Climate change adaptation in the Llobregat Delta: local response-ability

Anna Marín Puig

Universitat Autònoma de Barcelona

Tesi Doctoral

Climate change adaptation in the Llobregat Delta: local response-ability

Anna Marín Puig

2023

Programa de Doctorat en Geografia

Dirigida per Dr. Eduard Ariza Solé i Dr. Antònia Casellas Puigdemasa

Departament de Geografia (Facultat de Filosofia i Lletres)
Universitat Autònoma de Barcelona (UAB)

Abstract

Uncertainty has evolved as a subject of analysis in parallel with the growing acknowledgment of challenges associated with predicting the behaviours of complex systems. In the field of environmental science and climate change research, various measures and management strategies for uncertainty have been proposed for distinct purposes. The aim of this thesis is to investigate the roles of uncertainty in relation to local response capacities in situations of high complexity and change. I endorse an understanding of uncertainty as a relational factor at the core of response-ability, distinguishing three main human response attitudes: (i) efforts to minimize it, (ii) accepting it as inherent, and finally, (iii) seeing it as a window of opportunity for transformation. Each one corresponds to a different depth of responsive change (coping, adaptive, transformative) and is addressed from three different theoretical backgrounds (risk assessment, knowledge-for-governance, affective adaptation, and sense of place).

For each theoretical framework, I have developed an analytical approach designed to address different natures of uncertainties considered relevant to the case study of the Llobregat delta (Barcelona). To achieve this, a variety of methods is employed, which encompass remote sensing techniques for mapping deltaic floods during compound extreme rainfall-wave events. I also rely on post-normal uncertainty assessments to enhance knowledge quality in adaptation policy assessment. Finally, I explore metaphorical place-framing analysis and sense of place processes through dynamic discourse.

The results identify different sources of uncertainty acting as a clear social barrier to local response-ability. First, uncertainties are located in the available flood-exposure data at the local level, for example, due to the low integration of multiple and interacting drivers of change, such as the intersection of fluvial, pluvial, and marine flooding. Second, uncertainties in the knowledge governance sustaining local adaptation policy processes undervalue place-based vulnerability assessments. Third, uncertainties emerge from territorial conflicting place-frames, which are difficult to address solely through political and cognitive understanding. Overall, this thesis contributes to the academic literature on local barriers to adaptation by integrating insights from various academic approaches that deal differently with uncertainty and are related to nested levels of change.

Resum

L’estudi de la incertesa ha evolucionat com a objecte d'anàlisi per si sol en paral·lel a l'augment dels reptes associats a la predicció del comportament de sistemes complexos. En el camp de les ciències ambientals i del canvi climàtic s'han proposat diverses mesures i estratègies de gestió de la incertesa amb diferents propòsits. L'objectiu d'aquesta tesi és investigar els rols de la incertesa en relació amb les capacitats de resposta locals en situacions d'alta complexitat i canvi. Presento una comprensió de la incertesa relacional distingint entre tres actituds humanes principals: (i) esforços per minimitzar-la (ii) acceptar-la com inherent, i finalment, (iii) veure-la com una oportunitat de transformació. Cada una correspon a una capacitat diferent davant del canvi climàtic (fer front, adaptar, transformar) i es tracta des de tres marcs teòrics diferents (avaluació de riscos, qualitat del coneixement per a la governança, i adaptació afectiva a través del sentit del lloc).

Per cada marc teòric he desenvolupat un marc analític pensat per abordar diferents naturaleses d'incerteses considerades rellevants en el cas d’estudi de la inundació del delta del Llobregat (Barcelona). Una pluralitat de mètodes associats a cada marc analític ha estat aplicat en aquesta recerca. Primer, tècniques de teledetecció per cartografiar una inundació a l’àrea d’estudi. Segon, tècniques d’avaluacions d'incertesa post-normal aplicades als plans locals d’adaptació. Tercer, l'anàlisi del discurs a través de metàfores sobre el sentit del lloc (i el seu potencial transformador) en processos de conflictes territorials.

Els resultats identifiquen com diferents fonts d'incertesa actuen com a barrera social per a la capacitat de resposta local. Primer, els mapes disponibles d’exposició a la inundació no contemplen les incerteses associades a la complexitat del risc a escala local, per exemple, no integren la intersecció i simultaneïtat d'inundacions fluvials, pluvials i marines. Segon, les incerteses vinculades a la governança del coneixement que sustenten els processos de polítiques d'adaptació local infravaloren les avaluacions de vulnerabilitat en l’anàlisi del risc. Tercer, les incerteses que sorgeixen de les visions confrontades del lloc demostren que son difícilment tractables només des d'una comprensió tècnica i política. En conjunt, aquesta tesi contribueix a la literatura acadèmica sobre les barreres locals per a l'adaptació al canvi climàtic, mitjançant la integració d'idees de diverses aproximacions acadèmiques que aborden la incertesa de manera diferent.

Resumen

El estudio de la incertidumbre ha evolucionado como objeto de análisis en paralelo al aumento de los retos asociados a la predicción del comportamiento de sistemas complejos. En el campo de las ciencias ambientales y del cambio climático se han propuesto diversas medidas y estrategias de gestión de la incertidumbre con propósitos distintos. El objetivo de esta tesis es investigar los roles de la incertidumbre en relación a las capacidades de respuesta locales en situaciones de cambio y alta complejidad.

Presento una comprensión de la incertidumbre relacional distinguiendo entre tres principales actitudes humanas: (i) esfuerzos para minimizarla (ii) aceptarla como inherente, y finalmente, (iii) verla como una oportunidad de transformación. Cada una corresponde a una capacidad distinta ante el cambio climático (afrontar, adaptar, transformar) y se trata de tres marcos teóricos diferentes (evaluación de riesgos, calidad del conocimiento para la gobernanza, adaptación afectiva a través del sentido del lugar), respectivamente.

Para cada marco teórico he desarrollado un marco analítico pensado para abordar diferentes naturalezas de incertidumbre consideradas relevantes en el caso de estudio del delta de Llobregat (Barcelona). Una pluralidad de métodos asociados a cada marco analítico se ha aplicado en esta investigación. Primero, técnicas de teledetección para cartografiar una inundación en el área de estudio. Segundo, técnicas de evaluaciones de incertidumbre post-normal aplicadas a los planes locales de adaptación. Tercero, análisis del discurso a través de metáforas sobre el sentido del lugar (y su potencial transformador) en procesos de conflictos territoriales.

Los resultados identifican cómo diferentes fuentes de incertidumbre actúan como barrera social para la capacidad de respuesta local. Primero, los mapas disponibles de exposición a la inundación no contemplan las incertidumbres asociadas a la complejidad del riesgo a escala local, por ejemplo, no integran la intersección y simultaneidad de inundaciones fluviales, pluviales y marinas. Segundo, las incertidumbres vinculadas a la gobernanza del conocimiento que sustentan los procesos de políticas de adaptación local infravaloran las evaluaciones de vulnerabilidad en el análisis del riesgo. Tercero, las incertidumbres que surgen de las visiones confrontadas del lugar demuestran que difícilmente se pueden tratar solo desde una comprensión técnica y política. En conjunto esta tesis contribuye a la literatura académica sobre las barreras locales en la adaptación al cambio climático mediante la integración de ideas de distintas aproximaciones académicas que abordan la incertidumbre de diferente manera.

Acknowledgements

Gràcies Eduard i Antònia per haver-me donat l'oportunitat d'iniciar aquesta etapa. Un autèntic privilegi que m'ha permès tenir el temps i els mitjans per aprofundir en aspectes acadèmics a través d'una temàtica que m'apassiona. Gràcies per l'empenta em va permetre assistir a la Tranformation Conference (2019, Xilè), una experiència transformadora que ha marcat el transcurs de tota la recerca. Gràcies per fer possible la influència d'en Paulo a les nostres recerques, un veritable impuls de motivació i de creativitat. Agraeixo també el seguiment i la vostra gran disponibilitat al llarg de tots aquests anys. Però sobretot, gràcies per la confiança dipositada en mi en tot moment, una confiança que m'he fet meva i que m'ha permès explorar diferents camins sense por i disfrutant del procés.

Merci également à François de m'avoir ouvert les portes du CIRAD dans l'une des périodes les plus compliquées de ces années, de m'avoir offert une font d'inspiration et direction renouvelée qui a ravivé mon enthousiasme, et pour une complicité qui est restée jusqu'au bout.

A tots els membres del grup, especialment el Gino (company de viatge des del començament), la Javi i l'Ale (gràcies pel suport amb els gràfics) amb qui hem mantingut una relació de recolzament i profunda confiança en els nostres processos paral·lels. També a la Lili i la Bri, les meves companyes 'proposadores', amb qui hem mirat més enllà del doctorat. Agraïments també per la Deisi, pel desplegament fet sobre el terreny. També al Miquel per engrescar-se amb els mapes. I a tot el departament de geografia, també els que ja no hi són, els doctorands que han anat succeint molt abans que jo i que m'han recolzat des de la distància, els que s'han anat jubilant,… gràcies a tota la comunitat del departament de geo per la quotidianitat i familiaritat de tants anys que reconforta.

Als companys de la Taula del Llobregat, que em van integrar al grup promotor i amb qui he après ha vincluar l'activisme i la recerca, fent-me sentir una actora més de la conca i de retruc del cas d'estudi. Gràcies especialment a l'Annelies, en Jep i en Jordi pel suport en l'organització de la jornada al Palau Robert, per compartir informacions i documentació local de gran interès per la recerca. Un record molt sentit per en Pep que

creia tan en la meva recerca i que em va invitar a donar la meva veu en programes de ràdio i documentals. En Pep però també a en Paulo, que m'hauria agradat que veiéssin com finalment hi posava el punt final. També un agraïment especial a les persones entrevistades per la seva amabilitat i disponibilitat per compartir el seu temps i participar d'aquesta recerca.

Finalment, a tots els familiars i amistats més estimades, pel recolzament, l'afecte i la perseverança. Especialment a la a la Tere i a l'Enric que seguiu sent el meu suport incondicional. Aquesta mare que sino fos tan super-àvia jo no hauria pogut acabar. I al Karim i al Nil, gràcies per la paciència i comprensió, que de tant petits que éreu quan vaig començar que ara no us imagineu que farà la mama si no és el doctorat.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS:

ACA Agència Catalana de l'Aigua (Catalana Water Agency)

AMB Àrea Metropolitana de Barcelona (Barcelona Metropolitan agency)

EIA Environmental Impact Assessment

IPCC Intergovernmental Panel on Climate Change

KQA Knowledge Quality Assessment

ZEPA Special Protection Area for Birds

1. INTRODUCTION

1.1. Setting the context

'It's the End of the World as We Know It'[1] is the title and leitmotiv of a well-known song characterized by its frenetic, chaotic, and rushed delivery of words, which nicely conveys our accelerated changing world. Such global and climate changes are adding to an increasingly complex and uncertain planet that we cannot fully understand or control (Sardar, 2010). While changing earth conditions transcends the territory on all spatial and temporal scales (Steffen et al., 2018), its impacts take place in specific places where uncertainties are perceived, and response needs to happen. Incremental and transformative responsive changes are required, whether to guide societies away from high-carbon living or in response to the increasing impacts of a changing climate (Fazey et al., 2018).

Whereas human adaptation is unavoidable (Parry et al., 2008), dominant approaches to addressing the climate crisis to date have been insufficient (IPCC, 2022). On one hand, societies hardly move towards sustainability transitions. The same patterns and inertias linked to our dominant economic model of development and technical approaches to problem-solving persist, and they are failing to deaccelerate main socioeconomic and ecologic trends (Steffen et al., 2015). On the other hand, implementation of climate change adaptation measures is rather lacking (Woodruff & Stults, 2016). Quoting the latest IPCC report, 'across all sectors and regions, observed human adaptation is dominated by small incremental, reactive changes to usual practices often after extreme weather events' (IPCC, 2022:71). The slow progress in planned climate change adaptation is a topic addressed in academic literature through the concepts of 'barriers' and 'limits' to adaptation (Moser & Ekstrom, 2010).

Several socioeconomic, institutional and cognitive barriers to anticipatory adaptation planning exacerbate in smaller towns and cities, where decision-making power is more limited and resources are scarcer than in main urban areas (Paterson et al., 2017). The most frequently cited barriers of small agglomerations (less than 100,000 inhabitants) are

[1] Album *Document* (1987) by the rock band R.E.M., and it was also referenced in Ioan Fazey's keynote presentation at the Leverage Points 2019 Conference (Leuphana University.

a lack of sectorial and jurisdictional competence, crowded municipal agendas, insufficient skills to design adaptation policies and economic constraints on implementing measures (Measham et al., 2011; Reckien et al., 2015; Simonet & Leseur, 2019). While barriers are theoretically expected to be surmountable, in practice, they may function as a 'limit' to adaptation if the necessary capacities cannot be mobilized to overcome these challenges (Leichenko & O'Brien, 2019).

Barriers and limits are posing a serious compromise to communities exposed to multiple interacting stressors. Coastal areas are the paradigmatic example of climate change exposure (Neumann et al., 2015). Among them, delta regions are identified as global hotspots of climate-change vulnerability and risk due to the concentration of people and engineering infrastructures, as well as the intrinsically dynamic nature of coastal systems (Hill et al., 2020; MedECC, 2020; Renaud et al., 2013). The occurrence of multiple and interacting drivers of change as discussed by Ibáñez et al. (2019) or Nicholls et al. (2020) introduces a high degree of complexity into deltaic environments. Likewise, deltas serve as excellent laboratory-regions in which all sources of uncertainty are amplified. The Llobregat delta in the metropolitan area of Barcelona, represents an icon of complexity, dynamic changes and a diversity of contested threats (Germain, 2018; Pino & Isern, 2018).

1.2. The research problem addressed

Social, cognitive and non-exogenous adaptation barriers, as discussed by Adger et al., (2009), are increasingly addressed to better understand why adaptive capacity does not necessarily translates into action (Adger & Vincent, 2005; Mortreux & Barnett, 2017). Likewise, Pelling & High (2005) acknowledge the difference between latent capacity and mobilizing capacity. This gap between capacities and action poses a research challenge: to better understand why we do not respond effectively to climate change. Subjective and relational factors, such as agency, need to be considered in addition to objective measures of capacity (assets-based approach) and to view them as reflexive, dynamic, and subject to social and temporal differentiation (Brown & Westaway, 2011). Psycho-social factors including risk perception, place attachment, or competing concerns, are a central focus of this research (Mortreux & Barnett, 2017), equally to address incremental and transformative agentic responses to climate change (Marshall et al., 2012; Quinn, Bousquet, & Guerbois, 2019; Ziervogel, 2008).

The argument of this thesis is that perspectives and attitudes toward uncertainty can add relevant insights to this research challenge, both in terms of mobilizing existing capacities and enhancing limited capacities. Accordingly, it positions uncertainty as the central axis of the analysis of local response capacity by asking how different approximations to uncertainty contribute to adaptive and transformative capacity building. Indeed, as Armitage & Plummer (2010:290) pondered 'Why are we concerned about building adaptive capacity? The short answer is to deal with change and uncertainty'. This leads us to the subsequent question: how do we deal with uncertainty? Based on a relational approach of uncertainty relative to the deep of change I distinguish between three attitudes towards uncertainty: reducing (cope), accepting (adaptive), celebrating (transformative). Such a relational approach to uncertainty encompasses the range of Walker's et al. (2003) nature of uncertainty extremes: from epistemic uncertainty (imperfection of knowledge) to ontological uncertainty (unpredictability of the system).

These triple entryways to uncertainty articulated the three research questions which are explored through the application of three distinct theoretical frameworks. Incremental changes to reduce the risk of not knowing (*doing things better*) is studied through the theorical frame of **risk-based management** (see section 2.2). Critically redefining how we handle uncertainty through democratic means (*doing better things*) is conceptualised through the lenses of **post-normal science** (see section 2.3); and third, celebrating uncertainty as a way out of a dominant paradigm (*seeing things differently*) is reached through **affective adaptation** (see section 2.4). These three thematic strands, though apparently disconnected, are chained together, each contributing to differentiated understandings of capacity-uncertainty relationships.

The three complementary orders of change to address uncertainty are inspired by Bateson's levels of learning (1972), and subsequent models based on it (Argyris & Schön, 1978). As shown in Fig. 1 they are nested systems, where higher-order learning impacts the lower levels.

1.3. Research questions

The central guiding question is to identify the factors, processes, and relationships that inhibit local responsiveness to global climate change by interrogating how different approximations to uncertainty contribute to adaptive and transformative capacity building. The research process is organized around three distinct inquiries, each approached from different perspectives on uncertainty. The following questions are

addressed using the same case study, the non-urbanised areas of the southern lobe of the Llobregat delta.

QUESTION 1. What are key spatial uncertainties in municipal flood exposure data associated to complex compound climatic events?

QUESTION 2. Is the place-based vulnerability knowledge used and produce in adaptation plans useful to enhance local adaptive capacities?

QUESTION 3. How do competing place-framing processes affect community awareness and local response-ability to change and uncertainty?

1.4. Objectives

Human adaptive and transformative capacities to changing environmental conditions rely heavily on attitudes and approaches towards the emergence of multiple uncertainties. Starting with a relational view of uncertainty as a multi-level learning process, the principal aim of this dissertation is to explore community response capacities to reduce local vulnerabilities by focusing on three different understandings of uncertainty as interconnected orders of change. Three secondary objectives are presented, each aligned with one of the three levels of response capacity and change. Within each layer of change, uncertainty is examined with regard to risk assessment, knowledge governance and the inner dimension of affective and discursive agency.

i) Reducing the risk of not knowing

Acknowledging the complexity involved in assessing local hazard exposure, which involves considering interconnected and compounded hazards, along with contextual vulnerabilities, the goal is:

- to identify non-urbanised areas that are the most exposed to coastal flooding in the southern lobe of the Llobregat delta.

ii) Quality in the knowledge-governance interface

Elevating contextual complexities in place-based vulnerability assessments as a critical component in developing effective adaptation plans, the goal is:

- to analyse the quality of context-specific knowledge in local adaptation plans relative to its usefulness in fostering adaptive capacities.

iii) Conflicting place-frames through affective lens

Acknowledging that transformative capacities necessitate more than just a cognitive understanding of change and uncertainty, the goal is:

- to explore the affective dimensions of conflicting place-framing process and its role for deliberate transformative changes.

Chapter 2

2. THEORETICAL FRAMEWORK

The chapter sets the stage by offering an essential context for climate change adaptation strategies and placing them within the broader framework of global environmental governance. It highlights the challenges faced by cities and towns in responding to a changing climate and global climate agendas. Despite increased research on adaptation (Preston et al., 2015) and policy development (Reckien et al., 2018), implementation of adaptation measures is residual, limited to small incremental changes with minimal progress in reducing local vulnerabilities (IPCC 2022). A commonly cited barrier to developing and implementing adaptation strategies is uncertainty. Framed as a wicked and complex policy issue (Rittel & Webber, 1973), uncertainty is inherent in climate change adaptation plans. However, the connotations of uncertainty differ between incremental strategies and transformative ones. In incremental strategies, uncertainty is usually approached as a manageable, quantifiable and predictable factor, whereas in transformative strategies uncertainty entails more radical and unpredictable changes that require a different understanding and response.

Accordingly, human adaptative and transformative capacities regarding climate change vulnerability rely heavily on how uncertainties are understood and responded to (Scoones & Stirling, 2020). From this stance, a relational approach to uncertainty is presented and illustrated through three distinct lenses that are analogous to the scales for change proposed by Pahl-Wostl (2009). Such a relational approach to uncertainty encompasses both Walker's et al. (2003) nature of uncertainty extremes: epistemic uncertainty (imperfection of knowledge) and ontological uncertainty (unpredictability of the system). In between, it also incorporates a third nature of uncertainty, as proposed by Brugnach et al. (2008), which includes uncertainties arising from diverse and sometimes contradictory problem framings. The understanding and recontextualisation of uncertainty in relation to the three orders of change directly impacts the mobilisation of distinct response capacities.

Building on organisational change literature, and according to the depth of change, it has become common to distinguish between three orders of change (Argyris & Schön, 1978), which stem from Bateson's learning levels (1972). First-order change (or incremental change) aims to do things better within the existing logic and taking the context as a given. Second-order change is characterised by a process of reframing problems, practices and assumptions within a value-normative framework. Third-order change emphasises the

meta level of change and aims to 'change the way we change' (Termeer et al., 2017: 561). This capacity refers to the human 'experience of seeing our worldview rather than seeing with our worldview so that we can be more open to and draw upon other views and possibilities' (Sterling, 2010:23).

1st order: Positivistic uncertainty (*Uncertainty as a lack of knowledge)*. From this standpoint, human capacities are mainly expected from the scientific community. As regards climate change adaptation, the demand is to provide more accurate risk assessments. This is the epistemic uncertainty, or incomplete knowledge (Walker et al., 2003) due to lack or unreliability of available data, gaps in theoretical understanding or ignorance. The aim is to reduce epistemic uncertainty by gathering more data, downscaling models, communicating the range of uncertainty to decision-makers through probabilistic scenarios, etc. Reflecting on this positivist view of uncertainty, **section 2.2**. introduces climate risk management by pointing to uncertainties related to complex flood risk assessment in coastal areas.

2nd order: Post-normal uncertainty *(Uncertainty as an opportunity in processes of reframing and rethinking preconceived assumptions)*. Building upon a sincere recognition of irreducible uncertainties and the impossibility of neutral knowledge, the aim is to embrace a plurality of epistemologies. This raises questions of purpose and values (how and by whom decisions are made). As regards climate change adaptation, it entails wider participation in the science-policy process to ensure inclusiveness. Capacity-building stems from cultivating reflexive abilities and social learning among academics, practitioners and the affected population. In **section 2.3**, the pertinence of a post-normal view of uncertainty within the context of adaptation planning is examined in both knowledge-production processes (transdisciplinary approaches) and quality of adaptation knowledge for policy (Knowledge Quality Assessment).

