Differentiating the value of land from that of real estate to better understand the impacts of NNLT on housing affordability

AN APPLICATION OF MULTISCALE GEOGRAPHICALLY WEIGHTED REGRESSION (MGWR)

Belgian Geographers Day 2024
Charlotte Bernier – 15 mars 2024

Context

The NNLT target: a European ambition

- Communication from the European Commission in 2011
- **« No Net Land Take »** by 2050

… locally declined

- In Flanders, with the “Bouwshift” policy
- In Wallonia, with the “Schéma de Développement Territorial”
- Drastic limitation of soil artificialization (“Stop-concrete”)
- Meet the growing demand for housing (↗ number of households)

How to reconcile land restrictions and housing affordability?

Housing affordability

Different issues

- Description of household expenditure
- Analysis of housing market trends
- Predicting a household's ability to pay its rent or mortgage
- Match between the type of housing and the type of household that occupies it
- Defining housing needs for public policy purposes…

Several dimensions

- Financial accessibility
- Quality standards
- Sanitation, decency
- Access in terms of mobility
- Spatial justice
- Socio-spatial segregations…

Underlying questions

- What type of housing?
- Owners? Tenants?
- For who ?

…

Several dimensions

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- Quality standards
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- Access in terms of mobility
- Spatial justice
- Socio-spatial segregations…

One dimension of housing affordability

Housing prices on the market of “second-hand” real estate

➔ **Owners**

Causes of increases in values?

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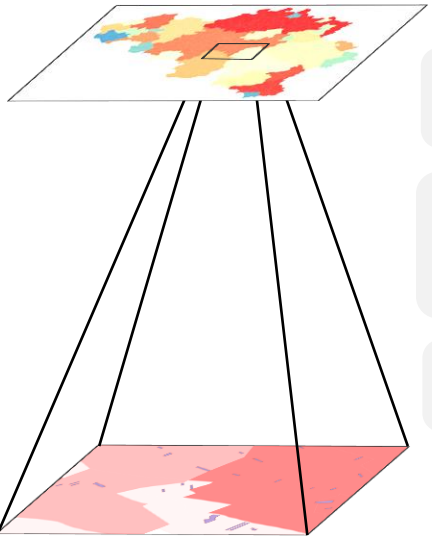

Inter-market scale: macroeconomic factors

↗ **Demand** (↗ number of households ; ↗ income ; ↘ borrowing rate)

Inelasticity of supply (scarcity of land, too long delays in obtaining permits, etc.)

Socio-economic disparities (↗ income or wealth gaps…)

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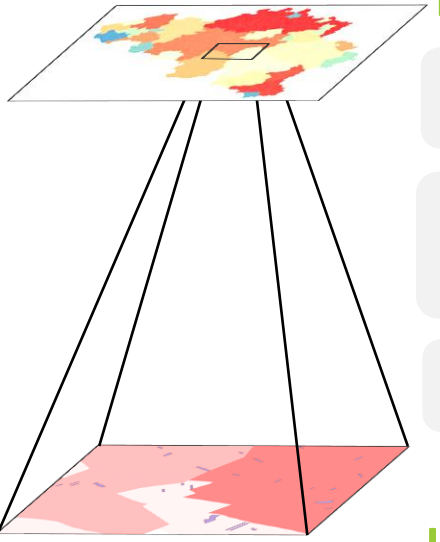

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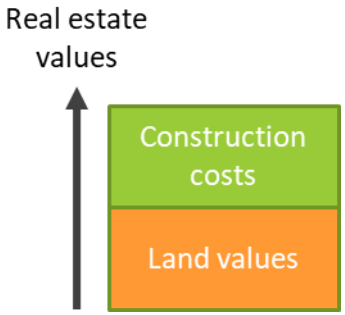
Intra-market scale: housing, a combinatorial good

Build structure

Living surface area, quality and age of construction…

Land

Localisation, accessibility, quality of the physical and social neighborhood, relief…

