



# PREFERENCES FOR NATURE-BASED SOLUTIONS AIMING AT REDUCING FLOOD RISKS

Results of a Discrete Choice Experiment in the Lez catchment (France)

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Géosciences pour une Terre durable

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# NATURE-BASED SOLUTIONS FOR REDUCING FLOOD RISK

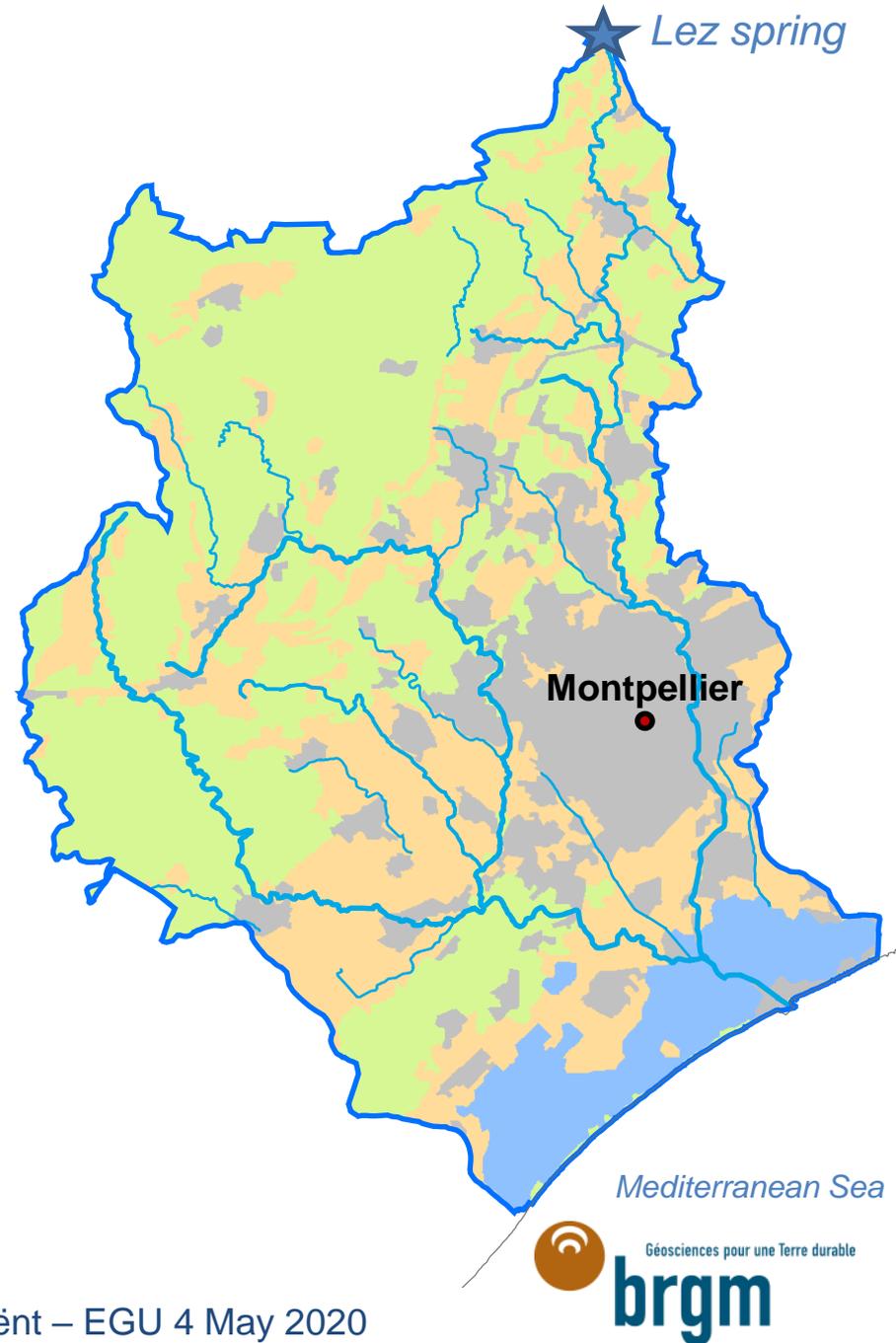
- **Nature Based Solutions (NBS)** are increasingly promoted as innovative solutions to address water risks, especially flood risk reduction
- Their specificity, in comparison to grey solutions, is their capacity to produce a multiplicity of co-benefits
- **Assessing these co-benefits** is therefore fundamental to evaluate properly the opportunity for local authorities to invest in NBS

## Do people attach an economic value to the co-benefits associated to NBS aiming at reducing flood risk, and how much?

- Conservation of natural and agricultural areas *versus* green infrastructure: what are the population's preferences?
- Is there some heterogeneity in preferences ? What are the factors explaining this heterogeneity?

# THE LEZ CATCHMENT

- 640 km<sup>2</sup>, 460 000 inhabitants
- Rapid urbanisation in the plain  
+2920 ha from 1990 to 2012  
(+1,2%/year)
- Typical Mediterranean weather →  
Flash floods of the Lez and its  
tributaries + runoff flooding in urban  
areas
- 2014: 65 million € damages for private  
housing and businesses
- 78% due to runoff



# THE LEZ CATCHMENT

## Flood risk & future urban development

- Population growth
- Challenge to manage urban development with flood risk management in the future

**TODAY**

+ 140 000 inh.  
(+75 000 housing)

↓

**2040**  
If urban sprawl continues

**Example 1**  
urban area  
(historic centre)



**Exemple 2**  
urban area  
(centre periphery)



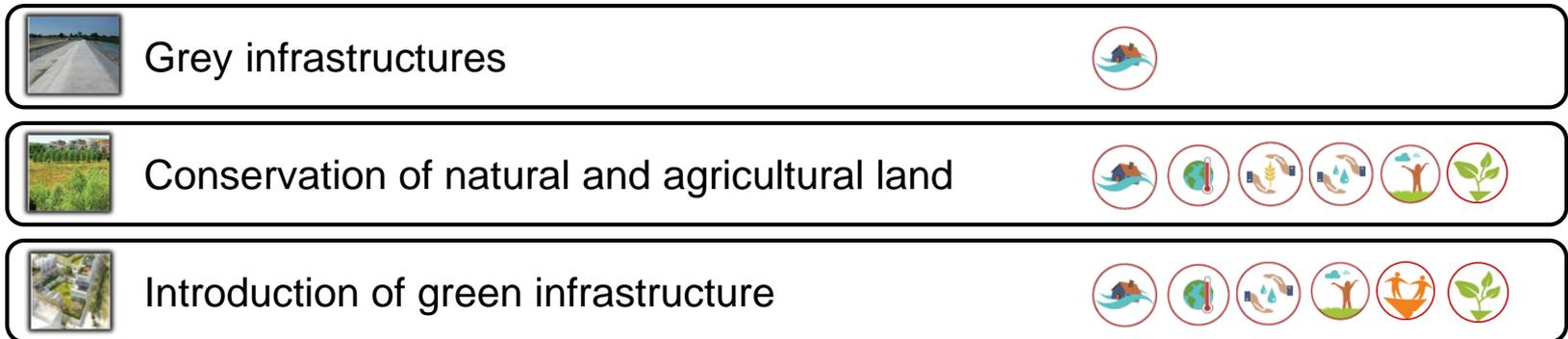
**Example natural and agricultural area**



