Master’s degree in Computational Social Sciences 2024-2025

Master Thesis

Modeling perceived urban insecurity: an empirically grounded agent-based simulation

Sara Cristina Herranz Amado

Supervisor:

Iñaki Úcar Marqués

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WHY URBAN INSECURITY PERCEPTION?

Traditional methods are static tools:

- Miss everyday dynamics of fear
- Ignore interaction with routines & space

Perceived insecurity goes beyond crime stats:

- shaped by spatial cues, symbolic meanings & social dynamics.
- **Fearscapes** (Pain, 1997):
  - Poor lighting, visible disorder, harassment →
  - Avoidance behaviours & social fragmentation.

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WHY USING ABM?

- Simulate complex, emergent patterns from interactions between people & places
- Incorporate diverse agent behaviors
- Exploration & testing tool
- Try “what-if” scenarios (lighting, youth, routines)
- Anticipate effects of interventions (Izquierdo et al., 2020)

To capture the lived, relational nature of insecurity to move beyond crime data and reflect embodied fear

AIM & OBJECTIVES

Main purpose

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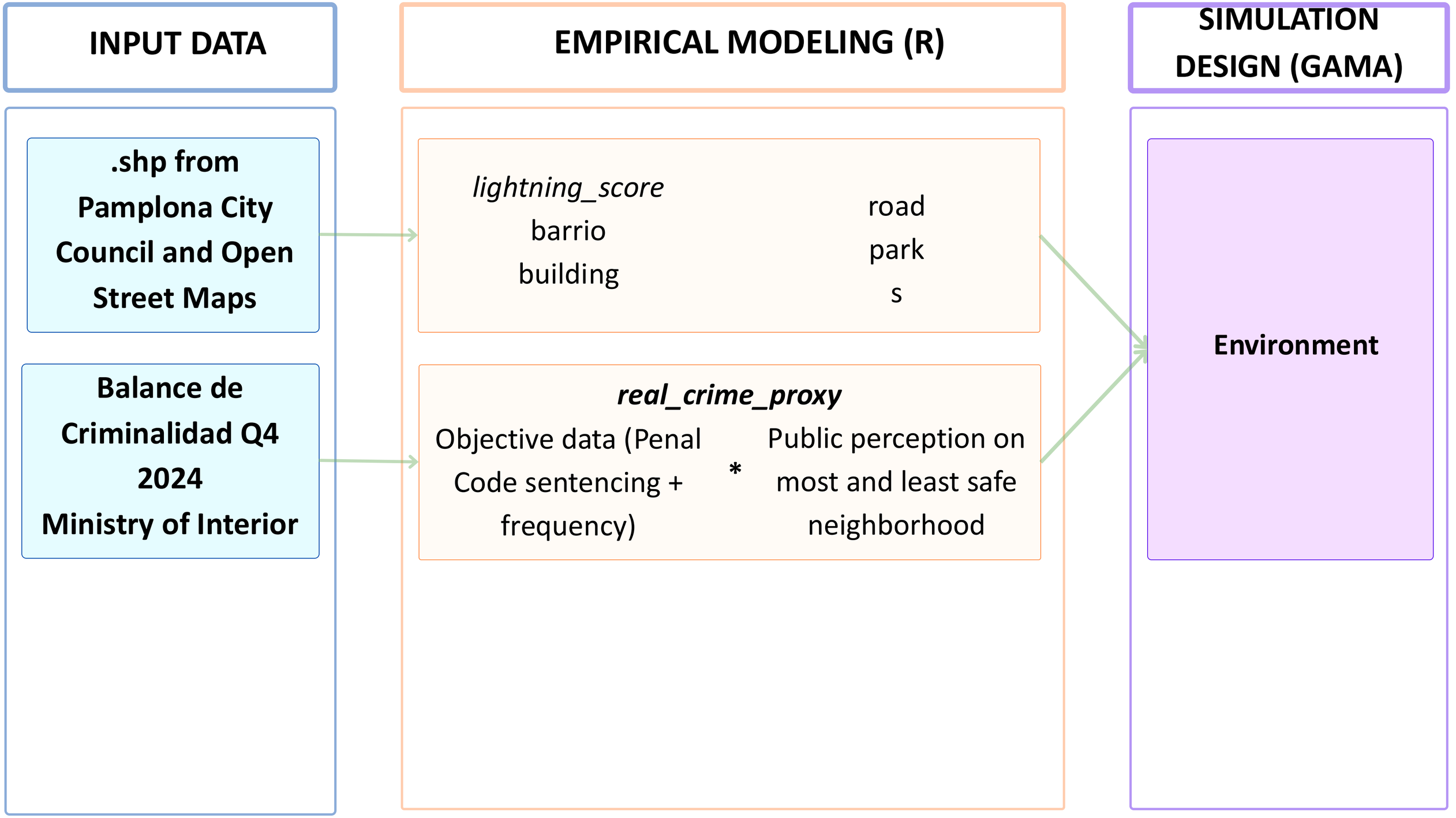
Applicability

