INTERNATIONAL MEETING OF DOCTORAL STUDENTS IN CIVIL ENGINEERING **(EIDEIC)** 2023

Developments in **GIS** modelling of urban environmental risks and mitigation strategies with **NBS**

4th year of Doctorate program

3rd year FPI scholarship

Expected submission date:
Q3-Q4 2023

Directors Dra. Cristina Manchado del Val

Dr. Daniel Jato Espino

PhD Candidate: Alejandro Roldán Valcarce

Tutor Dr. Jorge Rodriguez Hernández

State of competences

Training (259h) / 20 Courses → **CA05**

- Compulsory multidisciplinary training: 95h (Basic + Advance Courses)

3 Scientific publications: 2 publications since 2020 & 1 Under review

Year:	2021	2022	2023*
			
Journal:	(1) IJERPH **Q1**	(2) Urban Climate **Q1**	IJDRR **Q1**

CB12, CB13, CB15, CB16
CA02

1 Software patent: ArcGIS Software addin for urban flood identification

Favourable assessment of the yearly Research Plan (PI): 1st, 2nd and 3rd year → **CB11, CB14**
CA01, CA03, CA06

State of competences

1 International mobility: ⟶ **CA04**

- Zurich (Swizterland) **EAWAG**: Swiss Federal Institute of Aquatic Science and Technology

6 Conferences and seminars: **CB12, CB13, CB15, CB16** **CA02**

- 2nd SAFERUP Week (**SaferUP Award** 2020: Best external poster)
- Montag Seminar in EAWAG's Department Urban Water Management (As speaker)
- ICUD 2021(Online Poster Session)
- 11th IAHR Spain Young Professionals Network Webinar (As speaker)
- RedSUDS 2023 (Poster session)
- Novatech 2023* (July 2023) *poster approved

Other activities: **CB12, CB13, CB15, CB16** **CA02**

- Collaboration in European and Spanish Research Projects FORESEE / HOFIDRAIN / D4Runoff / SUDSLong / Pequeingenieria
- 1st Cities Skylines Championship in UC (2nd in Spain)
- European Researchers' Night 2022
- EIDEIC 2020
- Lecture in Sustainability in Construction (14h)
- 3rd Challenge in UC (Scape Room)

State of competences

CODE	Basic Skills	
CB11	Systematic understanding of a field of study and command of the skills and research methods related to the field.	✓
CB12	Skill to conceive, design or create, implement and adopt a substantial process of research or creation.	✓
CB13	Skill to contribute to the enlargement of the knowledge limits through an original research.	✓
CB14	Skill to carry out a critical analysis and assessment and synthesis of new and complex ideas.	✓
CB15	Skill to communicate with the academic and scientific community and with society in general about the scope of knowledge in the ways and languages of common use in the international scientific community.	✓
CB16	Skill to encourage, in academic and professional contexts, the scientific, technological, social, artistic or cultural progress in a society based on knowledge.	✓
CODE	**Capacities and Personal Abilities**	
CA01	Cope in contexts in which there is little specific information.	✓
CA02	Find the key questions to be answered to solve a complex problem.	✓
CA03	Design, create, develop and undertake new and innovative projects in the knowledge scope.	✓
CA04	Work both in teams and individually in an international or multidisciplinary context.	✓
CA05	Integrate knowledges, face complexity and formulate judgements with limited information.	✓
CA06	Intellectual criticism and defence of solutions.	✓

Research

Objectives:

1. Identify urban areas with environmental hazard such us floods or urban heat island effect in GIS.

2. Identify vulnerable urban areas against floods or urban heat island effect.

3. Identify suitable locations to implement NBS to maximise their potential to mitigate environmental risks in critical areas.

Hypothesis:

Based on a set of spatial variables of the city, it is possible to locate areas prone to environmental risks and to measure the mitigation of these risks using NBS.