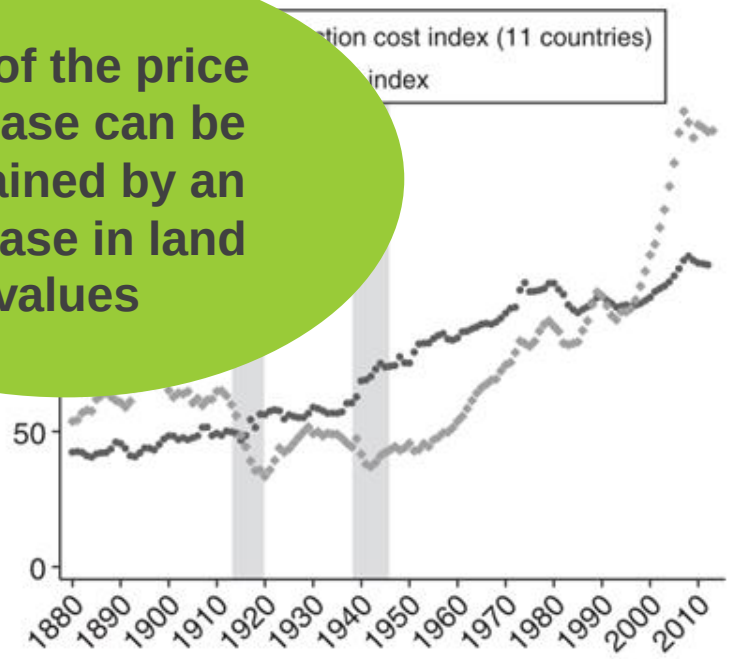


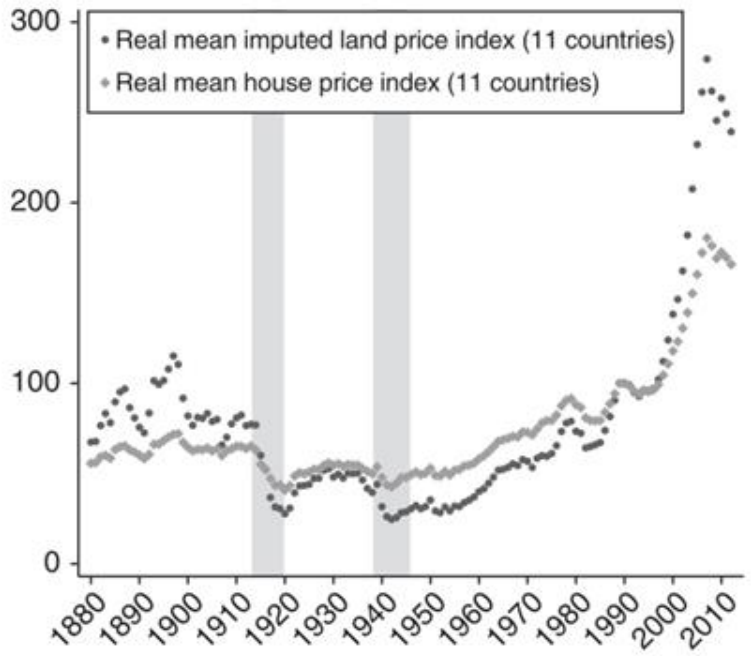
What share of the land?

Construction costs
versus
House prices

Land prices
versus
House prices

80% of the price increase can be explained by an increase in land values





Decomposition of land prices and construction costs in 11 OECD countries (Knoll *et al.,* 2017, p. 345)

Impact of land supply restrictions?

Impact of land supply restrictions?

Liberalized market context

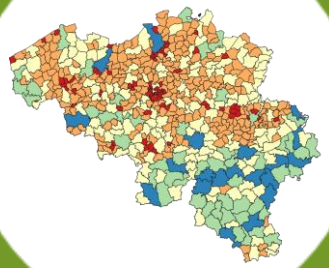
+

Underdeveloped policy instruments for affordable housing

↗ issues of already existing problems of housing affordability, socio-spatial segregation, socio-spatial polarization and spatial justice

Importance of a good inventory and a detailed understanding of the dynamics

(principalement Bibby *et al.*, 2020a; 2020b; Cavicchia, 2021)



Mapping values

Why ?

A mapping of land values for a better understanding of the residential real estate market

➔ **Does land actually drive the increase in real estate prices ?**

- If so, to what extent and what are the regional differences ?
- Has this trend changed over time?
- Better understanding of the effects of influencing factors (inter/intra-market scales, spatial variability of these effects, etc.)