- Provide a flexible tool to test scenarios for researchers and policymakers

PAMPLONA AS A CASE STUDY

- Recent survey data (2023) on perceived insecurity
- Psycosocial variables (relevant according to literature review)
- Availability of crime data


INPUT DATA
EMPIRICAL MODELING (R)
SIMULATION DESIGN (GAMA)
.shp from Pamplona City Council and Open Street Maps
Balance de Criminalidad Q4 2024 Ministry of Interior
lightning_score
barrio
building
road
park
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real_crime_proxy
Objective data (Penal Code sentencing + frequency)
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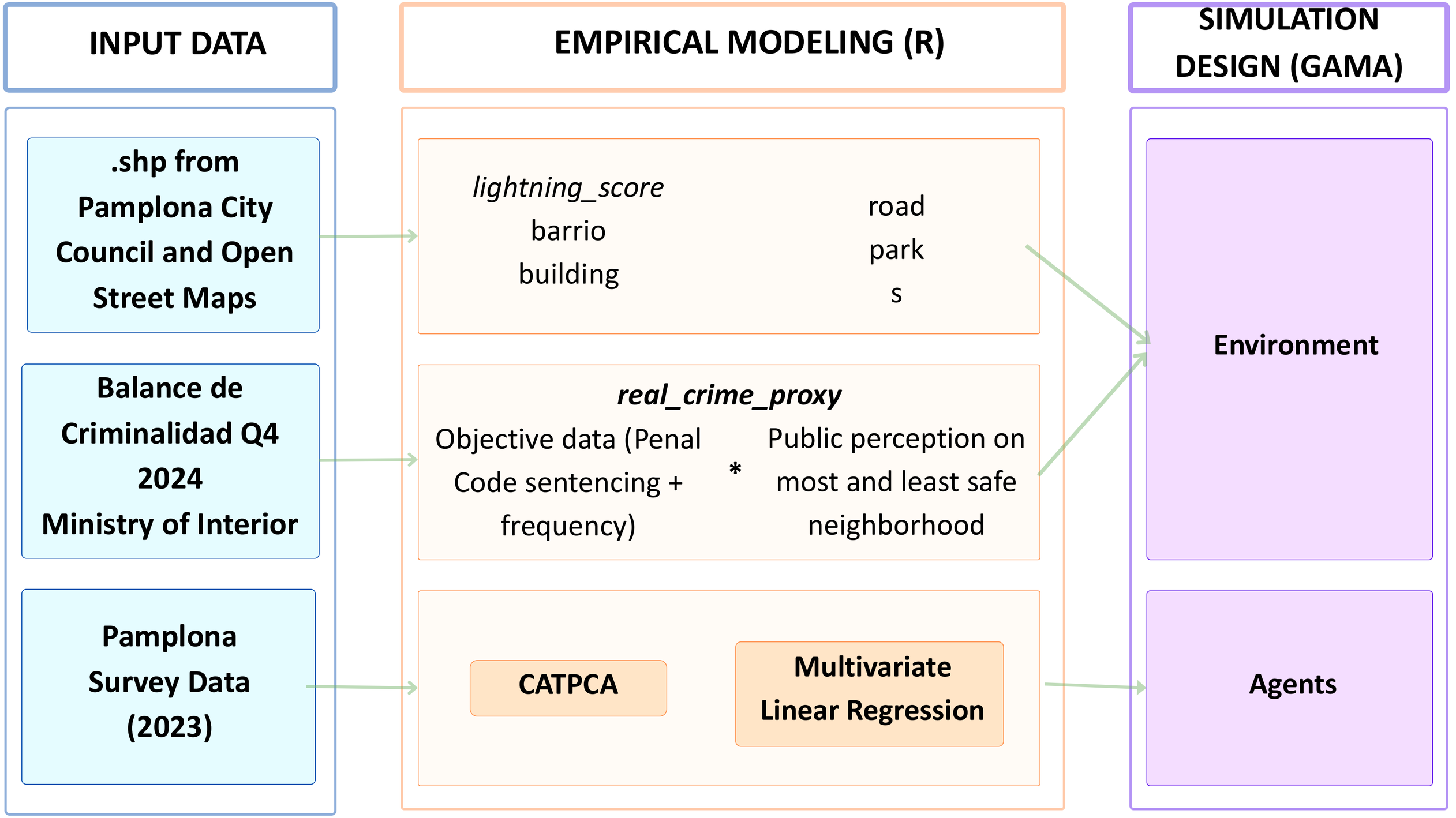
Public perception on most and least safe neighborhood
Environment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CATPCA
Multivariate Linear Regression
Environment
Agents