3rd order: Transformative uncertainty ***(****Uncertainty as a chance to transform the context)*. This refers to the ontological nature of uncertainty, the unpredictability due to inherent variability (Walker et al., 2003). This positioning explores ways of living and sensing deep uncertainty to open up new possibilities for being, thinking and acting. Beyond the anxiety and fear driven by situations involving crisis, urgency and indeterminacy, this approach embraces uncertainty to allow room for hope, leading to an emancipatory politics for the future (Scoones & Stirling, 2020; Solnit, 2020). Uncertainty is inherent in a transformative process, and it is the catalyst for affective agency to emerge

(McManus, 2011). Capacity-building stems from the recognition of a multiplicity of trajectories arising from a relational ontology, as well as the contestation of emplaced subjectivities embedded in place-based affective relationships (Bousquet; et al., 2022; Nightingale et al., 2022; Massey, 2005). **Section 2.4** builds on sense of place literature to delve into affective adaptation to climate change in response to transformative changes.

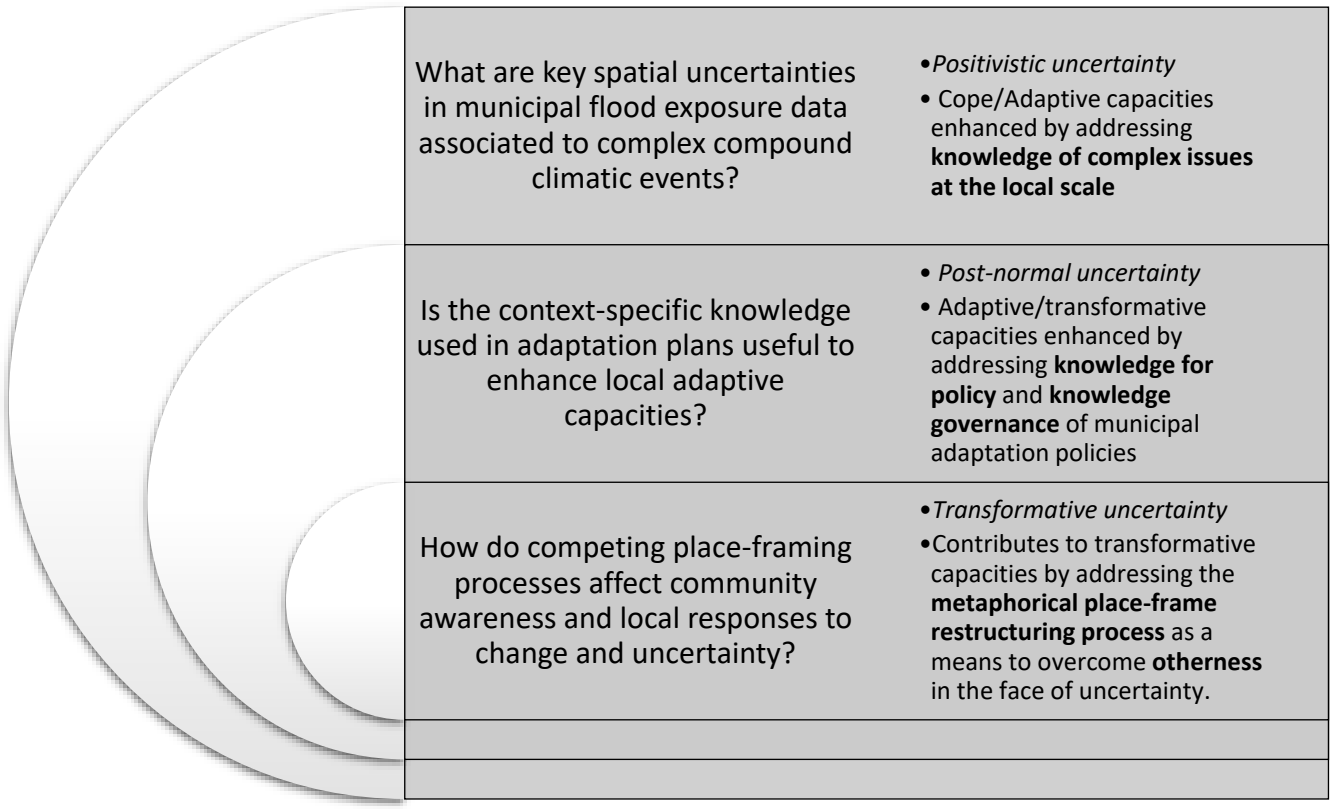


Fig. 1 Thesis structure according to the three uncertainty-capacity relationships chosen to answer the main research questions. Source: own production.

2.1. Incremental and transformative adaptation to climate change at the municipal level

'Only One Earth' was the motto for the first World Summit. The 1972 Stockholm Conference was the starting point for the international community's debates on principles to preserve the quality of life on Earth. Global environmental governance was formally settled in Stockholm (via the establishment of the United Nations Environment Programme, UNEP) and was given a greater impetus by the institutions created at the Rio Earth Summit in 1992 (Najam & Muñoz-Cabre, 2009). However, to date, countries have barely moved towards sustainability transitions (Nightingale et al., 2019) and instead have implemented similar patterns and fallen into the same inertias, which are failing to deaccelerate the main socioeconomic and ecologic trends (Steffen et al., 2015).

Although it is a global matter, climate impacts and the responses to it are felt on the local scale. This municipal-city responsibility traces its roots back to the 1992 Earth Summit in Rio de Janeiro, where the catchphrase 'Think globally, act locally' was coined. Cities and municipalities have become prominent players in climate governance at the national, European and global levels, a role that was made internationally official at the 2015 Paris Climate Conference (Paris Agreement, 2015). The signing of the Paris Agreement on Climate Change in 2015 was aimed at limiting global warming to 2ºC (ideally to 1.5ºC) by the end of the twenty-first century (Paris Agreement, 2015).

This temperature target represents a shared recognition that the implications of climate change are alarming, unevenly distributed and costly, and that the adaptation struggles will increase as global temperatures rise. In considering adaptation options, radical differences need to be acknowledge between low-end and high-end scenarios of climate change in terms of both rising temperatures and tipping points (Leichenko & O'Brien, 2019; Lenton, 2013). As stated in the latest IPCC report, keeping temperatures well below 2°C, as per the Paris Agreement, involves much more than incremental changes but instead necessitates significant transformative system changes (Fazey, Carmen, et al., 2018; IPCC, 2022).

2.1.1. Local adaptation planning challenges

While climate governance was initially led by mitigation debates, today climate change adaptation is acknowledged as unavoidable (Fazey, Carmen, et al., 2018; Parry et al., 2008). Regardless of efforts to mitigate greenhouse gas emissions, we are already

experiencing changes which will dramatically accelerate and intensify in the near future (Steffen et al., 2018). Climate change adaptation in human systems is defined in the latest IPCC report as 'the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities' (IPCC, 2022:2898). Broadly speaking, adaptation is a 'change' made in response to new conditions (Leichenko & O'Brien, 2019). Different types of adaptation have been distinguished based on how this 'change' is made, including anticipatory versus reactive, autonomous versus planned and incremental versus transformational adaptation (IPCC, 2022).

Anticipatory adaptation planning generally entails a process of iterative risk assessment and management (see 2.2.1). Common adaptation stages are awareness, assessment, planning, implementation and monitoring and evaluation (IPCC, 2022). The need for public participation and community engagement has featured prominently since Rio '92 and has been welcomed in local adaptation planning as a growing capacity need (Hügel & Davies, 2020; Moser & Pike, 2015). Close proximity to stakeholders and communities provides local decision-makers with the opportunity to implement participatory processes that are specifically tailored to community-based practices, leveraging local knowledge and its contexts. Furthermore, cities' and municipalities' climate change adaptation plans are asked to be aligned with and reinforced by the sustainable urban development paths framed in the United Nations Sustainable Development Goals (SDGs) (Sanchez Rodriguez et al., 2018).

Yet several socioeconomic, institutional and cognitive barriers to anticipatory adaptation planning (Moser & Ekstrom, 2010) are exacerbated in smaller towns and cities, where decision-making power is more limited and resources (of all types) are scarcer (Paterson et al., 2017). The most frequently cited barriers to local (and small) jurisdictional adaptation strategies are a lack of sectorial and jurisdictional competence, crowded municipal agendas, insufficient skills to design adaptation policies and economic constraints on implementing measures (Measham et al., 2011; Reckien et al., 2015; Simonet & Leseur, 2019). On the other hand, some authors have suggested that limited resources can act as a driver, as they might contribute to flexibility, innovation and creativity (Anguelovski & Carmin, 2011; Ziervogel, Archer van Garderen, et al., 2016).

To support urban emissions reductions and adaptation at a sub-national level, a variety of international and regional city networks (C40 Cities Climate Leadership Group, ICLEI International Council for Local Environmental Initiatives, the Compact of Mayors, the

Regional Learning Network-Latin America) have been established in the last two decades. In Catalonia, municipalities at the forefront of adaptation planning were under the umbrella of the European Covenant of Mayors Initiative on Adaptation to Climate Change (Mayors Adapt, 2014). The municipalities that joined the initiative were asked to develop the 'Pla Local d'Adaptació al Canvi Climàtic' (PLACC) and commit to contributing to the overall aim of the EU Adaptation Strategy (European Comission, 2013). Most of them were already signatories of the Covenant of Mayors (CoM, 2020 goal) and had previously developed their corresponding local mitigation plan ('Pla d'Acció d'Energia Sostenible, PAES'). The Covenant of Mayors and the Mayors Adapt initiatives officially merged in the EU Parliament in October 2015 (see Fig. 2). The new Integrated Covenant of Mayors for Climate and Energy (hereafter, the Covenant) is a transnational climate network of cities based on a multilevel-governance model and is a key driver in boosting the adaptation plans of small agglomerations (Reckien et al., 2018). Signatory cities pledge action to support implementation of the new 2030 EU targets Fig. 2.

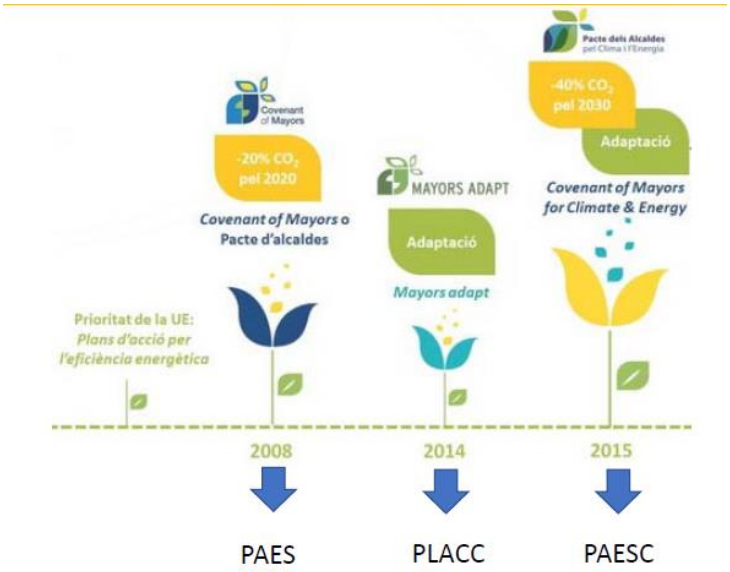


Fig. 2 The forerunners of the Covenant of Mayors for Climate & Energy and its translation into municipal mitigation and adaptation plans in Catalonia. Source: adapted from Diputació Barcelona (2018).

While these networks have been shown to provide a platform for greater engagement and the spread of climate change adaptation into local agendas, many current adaptation efforts are actually adaptation planning rather than implementation (IPCC, 2022). Indeed, the focus on the local scale does not mean higher efficiency in implementing strategies in response to climate impacts (Simonet & Leseur, 2019; Woodruff & Stults, 2016). This

means that local adaptation plans are not *per se* translating into on-the-ground reductions in vulnerability. However, the goals of the Paris Agreement are attainable if medium-sized and small cities and towns are included and initiatives are not limited to most leading larger cities in metropolitan regions (Kern, 2019; Simonet & Leseur, 2019). As Kern noted, 'around 40% of Europe's population lives in non-metropolitan regions (Eurostat 2016), and even in metropolitan regions many suburban cities and towns have not developed any relevant strategies' (Kern, 2019:126).

2.1.2. Diverse climate change discourses

The common way society responds to a changing climate is under the frame of an 'environmental problem' that needs to be addressed by reducing emissions and protecting potential human and economic damage through adaptation efforts. But this is not the only way to understand and address climate change. There are alternative framings of climate change, or in the words of Leichenko & O'Brien (2019:41), answers to the question: 'What kind of a problem is climate change?' This is a key question, as how we define a problem influences the types of solutions that will be identified and prioritised. Building on several previous works (Leichenko & O'Brien, 2008; O'Brien et al., 2007), the same authors distinguish between the biophysical, critical, resilience,[2] integrative and dismissive discourses. Below, I expand on these five discourses, which clearly align with the three recontextualizations of uncertainty presented in this dissertation. This expansion not only enhances our comprehension of each discourse in the context of a changing climate but also sheds light on the types of capacities (academic, governance, individual), and proposals for transformative change mobilised in each way of sensing climate change.

To systematically illustrate the interplay between various discourses, uncertainty and capacities, Table 1 categorically encapsulates them, aligning with the structural framework proposed in this thesis. Despite the effort of simplification (Tab. 1) these categories are not rigid or mutually exclusive, and there is no clear demarcation line between them, as the diverse lines of thought often interconnect and influence one another. This table is not meant to be exhaustive, but rather serves as a reference point to highlight some of the primary aspects discussed throughout this thesis. Therefore, the purpose is to summarize the key characteristics of climate change discourses, serving to organize and provide structure to this theoretical chapter.

[2] The resilience discourse is not included in Leichenko and O'Brien (2019).

The first one, the **biophysical discourse**, the most prevalent discourse on climate change, is the one articulated by Earth-system science research, emission scenarios and global climate models. The identification of the Anthropocene as a new geological epoch distinguished by the human influence on Earth-system processes is the hallmark of this biophysical discourse (Steffen et al., 2015). It is based on the positivistic assumption that more data and greater scientific knowledge will reduce the climate change uncertainties of potential climate futures. The science-policy interface is of paramount concern within the biophysical discourse, especially in promoting techno-managerial responses and solutions (see 2.1.3). This is the dominant discourse endorsed by local adaptation plans (2.1.1), in which the attitudes and responses towards uncertainty are equivalent to positivistic uncertainty, that is, formally seeing uncertainties as risks. As regards individual and collective human responses, as noted by Leichenko and O'Brien, the biophysical discourse emphasises the role of individual behavioural and attitudinal changes towards sustainable practices (recycling, bicycling, etc.), focusing on the power of individual choice 'rather than… collective action, social struggle, and political change' (2019:47).

In essence, the primary narrative surrounding climate change has overlooked social theory (Shove, 2010). In response, **critical discourse** questions biophysical sense-making 'dominated by the natural sciences and focused on environmental rather than social change' (Lövbrand et al., 2015: 211). From this lens, global environmental change is a 'social problem' and must be redressed by challenging the power and economic structures that perpetuate it. In this line, the concept of 'Capitalocene', as the Age of Capital, captures the causality of climate change more precisely than the concept of Anthropocene (Moore, 2016). Instead of focusing on reducing emissions and impacts, the critical discourse addresses the root causes of risk and vulnerability (Ribot, 2014), including the economic and social processes and inequalities (gender, racial and ethnic discrimination) that contribute to uneven adaptive capacities. Addressing climate change entails revealing underlying causes of social and environmental injustices and questioning the status quo. Stemming from a political discourse, it draws upon social theory to give emphasis to individual and collective capacities to challenge and transform current development trajectories (see 2.1.4).

This second discourse acknowledges a *post-normal uncertainty* (Fig. 1). Adaptation is not a politically neutral process (Eriksen & Selboe, 2015). Researchers from the critical

discourse question the positivistic approaches to science, arguing that science is neither neutral nor unbiased (see 2.3). Instead, they advocate post-normal science approaches (Ravetz, 2006). Accordingly, the discourse emphasises the importance of wider participation in the *science*-policy process to ensure inclusiveness in climate-change related decisions (see 2.3.2), to such an extent that (Ziervogel, Archer van Garderen, et al., 2016) instead call it the *knowledge*-policy process (to include local, managerial, and scientific knowledge). Another discourse that holds significant academic implications in the field of climate change adaptation and shares a similar approach to post-normal uncertainty, particularly in terms of complex system thinking, is the **resilience discourse**.

The discourse on social and ecological system resilience originates in the field of ecology, stemming from the recognition of multi-equilibrium dynamics of ecosystems (Holling, 1973). This discourse expanded into a framework to analyse human-environment dynamics leading to a new object of study known as socio-ecological systems (Berkes et al., 2003). Adaptability and the way complex systems respond to disturbance and change over time are core concepts that have played a crucial role in shaping the development of resilience thinking (Mathevet & Bousquet, 2014). Approaches and tools from this discourse acknowledge social and ecological feedbacks, cross-scale interactions, emergence, shocks, non-linear changes, and the potential for multiple viable pathways (Gunderson & Holling, 2002). This recognition is exemplified through various means, such as identifying thresholds, local knowledge, polycentric governance, or employing adaptive management and co-management strategies to make policy and institutions more flexible in the face of uncertainty (Ostrom, 1990).

While the socio-ecological resilience framework has facilitated encounters among diverse disciplinary backgrounds, concerns have emerged regarding the utility of employing this scientific concept to support and guide development (Béné et al., 2016; Bousquet et al., 2016). Specially by a poor treatment of power dynamics, agency, cultural values, and other normative factors that are essential for the development and functioning of social-ecological systems (Cote & Nightingale, 2012). Moreover, critiques have been raised regarding how the operationalisation of the coupled systems framework inadvertently reproduces the separation it seeks to repair by treating humans and nature as distinct entities (West et al., 2020).

In the context of climate change, it enables a particular emphasis on developing the capacities to understand and navigate change, either through simple adjustments or

profound, transformative structural changes (Tschakert & Tuana, 2012). The term 'transformative capacity' was coined within this discourse by Olsson et al. (2010) to refer to the capacity to transform social-ecological systems' trajectories toward ecosystem stewardship. The academic literature on stewardship has grown exponentially since then (Mathevet et al., 2018), and the importance of values, attitudes, agency, and grassroots knowledge has become a better way to capture people's perceptions of what is worth achieving (Enqvist et al., 2019).

The **inclusive discourse** stems from a holistic perspective which 'sees climate change as interconnected with multiple processes of environmental, economic, political, and cultural change, and closely linked to individual and shared norms, beliefs, values, and worldviews', as well as emotions and narratives (Gibson-Graham, 2011 quoted in Leichenko & O'Brien, 2019:53). It builds on works aimed at challenging dualistic views of nature, mainly from philosophy, geography and feminist theory (Gerber, 1997; Leichenko & O'Brien, 2019). The integrative discourse focuses attention on how subjectivities reflect and influence social systems and human-environmental relationships. Whereas the biophysical and critical discourses stem from either physical or social systems, the integrative discourse erodes the boundaries between the two rationalities. Merging these areas of inquiry goes beyond merely including social science into biophysical frames of analysis (e.g., integrating demographic and economic data in rational-choice models of decision-making and probability-based risk assessment modelling efforts), and it encompasses a plurality of discourses and ontologies (Nightingale et al., 2019; O'Brien & Leichenko, 2019). Beyond the integration of multiple perspectives' expertise and methods, including transdisciplinary approaches to mitigation, adaptation and transformation (Ziervogel, Cowen, et al., 2016), inclusive approaches to climate-change research transcend the exclusively cognitive approaches to learning and embrace a relational ontology.

As regards people's responses to changing environmental conditions, the integrative discourse inquiries into the deeper factors in social systems that influence human behaviours and actions, such as identity, core values and worldviews (Masterson, Stedman, et al., 2017). Cultural codes and hegemonic practices can perpetuate social and environmental inequalities, shaping how we collectively make sense of and respond to a changing environment (Eriksen et al., 2015). At the same time, exposing and challenging those underlying social assumptions 'opens up the possibility for resistance or reframing

of domination; in short, the power to act, or in other theoretical language, agency' (Eriksen et al., 2015: 528). In this sense, the inclusive discourse reinforces the critical and socio-ecological resilience discourses by advocating transformative capacity-building and the role of human agency and affective relationships.

From an ethics of care perspective responsibility is not conceived as a subjective obligation, rather it emerges from 'a practice of relationality and thus can be best framed in terms of response-ability' wherein the acknowledgment of vulnerability and interdependence becomes paramount (Moriggi et al., 2020:5). Affect allows the uncertain, random and ultimately unpredictable effects of transformative effort to be better captured. This frame of uncertainty places values, affects, normative commitments and diverse experiential ways of knowing worldwide at the forefront, so climate change is confronted with 'contested politics and the everyday foundations of action rather than just data' (Nightingale et al., 2019:343). It involves a shift in the operative way of knowing and thinking that shapes people's perception of and interaction with the world (Sterling, 2010).

Finally, the **dismissive** discourse argues that climate change is not a problem. Climate change is denied by dismissing the scientific evidence, the human causes of climate change or its significance relative to other issues (Norgaard, 2011). Although it has scarce relevance in the academic sphere, this discourse holds considerable political influence. A broader interpretation of the dismissive discourse could encompass individuals who acknowledge the significance of climate change but choose to ignore the issue as it feels too distant or overwhelming to address (Leichenko & O'Brien, 2019). Norgaard (2011) refers to this type of socially organised dismissal as implicatory denial, which is explained by Leichenko and O'Brien as an indirect form of denial in which 'knowledge about climate change is accepted but not translated into action' (2019:52). This implicatory denial is somehow equivalent to the 'cognitive dissonance'[3] applied to climate change described in Gancille (2019).

[3] Coined by the psychosociologist Léon Festinger (1957).

Orders of change	Uncertainty frame	Approached in this dissertation through:	Climate change discourse	Paradigms	Academic proposals to deal with climate change uncertainty	Vulnerability	Local response	Proposals for transformative change
FIST	Positivistic	Hazard-exposure local mapping	Biophysical	Modernist (mechanistic)	Risk management	Outcome vulnerability (Fig. 4)	Individual behavioural choice	Technological and engineering development
SECOND	Post-normal	Knowledge Quality Assessment	Critical	Complex (Constructivist)	Plural epistemic; Knowledge co-production	Contextual vulnerability (Fig. 4)	Emancipation; Collective action,	Political ecologist, ecological economics.
			Resilience	Complex (adaptive systems)	Adaptive governance and co-management	Dynamic property of a system	Social learning	Stewardship
THIRD	Transformative	Metaphorical place-framing and senses of place process	Integrative	Relational (transactional)	Affective adaptation (Relational ontology)	Situated, values-based, relationally produced.	Response-ability	Ethics/practices of care

Tab. 1 The three levels of 'depth' in relation to change and uncertainty. This three levels should not be seen as discrete sets as there is clear overlap between them. The table's content does not pretend to be exhaustive; it is intended to facilitate the understanding of the classification proposal through the use of selected examples. Source: own production.