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➔ **Since the NNLT is likely to have significant effects on the price of housing and the problems already present, knowing the initial situation correctly seems essential**

- What effects does land availability have on the price ?
- Can we simulate the effects of ZAN on the price and therefore on housing affordability ?

Concrete objectives

Does land actually drive the increase in real estate prices ?

- **Differentiate** land and real estate values**, even for plots already built**

➔ **Have a map of land values**

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Does land actually drive the increase in real estate prices ?

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➔ **Have a map of land values**

$$y = \beta_{c1}x_{c1} + \beta_{c2}x_{c2} + \cdots + \beta_{t1}x_{t1} + \beta_{t2}x_{t2} + \cdots + \varepsilon$$

Prices of real estate

Construction related variables

Land related variables

$$y = y'_{construction} + y'_{land} + \varepsilon$$

$$y'_{land} = y - y'_{construction} - \varepsilon$$

Concrete objectives

Does land actually drive the increase in real estate prices ?

- **Differentiate** land and real estate values**, even for plots already built**

➔ **Have a map of land values**

- Better understanding of the effect of variables on price over time and space, **including land availability**

What are the effects of NNLT? What initial situation?

- So far, what effects has land availability had on the price?
- **Simulate the implementation of the NNLT by modifying the land availability variable**

Variables and data

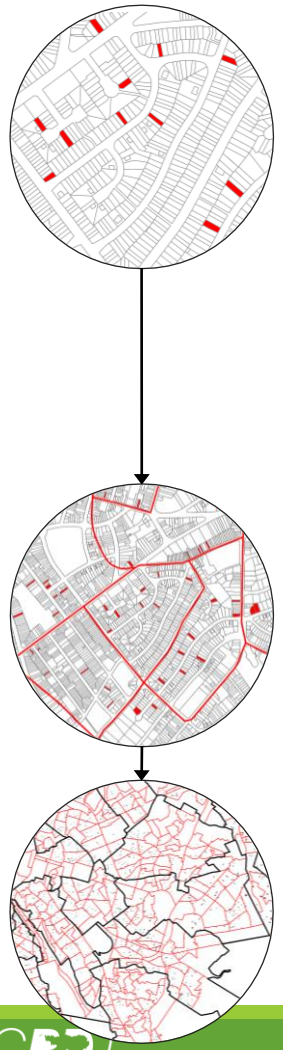
Variables and data

LEVEL I – Scale of the plot – Whole of Belgium

Sales data (2009 to 2020) obtained from SPF Finances/FOD Financiën with characteristics of the property and the plot (m^2, number of facades, rooms, garden, etc.)

Various sources : noise pollution, accessibility to the employment center, to a train station, slope of the land, land availability, etc.

Variables and data



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LEVEL II – Statistical sector /neighborhood :

Various sources : income, quality of buildings, environment, nature, various aspects of social development, etc.

LEVEL III – Municipalities :

Various sources : social and economic context, etc.

Variables and data

15 variables **tested** to explain the price of the plot of land

21 variables **tested** to explain the price of real estate (6 construction variables + 15 land variables)

Problems to solve

Data issues

- Belgian land registry data of low quality and not often updated
- Different scales of data
- **Non-uniformity of the distribution** of observations

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Issues related to the use of classic OLS

- **Spatial heterogeneity** of the effect of certain variables on the price of housing (e.g., plot size)
- No consideration of the greater probable “resemblance” between two close entities than between two distant entities

➔ Need to define the extent of the real estate market studied *a priori*

GWR models

GWR

- Allows **variation of regression coefficients** β_j
- Calibrates a separate regression model at each point using a "data borrowing" system that weights observations serving as regression points based on their distance from each other

$$y_i = \sum_{j=0}^{m} \beta_j(u_i, v_i) x_{ij} + \varepsilon_i$$

With n observations where $i \in \{1,2, \dots, n\}$ localised in (u_i, v_i)

x_{ij} being the j^{th} independant variable and $\beta_j(u_i, v_i)x_{ij}$ the j^{th}coefficient