**3200 ha**  
waterproofed

## 3 types of solutions to manage flood risk in the future

NBS



# METHOD: DISCRETE CHOICE EXPERIMENT (DCE)

## Preliminary workshops

- Organisation of 2 workshops with local stakeholders (June 2018 and February 2019)
- Evolution of the Lez catchment by 2040
- Selection of relevant NBS,
- Identification of expected co-benefits, implementation level and barriers
- Presentation of the CE method



## DCE survey

- February – July 2019: preparation
- August 2019: face-to-face interviews with 29 respondents (pre-test survey)
- September 2019: on-line survey

Des solutions fondées sur la nature pour diminuer le risque inondation sur le bassin versant du Lez (34)?

**PREAMBULE**

Ce questionnaire a été développé par le BRGM\* dans le cadre d'un projet de recherche européen. Son objectif est de connaître votre opinion sur la place de la nature en ville et le risque inondation. Cette enquête présente différents scénarios de développement urbain. Ces scénarios sont issus de travaux de recherche et non des projets des collectivités territoriales en charge de l'urbanisme et du développement du territoire. Ils serviront toutefois à alimenter les réflexions pour la réalisation de futurs projets d'urbanisme et de développement du territoire.

\* Le Bureau de recherches géologiques et minières (BRGM) est un établissement public de recherche dans le domaine de l'eau, de l'environnement et des risques naturels (<https://www.brgm.fr>)

Avant de commencer, nous souhaitons nous assurer que vous habitez bien sur le bassin versant du Lez.

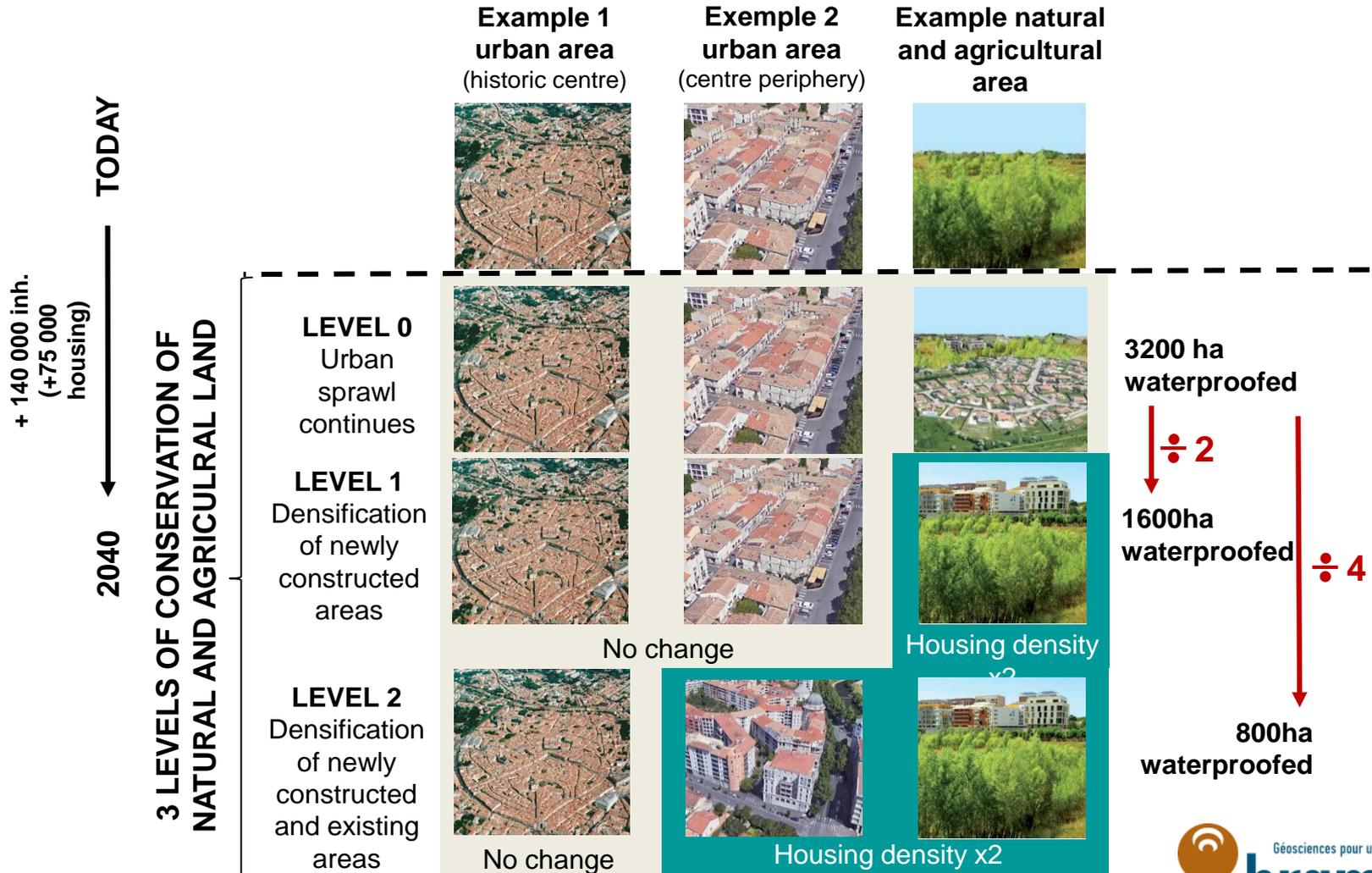
Quelle est votre commune de résidence?