2.1.3. From incremental to deliberate transformation

According to the IPCC (2022), the majority of climate risk management and adaptation currently being planned and implemented is incremental (i.e., maintaining the essence of a system or process at a given scale). Incremental adaptation measures can address reducing sensitivity, altering exposure or increasing resilience to cope with change through technical, managerial or behavioural human interventions (Leichenko & O'Brien, 2019; Park et al., 2012). Technical adaptation refers mainly to engineering (dams, irrigation systems, household rainwater storage, etc.). Managerial options relate to adapting regulations and policy to novel climate conditions (land-use planning, establishment of early warning systems, etc.). Behavioural measures could include changing the timing of agricultural calendars or adjusting outdoor work schedules to avoid heat spikes. All those intervention examples focus on reducing vulnerability or minimising future exposure based on incremental changes.

While incremental adaptation overlaps with risk management, sustainable development and building the resilience of socioecological systems, transformational adaptation is commonly promulgated as extreme actions forced or necessitated by the limits of incremental adaptation (Dow et al., 2013), whereas the limits to incremental adaptation also include adaptation barriers (i.e., factors that hinder adaptation planning and implementation, see 2.1.1) if not enough resources and capacities are mobilised. Incremental adaptation, mostly led by hazard-risk frameworks and vulnerability assessments, have tended to prioritise an impact-focused approach, with adaptive capacity playing a secondary role (Eakin & Luers, 2006). Departing from a biophysical threat, the focus is often on exposure and sensitivity to estimate impacts. To a lesser extent, adaptive capacity is approached as a primary vulnerability factor, but as a modulating variable of damage.

Instead, in transformative approaches the adaptive capacity is brought to the forefront. Transformative approaches to climate change emanate from the critical[4] and resilience[5] discourses (post-normal uncertainty). Indeed, the concept of adaptive capacity is often associated with hazard-risk approaches, but its origins can be traced back to Amartya

[4] Emanating from the root of critical discourse, transformative approaches seek to address not only the reduction of risk but also the underlying issues of social justice (Pelling et al., 2015).

[5] Resilience perspective explicitly deals with transformability, defined as the ability to create a 'fundamentally new system when the ecological, economic, or social structures make the existing system untenable' (Folke et al., 2010:3).

Sen's capabilities theory and the sustainable livelihoods assessments developed in the 1980s and 1990s. Amartya Sen's analytical framework demonstrated that the 1943 West Bengal famine, while triggered by climate stress, also had political-economic causes (1982). When applied to climate change research, the political-economy and political-ecology approach brings human capacity to the core of the theoretical conceptualisation of vulnerability (see critical discourse, 2.1.2). Associated with an individual's ability to make choices and act, adaptive capacity is seen as an essential component of human wellbeing. Hence, efforts to build adaptive capacity play a crucial role in addressing issues related to equity.

Transformational adaptation is a multifaceted concept encompassing diverse interpretations, all of them focusing on the broad notion of fundamental societal change as opposed to change that is minor, marginal or incremental (IPCC, 2022). Distinguishing between incremental and transformational adaptation is not always clear-cut and definitive. Some incremental actions stay incremental, while others may lead to more transformational change over time. Transformational adaptation encompasses social, environmental, and technical domains, focusing on three dimensions: the depth of change, the breadth of change, and the speed of change (Fazey, Moug, et al., 2018). The significance of these three dimensions in determining whether change is considered transformative is subsequently determined by the issues of concern (Fazey, Moug, et al., 2018).

Just like adaptive actions, transformational adaptation can lead to unpredictable desirable or undesirable outcomes (IPCC, 2022). Some types of transformation (e.g., resettlement) may be inevitable regardless of current and future levels of GHG mitigation (IPCC, 2022). However, if emissions levels keep increasing, a more significant degree of 'undesirable forced transformations' will be needed (IPCC, 2022:179). While AR5 identified transformational adaptation as a subject for future research, the latest IPCC report, AR6, has elevated transformational adaptation to the category of core concept (IPCC, 2022). Low emissions pathways consistent with Paris Agreement goals require deep social and technological transformations (Fazey, Moug, et al., 2018; O'Brien, 2018). Likewise, AR6 highlights that transformative system change is required to meet the SDGs (IPCC, 2022).

O'Brien (2012) noted that while 'transformational adaptation' has the capacity to embrace extensive change, it does not necessarily challenge the prevailing power imbalances, and she proposes the concept of 'deliberate transformation', which involves

intentionally creating alternative futures that explicitly incorporate ethics, values and sustainability. The differences between the notions of ‘transformational adaptation’ and 'societal transformation' are described as follows whereas ‘the former tends to denote reactive change in spatially or functionally delimited systems the latter may refer to the redesign of modern societies as a whole, a redirection of civilisation’ (Feola, 2015: 377).

This dissertation supports and builds on this concept of deliberate transformation. The need for transformative changes through an inclusive discourse to address climate change (see 2.1.2) is supported by the lessons learned from the previous 1987 UN Sustainable Development Goals and their insufficient focus on the ontological roots of environmental issues. The concept of sustainable development coined by the Brutland Commission in 1987 turned into a ‘politically correct term’ yet one that is devoid of content and with a limited impact on altering the status quo (Casellas, 2010). The sustainable development agenda had a low impact because it did not question the underlying assumptions of the policies in the prevailing economic system (Najam & Muñoz-Cabre, 2009) which are rooted in the Western notion of ‘development’ (Rist, 2002). Some contend that not only did the ‘sustainability turn’ fall short of altering the primary socioeconomic patterns but it also neutralised the political change that underpinned the environmental and intellectual movements of the 1970s and 1980s (Freire Vieira, 2009; Poli, 2011).

As regards climate change, although numerous scientists use carbon budgets to argue against the current carbon-intensive economy, the perception of climate change as an emissions problem stems from values and social relations that are embedded in the status quo of a global capitalist economy reliant on carbon-based energy forms (Nightingale et al., 2019). Ignoring those human inner variables within adaptive and transformative capacities leads to traps when trying to bring about change (Grenni et al., 2020). Various mechanisms, such as peoples’ opinions and worldviews, underlying norms and values, incentives, power relations and institutions, are embedded in dominant paradigms that do not support transformative shifts (Pahl-Wostl, 2009).

The transformative approach within the inclusive discourse extends beyond the limits of conventional adaptation (Leichenko & O’Brien, 2019; Pelling et al., 2015). It allows for a deepening of these intangible variables of adaptive capacity that interfere with the willingness to adapt and change. As quoted in Horlings et al. (2020:356) ‘conditional for these transformations to occur is a deep adaptation to uncertainty and change, including the emotional and psychological attitudes needed to change awareness and behaviour’.

Making sense of transformations is explored beyond cognitive frames of analysis, including embodied and affective ways of knowing (Berchon & Bousquet, 2021). Additionally, the uses of narratives and metaphors (Linnér & Wibeck, 2019; Riedy, 2022), relational perspectives on ethics/practices of care (West et al., 2018, 2020), collaborative creative processes and arts-based methods (Galafassi et al., 2018; Pearson et al., 2018), collective memories, place-framing and the politics of imaginary futures (Feola et al., 2023) are just some examples of different academic and analytical approaches to better comprehend transformative processes from the inclusive discourse.

2.2. Adaptation to climate change framed as a risk-based management approach

Risk management involves exploring, making and acting on decisions under conditions of uncertainty and complexity (Jones and Preston, 2011:2)

In its 4th Assessment Report in 2007 (AR4), the IPCC noted the need to identify a decision framework for climate change encompassing both mitigation and adaptation and remarked on the expanding use of risk-based management approaches to fill this gap. 'Therefore, risk management is an approach that is being pursued for the management of climate change risks at a range of scales; from the global (mitigation to achieve "safe" levels of GHG emissions and concentrations, thus avoiding dangerous anthropogenic interference), to the local (adaptation at the scale of impact), to mainstreaming risk with a multitude of other activities' (IPCC, 2007:140).

However, as noted by Birkmann and Mechler (2015), adaptation to climate change was not formally framed as risk management until the emergence of two main milestones: the IPCC Special Report on Managing the Risk of Extreme Events to Advance Climate Change Adaptation, hereinafter the SREX report (IPCC, 2012), and the IPCC fifth assessment report (IPCC 2014), hereinafter the AR5. The former stated 'There is high confidence that although hazard events are usually considered the cause of disaster risk, vulnerability and exposure are its key determining factors. Furthermore, contrary to the hazard, vulnerability and exposure can often be influenced by policy and practice, including in the short to medium term. Therefore disaster risk management and adaptation strategies have to address mainly these same risk factors (Cardona et al., 2012).

The emergence of climate-risk management in the field of climate change adaptation can be explained by the intrinsic challenges of linking climate science to practical decision-making on long-term anticipated trends. Some researchers (e.g., Patt, 2013) suggest that mainstreaming climate change into natural-hazard risk management (i.e., focusing on shorter term risks) could build experience and capacity for adapting to longer-term changes. Risk management, a well-established discipline previously applied to natural hazards in many different contexts and at different scales, had the advantage of easily fitting into the climate policy domain. It was found to be a useful approach because it was familiar to decision-makers, financial entities and private companies, because, in fact,

risk management aligns well with economic-efficiency criteria, a well-established approach to climate policy (Yohe & Leichenko, 2010).

But the principal advantage that the risk-based approach offered the climate adaptation field was that it was designed for decision-making under uncertainty (Jones & Preston, 2011). As noted by Yohe and Leichenko: 'since uncertainty is ubiquitous in regard to climate change and its impacts, it is not surprising that deliberations about how to respond are now couched explicitly in terms of risk' (2010: 31). A risk-based approach to adaptation assumes that climate change impacts are managed the same way as other types of weather risks, such as extreme weather events (Field et al., 2012; Leichenko & O'Brien, 2019). Risks are described in terms of the probability of a particular weather-event multiplied by some measure of its consequence (Yohe & Leichenko, 2010). Thus, risk management copes with uncertainty in decision-making within a framework for weighing likelihood and consequence.

*Risk = (probability of an event) * (consequences of that event)*

To make a risk-management approach to climate change adaptation operational, in AR5 the IPCC introduced a framework in which risks result from dynamic interactions between the likelihood of a climate-related hazard occurrence and the potential local impacts (exposure and vulnerability) (see Fig. 3).

Fig. 3 Determinants of risk. Source: adapted from IPCC (2022).

Accordingly, risk management, defined as 'plans, actions, strategies or policies to reduce the likelihood and/or magnitude of adverse potential consequences, based on assessed (see section 2.2.1 below) or perceived risks' (IPCC 2022: 133), can do so by reducing exposure (e.g., building away from flood-prone zones) or reducing vulnerability (i.e., diminishing sensitivity and/or enhancing adaptive capacity).

Adaptation plans of towns and cities rely on baseline assessments (climate-related hazard and potential local impacts) to decide on management strategies and adaptation alternatives. Those risk-based assessments (see 2.2.1) include the exposure-hazard assessment, i.e., the identification of hazards and their potential magnitudes/severities as they relate to specific local places (see 2.2.1.1), and the vulnerability assessments that identify the population's sensitivity to such exposure and capacity to cope with and recover from them (see section 2.2.1.2). Based on complex systems behaviour, the following subsections summarise the main challenges and uncertainties in the effort to make integrative risk assessments of climate change meaningful at the local scale.

2.2.1. Climate risk assessments and uncertainty

> 'Hazards, exposure and vulnerability may each be subject to uncertainty in terms of magnitude and likelihood of occurrence, and each may change over time and space due to socio-economic changes and human decision-making' (IPCC, 2022: 2921)

Risk models and assessment methods have emerged from the interplay among hazard, vulnerability and exposure (Fig. 3). Risk assessment is the qualitative and/or quantitative scientific estimation of risks (IPCC, 2022). The objective of risk assessment is to provide evidence-based information for a particular type of decision-making process. Accordingly, any risk assessment is purposeful (Adger et al., 2018). It requires different types and dimensions of risk to be measured to discern the most prominent risk for which urgent actions are most needed. Vulnerability reduction is a core common element of adaptation and disaster risk management, it constitutes an important common ground between the two areas of policy and practice (Cardona et al., 2012).

Risk assessments in climate change adaptation planning can be either top-down 'scenario-led' or bottom-up, if the analysis begins with contextual local vulnerability factors (Fig. 4). The two approaches have also been conceptualised by O'Brien et al. (2007) as 'outcome vulnerability' and 'contextual vulnerability'. She emphasises that each is rooted in different discourses on the nature and causes of vulnerability. In the bottom-up approach, vulnerability is not a climate outcome (Fig. 4) but a dynamic social precondition modulated by inequities in resource distribution and access. Tracing the chains that damage people's adaptive capacity is the entry point of vulnerability assessments. A limitation of this approach, which is also shared with the outcome

approach (i.e., top-down), is its minimal attention to the subjective factors that influence vulnerability and adaptation (O'Brien & Wolf, 2010).

Most risk-scoping guidance is consistent with top-down and predictive approaches (Wilby & Dessai, 2010). These climate scenario-driven or 'standard approach' assessments tend to focus on linear cause-and-effect relationships, usually limited to one climate-hazard (e.g., sea level rise) or to one specific sector (or exposure unit) to estimate potential impacts (flooding of properties and infrastructures). The resulting end-point vulnerability (Kelly & Adger, 2000:326) is commonly reported as a manageable score or index (i.e., *high-low*) to inform policy strategies. When exposure converges with high vulnerability, a priority risk is identified.

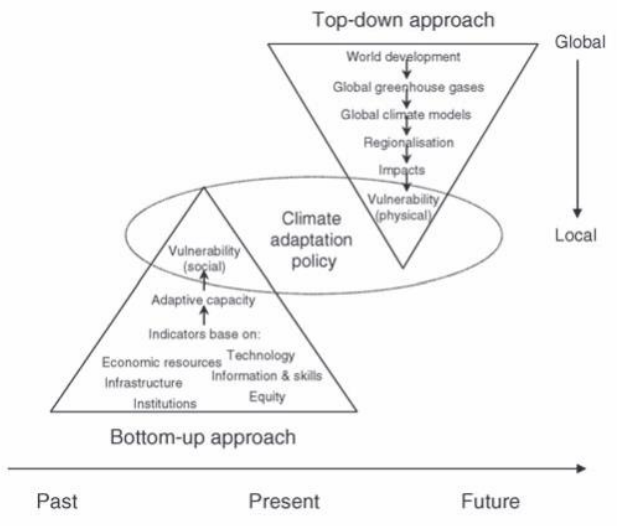


Fig. 4 'Top-down' (also called 'output-vulnerabilities') and 'bottom-up' (also called 'contextual-vulnerabilities') approaches used to inform climate adaptation policy. Source: Dessai and Hulme (2004).

The advantages of this approach are that it is partly transferable, at least regionally, as climate-hazard probability data depends on downscaling global climate models. They are also flexible approaches which allow a broad array of future states or consequences to be captured. Additionally, top-down approaches are more amenable to quantitative analysis within the critical linkages between climate and society and allow for comparisons across space and time (Jones & Preston, 2011). However, these scenario-led have not had a very effective impact on redirecting policy and action towards local adaptation (Wilby & Dessai, 2010). The core role played by changing climate projections in guiding adaptation

policy has revealed a series of shortcomings that can be grouped into three thematic strands:

a) Uncertainty propagation:

Without rejecting the understanding that modelling reveals, these efforts are not free of uncertainty, which is amplified with each step, with local impact assessment and adaptation responses being the last stage of the workflow (Fig. 5). The uncertainty cascade starts within the range of possible futures scenarios, in which greenhouse gas emissions serve as input for global climate models and uncertainty is propagated through regional downscaling and working towards the range of possible impacts.

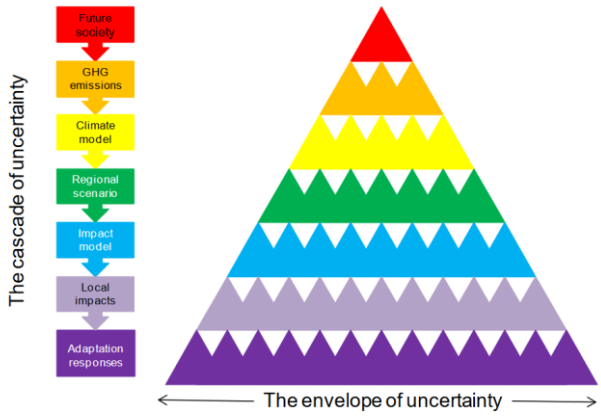


Fig. 5 The cascade of uncertainty. Source: Wilby & Dessai (2010)

b) Biases towards the biophysical approach:

Scenario-led framing has prioritised technical science and ways of knowing within international policy domains encompassing the global and climatic time scales (Hulme, 2010; Nightingale et al., 2019). This top-down approach situates the causality of the climate hazard without considering the dynamic socioeconomic aspects that drive exposure and vulnerability (Ribot, 2011). Biophysical impacts-driven adaptation assessment prioritises local sectoral and technological capacity-building rather than addressing the root socioeconomic causes of vulnerability (Brooks, 2003). Understanding adaptation as a social process means that more is required than just estimating the consequences of biophysical threats to a specific exposure unit. It demands the inclusion of social

science research, which a simple end-point vulnerability can hardly embrace (Kelly & Adger, 2000; Ribot, 2014).

c) Difficulties integrating complexity:

Understanding and managing risks means accounting for multiple complexities. For example, how does an adaptation measure undertaken to reduce a risk affect other sectorial or regional risks? To what extent do interactions of compounding hazards (e.g., sea level rise, coastal storms) or compounding vulnerabilities interact to affect the overall nature of a risk? Or how do multiple risks (climate and non-climate) interact and affect novel emergent risks? Although novel risk-assessment frameworks and approaches are starting to incorporate such complex interactions, many climate-change risk assessments fully ignore them (Simpson et al., 2021), a pattern even more pronounced in policy risk assessments. Analysts and managers tend to divide risk assessment into individual hazards, sectors, regions or other tractable component-oriented approaches, thus missing important complex interdependencies within human and environmental systems that generate climate-change risks (Harrison et al., 2016; Simpson et al., 2021).

2.2.1.1. Hazard exposure analysis

The concept of 'exposure' refers to the spatial dimension of risk. Assessing exposure allows global climate hazards to be grounded in specific local incidences. Accounting for contextual factors that modulate the spatial distribution, intensity and frequency of the climate-hazard exposure evaluation commonly relies on cartography data. Exposure is defined by AR6 as 'the presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected' (IPCC 2022: 2908). Exposure analysis has been widely used to identify which areas, society-sectors or communities are most likely to be affected by rising sea levels and what rates of increase can be expected over different time horizons (Leichenko & O'Brien, 2019).

In low-elevation coastal zones (LECZ), such as river deltas, small changes in the water level can have dramatic hydrological effects such as flooding, salination and waterlogging due to drainage difficulties. Even a slight increase in sea levels means higher tides, greater storm surges and more costal erosion. Furthermore, the human population in deltaic plains has grown dramatically over the past 100 years (Safra de Campos et al., 2020). Many

deltas have become a focus of economic development by concentrating public infrastructures and locating transport facilities very close to current sea levels (Nicholls et al., 2020), not to mention parallel processes of land subsidence (due to groundwater removal, diversion of rivers, etc.) and sedimentary imbalances (driven by river regulation and other factors). All these dynamic processes add complexity to envisaging local exposure risk assessments.

As regards extreme events, deltas are especially prone to compound events, which means the combination of multiple drivers and/or hazards that exacerbate risks (Zscheischler et al., 2018). Compound events can be influenced by many factors, such as permanent sea-level rise, storm surges and freshwater inflows from rainfall. Interconnections between hazards can lead to non-linear increases in the magnitude of individual events, challenging the resilience of populations living in floodplains (MedECC, 2020). Exposure to coastal flooding from rising sea levels can be underestimated if permanent sea level rise is considered in isolation from other sea-level oscillations (Vitousek et al., 2017) or other continental flood sources. There is not only an association between hazards but also interconnections between different risks, which adds more complexity to coastal flood exposure. A paradigmatic example in coastal studies is the interlinkage between coastal flood risk and coastal erosion risk, as both are interrelated by intensifying one another.

Land use and territorial planning are also key factors in risk reduction (Cardona et al., 2012), but to make that happen, it is necessary to have local-scale risk mapping. Integrated approaches to risk are needed at different scales, as well as cross-scale interlinkages. The local scale is the focus of this dissertation, which points to the challenges local entities and municipalities face to benefit from such enriched risk assessments. More commonly, local authorities must deal with a compilation of sectorial risk directives (fire risk, river flood risk, sea-level rise risk, water scarcity risk, etc.) without a comprehensive understanding of potential compounding interactions that may occur among these various risks. This lack of holistic comprehension can make it challenging for local authorities to effectively address and mitigate the interconnected risks they face.

2.2.1.2. *Vulnerability assessment to evaluate risk*

> *The degree of uncertainty inherent in determining vulnerability and adaptive capacity, as potential future states, is similar in scope and dimension to the uncertainty involved in future climate projections* (Adger & Vincent, 2005: 408).

Understanding vulnerability is a prerequisite for understanding risk. Exposure is a necessary but not sufficient determinant of risk; it is possible to be exposed to risk without experiencing damage (Cardona et al., 2012). Vulnerability, commonly understood as a measure of the susceptibility to harm, is the most obvious manifestation of the social construction of risk and a core concept in climate change research and policy (Leichenko & O'Brien, 2019). Vulnerability assessments provide an understanding of the complex mix of factors that allow us to identify which groups or regions are more prone to harm (**sensitive**) or less able to respond to climate stresses (**adaptive capacity**).

Research on adaptive capacity has grown exponentially since the Intergovernmental Panel on Climate Change (IPCC) recognised adaptive capacity as a critical component of vulnerability in 2001 (Siders, 2019). Capacity is an important element in most conceptual frameworks of vulnerability and risk, and it usually distinguishes between 'coping' capacity (i.e., the ability to react and to reduce damage) and 'adaptive' capacity (the ability to anticipate) (Cardona et al., 2012). Adaptive capacity not only modulates vulnerability (reducing exposure and sensitivity) but is its sole dimension 'shaped by human actions' (Engle, 2011: 649). Recognising the role of capacity in reducing risk acknowledges that people are not 'helpless victims' (Gaillard, 2010).