ε_i the error term

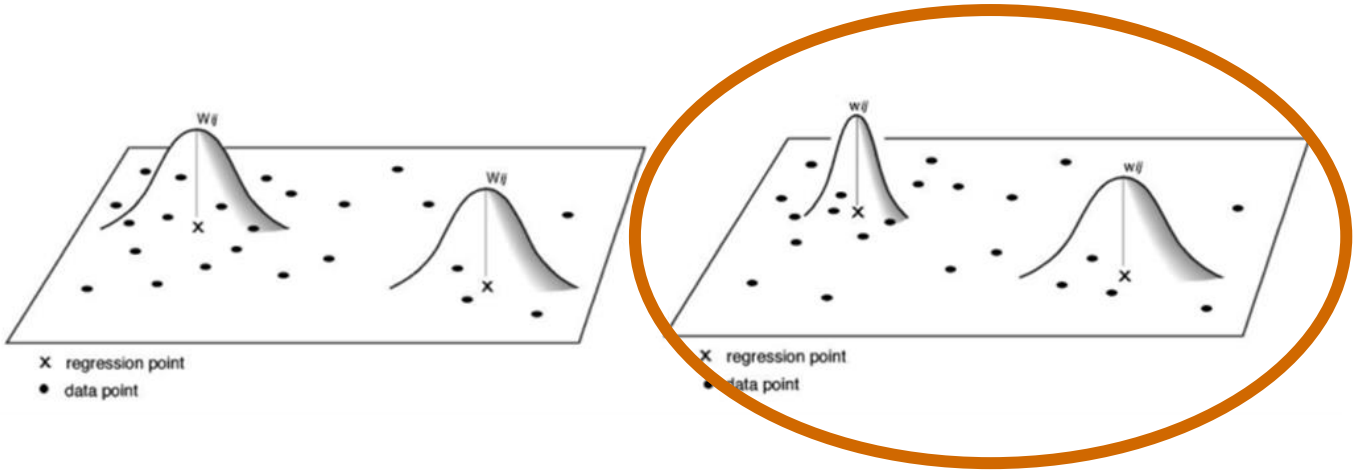
y_i the dependent variable (here the price)

(Fotheringham *et al.*, 2017)

GWR models

GWR

Adaptive Bandwidth Kernel



- **Calculation of ONE optimal bandwidth/number of nearest neighbors**
- Better handles irregularly shaped study areas, **non-uniform spatial distributions of observations**, and boundary effects

GWR = ONE unique bandwidth size/number of neighbors for all independent variables

(Fotheringham *et al.*, 2017)

(M)GWR models

MGWR

Allows variation of regression coefficients

AND a different bandwidth for all the variables considered

$$y_i = \sum_{j=0}^{m} \beta_j(u_i, v_i) x_{ij} + \varepsilon_i \quad \Rightarrow \quad y_i = \sum_{j=0}^{m} \beta_{bwj}(u_i, v_i) x_{ij} + \varepsilon_i$$

Where bwj indicates the bandwidth used to calculate β

Using the Python Package :
https://mgwr.readthedocs.io/
See as well :
https://github.com/pysal/mgwr

(Fotheringham *et al.*, 2017)