Précédent Suivant →

# NATURE-BASED SOLUTIONS



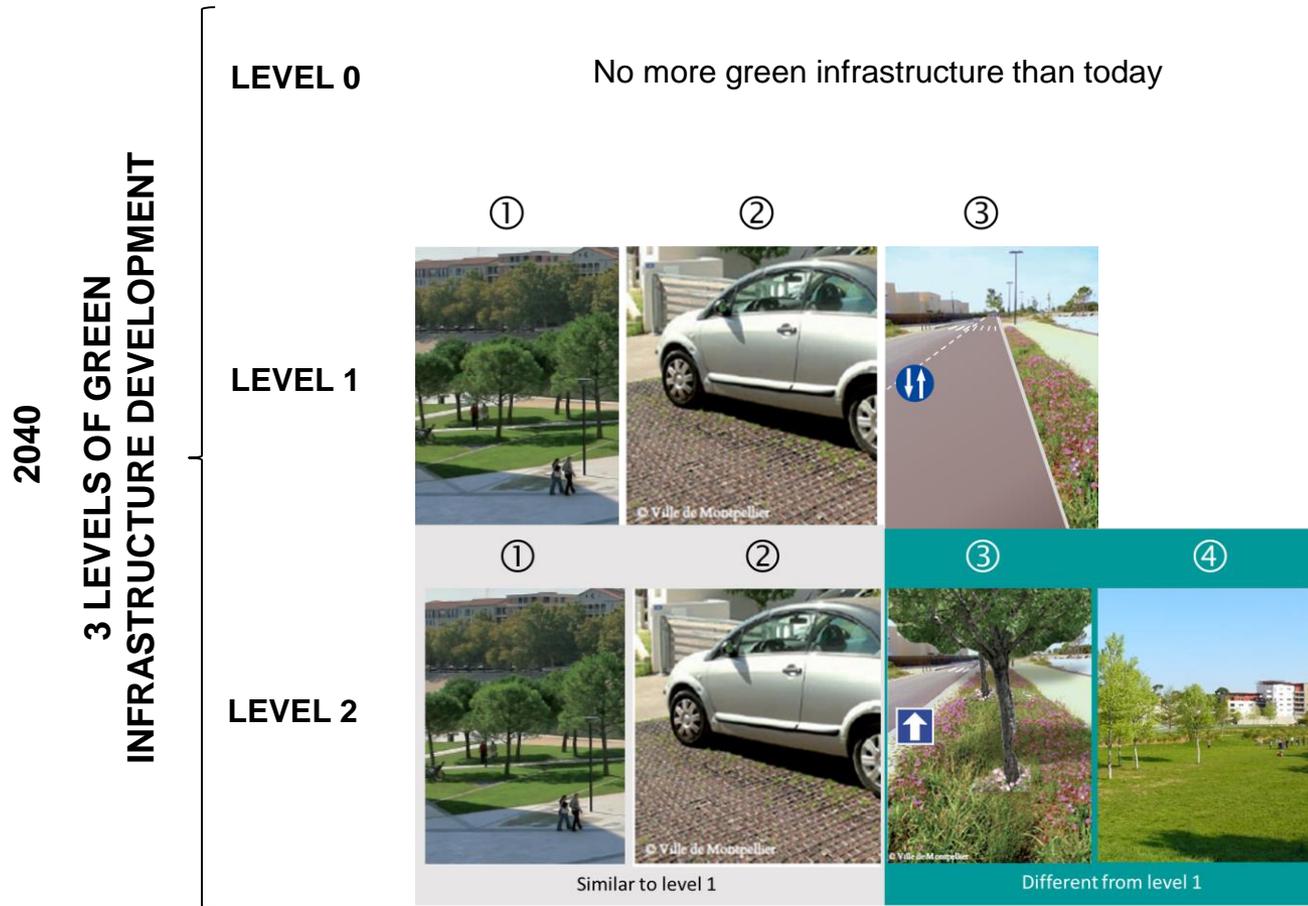
Conservation of natural and agricultural land



# NATURE-BASED SOLUTIONS



Introduction of green infrastructure



# CHOICE EXPERIMENT

## Attributes and levels

<p><b>ATTRIBUTE 1</b> Conservation of natural and agricultural land</p>	<p><b>LEVEL 0</b> Continued urban sprawl</p> <p style="text-align: center;">X</p>	<p><b>OR</b></p> <p><b>LEVEL 1</b> 1600 ha of preserved natural and agricultural areas</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  No change         </div> <div style="text-align: center;">  Housing density x 2         </div> </div>	<p><b>OR</b></p> <p><b>LEVEL 2</b> 2400 ha of preserved natural and agricultural areas</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  No change         </div> <div style="text-align: center;">  Housing density x2         </div> </div>
<p><b>ATTRIBUTE 2</b> Green infrastructure</p>	<p><b>LEVEL 0</b> No more green infrastructure</p> <p style="text-align: center;">X</p>	<p><b>OR</b></p> <p><b>LEVEL 1</b></p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>①</p>  </div> <div style="text-align: center;"> <p>②</p>  </div> <div style="text-align: center;"> <p>③</p>  </div> </div>	<p><b>OR</b></p> <p><b>LEVEL 2</b></p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>①</p>  Similar to level 1         </div> <div style="text-align: center;"> <p>②</p>  </div> <div style="text-align: center;"> <p>③</p>  Different from level 1         </div> <div style="text-align: center;"> <p>④</p>  </div> </div>
<p><b>ATTRIBUTE 3</b> Contribution to local taxes</p>	<p>20, 40, 60, 80, 100 or 120 €/household/year</p>		

# CHOICE EXPERIMENT

## Choice sets

- Relative preference between attribute levels inferred from the statistical analysis of choices in several choice sets
- Experimental design elaborated with the NGENE software (D-efficient design)
- 2 blocks with 6 choice sets each → respondents randomly respond to 1 block

Conservation of natural and agricultural land	<b>Alternative A</b>	<b>Alternative B</b>	None of the 2 strategies
	<b>LEVEL 2</b> 2400 ha of preserved natural and agricultural areas	<b>LEVEL 1</b> 1600 ha of preserved natural and agricultural areas	
Green infrastructure			
	<b>LEVEL 1</b>	<b>LEVEL 2</b>	
Contribution to local taxes			
	60€/household/year	60€/household/year	