Research Method

Floods

5.2-IC Surface Drainage Spanish Standard

ArcDrain®

Subcatchment hierarchy

DTM
Buildings
Soil Permeability
Land Use

Case Study: Santander

UHI

Satellite Data: **LST**

$\Delta T = LST_{day} - LST_{night}$

ArcUHI*

AI
- MLR
- RFR
- SVR

DTM
Buildings
Albedo
Land Use

Case Study: Madrid

Urban Vulnerability

Demography
Socioeconomics
Infrastructures

Correlation & PCA

Spatial distribution of inequality

Case Study: Santander

R I S K

NBS expertise

- Improvement features
- Compatibility (land use, area min)
- External boundaries
- Cost (Construction & Maintenance)
- …

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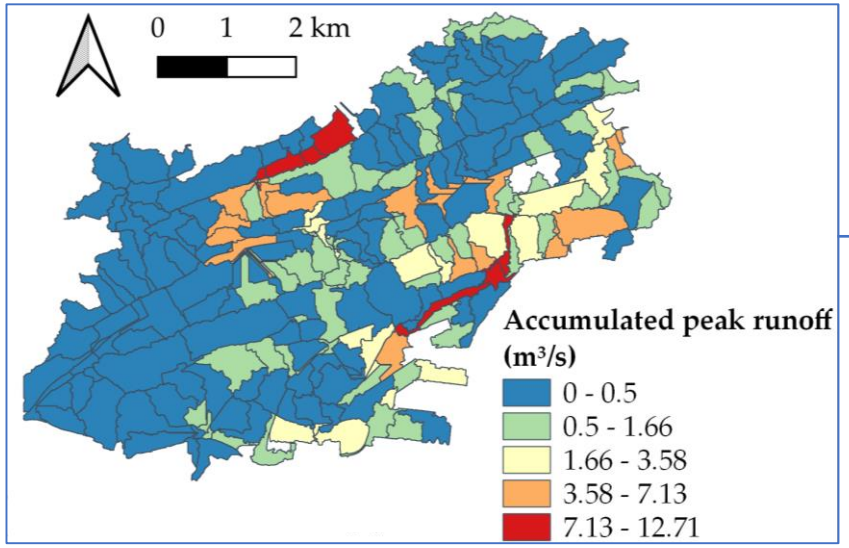
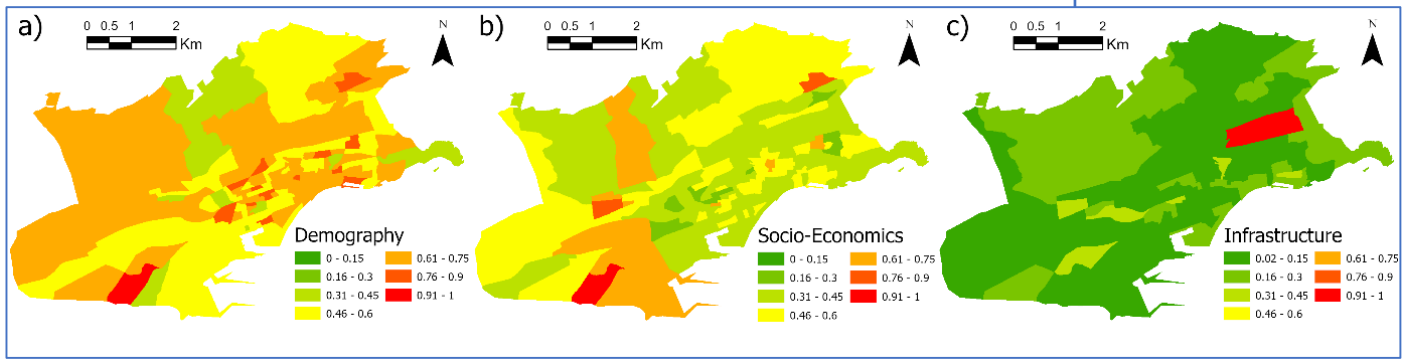
Research Results