- ***prediction***: linear combination
  - *gen_ins*
  - individual effects: gender, nationality, past victimization
  - social exposure: proximity to visible botellonero
  - contextual modifier (only at night):
    - *real_crime_proxy * crime_weight*
    - *darkness * lightning_score*

resident

Number of residents 167

minimal speed 0.2777777777777778

maximal speed 1.3888888888888888

Earliest hour to start work 6

Latest hour to start work 08

Earliest hour to end work 16

Latest hour to end work 20

Threshold is insecure 01.0

Prob. leisure outside own neighborhood 0.20

GIS

botellonero

Number of botellonero groups 7

N° of days botelloneros are visible 3

contextual

Crime weight 0.5

Monitors

Number of secure people: 167

Number of insecure people: 0

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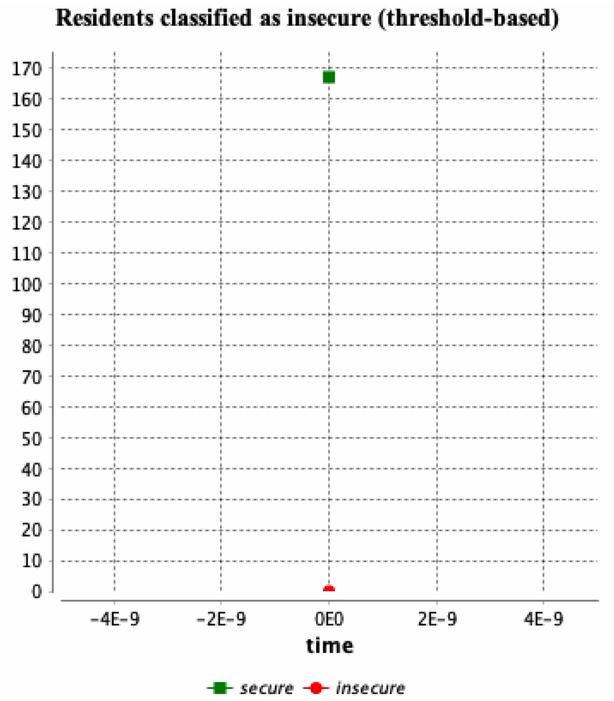