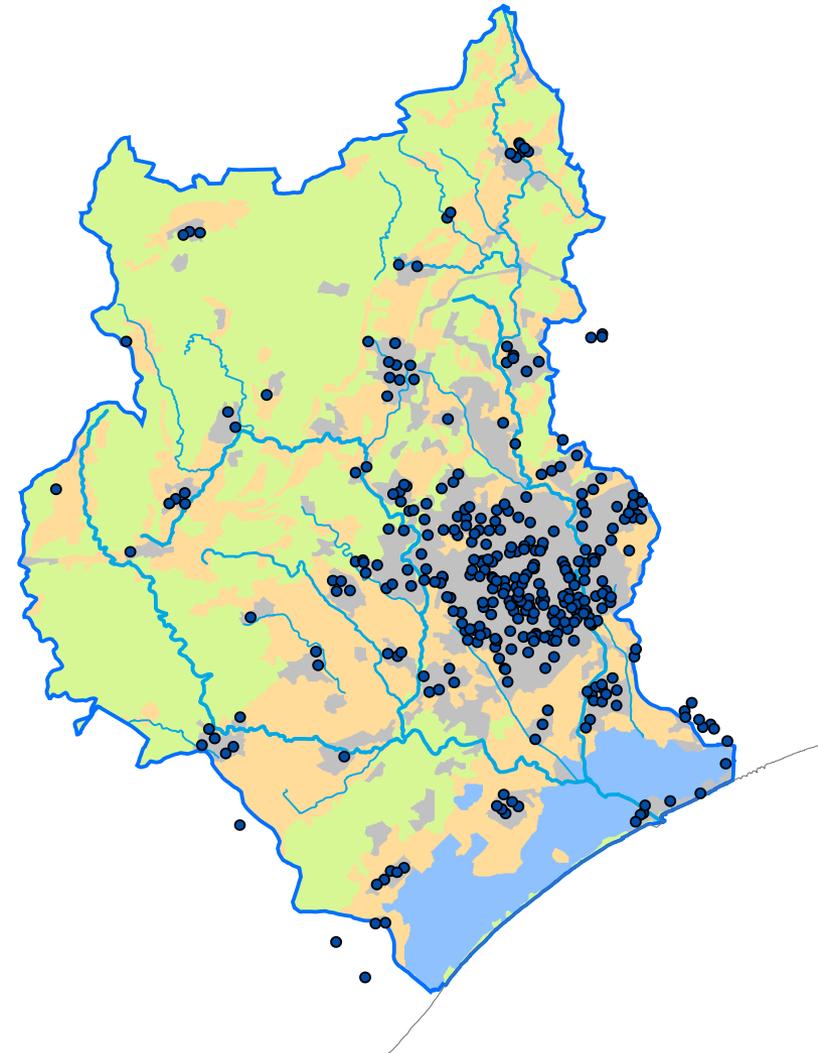
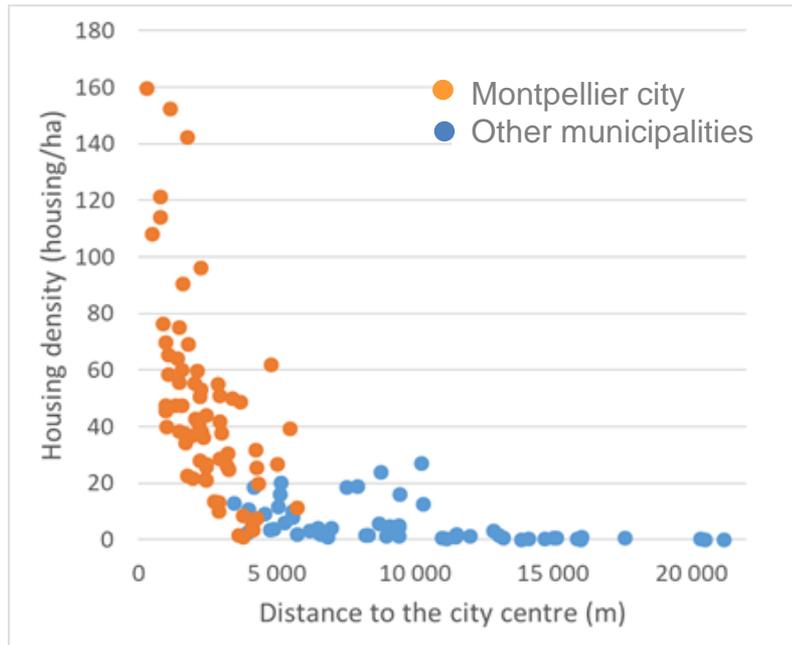
Tick your preferred option

# DATA DESCRIPTION

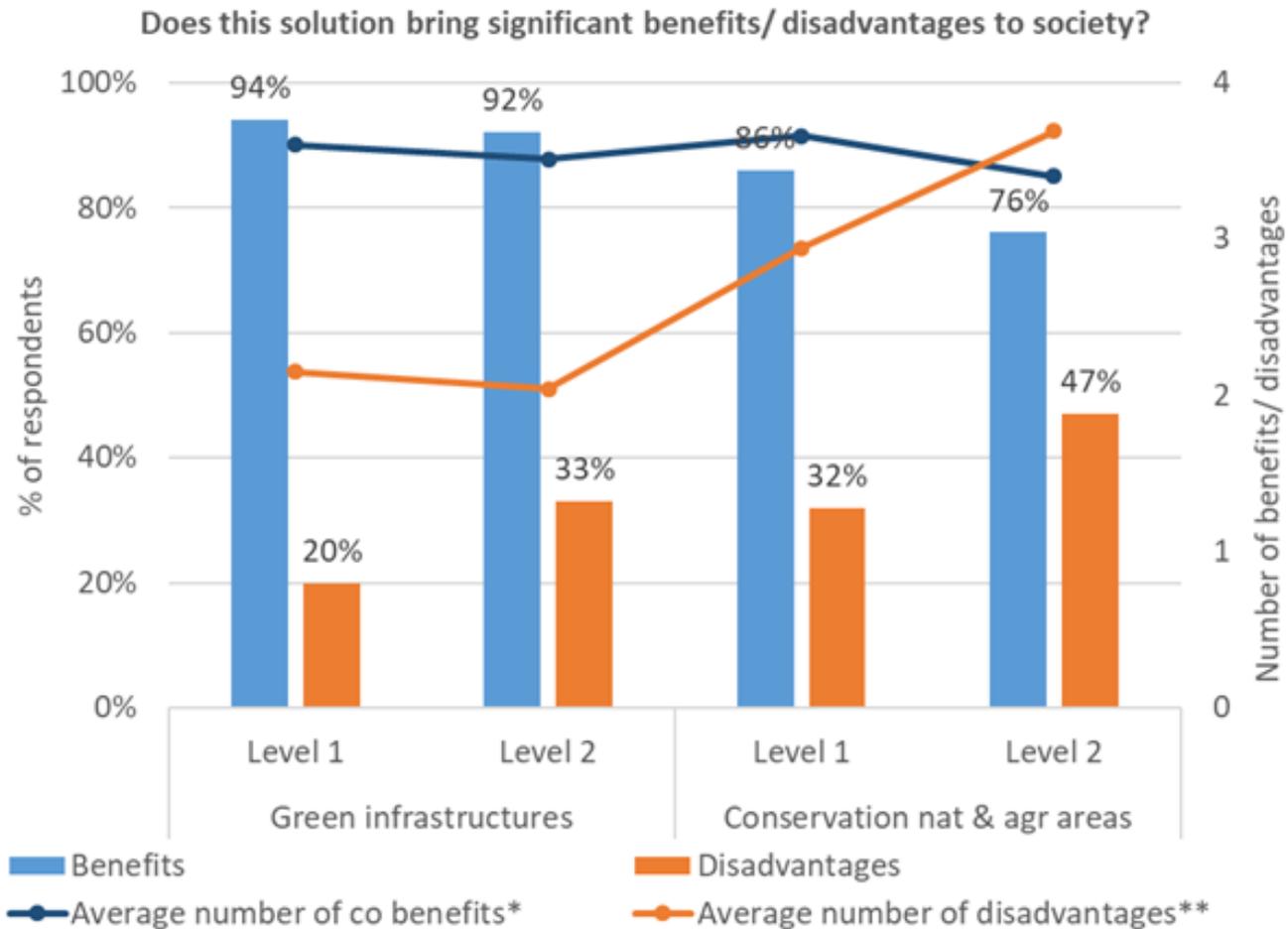
## 400 respondents living on the Lez catchment