However, within vulnerability assessments, evaluations based on assets have typically been the primary means of determining adaptive capacity (Brown & Westaway, 2011; Mortreux & Barnett, 2017). Those frameworks assume that adaptive capacities depend on natural capital (access to natural resources), physical capital (infrastructure and technological solutions), financial capital (paying for adaptations), social capital (xx) and human capital (education and health) (Mortreux & Barnett, 2017). Proxy variables for adaptive capacity, such as gross national income (to demonstrate financial wealth), public health expenditure (as a proxy of institutional stability) or literacy rates (as a proxy of human capital), chosen as a benchmark and aggregated in vulnerability indices, are employed in studies on a local, national and regional scale (Mortreux & Barnett, 2017).

Regardless of the scale, these top-down assessments only highlight the resources available for adaptation. In this sense, adaptive capacity relates to the potential for adaptation to take place, with deep uncertainty as to whether this capacity is going to be mobilised to adapt to projected impacts (Adger & Vincent, 2005). As a result, the main limitation of an assets-based approach for assessing adaptive capacity is the underlying 'theoretical assumption that capacity translates into action' (Mortreux & Barnett, 2017:3).

Similar to the assets-based approach, the prevalent method of assessing vulnerability is through the use of indicators. Hinkel (2011) noted the epistemological impossibility of measuring a theoretical concept and argued that it is more accurate to speak about making the concept operational instead of measuring it. Vulnerability indicators range from the biophysical to the socioeconomic and institutional (Füssel, 2007). Proxy indicators are generally employed to construct indices of dimensions of vulnerability to different stressors (some examples for adaptive capacity provided above). Different model structures linking exposure, sensitivity and adaptive capacity have been advanced in the literature (Thiault et al., 2021). Most commonly, in adaptation policy assessments, pairs are established by linking the vulnerability of one component to one stressor.

Practical challenges and limitations of methodological approaches, such as aggregation methods or weight estimation, have been identified as sources of uncertainty (Tate, 2013; Tonmoy et al., 2014), and alternative methodological proposals to deal with nonlinearity and incommensurability have been put forth (El-Zein & Tonmoy, 2017). Problems for measuring a theoretical concept like those mentioned above extend to challenging its validation process (Preston, Yuen, et al., 2011). There is no outcome measure against which researchers can validate their results, not to mention the validation of 'future' vulnerability states (Eriksen & Kelly, 2006; Hinkel, 2011).

From a complex set of drivers and interacting conditions, vulnerabilities emerge, evolve and redistribute (Bousquet et al., 2021). Adaptive capacity can occur through dynamic interaction and feedback relationships that generate novel behaviour or emerging properties which cannot be predicted or understood simply by examining the system's parts (Berkes et al., 2003; Folke, 2006; Gallopín, 2006). Simplifying complexity is necessary to produce information that can be used for governance. However, in contrast to simple systems, a complex system cannot be adequately apprehended using a single perspective or analytical choice. Within vulnerability research, different traditions

(hazard-risk approach, political ecology and SES resilience approach) have framed place-based vulnerability representations within different discourses and distinct analytical choices (Eakin & Luers, 2006), see Tab. 1.

Without rejecting their potential complementarity and fruitful interdependences (Adger, 2006; Eakin & Luers, 2006), each analytical choice not only prioritises different types of knowledge but also embraces complexity differently and emphasises different types of responses (O'Brien et al., 2007). The vulnerability representations resulting from the same system studied from different analytical choices and/or scales might not be equivalent (Kovacic, 2017; Nightingale, 2016; O'Brien et al., 2004). Consequently, complexity is by default a source of uncertainty. However, the dominant narrative of adaptation policy accounts exclusively for climate uncertainty.

2.3. Second-order science and Knowledge for policy

> *Post-Normal Science evolved from a criticism of Probabilistic Risk Analysis, and put the essentially political idea of Extended Peer Community at its core* (Ravetz, 2006: 275).

First-order thinking depends and is defined on the 'culture of modernity' (Beck, 1992), within which science is presented as the embodiment of truth that can objectively guide governments' decisions and provide rational principles to address political and social challenges (Irwin, 2021). Informed decision-making builds on the knowledge of 'independent' scientists and experts and it is communicated to the wider public with a language of certainty. Within this positivistic and technocratically derived view of government, the role of the affected population regarding risk issues is not contemplated.

Post-normal science developed as an alternative to approach complexity in the science–policy interface (Funtowicz & Ravetz, 1990). Funtowicz & Ravetz (1993) argued that science's classical linear methodology could not properly answer current complex conflicts. Post-normal science focusses on 'the level of uncertainty and… the stakes involved as a way to adapt scientific practices to each situation' (Kovacic, 2015:23). That is, it deals with 'wicked problems', i.e., those that do not have a canonical solution (Rittel & Webber, 1973), through an appeal to a plurality of epistemologies within the production (see 2.3.2) and validation (section 2.3.1) of knowledge. This requires 'extended peers', who include not only multidisciplinary scientists but also the affected population, and 'extended facts', which include not just causes but also reasons (Ison et al., 2007). Post-normal science emphasises widespread participation and the democratisation of science to better deal with the socio-environmental global crisis and its deep uncertainties.

Second-order science lineages spring from the work of Horst Rittel, who called for the development of second-generation systems approaches (Rittel, 1972), and the sub-field of second-order cybernetics in Stuart Umpleby's work. Second-order rejects the commonly held assumption in science and research that an observer can or should be independent from what is observed (Fazey, Schäpke, et al., 2018; Umpleby, 2016). Rittel and Webber point out that the information used to represent a problem 'depends on one's idea for solving it' (1973:161). Thus, post-normal science, along with Mode 2 science (Gibbons et al., 1994; Nowotny et al., 2003) and Science and Technology Studies (Jasanoff, 2015), argue that science is neither neutral nor unbiased, and that the products

of science 'embody beliefs not only about how the world is, but also how it ought to be' (Jasanoff, 2004:19). Accordingly, second-order science involves a call to reflexivity to critically explore how perceptual, cognitive, theoretical, linguistic, political and cultural contexts influence interpretations, research and outcomes (Fazey, Schäpke, et al., 2018; following Latour, 2004).

Reflexivity entails questioning processes and institutions, not just the science itself (Craye, 2006), such as knowledge-governance processes of complex issues at the local scale. The next subsection (2.3.1) further develops this 'post-normal view of uncertainty' (Dessai & van der Sluijs, 2007: 61) and its implications for governance in the context of local adaptation plans. Risk assessment and vulnerability characterisation considered a post-normal issue constitutes a starting point for advancing the quality of context-specific knowledge in policy-making. Thus, the research agenda of post-normal science emerging from this framing is concerned with the methodology of extended peer-review processes and the democratising expertise in adaptation governance (Carrozza, 2015). In section 2.3.2, alternative forms of research capable of integrating different kinds of knowledge are addressed in relation to adaptation policy and its role not only in providing relevant advice to policy-makers but also as a social process reinforcing institutional adaptive capacity.

2.3.1. Knowledge quality assessment for adaptation governance

Quality becomes the organising principle of post-normal science because the old idea of scientific truth is no longer attainable or relevant for policy (Funtowicz & Ravetz, 1994).

The complexities and uncertainties found in exposure and vulnerability assessments (see 2.2.1.2) should not necessarily impede good quality assessments to address specific decision-making processes. Given that vulnerability assessment and adaptation strategies are 'wicked problems' (Hinkel, 2011; Moser & Dilling, 2012), 'the social role of science is both methodological and politically problematic' (Farrell, 2010:19) and thus a purely positivistic uncertainty approach to evaluating it is inappropriate (van der Sluijs et al., 2008). Eriksen et al. remind us that 'what counts as "adaptive" is always political and contested' (2015: 523) and consequently requires a procedural and epistemic quality assessment. Therefore, I propose moving from scientific research to specific vulnerability assessments framed by the domain of policy analysis that involves both facts and values (Patt et al., 2012). Beyond assessing the strength of evidence using conventional scientific

standards, knowledge quality assessment is based on reflexive approaches to uncertainty based on complex systems or a post-normal view of uncertainty (Funtowicz & Ravetz, 1990). Challenges found in the assessment of science for policy are addressed through the lens of post-normal science by transcending the classical concept of 'technical uncertainty' and instead viewing 'quality' as a function of context. Knowledge assessment for policy as a function of context leads to a more precise quality assessment (Kovacic, 2015).

There is no direct relationship between quality and uncertainty, i.e., high-quality knowledge is not equivalent to low uncertainty. The quality criterion for evaluating the knowledge used and produced for informing societal and political debates is *fitness for function*. As such, "quality is not only about the product but also includes process, people, and purposes when information is to be fit for sustainable decision-making" (Funtowicz & Ravetz, 1993 quoted in Kønig et al., 2017:13) or is intended to enhance local governance capacities.

Practical tools for quality evaluation aim to promote transparency by divulging the constraints found and the decisions taken on dealing with stochastic and nonlinear processes, and the limits of scientific knowledge for policy demands. These tools include quantitative approaches (Monte Carlo test), mixed approaches capturing both quantitative and qualitative elements (NUSAP- Numeral, Unit, Spread, Assessment and Pedigree), and qualitative approaches (KQA, Uncertainty guidance, extended peer-review, model quality checklist) (van der Sluijs et al., 2006). These methods have been applied to specific case studies in exploring the quality of environmental indicators for governance, such as beach quality indexes (Bombana & Ariza, 2018, 2019) or the quality of climate change adaptation projects (Haque et al., 2017). However, the academic literature on KQA has mostly focused on theoretical terms within the ambit of the philosophy of science, and less effort has been dedicated to assessing its practical applicability.

The knowledge used in climate change adaptation policies influences decision-making in the effort to reduce vulnerability. Therefore, policymakers and resource managers should be aware of knowledge uncertainties in making informed decisions. In that regard, three challenges should be highlighted:

1. Not all uncertainties can be resolved by gathering more data (i.e., irreducible uncertainty); nor can all uncertainties always be expressed quantitatively.

2. Vulnerability measures do not only respond to "stating facts" but also to how a system is likely to function in the future, which cannot be developed through strict reliance on predictive logic.

3. "Positivistic" uncertainty analysis (i.e., accounting for the deviation from deterministic knowledge) refers exclusively to scientific content and is suited specifically to the scientists' view (or to the modellers' view), with low relevance within the socio-political sphere (Maxim & van der Sluijs, 2011).

There is a lack of consensus on vulnerability metrics in the academic literature (2.2.1.2), and the international climate network of cities promotes a standardized approach of Risk and Vulnerability Assessment (Joint Research Centre, 2018) based on qualitative and descriptive measures of composite indicators. For example, exposure to flood includes descriptors such as 'lack of green urban areas', while sensitivity to flood includes socioeconomic variables such as 'high share of low-income households' (Joint Research Centre, 2018). But how can these descriptive measures be validated? This dissertation applies a KQA tool (see 4.2.1) to address the unattended uncertainty characterization of the context-specific knowledge required in the risk equation.

By context-specific knowledge I refer to scientific, local and managerial–political knowledge used to develop exposure and vulnerability indices. In this sense, this dissertation, like Ziervogel, Archer van Garderen, et al. (2016), uses the terminology *knowledge-policy interface* which (better than the concept of *science–policy interface*) advocates the importance of other forms of knowledge alongside scientific knowledge within adaptation plans. The analytical proposal differs from technical uncertainty analysis by addressing both the social context and the process of knowledge production. The inclusion of the social dimensions of uncertainty (instead of the ideal of *truth* knowledge) is justified by the inherent epistemic uncertainty surrounding vulnerability characterization, as well as by its political implications.

The term 'knowledge quality' in this dissertation is consistent with 'usable science', since both are explicitly conceived to contribute to a decision-making process (Clark & Majone, 1985). The vulnerability KQA framework, which I advance and explore in section 4.2.1 —like the climate science usability approach—a 'function both of the

context of potential use and of the process of scientific knowledge production itself' (Dilling and Lemos, 2011, p. 680). Both approaches contribute to enhancing the relevance of science for policy in a context of environmental change. The usability approach has predominantly focused on the relevance of climate information for decision-making (Kirchhoff et al., 2013; Lemos et al., 2012) or the effectiveness of research programmes for informing decision-making (Ford et al., 2013). Less attention has been given to the usability of context-specific knowledge used in communicating climate change vulnerabilities to local councils. Unlike the usability approach, the KQA looks through the lenses of knowledge uncertainty in managing complex socioecological systems.

2.3.2. Co-production and context-specific knowledge in local adaptation strategies

> *A key indicator of (collaborative research) project success is the extent to which the knowledge integration outputs are used by those who input their knowledge*
> (Raymond et al., 2010:1770).

In the face of the challenges to achieve reliable knowledge of unpredictable and non-linear systems, many alternative forms of research that are more democratic, inclusive and action-oriented and that integrate different forms of knowledge have emerged over the last three decades (Fazey, Schäpke, et al., 2018). Knowledge production patterns associated with post-normal science advocate promoting the integration of disciplines and the co-creation of knowledge by diverse actors to enhance their societal contribution and relevance in a policy-making context. Since climate change research and policy is a paradigmatic example of post-normal science (Carrozza, 2015), this section focuses on the knowledge production process in adaptation policy processes. Adaptation plans and policies are formal institutions that provide for the governance of climate change adaptation. A climate-adaptation plan should outline how global climate change is projected to impact a target community and identify adaptive local responses (Preston, Westaway, et al., 2011). But, as argued above, since facts and values are intertwined participative approaches can expand the knowledge base and the value base of local adaptation decisions.

Different types of knowledge that are more locally specific, experiential or embedded in cultural traditions and culture (local ecological, traditional ecological, personal, tacit, lay, etc.) have being identified as relevant in climate change adaptation (IPCC, 2022) and more broadly in the environmental management literature (Reyes-García et al., 2019).

Adaptation planning not only requires more local knowledge but a robust and challenging integration of different forms of knowledge (Raymond et al., 2010; Kettle et al., 2014). Local authorities are familiar with the governance and socioeconomic context and may be also aware of the vulnerabilities of their jurisdictional territories, but understanding how these vulnerabilities are related to climate change risk and impacts is less clear.

On the other hand, vulnerability assessments require context-sensitive knowledge in dialogue with multidisciplinary academic literature and must be aligned with other sectorial policies and local strategies. Developing adaptation plans requires integrating climate change science, local vulnerability to climate impacts and the broader socioeconomic and governance context of application (Ziervogel, Archer van Garderen, et al., 2016). Accordingly, the three dominant knowledge forms, classified as scientific, managerial-political and local, are needed to understand and manage the changing climate. Throughout this dissertation, I refer to context-specific knowledge to embrace these three forms simultaneously.

Insights on how policy interfaces and iterates with these different kinds of knowledge is vital when developing local adaptation plans. The importance of situated knowledge (Porcuna-Ferrer et al., 2023), local involvement, and a two-way engagement between scientists and a plurality of stakeholders has long been acknowledged in the creation of climate risk and adaptation information (Lemos & Morehouse, 2005; Vogel et al., 2007). This integrative research method is usually referred to as knowledge co-production and has had a growing impact on the academic field of climate change adaptation (Bremer & Meisch, 2017) Local engagement can provide highly detailed, locally relevant information about assets, activities and populations at risk, with the added value that it can create buy-in to the climate assessment process and facilitate new learning opportunities (Leichenko et al., 2014). Knowledge integration offers opportunities for new knowledge to emerge for both scientists and stakeholders and can enhance decision-making (Kettle et al., 2014).

The call for greater involvement challenges procedural approaches to integrating the diversity of participants and knowledge claims in a defensible decision-making process (Failing et al., 2007). Knowledge co-production methodologies for adaptation governance range from participative workshops to participative modelling (Barreteau, 2003), participative mapping (Fagerholm et al., 2021) or collective serious games (Daré et al.,

2021). As common ground, several factors can facilitate success at the early stages of the process of vital importance that ensures:

a) inclusiveness of a broad range of community members, including representatives of voiceless groups,
b) joint framing of problems, goals and collaborative social inquiry, and
c) that these processes are systematic, reflexive, cyclic and very flexible to facilitate the integration of multiple views, in accordance with adaptive co-management literature.

Knowledge co-production, understood as 'the deliberate collaboration of different people to achieve a common goal' (Bremer & Meisch 2017:2), can strengthen the adaptation knowledge-policy interface (Ziervogel et al., 2016). The social inquiry process that underpins knowledge co-production which encompasses exchanges, co-evolution and joint knowledge construction (van den Hove, 2007) is as important as the final adaptation plan because it facilitates social learning and competence-building (Armitage et al., 2011; Schneider, Giger, et al., 2019). Co-production can provide a setting for learning to learn, consequently enhancing adaptive institutional capacities. It can contribute to transformative capacities if adaptation to climate change is co-produced with society as an object of social justice (Ziervogel et al., 2022).

The increasing emphasis on transformative adaptation requires, according to Ziervogel et al. (2022: 608) 'attention to new types of capacity building that rely on knowledge creation at a grass-roots level as the first phase of building capacity, and on the empowerment of community actors to meaningfully inform and implement adaptation responses as the second phase' (Fig. 6). This approach builds on previous political-ecologic and geographic understandings of 'social vulnerability' which emphasise causal analysis of differential adaptive capacity (see Fig. 4). The focus is redirected on 'the grounded social causes of precarity that expose and sensitise people to hazard' (Ribot, 2014: 668), the lack of adaptive capacity and its underlying causes. Ribot (2014) posits that the factors that determine vulnerability are primarily twofold: firstly, access to assets (determined by socioeconomic and cultural factors); and secondly, individuals' capacity to shape the political-ecological context. People's ability to re-shape the social context that creates their vulnerabilities is termed 'emancipation' by Ribot (2014) and 'empowerment', referring to Watts (1991).

What factors contribute to this empowerment? Traditional assessments of adaptive capacity have focused on an assets-based approach, forgetting the capability to convert resources into effective adaptive actions (Brown & Westaway, 2011). Acknowledging the differences between latent social capacity and the ability to mobilise these capacities (Pelling & High, 2005) has brought renewed assessments which incorporate a new core determinant of adaptive capacity, the concept of 'agency' (Cinner et al., 2018). Agency[6] is defined as 'the ability of people (individually or collectively) to have free choice in responding to environmental change' (Cinner et al., 2018:120). It is a pivotal aspect for capacity-building because agency activates the other domains of adaptive capacity. According to Cinner et al. (2018), the five interlinked domains of adaptive capacity are: assets (that people can rely on during times of necessity), flexibility (to change strategies), social organisation (to organise and act collectively), learning (to recognise and respond to change) and agency (to determine whether to change or not).

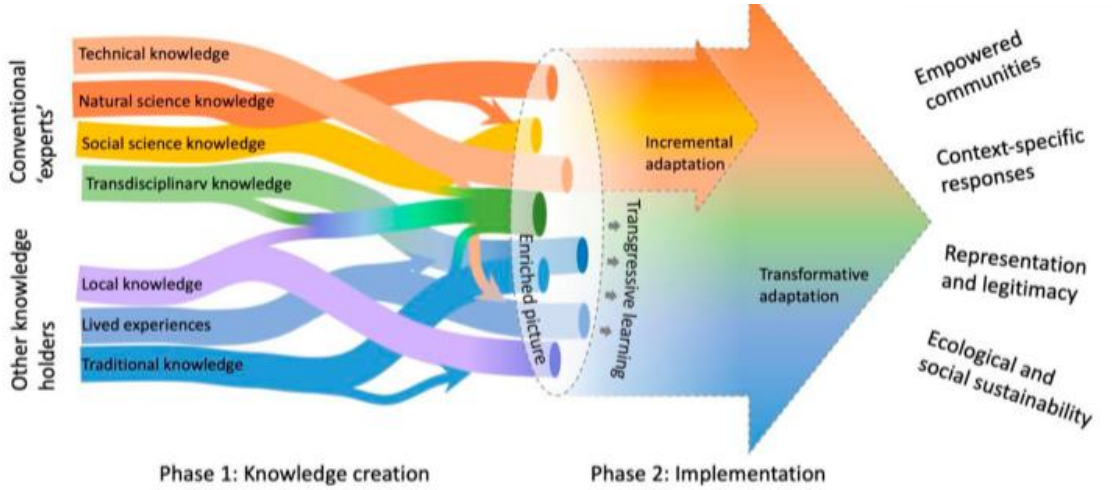


Fig. 6 Capacity building for transformative adaptation. Source Ziervogel et al. (2022)

Building agency for adaptive capacity to climate change involves according to Cinner et al. (2018) incorporating local knowledge and expertise into both scientific research and policy-making processes, and it also implies empowerment of the affected population through participatory procedures such as adaptive co-management. Additionally, Mortreux and Barnett (2017) point to psychosocial factors that mobilise or constrain agentic capacities, such as risk attitudes, personal experience, trust in and expectations of authorities and place attachment, among others.

[6] In section 2.4.3, in the context of the 'everyday agency' and place transformation, agency is defined in terms of Arendt's notion of 'making something new' (Arendt, 1958).

2.4. Relational framing of adaptation and transformation: A place-based affective approach

Real hope of radically progressive social transformation may lie more in the mutualities of caring than in the hierarchies of control (Stirling, 2019:219).

Despite the advantages of knowledge co-production processes in improving knowledge integration, they are still constrained by the underling notion of knowledge deficit (i.e., filling knowledge gaps) and the view of uncertainties as risks (Nightingale et al., 2019). Based on evidence from a multi-case study analysis, Harvey et al. (2019) warn that the potential for transformative changes often linked with co-production processes may be overstated. Also noted by Schneider et al. (2021) evidence on whether transdisciplinarity leads to transformations is lacking. A type of co-production that can lead to transformation goes beyond consulting stakeholders (within a predefined frame of reference) to get richer fitness of users' definition of complex problems or enhanced data for ongoing adaptation efforts. Instead, it involves adopting pluralistic approaches to knowledge and appreciating uncertainties not solely as a cognitive process but as an ontological one (Nightingale et al., 2019). This goes beyond advocating increased interdisciplinary collaboration within climate change research and entails a more profound transformation. Such a pluralistic approach means taking climate change as a co-produced issue from different framings arising from ways of knowing that are also embodied, experiential and affective (Nightingale et al., 2019). This requires conceptualising climate through its dynamic cultural and psychological symbolisms and integrating what climate means in different places to different peoples at different times (Hulme, 2008). Local response-ability requires a departure from pluralistic and bottom-up approaches (Haraway, 2016).

