296e-005	6.254768e-006	4.590572	0.0000044
LAMBDA	0.7485117	0.02274445	32.90964	0.0000000

REGRESSION DIAGNOSTICS
DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS

TEST	DF	VALUE	PROB
Breusch-Pagan test	1	4.048261	0.0442169

DIAGNOSTICS FOR SPATIAL DEPENDENCE
SPATIAL ERROR DEPENDENCE FOR WEIGHT MATRIX : **sp_weight.GAL**

TEST	DF	VALUE	PROB
Likelihood Ratio Test	1	549.3304	0.0000000

Não há

REGRESSION

SUMMARY OF OUTPUT: SPATIAL LAG MODEL - MAXIMUM LIKELIHOOD ESTIMATION

Data set	: **cells_sp.shp_pol**		
Spatial Weight	: **sp_weight.GAL**		
Dependent Variable	: **CANAQUEIMA**	Number of Observations:	1102
Mean dependent var	: 0.239335	Number of Variables :	3
S.D. dependent var	: 0.273988	Degrees of Freedom :	1099
Lag coeff. (Rho)	: 0.705852		
R-squared	: 0.611566	Log likelihood :	296.781
Sq. Correlation	: -	Akaike info criterion :	-587.561
Sigma-square	: 0.0291596	Schwarz criterion :	-572.547
S.E of regression	: 0.170762		

Variable	Coefficient	Std.Error	z-value	Probability
W_CANAQUEIMA	0.7058521	0.02375998	29.70761	0.0000000
CONSTANT	0.03810488	0.007496214	5.083217	0.0000004
ENERG	3.875093e-005	4.685025e-006	8.271232	0.0000000

REGRESSION DIAGNOSTICS

DIAGNOSTICS FOR HETEROSKEDASTICITY

RANDOM COEFFICIENTS

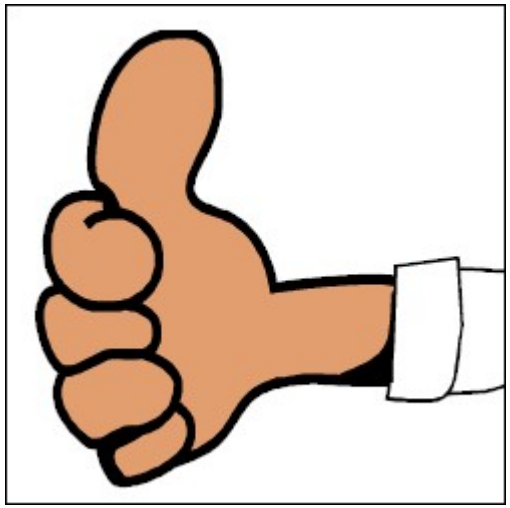
TEST	DF	VALUE	PROB
Breusch-Pagan test	1	0.1723241	0.6780545

DIAGNOSTICS FOR SPATIAL DEPENDENCE

SPATIAL LAG DEPENDENCE FOR WEIGHT MATRIX : **sp_weight.GAL**

TEST	DF	VALUE	PROB
Likelihood Ratio Test	1	593.2699	0.0000000

O valor de R^2 de 0,61 obtido pelo Spatial Lag pode mostrar que há como correlacionar os dados de Cana-Queima com os dados de FRP



E AS EMISSÕES?

$$M_x = C_e * FRP$$

C_e - coeficiente de emissão (kg/MJ)

(relação linear entre a taxa de liberação da *FRP*, integrada no tempo, e o consumo de biomassa)

Ecossistema	**$PM_{10\mu m}$**	**$PM_{2.5\mu m}$**	**CO_2**	**CO**	**CH4**	R **$PM_{2.5\mu m}$**	R **CO_2**	R **CO**	R **CH_4**
Agricultura	6,9	5,7	1515	70	2,2	0,826	219,5	10,1	0,31

Conclusão

- Ao se mapear a área queimada de cana-de-açúcar, pode-se usar os dados de FRP para estimar as emissões dos talhões.

- O cálculo de um coeficiente de emissão próprio para a cana-de-açúcar pode diminuir os erros associados à essa medição.

- Para aumentar o R^2, pode-se agregar outros dados, por exemplo, dados de área de “não-cana”.

Referências

- Pereira, Gabriel; Freitas, Saulo R.; Moraes, Elisabete Caria; Ferreira, Nelson Jesus; Shimabukuro, Yosio Edemir. **Estimating trace gas and aerosol emissions over South America: Relationship between fire radiative energy released and aerosol optical depth observations**. Atmospheric Environment, v.43, 40, 2009.

- Hu, Zhiyong. **Spatial analysis of MODIS aerosol optical depth, PM2.5, and chronic coronary heart disease.** International journal of health geographics, v.8, p.27, 2009.

- Hu, Zhiyong; Rao, K Ranga. **Particulate air pollution and chronic ischemic heart disease in the eastern United States: a county level ecological study using satellite aerosol data.** Environmental health : a global access science source, v.8, p.26, 2009.