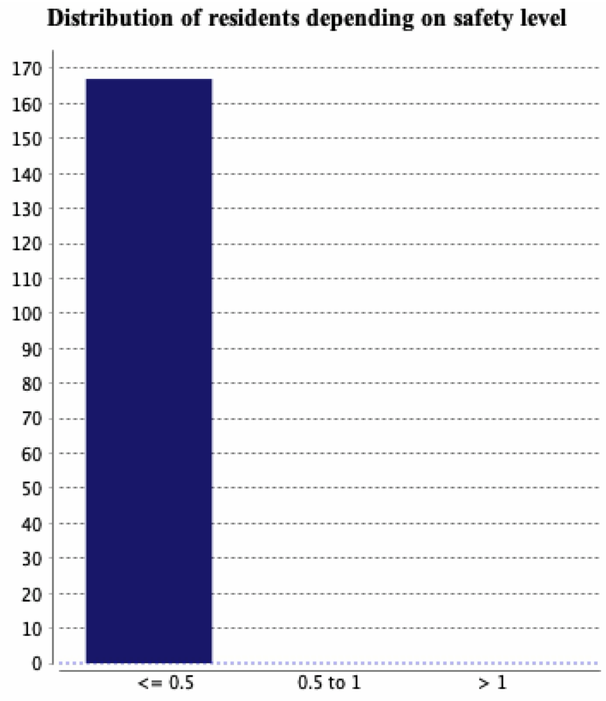

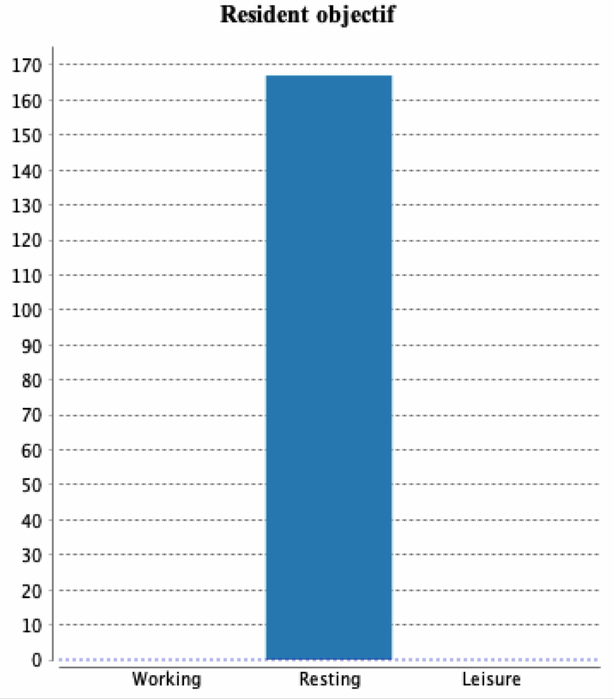

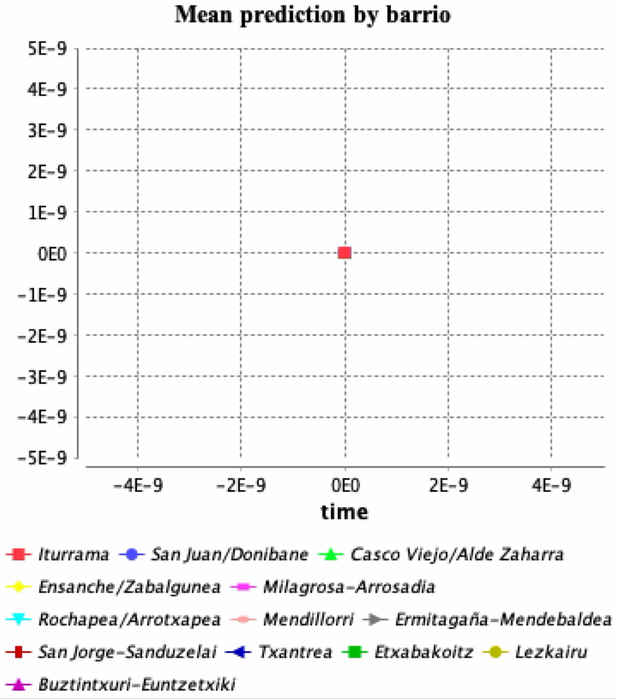

SIMULATIONS FOR DECISION-MAKING (I)

It's Friday night. Small groups of young people gather around different squares. At first, people pass by without issue, but for some residents this triggers discomfort.

The city wonders: are these feelings of fear significant enough to plan around?