Example

- 6783 houses
- 19 variables + intercept

OLS

R^2 = 0,53

GWR

Number of neighbors : 624

R^2 = 0,62

MGWR

R^2 = 0,71

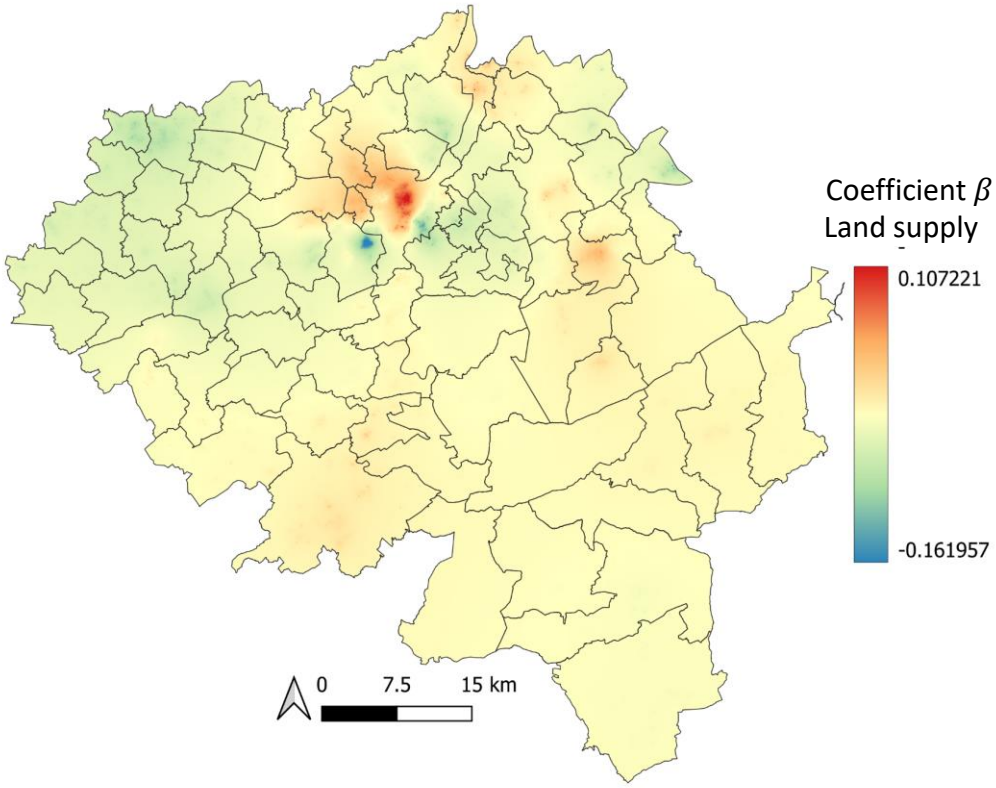
Variables	Number of neighbors
car_main_train	199
car_BXL	4846
car_GDL	4612
time_foot	6097
land_supply	6482
prop_nature	6782
noise	6751
socioEco1	2863
socioEco2	1227
socioEco3	6782
shape_Area	236
Slope_land	5798
Flood_zone	6782
living_surface	60
nb_facades	2096
age	866
garages	236
bathroom	1070
nb_housing	769