Characteristics	Sample	Lez catchment
Sample size	400	460 000
Sex (% of women)	67%	53%
Employment (% employed)	65%	48%
Mean net income (€/household/month)	2,714	
Mean household size	2,24	2,06
% living in Montpellier city	56%	60%

## ... along a rural-urban gradient

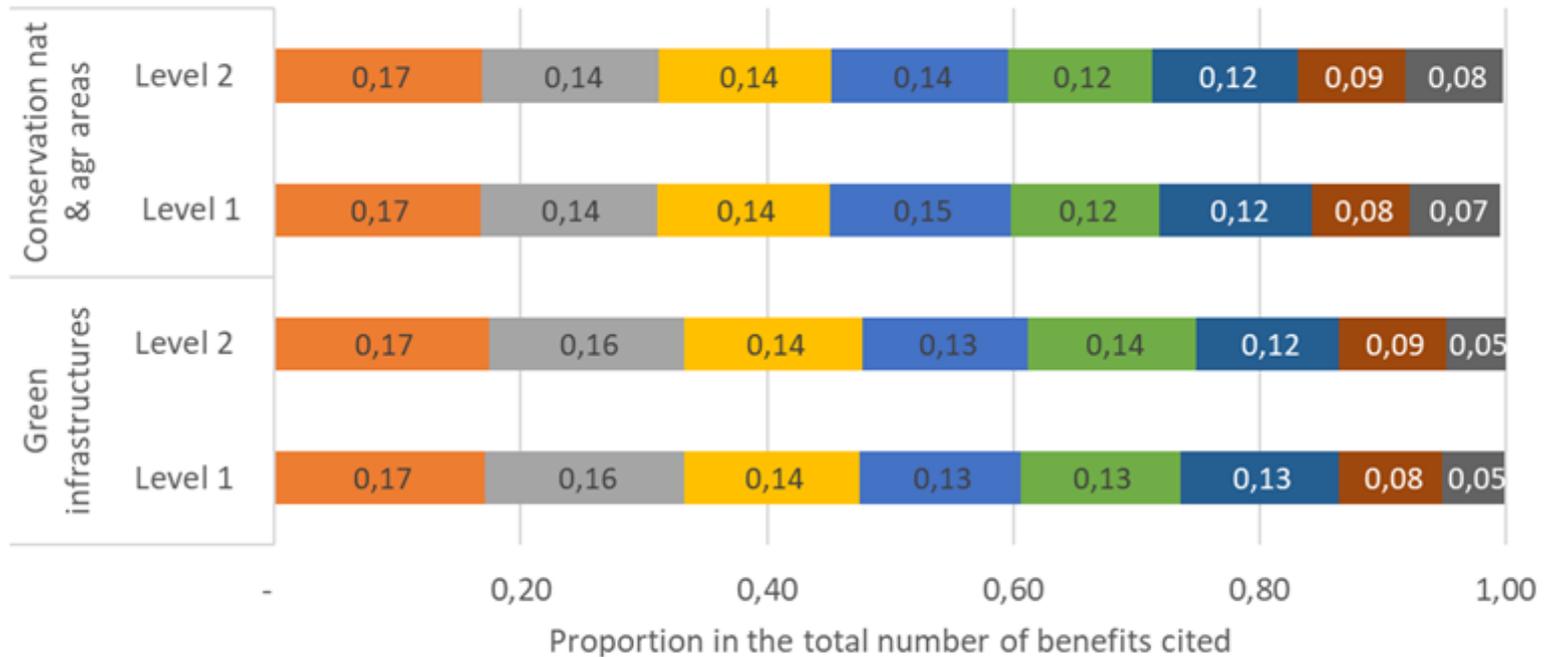


# SIGNIFICANT BENEFITS AND DISADVANTAGES ASSOCIATED TO NBS (1)



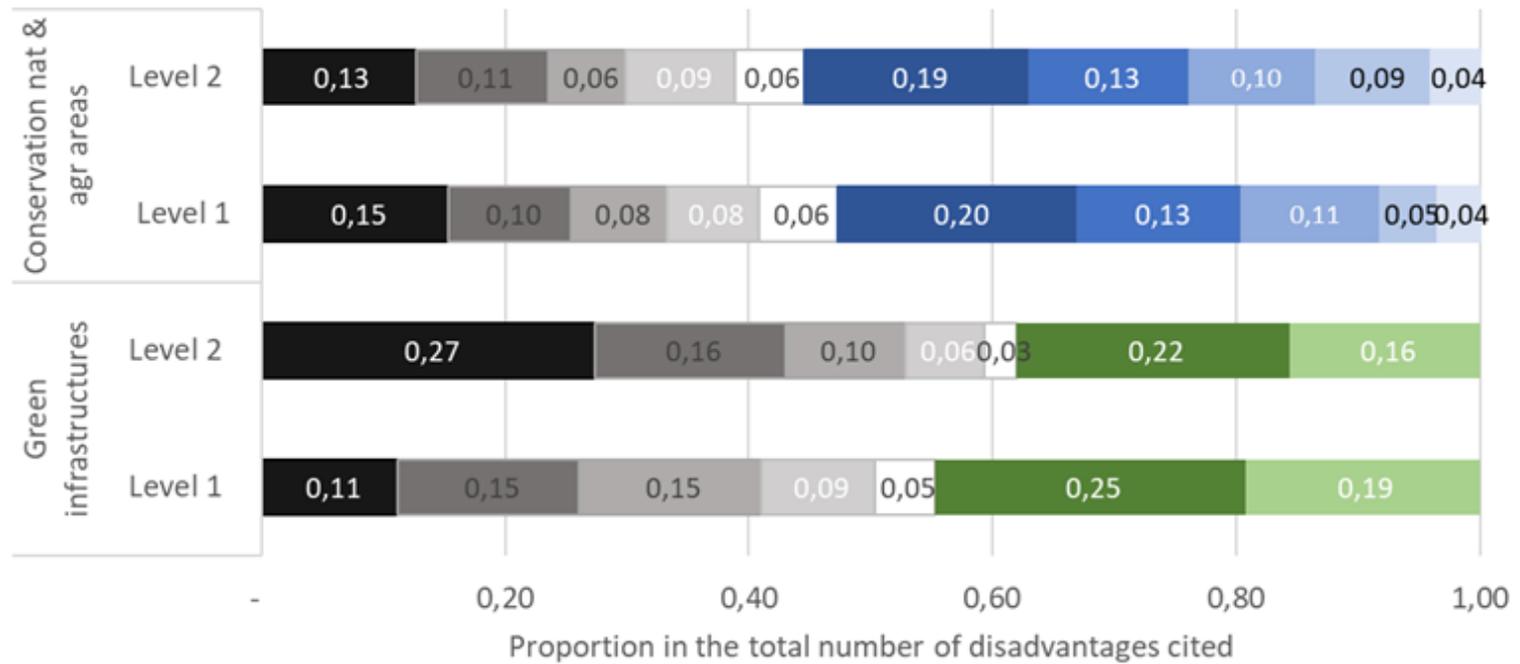
Note: quoted by those who consider that there are significant benefits (\*) disadvantages (\*\*)