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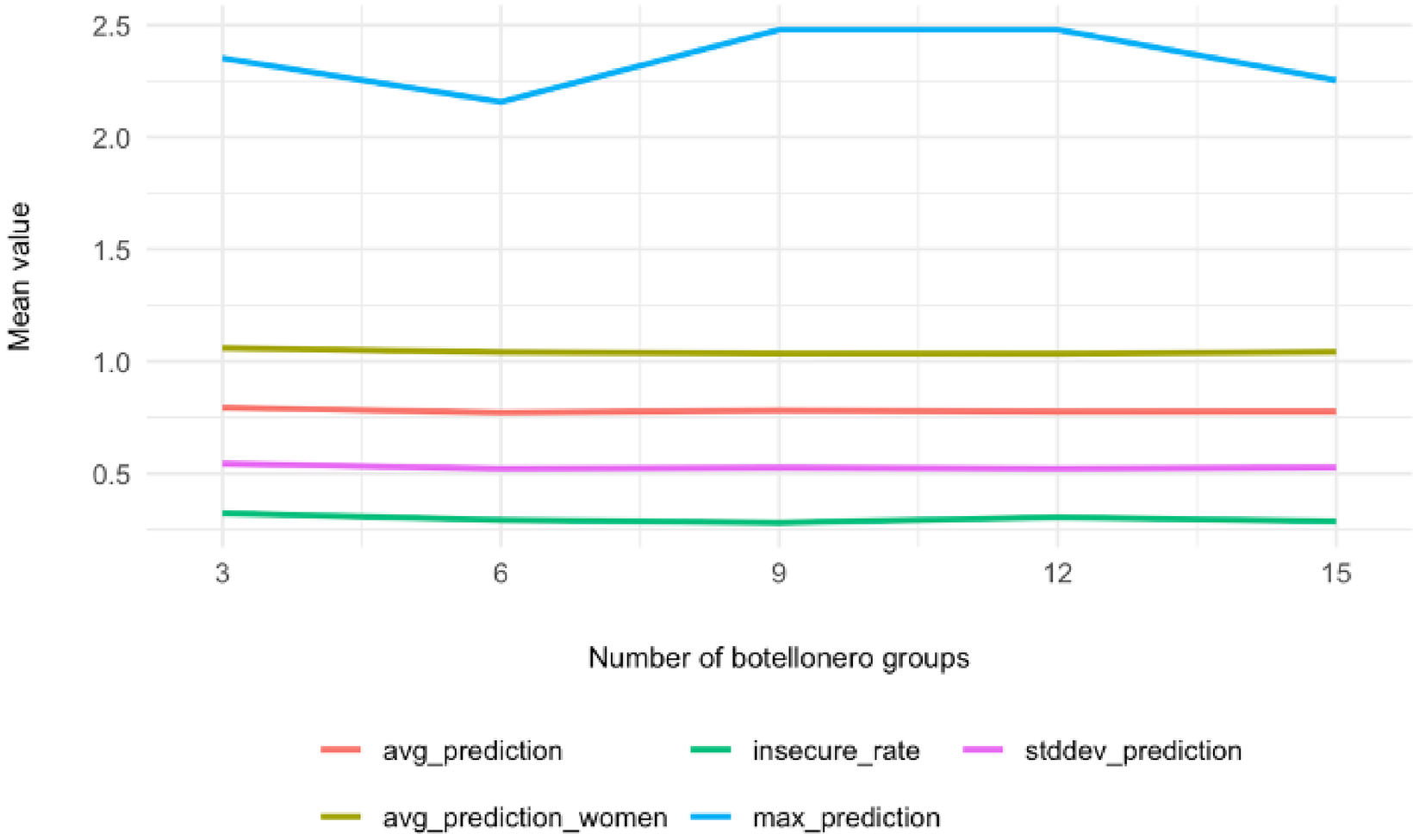

SIMULATIONS FOR DECISION-MAKING (II)

SANFERMINES

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- Shift in urban dynamics
- Disrupts everyday routines & exposure patterns
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- Policy question: *for whom does insecurity increase?*

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What would be needed?

- Adjust leisure & mobility parameters
- Model temporary urban layouts
- Include crowding and time-specific risks

TO SUM UP…

MODEL CONTRIBUTIONS

- Challenges purely criminological approaches of insecurity
- Improves on prior models (e.g., Izquierdo et al., 2020):
  - Adds agent heterogeneity (gender, vulnerability, nationality)
  - Includes temporal context
- Demonstrates internal coherence, empirical plausibility, and theoretical consistency

FUTURE IMPROVEMENTS

However, there are some **LIMITATIONS** that can be **ASSESSED** with

- No interaction effects between different variables → Robust global sensitivity analysis methods, such as Sobol indices or Latin Hypercube Sampling.
- Circularity in crime parameters → Georeferenced crime incidents data
- Fixed routines and lack of capacity for adaptation or learning → Feedback mechanisms (agents modify their behavior based on prior experiences)

THANK YOU VERY MUCH FOR YOUR ATTENTION

Questions or comments are welcomed!