Although there have been promising attempts to explore the interpersonal and political dimensions of transformation, it is still rooted in a cognitive and individualised understanding of society (Nightingale et al., 2022). This cognitive understanding of learning is also dominant in adaptive co-management praxis or knowledge production patterns associated with post-normal science, such as knowledge co-production, social learning and the deliberation processes found in the climate-change adaptation literature (Nightingale et al., 2019). Incorporating affect theory into adaptation research allows us to not only transcend the techno-managerial limitations of first-order science but also

move from a political stance and epistemic plurality to embrace an affective and relational ontology, enhancing our ability to enact transformative change (Bousquet; et al., 2022; Scoones & Stirling, 2020). Such an affective adaptation, as coined by Nightingale et al. (2022), holds the potential to envision more transformative processes and outcomes by allowing other ways of knowing, other approaches to uncertainty and impulses for action.

Through other ways of knowing, the authors say, 'affect opens up ways of knowing that are relational, embodied and experiential, allowing us to go beyond (only) cognitive learning in adaptation processes' (2022: 6). This kind of affective knowing is needed to transform the current inaction and promote effective climate action. A relational framing of adaptation and transformation requires acknowledging uncertainty and unpredictability as part of transformative processes. Uncertain and unpredictable outcomes always arise in both planned and unplanned encounters, as well as in cross-scalar interactions and the translation of knowledge into action. These emerging uncertainties give rise to affects and commitments, as affective relations form the foundation for taking action (Scoones & Stirling, 2020). This section provides an overview of how values-based approaches to vulnerability and adaptation research have sparked and energised place-based studies, reclaiming the relevance of sense-of-place research as a crucial domain for navigating this inquiry. The chapter concludes by highlighting the increasing convergence between the literature on the affective turn and the realm of sense of place. These two approaches are gaining traction in addressing one of the longstanding gaps in climate change literature: agency, or the ability to initiate and enact meaningful change.

2.4.1. Senses of place and adaptive capacities to climate change

> *One field of research that directly addresses values and behaviour, and which also shares the ontology of an interconnected social and natural world, is that of sense of place (Masterson et al., 2017: 1).*

Climate change affects many issues that we value, but still, we all experience implicatory denial in relation to climate change at some point (see 2.1.2). In the words of Hulme, 'climate change is not making sense to us: we have universalised the idea of climate, detached it from its cultural settings' (2008:8). The emphasis on global kinds of knowledge disconnected from specific localities has rendered human-scale experience invisible (Hulme, 2010; Nightingale et al., 2019). When global approaches are downscaled to localities, usually in form of risk assessment (see 2.2.1), scarce attention

is given to nonmaterial or intangible attributes related to climate change impacts (commonly summarised in economic costs) and human capacities to adapt (calculated as an assets-based approach). A focus on place brings attention to the specific material and symbolic environments where people shape their lives and find meaning (Adger et al., 2011). Additionally, place and identity allow for wider notions of well-being integrating what people care about, that is, awareness of everyday changes at the community level, such as 'lived values' at risk (Graham et al., 2013).

As a reaction of the poor explanatory power in understanding why societies or individuals do not make full use of their adaptive capacities (see 2.2.1.2), scholars are pointing to prioritising more grounded and inclusive place-based approaches that account for the symbolic, emotional and intrinsic meanings and values of the environment (Fazey, Schäpke, et al., 2018; Horlings et al., 2020). There is an increasing drive to perceive climate change as a situated phenomenon involving the relationships between people and places (Devine-Wright, 2013). An important element in this relationship is the impact that change will have on people's bonds with place and how this may shape adaptive behaviour (Devine-Wright & Quinn, 2020).

Investigating behavioural, cognitive and affective responses to changing environments is a complex but critical area of research, and senses of place is a pertinent concept for navigating this academic inquiry (Raymond et al., 2021). The term 'sense of place' comes from humanistic geography (Tuan, 1977), and since then, acknowledgement of the ontological importance of physical locations has raised apprehension among different theoretical and cross-disciplinary perspectives (Williams & Miller, 2021). Some of these approaches have proven to be productive lenses for expanding research on climate change adaptation by grasping the subjective dimension of adaptability.

By taking a values-based approach to adaptation, a more complete and fairer picture of risk is possible, because 'people are vulnerable to the extent that climate change influences not only their objective, exterior world, but also their subjective, interior world' (O'Brien & Wolf, 2010:233). This includes highlighting the significance of place-based values such as landscape, social values, heritage and traditional knowledge (Adger et al., 2011; Brooks et al., 2020; Brown & Raymond, 2007; Meo et al., 2021). For example, Marshall et al. (2017) provide an example of non-economic resource dependency by examining people's emotional connections to marine and coastal

ecosystems. They argue that this emotional bond provides an additional understanding of how people may be sensitised to changes that impact these seascapes. Also in relation to Australia's Great Barrier Reef, Gurney et al. (2017) found attachment connections that went beyond local communities, indicating the emergence of place attachment types that surpass geographical borders and do not necessitate ongoing direct experience.

Place theory has also contributed to a more accurate understanding of the complex relationship between sense-of-place dimensions and people's interpretation of place change and willingness to adapt. Changes to climate bring changes to places. While the connection between values and behaviours in the context of climate change has been studied, it is important to note that the relationship between sense of place and willingness to change is not always straightforward and causal (Bousquet; et al., 2022). A strong sense of place may sometimes make people resistant to change; for example, adaptation strategies can be refused by certain groups if the required adaptations threaten place identities (Quinn, Bousquet, & Guerbois, 2019). A case study based on the Camargue (France) illustrates how preservation efforts driven by the desire to protect cultural heritage and historical significance can result in 'fatal patrimonialisations' that hinder local populations' adaptation to changing circumstances, while also reinforcing the discourse and attachment to these legacies (Bousquet; et al., 2022). Conversely, place dispossession, such as in a gentrification process, or damaging impacts on a place can have significant affective consequences on people, resulting in feelings of loss and alienation and decreasing people's sense of belonging and perception of their ability to adapt and cope with change (Di Masso Tarditti et al., 2022; Fresque-Baxter & Armitage, 2012). As people value certain aspects or characteristics of places differently, they may in turn perceive different risks and experience unequal vulnerability to place change (Quinn, Bousquet, & Guerbois, 2019).

In recent years, there has been a growing recognition that understanding the relationship between change and sense of place requires a more nuanced and complex approach that goes beyond simply assessing the social acceptability of territorial projects, adaptation measures or risk perceptions (Bousquet; et al., 2022). A core claim is that place scholars need to be receptive to novel and sometimes unfolding senses of place that emerge in response to global challenges (Raymond et al., 2021). This involves questioning the stable, localised sense of place attachment experienced by an individual and instead

recognising it as a dynamic, relational and culturally and politically constructed phenomenon (Devine-Wright & Quinn, 2020; Di Masso et al., 2019). Accordingly, scholars and practitioners are increasingly turning to the lens of complexity theory to explore the complex, plural and dynamic relationships between people and places within the context of change. This perspective suggests that 'place attachment can be viewed as an emergent property of a complex system' (Di Masso et al., 2019:25). As noted by Williams & Miller (2021), the turn towards thinking of places as social-ecological assemblages can be observed both among interdisciplinary social sciences and humanities and in the transdisciplinary body of work on resilience of social-ecological systems. Accordingly, senses of place operate as boundary objects informing the development of more holistic approaches to changing environments and changing senses (Raymond et al., 2021) which stem from an epistemic and ontological pluralism (Williams, 2014).

2.4.2. Unpacking plural and contested visions of environmental change through the lens of place meanings

Given the diversity of disciplines that have approached place research, there are many different terms used to describe the connections people have with place, the most common being 'sense of place', 'place attachment', 'place meanings', 'place identity' and 'place dependence'. While these terms can overlap and are sometimes used interchangeably, they have slightly different meanings and nuances. Whereas the dominant term in environmental psychology is 'place attachment' (Di Masso et al., 2019; Lewicka, 2011; Manzo & Devine-Wright, 2021; Scannell & Gifford, 2010), human geography has mostly used the term 'sense of place' (Relph E, 1997; Tuan, 1980). This term has also been embraced by socioecological researchers as a more comprehensive concept that encompasses both the meanings of and attachments to place (Masterson, Stedman, et al., 2017; Stedman, 2016), and it is the term endorsed in this dissertation. Regardless of whether the overarching term used is 'place attachment' or 'sense of place', both integrate affective, cognitive and behavioural components (Masterson, Stedman, et al., 2017; Scannell & Gifford, 2010) (see Fig. 7).

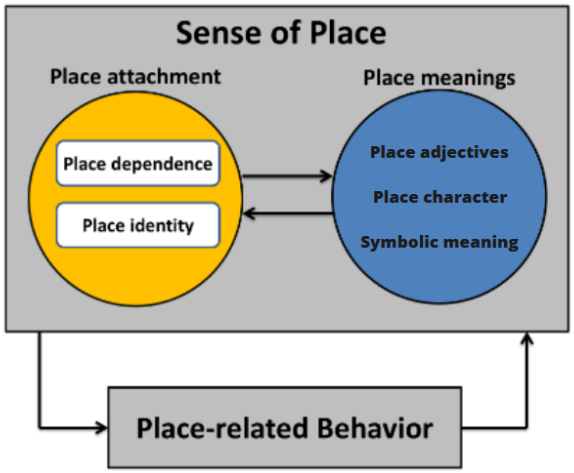


Fig. 7 Sense of place concepts. Source: adapted from Masterson et al. (2017)

Place attachment refers the emotional bond, usually positive, between individuals or groups and their environment. Therefore, it is an evaluative concept (i.e., good-bad) and is often assessed through scales that measure the strength of attachment (Stedman, 2016). Some researchers conceive place attachment as having two distinct but interrelated subdomains: dependence and identity (see Fig. 7). Place-dependence refers to a utilitarian or instrumental appreciation of this relationship, while place-identity refers to the ways in which people define themselves in relation to a particular place. On the other hand, place meanings differ from attachment in that they are essentially descriptive statement or cognitions 'about what a place is, what it is like, and the kinds of images it conveys' (Masterson, Stedman, et al., 2017:2) Meanings are social constructs and products of the interplay between biophysical characteristics of the place and sociocultural institutions over time (Stedman, 2008). This descriptive component of sense of place includes place adjectives (e.g., isolated, degraded, etc.); place character, which defines structures and functions that characterise a particular landscape (e.g., farmscape); and symbolic meanings (e.g., home) (Masterson, Stedman, et al., 2017).

The connection that individuals or groups have with a place is not solely affective or cognitive but also encompasses behavioural attitudes, responses and actions (Fig. 7). Place-related behaviour or 'experience-in-place' creates meaning (Manzo, 2005). The dialectic nature of the bonding process between behaviour and symbolism (Vidal & Pol, 2005) includes intentional actions that transform and give meaning to places, as well as routine and daily activities which also contribute to the territorial and embodied expressions of place-bonding relationships (Benages-Albert et al., 2015). Moreover,

attitudes and behaviours can also be influenced by a sense of place. For instance, researchers have explored how a sense of place contributes to stewardship attitudes (Devine-Wright, 2009; Sebastien, 2016; Stedman, 2002). When explaining pro-environmental behaviour and collective political engagement, Stedman (2008) noted that greater analytical attention is often given to place attachment than to place meanings. This has contributed to inconsistent findings given that place meanings are significant underpinnings of place attachment. The empirical study conducted by Brehm et al. (2013) in a New Hampshire watershed supports this argument, as it indicates that place meanings have a stronger influence on predicting environmental concern than place attachment.

A diversity of meanings can be attributed to a given setting. Understanding these meanings can shed light on how people assign value to different aspects of the environment. People attached to a place are not necessarily attached to the 'same thing' or same aspects of that place, leading to differential behavioural responses towards environmental changes (Stedman, 2016). Thus, it follows that conflicts over natural resources and place management are not between individuals who are attached to a place versus those who are not but rather among groups attached to different place meanings (Stedman, 2016). Place meanings frequently intertwine with notions of what constitutes legitimate or illegitimate land use; thus, sense of place is related to expectations or desires for that location (Yung et al., 2003). When territorial interventions disregard a particular meaning associated with a specific place, conflicts may arise, and these conflicts can act as a catalyst for reinforcing attachments to that place (Cadoret, 2017). The way place attachment evolves through the mediation of place meanings can either align with or resist established norms and expectations regarding the social order (Di Masso et al., 2021).

The meanings associated with a place are not merely abstract values, ideas and images; rather, people's understandings of place become expectations of and actions on how it should be used and managed (Harvey, 1996). Place meanings are politically contested (Williams & Stewart, 1998). These social meanings define and frame environmental issues, landscapes and the diverse visions of the future development of such places (Masterson, Tengö, et al., 2017; Yung et al., 2003). Through an investigation of place meanings in the Rocky Mountain Front region of Montana, USA, and their contestation in the context of resource management, Yung et al. (2003) provided an understanding of the broader political dynamics at play. The authors illustrated how senses of place were

intimately connected with people's concerns about changes in the landscape and policies formed at both local and national levels. A similar case study based on debates about conservation versus community livelihoods used contested place meanings to understand the complex and disputed visions of sustainability on the Wild Coast in South Africa (Masterson et al., 2017). A community counter-narrative of place-bonding emerged to contest a conservation intervention in a context of multiple landscape meanings. Similar to the case in Montana described by Yung et al. (2003), community opposition to conservation projects on the Wild Coast in South Africa was driven more by a feeling of disempowerment in accessing and managing their livelihoods than by the ethics of conservation itself.

An increased emphasis on politically aware understandings of the plurality of points of view regarding the changing environment is needed to open up spaces for negotiation among different stakeholders (Blaikie, 1995). Conceptualising 'place as the intersection of shared and contested meanings enables us to see how the images and values people hold for particular locations are connected to natural resource conflict and, where possible, conflict resolution' (Yung et al., 2003: 865). A pluralistic and dynamic approach to the place meanings attributed to a landscape is needed to identify common ground (Masterson et al., 2017). Such investigations can help us understand how these meanings are experienced and negotiated in everyday life (Bousquet et al., 2022; Davenport & Anderson, 2005). Engaging with multiple meanings assigned to a place can lead to diverse understandings of emerging issues and enrich the knowledge and solutions for tackling change, thereby fostering innovative transformations towards desirable pathways of development in social-ecological systems (Masterson, Stedman, et al., 2017).

As well as landscapes changes, the meanings of a place and associated people-place relations are constantly evolving, conveyed, spread and contested through discourse (Di Masso et al., 2021). But 'discourse is more than just language' (Yung et al., 2003: 856). By reducing it to linguistic accounts, researchers may inadvertently diminish the significance of the material practices that contribute to the creation and experience of place attachments (Di Masso et al., 2021). For instance, Di Masso and Dixon (2015) demonstrated the power of the discursive approach by examining the interplay between discourse and other material and embodied practices. They explored the contested and emerging meanings attributed to the public square in Barcelona locally called 'el Forat de

la vergonya', demonstrating how discourse interacts with different forms of engagement to shape these meanings over time. Just as feminist geographers have explored the micropolitics of place (Massey, 2013), thinking of places as social-ecological assemblages helps explain how structural power dynamics are embedded within the everyday expressions of emotional bonds between people and place (Di Masso & Dixon, 2015).

2.4.3. Transformative capacities: The interplay between senses of place and affective agency

What moves us, what makes us feel, is also that which holds us in place, or gives us a dwelling place (Ahmed, 2014:9).

Why are social and transformative changes so difficult to achieve? Despite the increasing acknowledgement of the need to address climate change through transformative changes, our understanding of the capacity to enact such transformations remains constrained (IPCC, 2022). Previous studies assessing adaptive capacity are useful but insufficient to meet the requirements of transformation (Ziervogel, Cowen, et al., 2016). Indeed, as mentioned in section 2.2.1.2, the understanding and treatment of adaptive capacity has been overlooked due to a lack of emphasis on the role of agency. However, even when agency is recognised as a catalyst for mobilising adaptive capacities, as in Cinner et al. (2018), a gap remains in understanding the specific factors that activate agency to adapt and change.

According to McManus, 'agency is rooted in worldly things, in *affective encounters* that shape or mobilise the capacity to act' (2011:25). She draws upon Spinoza's understanding of the pivotal role of affect in comprehending agency. Affect, in this formulation, is understood as 'the power to affect and be affected, and the relationship between these two powers' (Hardt, 2007 quoted in Singh, 2017:759). Affects are distinct from conventional understandings of emotions and refer to a relational force that circulates among bodies, amplifying or diminishing their capacity (power) for action (Deleuze & Guattari., 1988). Accordingly, affective relations form the foundation for taking action. Aligning with the philosophical tradition of Spinoza, the scholarly movement in the humanities and in cultural studies (Clough & Halley 2007) of the 'affective turn' (Hardt, 2007) challenges the traditional emphasis on cognition and rationality and encourages a dynamic and relational understanding of human behaviour and society.

The reciprocal relations of affecting and being affected play a central role in the constitution of human subjects, as well as larger collectives, emphasising the intricate interplay between affect and processes of subjectivation (González-Hidalgo & Zografos, 2017). In fact, it is through 'affective relations or how we respond to objects and others, that surfaces and boundaries are made' (Ahmed, 2014:9). Accordingly, affective relationships give rise to entities (not only humans) that are manifested as forms of action, and these actions also influence how we interact with others (Ahmed, 2014). Consequently, affective relationality transcends the rigid dualism of subject and object, bridging the gap between the natural and social domains that previous scholarship has been unable to accomplish (Singh, 2017). Additionally, affective relationality forges the inseparability of feeling and thinking in the human experience (Maiese, 2017), which resonates with 'sentipensar', a concept coined by Fernando Fals Borda referring to the 'art of living based on thinking with both heart and mind' (Singh, 2017:753). This viewpoint forms the foundation for transformative learning (Maiese, 2017) and place-based activism movements challenging dominant hegemonic world views (Escobar, 2016). Additionally, it aligns with the 'embodied cognition' needed to address sense of place research (Lewicka, 2011).

The integration of the 'affective turn' into place theory enriches the understanding of places as complex social-ecological assemblages. Conceptualising attachments as affective relationships brings the capacity to act to the forefront (Bousquet; et al., 2022). It enhances the discursive-constructivist approach by going beyond cognitive perspectives and embraces relational affective dynamics which offer deeper insights into possibilities for change and transformation (Bousquet; et al., 2022; Di Masso et al., 2021). Our everyday and familiar places are far from being a mere backdrop sustaining our capacities to act and engage with others and with ourselves (Centemeri, 2015). Attachment is therefore to be comprehended as the interdependence between ourselves and the materiality that we both shape and are shaped by through the processes of use and familiarisation that unfold over time (Centemeri, 2015).

Such affective relations often remain implicit in the daily course of life, and in many cases, they only become apparent when these relationships are contradicted or disrupted (Bousquet; et al., 2022; Sebastien, 2016). Affective agency, in this context, does not reside within individual consciousness; the capacity for acting, rather, is situated within

interactions and emerges from ‘affective arrangements’ (Slaby et al., 2019). When disrupted, the attachments revealed are not only acknowledged but also reclaimed and formalised through the mobilisation of the affected population (Bousquet; et al., 2022; Sebastien, 2016). Expressed in grounded practices, agency re-assembles places. This process can lead to the emergence of new configurations of affective relationships which, in turn, reconfigure affective agency. The capacity (power) or incapacity for action results from the trajectories of these interactions (Bousquet; et al., 2022).

Place is conceived as the dimension of multiplicity, as a dimension created through relations, which are full of power (Massey, 2005). These relations, from a place-assemblage perspective, include affective, discursive, material, corporeal and institutional practices and situated rearticulations from which senses of place develop (Di Masso et al., 2021; Di Masso & Dixon, 2015). Accordingly, ‘place-assemblages emerge and evolve as *emplaced subjectivities and practices* that unfold within a set of entwined discourses, material artefacts and corporealities that interact over time’ (Berroeta et al., 2021:45).

Neglecting those relational affective dynamics that shape the production of sense of place impacts the perpetuation of social and spatial vulnerabilities (Berroeta et al., 2021) and, by extension, the possibilities of transformation. One method capable of collectively grasping those everyday implicit micropolitics co-evolving with social constructions of senses of place is the technique of theatre forum (Berchon & Bousquet, 2021). A study conducted in North Senegal demonstrated the potential of this collective exploratory method to analyse and identify a variety of values and attachments to particular locations within the region, as well as to explore how these differing perspectives coexist and foster a shared vision for the territory (Bousquet; et al., 2022). Such an embodied way of exploring the affective assemblages that articulate senses of place represent methodological modalities that simultaneously elicit, stage, and reconfigure affective relationships with the place (Bousquet; et al., 2022).

Affect is directly linked to subjectivities, or the ways people are brought into relations of power. Change and transformation can be understood by examining the intricate interactions between entities that mutually influence and affect each other (Bousquet; et al., 2022). Within this relational framework, maintenance of the status quo necessitates the repetition and persistence of certain relationships over time. However, transformative outcomes arise when these repetitive emplaced relations undergo fundamental shifts,

opening up new socio-natural relations (Nightingale et al., 2022). In this manner, affective adaptation to effective transformation relies on contesting emplaced subjectivities as a means to connect power dynamics to relational affects between bodies (Nightingale et al., 2022).

2.4.3.1. Approaching paradigm change in shared and routine ways of seeing places

Place trajectories have been associated with research on socio-technical transitions (Murphy, 2015), stewardship transformations (Enqvist et al., 2019), future imaginaries (Chateau et al., 2021; Feola et al., 2023), or sustainability transitions and transformations (Grenni et al., 2020; Horlings et al., 2020; Raymond, Manzo, et al., 2021). All these approaches advocate for how the interplay between people and their environment shapes trajectories of societal change and transformation. This connection is rooted in the understanding that 'place is not just a thing in the world but a way of understanding the world' (Cresswell, 2005:11), even though we often take 'place' for granted (Tuan, 1977).