# SIGNIFICANT BENEFITS AND DISADVANTAGES ASSOCIATED TO NBS (2)



- Flood risk reduction
- Landscape conservation
- Air quality improvement
- Climate change mitigation
- Local urban temperature regulation
- Biodiversity conservation
- Recreational activities conservation
- Local agriculture and food production conservation

# SIGNIFICANT BENEFITS AND DISADVANTAGES ASSOCIATED TO NBS (3)

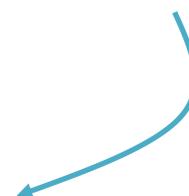
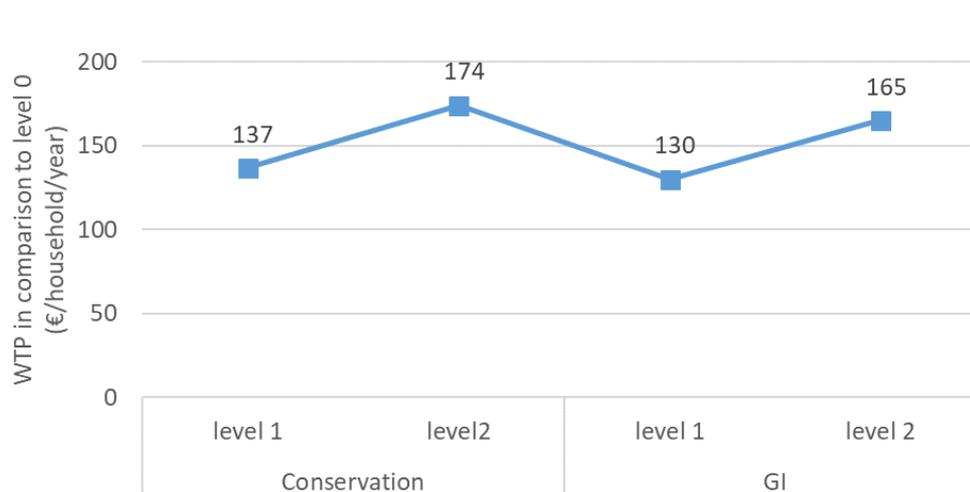


- Traffic and car parking problems
- High cost and implementation difficulties
- Negative green externalities (mosquitoes, allergies...)
- Insecurity
- Little effect on flooding
- Poorly maintained green spaces
- Low resistance to drought and urban pollution
- Landscape deterioration
- Increase in house prices
- Loss of cultural and historical heritage
- Barrier to village development

# WTP FOR NBS (1)

The sign of SD is irrelevant,  
must be interpreted as  
positive  
\*\* p<0.05  
\*\*\* p<0.01

	Conditional logit model	Mixed logit model
<b>Mean</b>		
Conserv_L1	0.319***	0.598***
Conserv_L2	0.755***	1.268***
GI_L1	0.327***	0.569***
GI_L2	0.728***	1.201***
BAU	-1.142***	-2.330***
Payment	-0.010***	-0.018***
<b>SD</b>		
Conserv_L1		-0.383***
Conserv_L2		0.923***
GI_L1		0.640***
GI_L2		0.793***
BAU		2.510***
Payment		-0.018***
<b>Log likelihood</b>	-2271.3637	-2004.7714
<b>AIC</b>	4554.727	4035.299
<b>BIC</b>	4596.018	4117,881