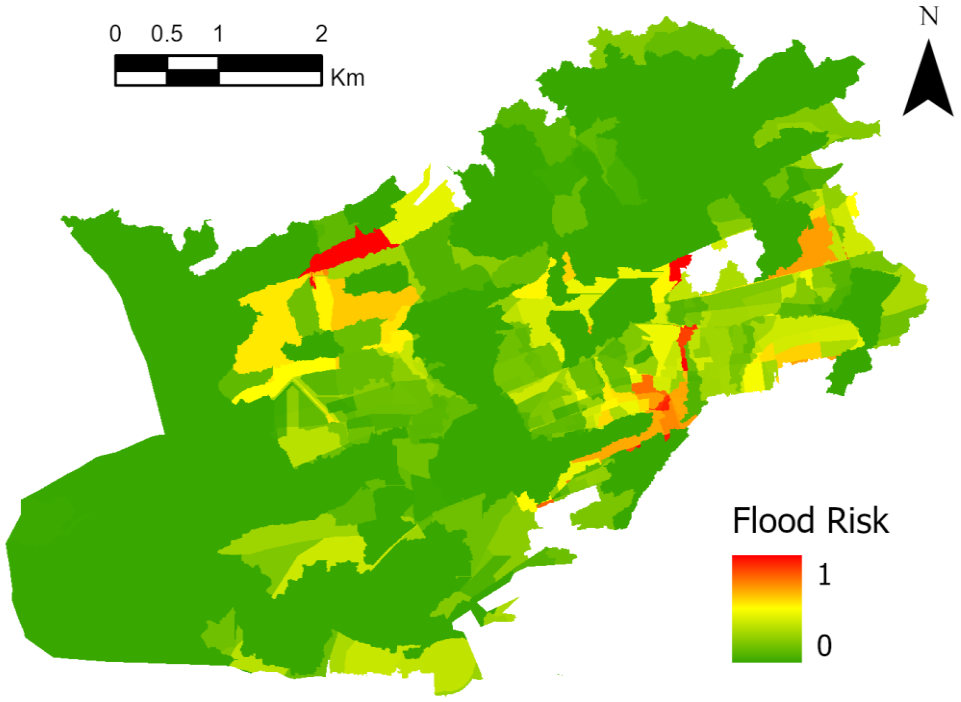
Flood Hazard



(1)