Additionally, as noted in Tab. 2Tab. 2 , there is a pattern connection between the process dimension of senses of place, as delineated in the seminal work by Scannell & Gifford (2010), namely 'cognition,' 'affect,' and 'behaviour,' and their alignment with the three domains of human experience, i.e., 'knowing,' 'seeing,' and 'doing', as articulated by Sterling (2003) in the context of paradigm changes. The three components of the process dimension of senses of place, as noted by Scannell & Gifford (2010), are common to other psychological concepts (e.g., attitudes). Yet, this patterned relationship, as depicted in Tab. 2, extends beyond the realm of psychology, and encompasses to other academic disciplines. Main examples come from whole system thinking applied to learning and paradigm change as well as place-based concepts such as transformation towards sustainable development or stewardship for resilient socioecological systems.

Aligning with the place-based inclusive discourse on climate change (as discussed in 2.1.2.) Tab. 2 follows a comprehensive "head-heart-hand" approach to systems transformation (O'Brien, 2018) by linking dimensions of sense of place and paradigm change. The 'knowing' domain, when applied to paradigm change, takes the form of the *eithos,* i.e., the dimension of ideas and concepts that shape our understanding. This *eithos* is linked to the cognition component, one of the triadic psychological aspects of a sense of place, referred to as place meaning. As elaborated in section 2.4.2, place meaning constitutes the descriptive component of the sense of place.

Sense of place (Scannell and Gifford, 2010)		Paradigm change (Sterling, 2003)	Systemic change (Banathy, 1991)	Sustainable development transformation (Gallopín, 2002))	Stewardship (Enqvist et al., 2018)
COGNITIVE	Place meanings	Knowing	Image	Understanding	Knowledge
AFFECTIVE	Place attachments	Seeing (awareness)	Vision	Willingness	Care
BEHAVIOUR	Actions	Doing	Design	Capacity	Agency

Tab. 2 Patterned relationship[7] between the triadic psychological components of sense of place dimensions and the interconnected dimensions of human experience to paradigm change. Source: own production.

The 'seeing domain' relates to the *ethos*, the affective, belief and imaginal dimension of paradigm. This domain aligns with the affective component of a sense of place. Place attachment is an evaluative dimension of sense of place commonly 'measured' in terms of intensity, but it can be also approached from qualitative terms such as the 'felt quality' of environment (Tuan, 1978) or place awareness.

Finally, the 'doing' domain when applied to paradigm change, refers to the *praxis*, a combination of reflective intention and action that corresponds to the behavioural component of a sense of place. This is the 'practiced' and 'lived' place, also called 'thirdspace' by Soja (1999) building upon the work of Lefebvre (1991). Stated through actions and practices, this domain includes institutional projects, and both routine activities as well as reactive human agency when facing perceived threats to place in the wake of significant events. It also includes transformative agency that can be found in the everyday, 'an agency that is grounded in the lived space, always embodied, and contingent on our relations with others in the place we share' (Selimovic, 2019:3). From this embodied relationship with the world, places evolve. By adopting a process and practices perspective on place, and by focusing on how place is performed, different place trajectories might be conveyed.

As noted by Selimovic (2019) under the term 'agency' defined as 'making something new' (following Arendt, 1958), directly points to the human 'capacity to generate new relations and new realities' (Honig, 1995 quoted in Selimovic, 2019:4). This generative capacity of ordinary agency in the everyday, as described in Selimovic (2019) and found

[7] By 'pattern relationship' Tab. 2 does not suggest a direct equivalence.

in ethnographic studies through practices of intersubjective care such as in in the Iraqi city of Raqqa (Al-Mohammad & Peluso, 2012), clearly aligns with affective transformative approaches of climate change adaptation.

As a matter of fact, the transformative strength of this dwelling approach of place process is rooted in the affective dimension (Hackmann et al., 2014; Vogel & O'Brien, 2022). This notion finds support in the work of Sterling (2003), who emphasized that among the three interrelated dimensions of human experience, the 'seeing' or *ethos* dimension holds the key to paradigm change. It involves the capacity to expand worldviews, allowing the simultaneous appreciation of diverse perspectives and expanding awareness (or framings) to encompass more possibilities (Sterling, 2003).

Chapter 3

3. CASE STUDY: THE LLOBREGAT DELTA

The area of study for this research comprises the non-urbanised areas of the southern lobe of the Llobregat delta in the metropolitan area of Barcelona; that is, the stretch from the new mouth of the River Llobregat to Port Ginesta (Fig. 8) coinciding with the coastal stretch defined as Section 8 (ICC, 2010). It covers the four coastal municipalities of the Baix Llobregat region (El Prat del Llobregat, Viladecans, Gavà, Castelldefels) and a small stretch of Sitges.

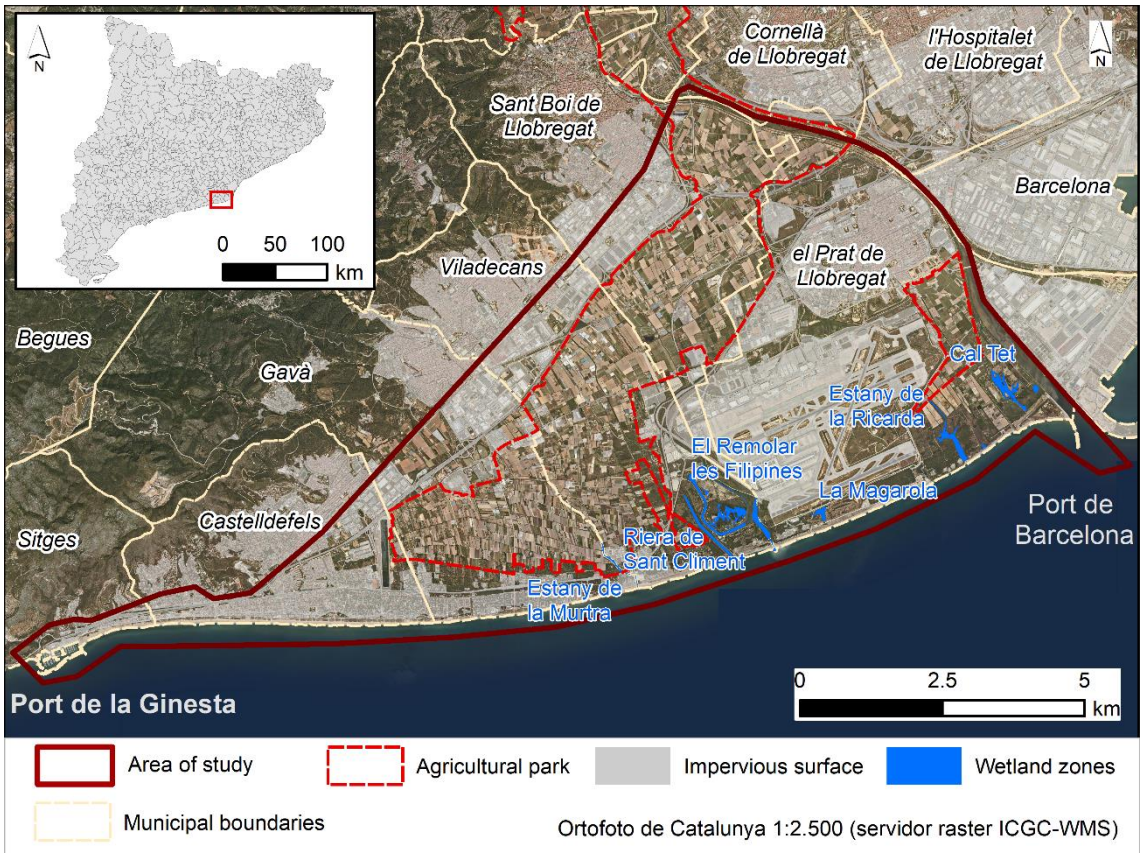


Fig. 8 Area of study location map. Source: own production.

The Llobregat delta plain occupies an area of 95.5[2] and 23 km of coastline (15 km in the lobe to the south and 8 km to the north). It is the second biggest delta and third in terms of wetland area on the Catalan coast. However, the natural wetlands make up less than 5% of the original surface (Marcé et al., 2012). The proximity of the delta to the city of Barcelona has caused its transformation from a "hostile and unpopulated territory to a metropolitan communications hub" (Esteban et al., 2018: 28). The expansion of the impermeable land surface means it now occupies almost 60% of the delta plain, intensely modifying the structure and functional properties of the landscape (Pino & Isern, 2018). Currently, most of the non-urbanised land is made up of farming plots in the Baix

Llobregat Agricultural Park and the natural areas of the Llobregat Delta Consortium for Natural Spaces. In other words, the spaces are defined in accordance with the protection measures afforded them (Germain, 2018; Albaladejo, 2015; Roda, 2015; Montasell & Dorda, 2006). However, development pressure, including the presence of main infrastructures and the large operators continue to be the sources of reiterated territorial conflict.

3.1. The formation of the delta

The Llobregat river originates in the Pyrenees Mountain range in the north-eastern part of the Iberian Peninsula and flows southward to meet the Mediterranean Sea, just south of Barcelona (Fig. 8). This river plays a pivotal role in shaping the origin and structure of the Llobregat delta through an ongoing dynamic interaction. This interaction involves the continuous contribution of sediment from the river, coupled with significant fluctuations in the sea level. The progradation process started about 2,300 years ago when the sea level stabilized in its current state (Esteban et al., 1996) enabling marine dynamics to shape the formation and evolution of the delta (Sans & Panareda, 2016).

The delta's encroachment into the sea is determined by the changes in the river and by coastal barrier formation. As Esteban et al., (2018) and Garcia-Lozano, (2019) explain, based on Marqués, (1984), the emergence of coastal sand bars parallel to the shoreline (fed by the dominant south-westerly current) caused the formation of shallow coastal lagoons which were filled by alluvial sediment from rivers and also from lateral streams. La Murta is a vestigial lagoon that originated from the refilling of an ancient bay (Queralt & Isla, 2018). These spaces, together with the old branches and beds of the river (Fig. 9) which were abandoned as a result of the unfavourable gradient, offer a topography that is lower than the surrounding area and act as receptors for the surface run-off produced upstream. Examples are the lakes of La Ricarda and El Remolar which could be former mouths of the river (Sans & Panareda, 2016).

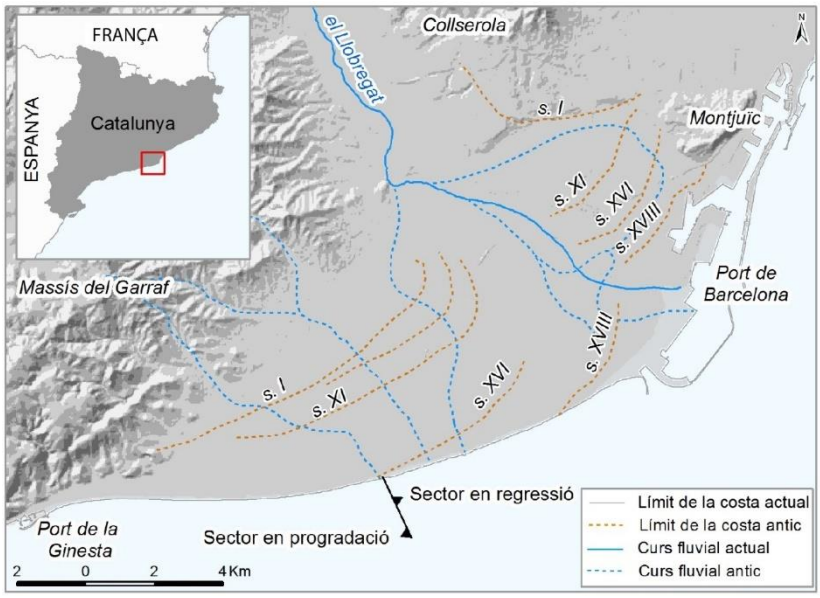


Fig. 9 Evolution of the coastline of the Llobregat delta. Source: Garcia-Lozano (2019).

In parallel with the evolution of the delta, two layers of sandy materials were formed, creating reservoirs of fresh water: the deep aquifer and the surface aquifer. These aquifers are separated by an impermeable clay wedge, ensuring their distinct storage and flow dynamics. The surface aquifer is primarily composed of fine and coarse sands, and it does not reach significant depths (maximum 20 meters) (Queralt & Isla, 2018). Its thickness typically ranges between 5 and 10 meters due to the presence of silts and clays from the unsaturated zone.

In areas where the covering of silts and clays over the surface aquifer is minimal, they become particularly susceptible to flooding during periods of heavy rainfall. This vulnerability arises when the phreatic level surpasses the ground level, a phenomenon commonly observed in wetland regions. Whereas, areas nearest to the Llobregat river, such as the agricultural district of La Ribera, the thickness of silts and clays is greater due to the sediment deposition resulting from the river's periodic flooding over the course of many years.

3.2. Intertwined historical periods

Places hold a 'layering of histories which sediment in place and become the bedrock for future action' (Cresswell, 2005:40) paraphrasing Lippard (1997).

One of the most notable features of the Llobregat delta lies in its mosaic of diverse land uses and landscapes (Esteban et al., 2018; Pino & Isern, 2018). This metropolitan delta is totally sealed in its northern lobe by one of Europe's major ports in the Mediterranean and it hosts the international Barcelona airport and metropolitan services. It is crossed by

a dense high-way, railway, and subway network, and it is home of almost 600,000 inhabitants (Esteban et al., 2018). Additionally, the Llobregat lower valley and delta represents the most important agricultural area in terms of land and crop production values in Barcelona (Serra et al., 2018). Moreover, remnants of deltaic wetlands, lagoons, and marshy lands persist, forming a designated EU Natura 2000 site (Germain, 2018).

The actual mosaic of land uses concentrated in less than 100 hectares is the result of successive waves of wilderness, farmscape, urban sprawl, and logistics-node landscape, each leaving a visible impact in today's landscape. To examine the competing meanings attributed to non-urbanised areas and the affective responses they evoke (see **Error! Reference source not found.**), it is crucial to consider its contingent and historical identity, which stem from the dynamics of senses of place experienced across different geographical and temporal scales (Berroeta et al., 2021).

The sequential snapshots correspond to the chronological progression of key announcements regarding the Llobregat river diversification, which ultimately came to fruition in the year 2004. Notably, these announcements often appeared afterwards catastrophic floods events (Milagro, 1989). Indeed, the combination of physical characteristics within the Llobregat basin, coupled with the Mediterranean climate patterns, has resulted in a notable historical record of floods and significant overflow events (Vide & Barriendos, 2004). The successive proposals for engineering river diversification were justified with the overarching goal of improving the sanitary conditions for the local population, mitigating flood risks, and considering economic and strategic factors (particularly the expansion of the Port of Barcelona) aligned with the dominant land character in each period.

3.2.1. From a marshy deltaic land to Barcelona's breadbasket

Already in 1891, it appeared the proposal to divert the final section of the Llobregat River, as outlined in the document titled 'Proyecto de saneamiento del subsuelo de Barcelona' (Project for the Sanitation of the Subsoil of Barcelona). The primary concern, in addition to addressing the risk of floods, was driven by sanitary considerations, aiming to eradicate paludism and facilitate the drainage and drying of marshy areas (Milagro, 1989). By that time, the first land transition in the delta was in progress. From a marshy deltaic landscape to Barcelona's 'breadbasket' (Deffontaines, 1949), represented a significant transformation that involved an intense process of drying marshlands (Codina, 1966), and the conversion from rainfed agriculture to irrigated agriculture (Tobaruela & Sans, 2003).

The establishment of two channels, the Infanta Canal (1819) and the Dreta Canal (1865), played a central role in this transformation. The expansion of agricultural activity together with the need to eradicate malaria meant the progressive drying of the delta—a process which culminated with the construction of a network of channels, locally known as 'corridors' in the western part of the delta (Capmany, 2004).

The drying process not only improved sanitary conditions but also enhanced accessibility and land communications, thereby catalysing the intensification of commerce (Codina, 1966). The advent of the railway connecting from Barcelona to Molins de Rei in 1854, and later extending it to Martorell, constituted a significant impetus for the agricultural transformation of the region (Tribó i Traveria, 2004). At the end of the XIX century, agriculture transcended its subsistence nature and embarked on a period of expansion, catering not only to the Barcelona market, but also reaching further to several European countries (Pomés, 2001). According to some authors, the peak period of deltaic irrigated agriculture is believed to have occurred during the republican period (1931-1936). The agrarian landscape dominated the delta, except for a reduced extension of wetlands and marshland that were nestled along the coastline.

The improvement in regional communication was also influenced by the early arrival of aviation activity in the delta. In 1918, the first aerodrome was inaugurated in Viladecans, with a regular flight from Toulouse to Casablanca (with layovers in El Prat, Alicante, Malaga, and Rabat). The flat terrain, lack of obstacles, mild climate, and proximity to Barcelona were some of the main attractions. During the Second Republic (1931), three aerodromes were in operation. However, in 1936, with the outbreak of the Civil War, they were first consolidated under the jurisdiction of the Catalan Ministry of Defense, and later, under the Ministry of Defense during the Francoist period (Gómez-Inglada, 2021).

The initial industrial developments took root in the left lobe of the delta. Additionally, following the discovery of water from the deep artesian aquifer (back in 1893), industrial activities embraced the right bank as well, specifically in areas such of El Prat and Gavà municipalities (Ferret, 1985). Initially, agricultural production coexisted with the emerging industrial system, which was not immediately linked to exponential urban growth. It was not until the latter half of the twentieth century, still during the Franco dictatorship, that urbanization and industrialization significantly expanded into the fertile deltaic plain. Then, the delta gradually became a recipient of activities that were displaced

from the neighbouring city of Barcelona, resulting in a substantial accumulation of industrial operations, jointly with a high expansion of urban land uses.

3.2.2. From Barcelona's breadbasket to Barcelona's backyard

In 1941 the National Airport was constructed. Despite complaints from the affected landowners, the agrarian fields were expropriated. In this second transition, agriculture, once a dominant economic activity, started to decline within the peri-urban context, and the looming threat of expropriation for future infrastructure or industrial projects (Tobaruela & Sans, 2003). Between 1955 and 1990, the agricultural area of the delta experienced a drastic reduction of 50% (Sempere Roig, 2009).

In 1968, the approval was given to channel the Llobregat river from Molins de Rei to the river mouth (Campmany, 2009). This decision was a historic demand of local authorities and civil society, finally addressed in the aftermath of the devastating flood of 1968, which resulted in the loss of numerous human lives. Simultaneously, the Chamber of Commerce, Industry, and Navigation of Barcelona conducted a study of the port environment, advocating for the diversion of the river towards the south-west (Milagro, 1989).

This led to the creation of the ‘Comisión Interministerial para el estudio del puerto de Barcelona y su entorno portuario’ (Interministerial Commission for the study of the port of Barcelona and its port environment), which in 1972 formulated a new project. This alternative project divided the channelled works into three sections, with the third section involving the redirection and diversion of the river, from El Prat de Llobregat to the sea, approximately 4 kilometres to the west (aligned with the Ricarda lagoon). The promoters strategically capitalized on the projected growth of the Port, emphasizing the low economic amortization of the river channelization without considering its diversion. Thus, the project was justified by employing security arguments, economic incentives, and strategic considerations, although it encountered staunch opposition from various fronts (Campmany, 2009).

In the midst of Franco's waning years, the battle in favour of river channelisation and against river diversion became a symbol of resistance against the dictatorship contributing to the broader movement calling for democratic reforms (Vila, 2009). The clamour that emerged from the peasant response to the urbanization of agrarian land, combined with a pervasive sentiment of long-standing marginalization by public authorities, fostered a

profound sense of stewardship for the remaining lands and a determination to reclaim decision-making power over their future (Sempere Roig, 2009). With the rallying call 'Save the Pla,' farmers were united through the Unió de Pagesos (Farmers' Union) and strongly supported by civil society. The works for the diversion and canalization of the final stretch of the river were not executed. However, it remained an intended action in the Metropolitan General Plan (1976).

Environmental destruction was already acknowledged as a significant issue in the 1970s and stood as a key argument against the diversion of the river, particularly regarding the contamination of the aquifer. This concern arose prior to the widespread acceptance of the ecological discourse among scientists, politicians, and civil society (Capmany, 2009). In 1974, the Water Commission of the Prat de Llobregat City Council initiated the first aquifer studies recognizing the critical situation of the aquifer caused by overexploitation and pollution. One of the measures to reverse the situation was the establishment of the groundwater Users' Community in the delta, which was officially formed in 1982 and marked Spain's pioneering effort in this regard. The Users' Community confronted the Port Works Board of Barcelona, which had built an inland port dock, causing a breach that enabled seawater intrusion into the aquifer and led to the closure of several wells.

Industrial and potash mining activities in the mid-section of the watershed exacerbated the deterioration of water quality as it reached the deltaic plain (Gorostiza et al., 2015; Lloret, 2004), a salt pollution that became naturalised (Gorostiza & Saurí, 2019). The Delta suffered significant impacts because of environmental disregard displayed by industrial activities and urbanization deficiencies. The river and channels turned into open sewers due to the lack of wastewater sanitation treatments. Aquifers were overexploited (Carrera et al., 2004), and extraction of aggregates from agrarian fields and riverbanks led to the formation of waste-filled pits (Mateu, 1990).

By the end of the 20th century, the Llobregat river was one of the most polluted rivers in Europe (Marcé et al., 2012). The beach was obviously affected by pollution from the watershed. Somewhat ironically, due to sanitary reasons beaches nearby the river-mouth were preserved from mass tourism[8], which permitted the maintenance of coastal land forms like dune systems, salt marshes and lagoons (Breton et al., 2000). In short, degraded

[8] Beaches were closed for bathing, which was forbidden until 2002.

spaces hosting marginal economic activities coexisted with wild and remoteness spaces (despite the proximity to Barcelona).

3.2.3. From Barcelona's backyard to metropolitan logistic hub

Within the third transition, the landscape underwent a deep transformation with the implementation of a pharaonic territorial project known as the 'Cooperation Agreement on Infrastructure and Environment in the Llobregat Delta' (Resolution of May 17, 1994)[9], commonly referred to as the 'Delta Plan'. On this occasion, although many of the objections to the river diversion re-emerge, democratic municipalities moderated their direct opposition and shifted their stances in the 1980s. They transitioned to a strategy of negotiating environmental and economic conditions, as well as compensations.

The major engineering interventions were the expansion of the Airport and Port, which required the diversification of the Llobregat River to accommodate these developments. The diversification works (involved relocating the river's mouth by 2.5 kilometres to the south), awarded in March 2001, and were completed in September 2004[10]. The strategy was devised with the goal of positioning the deltaic land as a prominent logistic-hub in the western Mediterranean, challenging the competitiveness of Marseille and Genoa (Milagro, 1989). By the turn of the 21st century, the production of goods in the area had dwindled while the focus shifted towards goods transportation and logistics, signifying a shift from industry to a more service-oriented sector (Esteban, 2006).