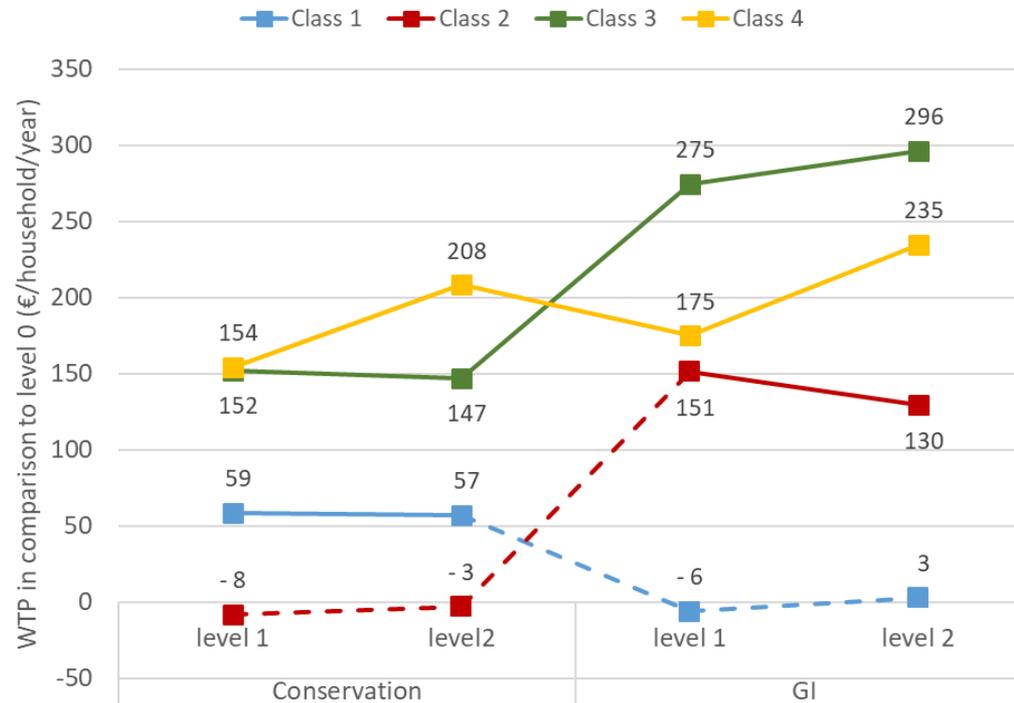


# WTP FOR NBS (2)

Latent class logit model

	Class1	Class2	Class3	Class4	Class5
<b>share</b>	0,146	0,102	0,239	0,314	0,198
<b>Conserv_L1</b>	0,7356304 ***	-0,0700386	0,5717595 ***	0,4485255 ***	0,7719042 ***
<b>Conserv_L2</b>	0,6792717 ***	0,0138486	0,5154286 ***	1,168559 ***	2,620024 ***
<b>GI_L1</b>	-0,1831882	0,9064748 ***	0,9175432 ***	0,5133191 ***	0,3989903 **
<b>GI_L2</b>	0,1453021	0,5645751 *	1,153366 ***	1,315174 ***	1,613025 **
<b>BAU</b>	-3,143992 ***	1,150489 **	-3,348362 ***	-0,337902	-4,043191 ***
<b>Payment</b>	-0,036677 ***	-0,0156981 ***	-0,0108835 ***	-0,0133727 ***	-0,0063523
<b>AIC</b>	4066.445				
<b>BIC</b>	4383.009				

\*\* p<0.05  
\*\*\* p<0.01

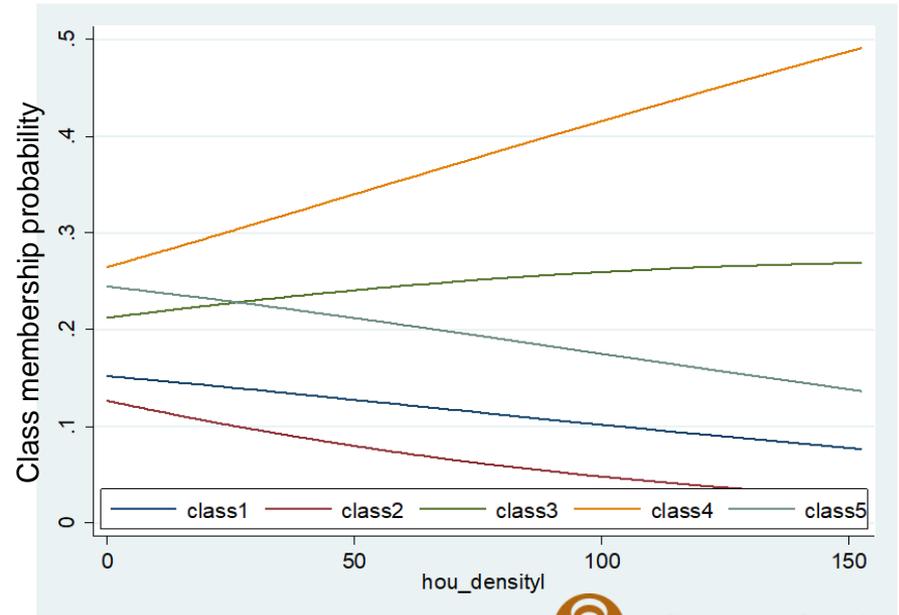
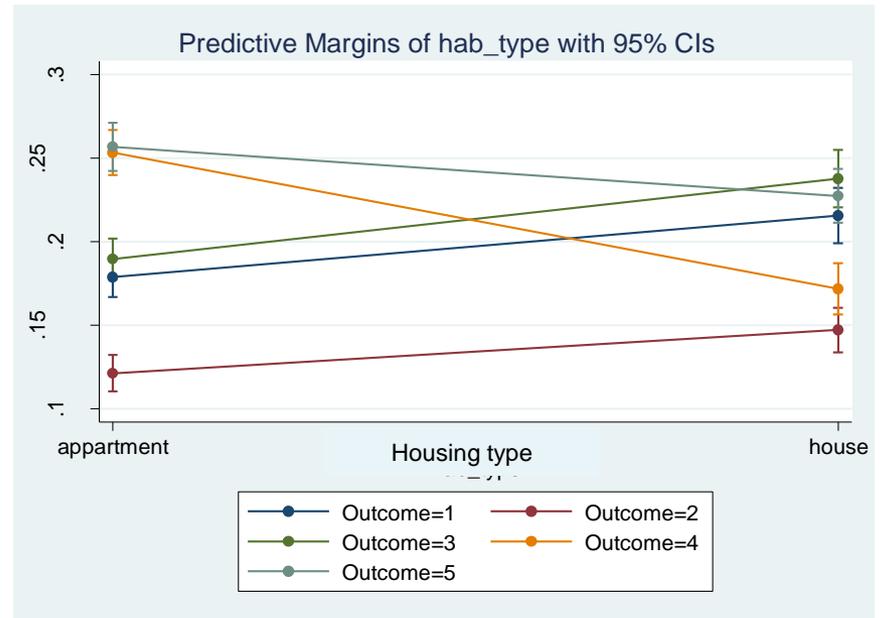
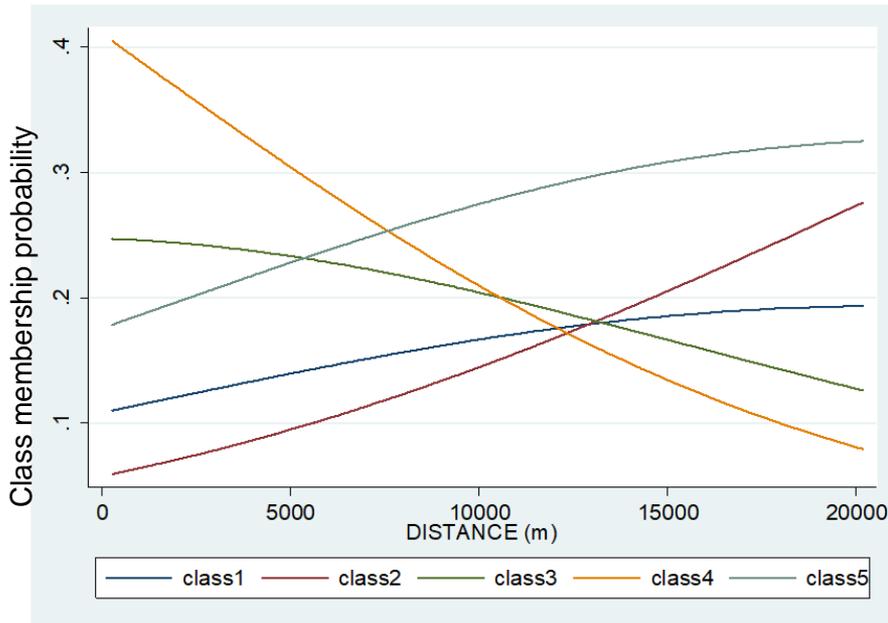