Example

GWR

Number of neighbors : **624/6783**

R^2 = 0,62



MGWR

Number of neighbors : **6482/6783**

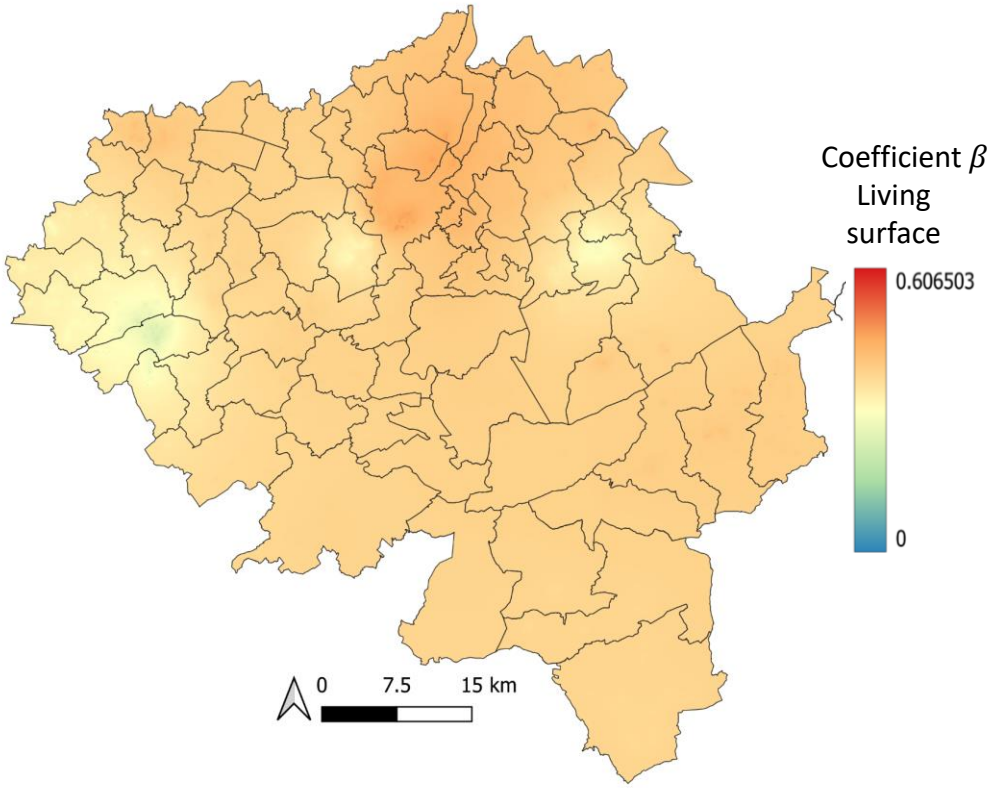
R^2 = 0,71

Example

GWR

Number of neighbors : **624/6783**

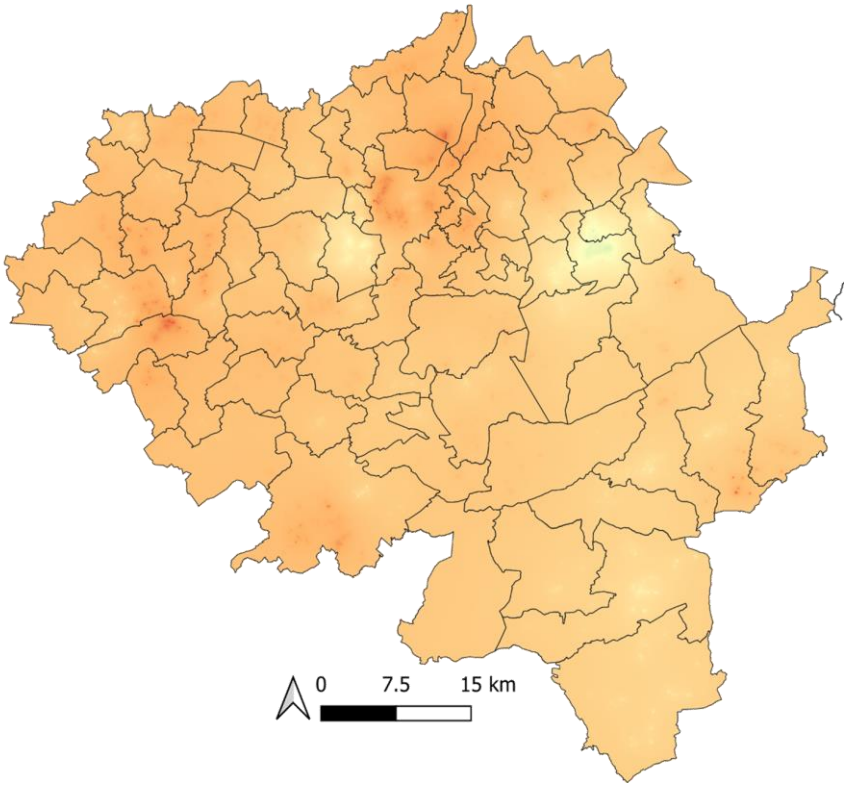
R^2 = 0,62



MGWR

Number of neighbors : **60/6783**

R^2 = 0,71



The problems of MGWR

MGWR

Although more efficient, MGWR models are however **very demanding in terms of calculation** and therefore time.

As an example - 16 CPU Server

- 14 600 plots of land (2019) + 15 variables

  = 6 days of treatment

- 92 000 real estate properties (2019) + 21 variables

  > 20 days of treatment (still in progress)

Identifying bandwidths is the longest part

Current/future objectives

1. **MGWR and GWR models for 2019**
   ➔ Determination of bandwidths and analysis of improvements with MGWR models
2. **Determination of a "*Best Model »*** (removing unnecessary variables)
   ➔ Possible differentiation between the price of land and the price of real estate
3. **MGWR for land and real estate for 2016, 2013, 2010**
   ➔ Evolution of the significance of variables in time and space
4. **Try a simulation of the implementation of the ZAN**
   ➔ Study of the effects on the price of land and real estate
5. **Exploration of the *Repeat Sales*** ➔ New insights into previous analyzes

CPDT
Conférence Permanente du Développement Territorial

Thank you for your attention !

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