Even before the implementation of the Delta Plan, in 1996, the Barcelona Provincial Council commissioned Unió de Pagesos to conduct a study on the establishment of an agricultural park in the Baix Llobregat region. The project was also endorsed by affected municipalities involved in participatory processes of local Agenda 21 (Roda, 2015). The Baix Llobregat agricultural park was established in 1997 with support from the European

[9] Resolution of May 17, 1994, by the State Secretary of Territorial Policy and Public Works, ordering the publication of the Cooperation Agreement on Infrastructure and Environment in the Llobregat Delta, signed between the Ministry of Public Works, Transport and the Environment, the Government of Catalonia, the City Council of El Prat de Llobregat, and the Association of Municipalities of the Metropolitan Area of Barcelona.

[10] The Supreme Court sentence in 2004 against the diversion, responding to administrative litigation by CUADLL, but works were already executed.

Union's LIFE programme (LIFE96ENV/E/264), and it stood as a pioneering initiative in Europe.

In parallel, 'natural protected areas' were progressively expanded through various national and European-level protective regulations[11] (Albaladejo, 2015). These areas, primarily located along the coastal fringe, comprise coastal wetlands habitats, including natural ponds, halophytic vegetation, and coastal dunes, with substantial coverage by pine forests. The Consortium for the Protection and Management of the Natural Spaces of the Llobregat Delta was created in 2005, and since then it has monitored activities, informative visits, and environmental education, consistent with the roles fulfilled by natural areas. Natural protected areas, together with the protected agrarian park, now constitute nearly the only remaining non-impervious surfaces in the study area.

The delta transformation came at the cost of increasing impervious surface and the river disconnection from its delta. In recognition of the environmental impacts resulting from the 'Delta Plan' a set of compensatory measures stipulated in the corresponding 'Environmental Impact Assessment' (EIA) documents for each infrastructure project was established. Additionally, new environmental infrastructures were implemented, such as the water treatment plant in El Prat del Llobregat in 2004. Efforts towards pollution reduction and spatial regulation led to the intensification of recreational uses, not only among the local population but also from neighbouring municipalities. As the delta's population began to rediscover the area, it transformed into a popular and valued place for everyday leisure activities (Esteban et al., 2018). The transformation of the beaches was remarkable, shifting from being prohibited for swimming to becoming overcrowded. However, the social revaluation of these spaces also caused coexistence conflicts with the remaining peri-urban agrarian production activities, especially regarding the recreational use of rural paths.

Present-Day challenges

The network of agrarian roads, along with irrigation and drainage networks, has experienced increased fragmentation due to urban metropolitan expansion resulting in a significant loss of functionality (Queralt & Isla, 2018; Roda, 2015). The gradual decline of agricultural activity mentioned in 3.2.2 has not been reversed, visually evidenced by

[11] Plan for Spaces of Natural Interest (PEIN), approved by Decree 328/1992, and the areas included in the Natura 2000 network, approved by the agreement GOV/112/2006.

the absence of generational relief among farmers. A similar pattern of decline is observed in terms of biodiversity indicators in the protected natural areas (De Roa & Esteban, 2018). Despite the continuous expansion of protected natural areas (Germain, 2018), the glaring lack of resources for effective conservation efforts in these areas remains evident (De Roa & Esteban, 2018).

On the other hand, an integrated socioeconomic and environmental assessment of the overall transformation of the delta has never been carried out (BR, 2019). The ongoing compensatory measures from the Delta Plan, have not been revisited, nor has their effectiveness been evaluated. In some cases, they have not even been implemented. Retrospectively, the long-term sustainability and effectiveness of these compensatory measures have not reached envisaged mitigation effects. For example, the expansion of the airport, which encroached upon a portion of the Ricarda lagoon drainage basin, included a commitment to contribute to an annual water volume of 0.458 hm3/year (as mentioned in the Environmental Impact Assessment, 2002). Currently, the Ricarda lagoon (see Fig. 8) is an isolated eutrophied pond intensified by the insufficient water contribution by AENA (0.288 hm3/year), well below the commitments established (Delta, 2021).

The naturalist association DEPANA[12] has capitalized on public complaints about ecological integrity of natural protected areas. After DEPANA's complaint to the European Commission in 2012 about the vulnerable status of specific bird species listed in Annex I of the Birds Directive (Directive 2009/147/EC), new contributions and reports have been submitted regarding the non-compliance of the EIA for the airport expansion. The infringement is headed by the absence of the 'Special Plan for the protection of the natural environment and landscape of the Llobregat Delta', which was contemplated even before the airport expansion and is being emphasized as a fundamental and urgent issue by the EU Commission.

Recently, in February 2021, the Commission called on Spain to respect its obligations with the Habitats Directive (Council Directive 92/43/EEC), 'Spain must take the necessary steps to avoid any further deterioration of the Natura 2000 site Delta del Llobregat as a consequence of the implementation of large infrastructure projects, such

[12] Lliga per a la Defensa del Patrimoni Natural (https://depana.org/)

as the expansion of Barcelona International Airport and Seaport' (EC notification available at https://ec.europa.eu/commission/presscorner/detail/en/inf_21_441). The EC letter of formal notice to Spain arrived three months before the AENA's official proposal of another airport expansion Fig. 18, with an inversion of €1.7 billion aimed to make Barcelona Airport a major international hub (La Vanguardia, 2021). The proposal required approval from the European Commission since the expansion affected areas of the Natura 2000 network, and therefore also required prior agreement with the Government of Catalonia, which was not obtained. The proposal did not move forward, but the debate is not closed.

Urban areas in the delta have continued to expand, and proposals for macro projects have been presented and debated, even in the face of soil protection regulations. This territory has consistently remained esteemed as a land reserve for urban development. Numerous grassroots local territorial movements have emerged. These movements often stem from past conflicts and struggles, arising from pre-existing groups or in response to unresolved situations (Paül, 2009). They form expansive and adaptable coalitions that transcend previous territorial conflicts, encompassing ecological and agrarian concerns. These movements have organized themselves into broad platforms that have shaped discourse and planning at both regional and basin levels. Notable examples include the Garraf-Ordal platform in 2002, and more recent initiatives such as the Taula del Llobregat, Zeroport, and SOS Baix Llobregat.

3.3. The Llobregat delta: sedimentary deficit and drainage system

The diversion of the River Llobregat in 2004, undertaken to facilitate the expansion of the port of Barcelona has exacerbated the historical problem of sedimentary deficit, pushing it into a chronic state (Martín-Vide et al., 2020). The 8-metre dyke channel in the new river-mouth, built to avoid inundation of the airport in front large-scale flooding, has resulted in the loss of fluvial sediment out to sea impeding the natural longitudinal sediment transport along the coast (Gracia & Calafat, 2019).

The process of littoral regression directly affects the beaches downstream from the port of Barcelona by hindering the transportation of sediment by longshore drift current and wave refraction (Garcia-Lozano, 2019). Also, the inflow of river borne sediment is already reduced due to the presence of three reservoirs, locks, channelization of the riverbed, and occupation of the flood plain as a result of urban and infrastructural growth (Prats-Puntí et al., 2021; Sánchez-Juny & Dolz Ripollés, 2004). The River Llobregat,

transformed into a channelled estuary, has become disconnected from its own delta (Gracia & Calafat, 2019). Despite the drainage sites, employing 100,000m^3 of sand a year (Fig. 10) as a compensatory measure approved under the EIA for the expansion of the Port of Barcelona (Official Gazette of the Government of Spain, 2005), the regression and loss of beach volume along the northern coastal stretch has not been reversed (Perelló et al., 2019). In contrast, the Castelldefels's shorefront is the stretch of beach currently in progradation (Fig. 9). The construction of Port Ginesta in 1986 has acted as a barrier to the longitudinal transport of sediment leading to the accumulation of longshore drift sediment in this area (Banchini et al., 2009).

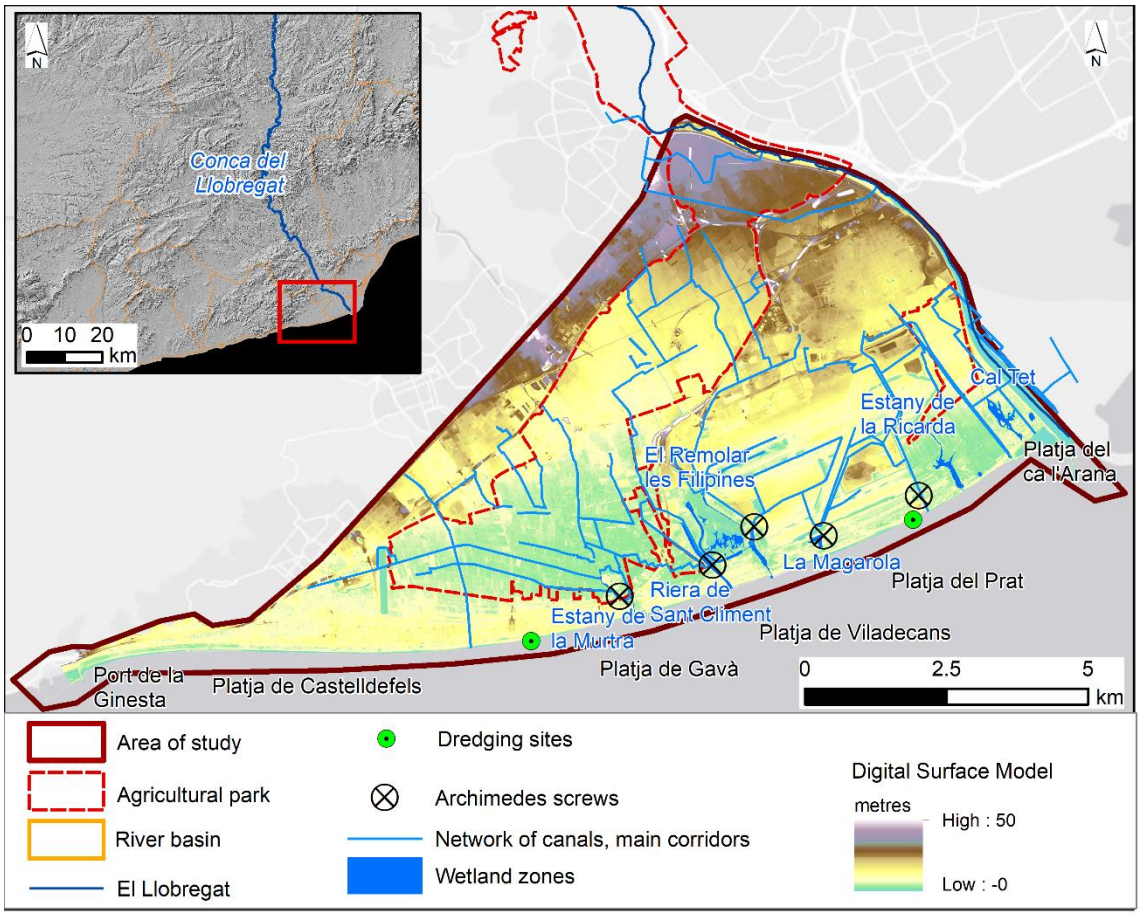


Fig. 10 Southern lobe of the Llobregat delta, with some elements of the drainage network. Source: own production.

Guaranteeing drainage in the delta plain is one of the historical concerns of the delta's population (Codina, 1966, 1971). Fig. 10 illustrates the gradual gradient, punctuated by coastal dunes and the lowest points of La Murtra and the Sant Climent stream. These variations in elevation create a deltaic landscape reminiscent of a shallow basin, providing insight into the progradation process of the delta plain (as discussed in section 3.1). Within this lowest sector, which resembles the concave portion of a bathtub, lies the

primary concentration of dunes and sandy soil within the delta. An interesting feature of this sector, characterized by an almost negligible gradient (Fig. 10), is that agriculture here takes advantage of capillary irrigation through the relatively elevated groundwater levels. The network of channels employed for both irrigation and drainage in this sector, referred to locally as 'corridors' (of depths ranging from 0.5 to 1 meter relative to the terrain's topography) is primarily supplied by the shallow water table and additionally by pumping from the Gavà-Viladecans biological treatment plant. When it rains, the corridors act as drainage channels towards La Murtra and El Remolar lagoon. The levels of the corridors are managed by means of two Archimedes screws on each side of the Sant Climent stream, and a third at La Murtra, capable of pumping 1.5m^3/s and operated by the farmers themselves (Fig. 10).

The drainage capacity is not the same between the different sectors of the delta coast and is not sufficient to avoid recurrent episodes of flooding of the agricultural fields. Barcelona airport has its own drainage system to ensure the protection of its installations, which considers both fluvial drainage and control of the water table. It has 15 Archimedes screws which discharge to the west into El Remolar via the Bogues canal, to the east into the Illa lagoon and centrally directly into the sea (Fig. 10).

The entire complex of historical infrastructures associated with the drainage and irrigation of the plain (small irrigation channels, rainwater channels, canals, etc), designed for a surface area of agricultural land much greater than that used at present, has lost part of its use (Queralt & Isla, 2018). The drainage problems are intensified by the increasing impermeabilization of the soils, reduced infiltration and the consequent increase in urban runoff overflows feeding into the traditional network of agricultural canals and rainwater channels which often discharge into the coastal lagoons (ACA, 2008b; De Roa & Esteban, 2018). Parallel to the ongoing expansion of urban, industrial and logistical land use, the road and rail infrastructure networks that cut across the main hydrographic network are an added obstacle which in periods of heavy rain act as water collection dykes (Solé-Perich, 2005).

3.4. Delta del Llobregat and local adaptation plans

Deltas are flood zones by definition. The sedimentary stability of deltas depends largely on extreme weather events (river flooding and maritime storms), when there is greater capacity for the movement of sediment (Day et al., 1995). Human occupation in flood-risk zones such as the Llobregat delta inevitable exposes it more to flooding (Barriendos

et al., 2019; Breton & Sauri-Pujol, 1997; Ribas et al., 2020). At the same time, anthropic pressure such as the impermeabilization of the land surface or the rigidisation of the coastline hinders the dynamics of the coastal ecosystem, and consequently, reduces the resilience of these coastal systems to face extreme climatic phenomena (CADS, 2021).

Maritime storms are one of the main climatic threats in the coastal areas of Catalonia (Sánchez-Arcilla et al., 2016). The principal associated risks are erosion and flooding, two effects that are interrelated since they are mutually intensifying (Guillén, 2008). According to existing records, over the last two decades there have been maritime storms of increasing magnitude along the Catalan coastline (Palacios, 2019; Pintó et al., 2020). This situation is made worse by the effect of the relative increase in mean sea level (MedECC, 2020). Moreover, predictions for climate change indicate an increase in the frequency of extreme rainfall, particularly affecting floodable areas and specifically the coastal plains (GENCAT, 2017). In this respect the policies for mitigating greenhouse gases are no longer sufficient and strategies for adaptation to climate change have been included in government agendas at the local, regional, and state level. The role of the town councils in fulfilling climate goals has been underlined further by the Paris Agreement (UNFCCC, 2015).

The coastal municipalities of the southern lobe of the Llobregat delta—El Prat del Llobregat, Viladecans, Gavà and Castelldefels—have approved theier respective Local Climate Change Adaptation Plans (AMB, 2015b, 2015a, 2018; Lavola, 2014). Driven by the commitment of the Covenant of Mayors (see section 2.1.1, Fig. 2), the plans adopted in 2015 are the first generation of CC adaptation strategies for small agglomerations (less than 100,000 inhabitants) in the region. The plans were promoted by the Barcelona metropolitan agency acting as a Covenant regional coordinator of both municipalities. Covenant intermediate coordinators are those public administrations (provinces, regions, etc.) providing financial and technical support to municipalities signing up to the Covenant. Accordingly, these regional parties are key determinants of the multilevel-governance boosted by the European Commission.

The documents produced are action plans—in some cases with referrals to intervention sectors—but of a non-binding character. They are conceived as a preliminary screening of most prominent climate risks based on a standardized approach (EC and EEA, 2019; Joint Research Centre, 2018). Consequently, the analytical framework of the vulnerability

assessment is operationalized and subordinated to obtaining a ranking of the most prominent climate risks that guide the actions programme. The plan structure is as follows: (i) geographical characterization of the municipality and review of local competences; (ii) regional climate projection; (iii) risks prioritization (includes a vulnerability assessment); (iv) programme of actions (horizon 2016-2020); and (v) monitoring/review. The third one, which is the vulnerability assessment conducted to justify the risk prioritization, is the focus of in-depth analysis in this thesis. In section 4.2 the uncertainty assessment proposed is further elaborated.

Chapter 4

4. METHODS AND DATA

In this chapter, the analytical frames, data analysis and data source employed in this doctoral thesis is justified with respect to each of the three overarching objectives. The three subsections are briefly introduced, highlighting their relevance in addressing the theoretical gap identified.

4.1. Flood exposure analysis

The assessment and management of flood risk in Catalonia are regulated by the European Directive 2007/60/EC (EC, 2007), and its transposition into Spanish law (Royal Decree 903/2010). For river and rainwater flooding, the Catalan Water Agency (ACA) and the Directorate-General for Civil Protection are responsible for risk assessment and management. Coastal flooding, however, falls under the jurisdiction of the Directorate General for Coastal and Marine Sustainability.

The Directive was introduced through three planning cycles each comprising three phases. The first phase involves the preliminary flood risk assessment and the identification of the Areas of Significant Potential Flood Risk (ARPSI) and Flood Risk Sections (TRI). The second phase includes the creation of hazard maps (graphic delimitation of the flood-prone areas) and risk maps (potential damage that may be caused by flooding), MAPRI. Finally, the third phase encompasses the development of the Flood Risk Management Plan (PGRI) which is produced and approved for each hydrographic demarcations.

In short, the flood risk mapping available for the area of study does not account for the potential simultaneous occurrence of both land-based and marine sources of flooding which may be especially important in delta regions (MedECC, 2020). Furthermore, the limited spatial resolution of cartographic flood sources, especially marine flood maps, holds low significance from the local community's perspective. Consequently, the particularities and local factors that determine the redistribution and intensity of flood exposure can be underestimated.

Finally, when considering the integration of climate change effects into flood risk assessments, the second Flood Risk Management Plan (for the period 2022-2027) has primarily received qualitative consideration, for example, with the identification of priority action areas (ACA, 2019). Regarding coastal flooding, the assessment

encompasses sea level rise scenarios outlined by the IPCC (IHCantabria, 2020). However, it currently overlooks the potential temporal flooding caused by extreme weather events.

To better characterising the spatial dimension of local flood risk in non-urbanised areas of the southern lobe of the Llobregat delta, this study employs the 'llevantada' event as a reference point. The 'llevantada' is a storm event characterized by robust winds from the east or northeast, leading to adverse weather conditions and heightened sea levels along the Catalan coast. This event serves to emphasize the necessity of considering both the simultaneous risks associated with compound events in a context of climatic change (Vitousek et al., 2017; Wahl et al., 2015).

Observation images obtained from the TerraSAR-X satellite during Storm Gloria, which occurred from January 19 to 23, 2020 (López-Bustins & Martín-Vide, 2020; Santasusagna Riu & Tort Donada, 2020) were used to generate the mapping of local flood identified during this extreme climatic event. To evaluate the marine influence on the flooding, oceanographic data and parametric calculations were carried out to estimate the level of marine flooding resulting from the storm.

Accordingly, this section consists of two different methodological sections:

- (4.1.1) The spatial delimitation of delta flooding during Storm Gloria through remote sensing methodology based on SAR images obtained by the Terra Sentinel-1 space observation mission.
- (4.1.2) The estimation of temporal sea level rise during the days of the storm.

4.1.1. Synthetic-aperture radar (SAR) image processing

The Sentinel-1 SAR senor forms part of a constellation of satellites of the European Space Agency (ESA) under the Copernicus programme. SAR technology operates in the microwave spectrum, which means it utilises the longest wavelengths in remote sensing. This allows it to observe cloud-covered areas, as its wavelength are greater than those of a water droplets. This makes them a very useful data source for carrying out spatial analysis in adverse atmospheric conditions. Sentinel-1 SAR imaging operates within the C-band spectrum, with a central frequency of 5.405 GHz, and offers dual polarization (VH/VV) (ESA, 2022).

Each pixel in the radar image represents the coefficient of backscatter from the signal emitted by the sensor to the earth's surface (Chuvieco, 2010). The backscattering

coefficient (or intensity of the return signal) depends to a great extent on the roughness of the terrain. The water surfaces behave as specular surface, reflecting the radar's return signal opposite to sensor's direction. Therefore, they exhibit significantly lower backscattering values compared with other types of land cover areas. This contrast allows the differentiation of water-covered areas.

4.1.1.1. Data

The Sentinel-1SAR images were downloaded free of charge from the Copernicus Open Access Hub (https://scihub.copernicus.eu/dhus/#/home). The imagery employed for the temporal remote sensing analysis is detailed in Tab. 3. The image captured prior to the storm serves as a reference for the permanent water masses. The post- storm image allows the identification of temporary water masses (flooded areas) by establishing differences with the reference image. The two images selected are consecutive in time (12-day orbital period). Both images have IW acquisition, ascending pass and are Level-1 Ground Range Detected (GRD) products (ESA, 2022). Pixel size is 10m in land geometry ($100m^2$).

Image	Satellite	Date of capture	Time of capture	Incidence angle
A (pre-storm	Sentinel 1-B	10 January 2020	20:25	30.54-46.25
B (post-storm)	Sentinel 1-B	22 January 2020	21:31	30.54-46.25

Tab. 3 Sentinel 1-B images used. Source: own production.

The extent of the images was reduced to adjust them to the area of study, and an extension into the sea was applied to include beach areas. To exclude urban areas from the study site an impervious surface mask was employed. The urban mask was generated through reclassifying the Land Use /Land Cover map of Catalonia, MUCSC, 2017, accessible at (<http://www.creaf.uab.es/mcsc/>). These areas were excluded due to the technical complexity of identifying flooding in urban regions using SAR data, which is complicated by the high backscatter intensity exhibited by these surfaces (Tavus et al., 2018).