# FACTORS INFLUENCING PREFERENCES HETEROGENEITY (1)

## Housing environment

- Distance to city center\*\*\*
- Housing type\*\*\*
- Housing density\*\*\*

\*\*\* Significance of the overall effect of each variable on class membership  $p < 0,01$

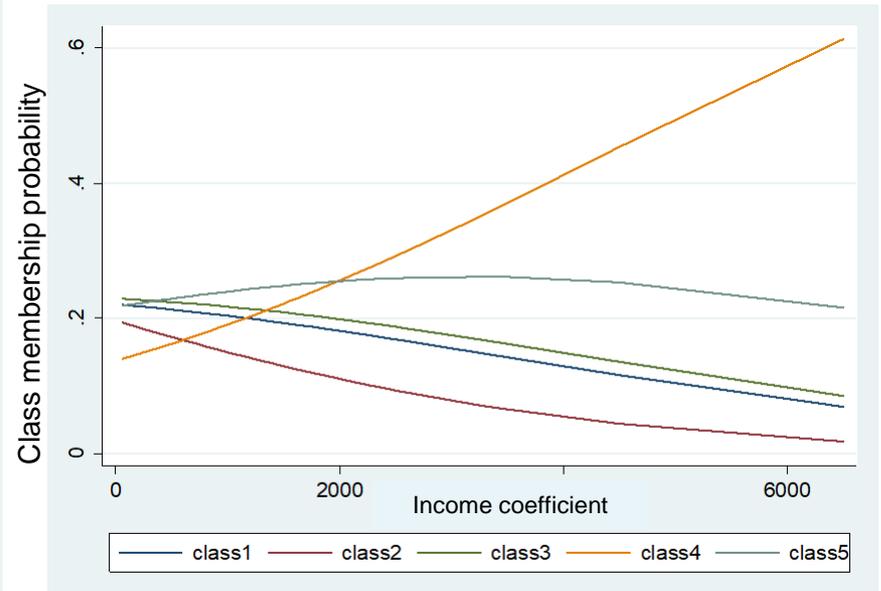
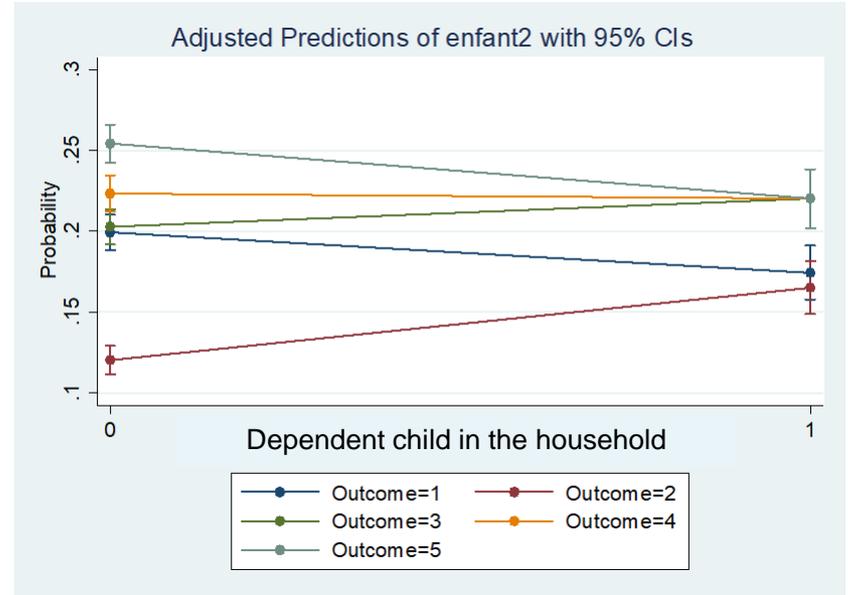
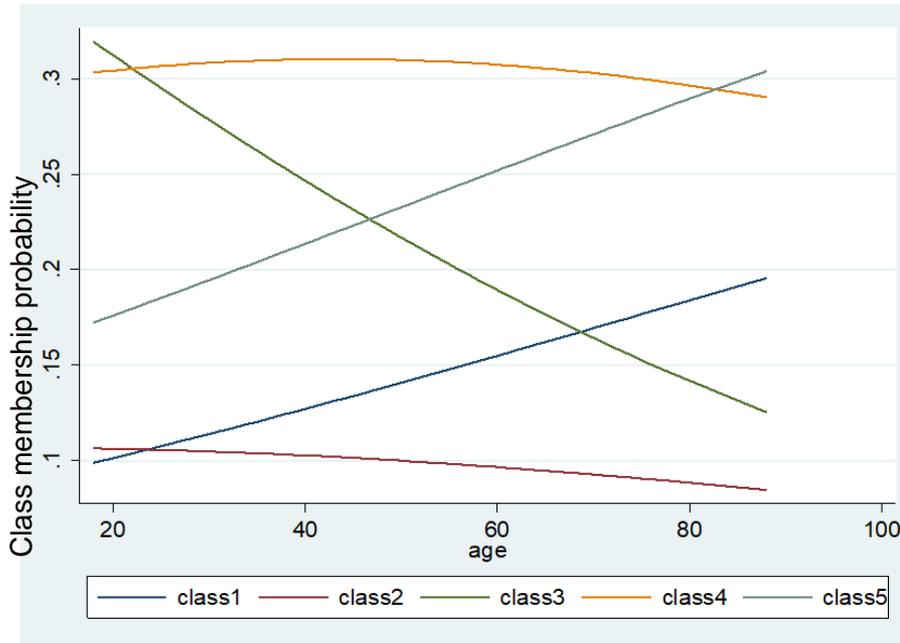


# FACTORS INFLUENCING PREFERENCES HETEROGENEITY (2)

## Household characteristics

- Age\*\*\*
- Dependent child in the household\*\*\*
- Income coefficient\*\*\*

\*\*\* Significance of the overall effect of each variable on class membership  $p < 0,01$



# CONCLUSION AND PERSPECTIVES

- Positive WTP for co-benefits associated to NBS implementation
- First study that studies explicitly the conservation of natural and agricultural land as a NBS
- We highlight resident's perception of tradeoffs entailed by the development of NBS in cities
- We analyse the heterogeneity of preferences for NBS among the population and show significant influence of housing environment (distance to city centre, housing density, housing type) and household characteristics (age, income coefficient, dependent child in the household)