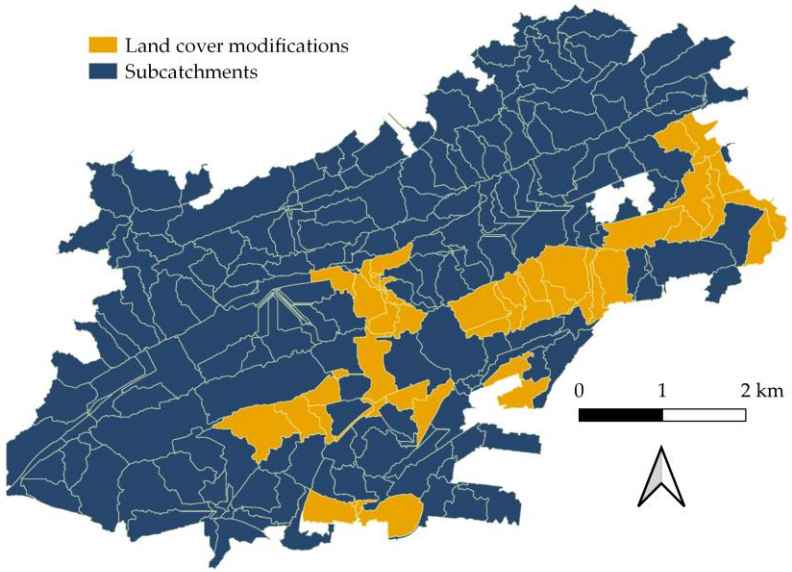
Flood Vulnerability





Flood Risk

Research Results



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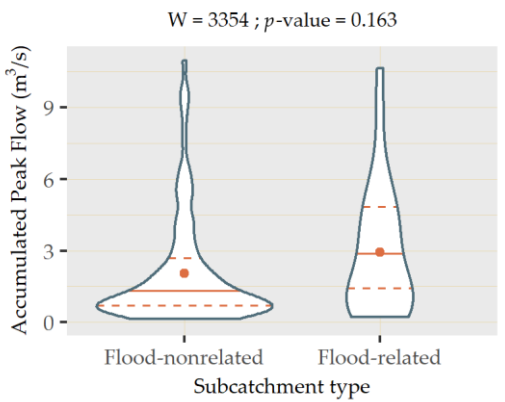
10%



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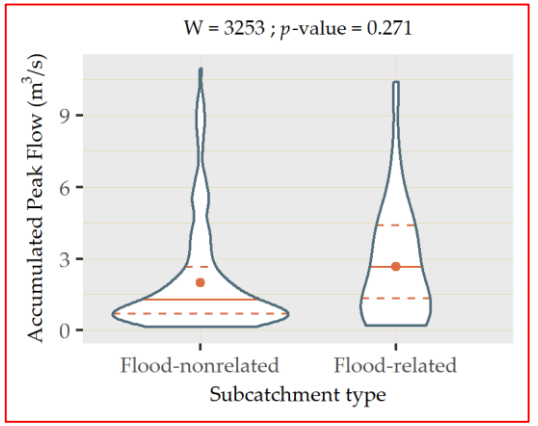

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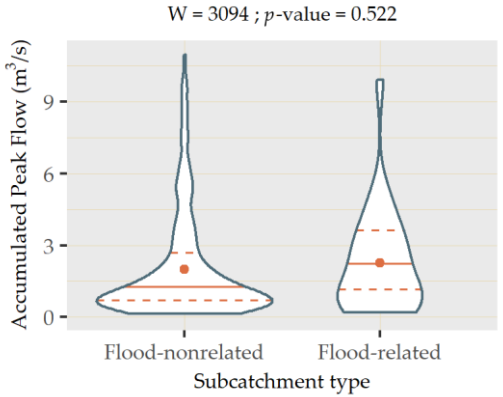

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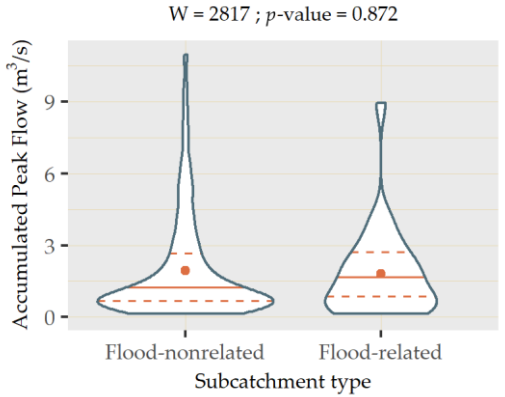

Main conclusions

1. The hypothesis that spatial variables can be used to locate risk areas and assess the effectiveness of NBS in risk mitigation was confirmed.
2. Effective methodologies were developed to identify environmental hazards and vulnerable areas in cities.
3. Nature-Based Solutions demonstrated their potential to mitigate environmental risks in urban areas.

Future working plan

- Automated scenario creation through AI.
- Integration models into a single add-in.
- Enhancement models.
- Gamification.

Thank you

Alejandro Roldán

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Bibliography

(1) Manchado, C., Roldán-Valcarce, A., Jato-Espino, D., & Andrés-Doménech, I. (2021). ArcDrain: A GIS Add-In for Automated Determination of Surface Runoff in Urban Catchments. International journal of environmental research and public health, 18(16), 8802.

(2) Jato-Espino, D., Manchado, C., Roldan-Valcarce, A., & Moscardo, V. (2022). ArcUHI: A GIS add-in for automated modelling of the Urban Heat Island effect through machine learning. Urban Climate, 44, 101203.