The processing and analysis of the Sentinel-1 data was carried out using the freely available SNAP software (Sentinel Application Platform, Toolbox Sentinel-1, version

8.0.4, which can be accessed at http://step.esa.int/main/toolboxes/sentinel-1-toolbox/s1tbx-features/). The two Sentinel-1 GRD images underwent a standard pre-processing procedures to apply the necessary geometric and radiometric corrections (Filipponi, 2019). In this study no filters were applied to mitigate speckle or granular noise which is prominent in SAR images. While filters improve the visual quality of the image, they also cause a reduction in spatial resolution (Tarazona et al., 2021). Hence, it is advised not to use filters for the detection of small spatial features (Filipponi, 2019).

4.1.1.2. Image classification

To identify temporary water masses, a supervised classification method was utilised, involving the visual interpretation of a multitemporal RGB composition. This method relies on disparities in signal intensities between pre- and post-event images, utilizing an RGB band combination to amplify temporal changes resulting from water presence. (Conde & De Mata Muñoz, 2019). The chosen band combination consisted of the VH polarization image for the red (R) band, and the post-storm image for the green (G) and blue (B) bands (also VH cross-polarized). This combination enabled the visualisation of red pixels with high backscatter values in the pre-event image, but significantly lower intensity (less than -21dB) in the post-event image.

The resulting multitemporal RGB composition identifies those surfaces that display specular reflective characteristics exclusively in the post-event image. Based on these tone differences, three training site were established for the respective classes: (A) permanent water masses, (B) temporary water masses, and (C) land not covered by water. Ground truth points were not used for image classification, so they were all reserved for results validation. The classification algorithm used with SNAP software was Random Forest (Breiman, 2001).

4.1.1.3. Validation

A total of 24 ground truth points were obtained from fieldwork (using a GPS) conducted between September 2021 and May 2022 (Fig. 14). The collected samples included agricultural fields, beach areas, nature space and areas bordering the urban zones excluded from the study. Among the sample set, 18 were identified as being flooded on 22 January 2022 and 6 not flooded. For some of the samples identified as flooded the informant gave us photographic evidence of the flooding. Given the small sample in relation to the area of study, it was necessary to work with a larger-than-usual confidence interval.

4.1.2. Estimation of temporary sea-level rise

In delta areas, river, rainfall, and coastal floods intersect, with the possibility of all three coinciding simultaneously (Ballesteros et al., 2018). Regarding the marine origin, a distinction is made between permanent flooding caused by sea-level rise associated with climate change (Nicholls et al., 1999), and sporadic flooding associated with coastal storms (Stockdon et al., 2007). During a coastal storm, the combined effect of astronomical tides, storm surges and wave runups contribute to elevating the sea level (Stockdon et al., 2007). The storm surge (meteorological tide) is produced by the combined effect of low atmospheric pressure and coastal wind (Anselme et al., 2011). While tidal fluctuations are recorded by tide gauges, the wave run-up is frequently estimated using parametric calculations that combine oceanographic data (significant wave height and wave peak period) with beach slope data (Stockdon et al., 2006). The magnitude of the wave runup, as shown in Fig. 11, is made up of two components: wave setup, which is the increase in sea level caused by breaking waves, and wave swash, which is the water layer or flow that washes onto the beach after wave breaking.

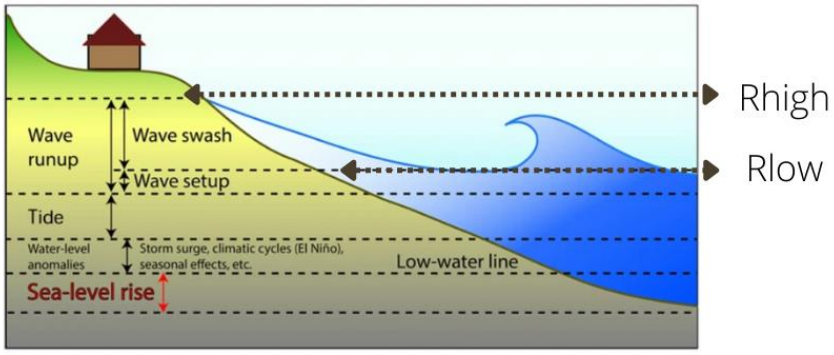


Fig. 11 Components of sea level contributing to coastal flooding. Source: Adapted from Vitousek et al. (2017).

4.1.2.1. Parametric estimation

In the field of coastal engineering, it's common to calculate the elevation at which 2% of the highest recorded wave runup values are situated (Stockdon et al., 2006), referred to as R_{high}. The depth of marine flooding during the storm Gloria was estimated using R_{low} defined as the sum of the astronomical tides and storm surge (wave gauge records) along with the calculation of the wave setup (η) I used the parametric equation introduced by Stockdon et al., (2006). This formula integrates the beach slope (β), significant wave height H_s (the mean height of the highest waves over a 30-minute period), the wavelength of the wave (L) and the period of the peak (T_p), which is the time between successive crests. The stages for calculating R_{high}

are the same as those described for R_{low} , differing only in the calculation of maximum wave runup instead of wave setup. This calculation is also based on the reference of Stockdon et al., (2006) and its result is subsequently combined with the tide effect.

A constant beach slope of 3º was assumed, coinciding with the value observed in recent studies on the morphology evolution of the coastal stretch under study (Perelló et al., 2019). Consequently, I accepted a single R_{low} value representing the entire coastal segment instead of conducting specific analysis based on different beach profiles.

4.1.2.2. Oceanographic data

Sea-level data was obtained from the Barcelona 2 tide gauge located at the REDMAR station of the Spanish Puertos del Estado. To align the vertical reference system of the oceanographic data (0 REDMAR) with the cartographic basis of the digital elevation model, the astronomical tide and storm surge data referred to as 0 REDMAR were converted to the sea level at Alicante.

Wave data was retrieved from SIMAR point 2109135 (2,08° E; 41,25° N). The SIMAR (SImulació MARítima) database, managed by Puertos del Estado, provides temporal datasets for wave parameters through a numerical model (Ratsimandresy et al., 2008). These simulated data are valuable for analysing long-term trends since they span from 1958 to the present day and are regularly updated. However, for analysing specific wave conditions in a particular storms, they can exhibit certain discrepancies compare to real data (Mendoza et al., 2011). To compute R_{low} and R_{high} this study had to accept this limitation due to the strong wave intensity during the storm, which caused the Barcelona buoy to stop recording data from January 20, 2020.

4.2. Knowledge for governance in local adaptation planning analysis

A risk-based management approach to climate change is dominant in local adaptation plans integrating climate-science data with place-based vulnerability assessments (see 2.2). There is an increased awareness of the need to address uncertainty in climate change adaptation policies (Kunreuther et al., 2014; Patt & Weber, 2014; van Bree & van der Sluijs, 2014). To date, strategies to account for uncertainty in adaptation decision-making have mostly relied on quantitative and statistical analysis of the climate-system information (Dessai & van der Sluijs, 2007). Uncertainties exist when trying to understand current and projected place-based vulnerabilities of target socioecological systems for the purpose of identifying local risks and impacts on climate change. Moreover, uncertainties in context-specific knowledge and societal responses to global climate change can potentially be quite large (Adger & Vincent, 2005; Moser, 2005; Patt et al., 2005).

However, those uncertainties have so far been relatively unattended (Dessai et al., 2007; Preston, Yuen, et al., 2011). This might partly be explained by the standardised approach grounded on the positivistic paradigm, which constrains the social dynamics of environmental change (Lövbrand et al., 2015; O'Brien & Leichenko, 2019). Furthermore, the context-specific nature of vulnerability assessments, the qualitative nature of many of these assessments and their challenging validation process (Preston, Yuen, et al., 2011) contribute to this explanation. The consequences of under addressing those uncertainties undermine the role of vulnerability assessments in supporting informed decisions in the policy arena (Preston, Yuen, et al., 2011). Since local adaptation policies are aimed at reducing vulnerability (Ribot, 2011), there is a need to address uncertainty in local vulnerability assessments and to reinforce the role of the context-specific knowledge of plans.

To this end, this analytical proposal (see 4.2.1) differs from technical uncertainty analysis because it addresses both the social context and the process of knowledge production to evaluate the quality of local vulnerability assessments and inform adaptation practitioners. The purpose is to interrogate the significance and usability of the vulnerability knowledges used/produced in attaining the goals of the plans (risk identification, vulnerability reduction, adaptive capacities enhancement).

4.2.1. The vulnerability KQA tool

The critical assessment of knowledge quality was performed by submitting and scrutinizing the content of the plans as shown in the KQA analytical framework (Tab. 3) below. Conceived as a friendly evaluative approach, the framework links qualitative uncertainty assessment theory with vulnerability guidance for planning process adaptation. The present analytical framework is the result of a synthesis from a previous work: the uncertainty matrix of quality assessments of environmental science for policy (Maxim & van der Sluijs, 2011). This matrix combines conventional uncertainty typologies to assess the knowledge base (Walker et al., 2003), with qualitative sources of uncertainty (Pereira & Funtowicz, 2009).

		KNOWLEDGE PRODUCTION PHASES		
		Problem framing	Knowledge production	Knowledge communication and use
UNCERTAINTY DIMENSIONS	Contextual	Why carry out the assessment at all? *Analytical choices influenced by socioeconomic & political context*	What kind of institutional arrangements govern knowledge-based plans? *Pertinence of knowledge management process & knowledge governance*	Is it relevant to the problem addressed? *External quality (fitness for purpose)*
	Procedural	Who defines/how to define the problem? *Shared vision, legitimacy*	By whom/how is the knowledge produced and validated? *Competences & validation (extended peer review)*	Who communicates/how to communicate? *Accountability, transparency, reflexivity*
	Substantive	What to assess? *Epistemic uncertainty in contextual understanding and by the simplification of knowledge claims*	Is it scientifically robust? *Technical, methodological and epistemic uncertainty*	Is it precise in reporting outcomes & uncertainties? *Internal quality*

Tab. 4 The vulnerability KQA framework. Source: own production drawing inspiration from Maxim & van der Sluijs (2011)

While the structure of Tab. 4 is the same as the original version (in the *x* axis, the knowledge production phases; in the y axis, the knowledge dimensions), I have reformulated the set of uncertainty typologies into fields of inquiry through nine guiding questions. Thus, it offers a more comprehensible framework of analysis than its predecessor and is tailored and extended to adaptation science for policy. The main contribution of the reformulated KQA tool with respect to the original version is the inclusion of a pivotal issue affecting environmental science for policy: the institutional arrangements and organizational practices that articulate knowledge-based processes with decision-making. This contribution fills a gap in the original version of the KQA tool

(Maxim & van der Sluijs, 2011:487), which leaves blank the central quadrant of the matrix without any uncertainty typology (knowledge production-contextual dimension). The inclusion of knowledge governance in Tab. 4 aims to point to relevant institutional and organizational challenges in adaptation strategies, that is, strengthening relationships between knowledge and action.

Problem framing refers to the process of defining the question to be addressed ("what is" vulnerable and "to which stressors".

- *Why carry out the assessment at all,* refers to what has motivated the assessment and under what kind of conditions. This places attention onto the influence of normative, political and socioeconomic priorities in the framing phase of the assessment (Hinkel, 2011; Schneider, Kläy, et al., 2019).
- *Who defines/how to define the problem?* is indicative of the legitimacy reached in the framing process (Cash & Clark, 2001) based on the sensitivity towards integrating divergent stakeholders' interests, values, beliefs, or risk perceptions. It is thus related to the inclusiveness and representativeness of vulnerable population groups (Mitrofanenko et al., 2018) and fairness (Graham et al., 2015).
- *What to assess,* entails making decisions on framing the system boundaries based on several assumptions. The quality of those assumptions (epistemic uncertainties) stem from incomplete knowledge of processes generating vulnerability (El-Zein & Tonmoy, 2015).

Knowledge production involves the process of measuring exposure, sensitivity, and adaptive capacity. This step, commonly developed through scoring indices/indicators, can encompass the selection of indicators, weight estimation and the aggregation methods used.

- *What kind of institutional arrangements govern knowledge-based plans?* addresses patterns of knowledge governance influencing the quality of context-specific knowledge used and reproduced. Good quality in this field of inquiry can be identified by questioning whether identified institutional arrangements have been helpful in connecting context-specific knowledge and action (Van Kerkhoff & Lebel, 2006; West et al., 2019). As the development of the plans is in itself an

adaptive capacity enhancement, this approach highlights the importance of social learning as a fundamental knowledge process (Gerritsen et al., 2013).

- *By whom/how is the knowledge produced and validated*, ranges from expert competences of knowledge producers to value-*ladenness* or value orientations in shaping the way questions are framed, data included and interpreted, data excluded, etc., and, who has validated the outcomes, and how (peer review, extended peer communities review) if applicable.
- *The scientific robustness* of vulnerability-index development includes an evaluation of the technical (i.e., inexactness), methodological (i.e., unreliability) and epistemic (i.e. ignorance) sources of uncertainty (Funtowicz & Ravetz, 1990).

Communication and use of the assessment outputs points to the reporting process of knowledge and uncertainties.

- *Is it relevant to the problem addressed?* This question critically assesses whether the knowledge produced and communicated is well contextualized for its intended use, and is thus more likely to be influential in the governance sphere. This includes the scale of assessment outputs, the environmental and socioeconomic stakes addressed and the options for action (suited to the available competences and/or capacities of end-users).
- *Who communicates/how to communicate* refers to the accountability reached in reporting assessment outcomes. Good quality is evaluated by identifying within the assessment-explicit argumentations reflecting existing alternative scientific evidence, data gaps or approaches excluded from the analysis and its impacts in results obtained.
- *Is it precise in reporting outcomes & uncertainties* refers to both the quantity (completeness-selective reporting) and the quality (accuracy-vagueness) attained. It also covers accuracy in making uncertainties explicit, as well as the potential implications of those uncertainties with respect to the policy addressed (Petersen et al., 2013).

4.2.1.1. Analytic procedure & Data

The analytical framework applicability confronts the context-specific knowledge of plans with local qualitative data gathered in the study area (documentary and fieldwork).

Primary source of data was collected, analysed, and contrasted with the knowledge contained in the plans (descriptive, purposive, and normative) referred to coastal inundation risk. The vulnerability KQA tool structures such evaluation by the occurrence of, and reference to, the nine guiding questions.

Documentary analysis

As a first step, I reviewed local documents concerning the region's geography and its evolution. To gain a better understanding of the local territory, and its institutional and political dynamics, the review included local news reports, newspaper articles, laws, regulations, and political and economic agreements. To gain knowledge about accumulated environmental impacts affecting the region, case-specific scientific studies related to geomorphological coastal dynamics, flood risk, groundwater governance and pollution were revised.

Additionally, documents of past Environmental Impact Assessments for each of the supra-municipal infrastructures built in the study area were scrutinized with special attention to ongoing redemptive measures. This step was essential for detecting disparities between the efficacy and continuous adherence to the prescribed measures, as perceived by key stakeholders, and the vulnerability state outlined in the plans (substantive dimension). Another thematic pillar of material analysed included local climate change adaptation within academic papers and grey literature on adaptation guidance for local practitioners, which became determinant in analysing the procedural quality of knowledge.

Field work

As a second step, and as a primary data source, a total of 22 semi-structured interviews were held with regional practitioners (including Covenant territorial coordinators), members of municipal institutions, water managers, coastal managers, officials of large infrastructure, and transport-logistics facilities, members of the water users' community, agrarian park farmers, natural park managers, environmental law experts and interest groups. The snowball sampling technique was used to identify these practitioners. An important source of bias in the representativity of our sample was the fact that it was not possible to interview either a representative of the International Airport or any agent from large operators through to medium and small enterprises. Participants were asked to

comment: present challenges faced by the target system (by them as individuals and/or as representatives of an institution, entity or collective), integration of climate risks into planning documents, and constraints/facilitators of local capacities.

Additionally, three workshops were organized from November to December 2019 to provide a platform for interaction among local political, economic, and civil society agents to discuss current and expected future problems. Most of the interviewed agents participated in the workshops, which were attended by a total of 24, 33 and 20 people respectively. The workshops were organized using the World Café methodology promoting intersectoral discussions of the complex societal challenges tackled. A total of 9 group discussions were held in each workshop. Workshop 1 perused discussion on present sensitivities aggravating local vulnerabilities. Workshop 2 focused on linking current vulnerabilities with projected climate pressures, placing emphasis on available local responses. Finally, Workshop 3 distilled insights from the prior sessions, incorporating input from social platforms and interest groups unable to attend the initial two workshops. The purpose was not to perform an analysis of narratives on the legitimacy of the plans. Accordingly, participants were not asked to comment on plan content, or on the veracity of the knowledge used for vulnerability indices. Rather, plans' quality assessment was performed indirectly through knowledge acquired in the rich qualitative material of the fieldwork (i.e., notes and transcripts).

4.3. Transformative place-based affective analysis

In this methodological section, I present an analytical proposal designed to tackle the subjective dimension of adaptability and response-ability by examining processes of changing senses of place. As argued in the theoretical section 2.4.2, place meanings play a central role in defining and framing environmental issues, risk perception, landscape changes and the diverse visions of the future development of such places (Davenport & Anderson, 2005; Masterson, Tengö, et al., 2017; Quinn, Bousquet, & Guerbois, 2019; Stedman, 2016; Yung et al., 2003). Nevertheless, fewer studies have explored how competing place meanings influence local responses to change and uncertainty (Köpsel et al., 2017).

Engaging with the multiple meanings assigned to a place enhances local governance by fostering inclusiveness in social-ecological processes and adaptation responses (Köpsel & Walsh, 2018; Masterson, Tengö, et al., 2017; Quinn, Bousquet, Guerbois, et al., 2019). However, in situations of competing place meanings, reaching a degree of common ground among affected population is necessary to guide local transformations toward shared desirable pathways (Bousquet; et al., 2022; Chapin & Knapp, 2015; Feola et al., 2023; Köpsel, 2018; Masterson, Tengö, et al., 2017; Pierce et al., 2011; Yung et al., 2003). Consequently, research focused on processes of bridging conflicting place meanings holds promise in unlocking local responses to change, uncertainty, and enhancing local capacities.

According to Westley et al. (2013) strategic transformative agency that promotes sensemaking based on communal meanings and visions is best suited following a disruptive event affecting the socioecological system. Aligned with Westley et al.'s (2013) concept of transformative agency, the present analytical proposal leverages two successive events that have greatly influenced the region: a severe flood event in January 2020, and the announcement of an airport expansion. The disruptive events served as window of opportunities to identify changes in processes of conflicting place-framing.

To explore the subjective construction of place in situations of contestation, I employ the concept of place-framing. Based on a relational understanding of place, Martin (2003) defines place-framing as shared understandings of place that emerge from and shape political territorial contestation. Moving beyond the politics of place (Pierce et al., 2011), this research delves into the affective dimension of conflicting place-frames through the lens of metaphorical place-framing and their dynamic evolution and trajectories.

Specifically, this study, through the dynamics of discourse, aims to identify a 'frame restructuring' process (inspired by Schön, 1993) capable of reconciling competing place perspectives. It seeks to uncover the generative potential of everyday agency and explore how metaphors can contribute to the dialogic process (Cameron, 2016), ultimately mitigating the 'other-ing' in territorial conflicts. A research exercise that implies moving from 'matters of concern' to 'matters of care' (Puig de la Bellacasa, 2017).

4.3.1. Metaphorical framing analysis in territorial concerns

Similar to analogies, metaphors allow us to see new things in term of others, more familiar, and thus, expanding our perception (Linnér & Wibeck, 2019). This occurs by applying one concept typically well-known (a source domain) to another (the target domain), usually more abstract or complex (Semino & Demjén, 2017). In contrast to the traditional understanding of metaphor as a rhetorical figure or poetic flourishes, Lakoff (1993) argued that metaphor is not primarily a matter of language but of cognition. Metaphors have the potential to structure our 'conceptual mapping' helping to establish a worldview that guides not just how we see, but how we relate to, our environment (Lakoff & Johnson, 1980). Through this practice, metaphors become an integral part of the process through which specific problems are formulated and solutions to them are framed (Schön, 1993), properties increasingly recognized for understanding and managing complex socioenvironmental challenges (Thibodeau & Boroditsky, 2011).

Metaphors in discourse are employed as framing devices (Thibodeau, 2017). Frames enable us to make both rational and emotional sense of the information we come across (Bateson, 1972). However, frames shed light to some aspects of reality while concealing others (Bateson, 1972; Goffman, 1974), potentially restricting our ability to perceive problems from novel perspectives (Larson, 2008). The framing effects of metaphor on specific issues is a topic that is typically explored through two main approaches: Critical Discourse Analysis and psycholinguistic experiments[13] (Thibodeau et al., 2019). Within the tradition of Critical Discourse Analysis, Cameron & Larsen-Freeman (2007) introduce a 'discourse dynamics' approach to metaphor, grounded in the complexity of dynamic systems. Metaphor becomes processual, emergent, and open to change.

When applied to the field of senses of place, metaphors in discourse can serve as framing devices for place-framing (Allan, 2023; Musacchio, 2009). In this dissertation they are

[13] The method commonly referred to as the Response Elicitation Approach tests how individuals process metaphors and employ them in their cognitive processes.

specifically employed to analyse processes related to territorial conflicts through the lens of conflicting place-frames. The metaphorical framing method within a specific territorial context holds significance in terms of both cognitive, affective, and behavioural aspects potentially leading to the emergence of generative capacities (see Fig. 12 and Tab. 2 in section 2.4.3.1).

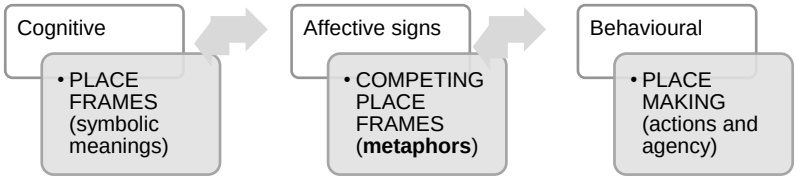


Fig. 12 Competing place frames through metaphorical framing. Source: own production.

The set of place-frames attributed to a site corresponds to the cognitive aspect of senses of place, the images it conveys. These meanings are commonly expressed through figurative language. Similes such as 'This place is like an oasis' (in the middle of the asphalt) provide evocative representation of the symbolic meanings converging in a place, while also highlighting the prevalence of situations involving antagonistic encounters between discursive and symbolic meanings. The analytical proposal presented in section 4.3.1.1., contends that the emergence of 'negative' or 'derogatory' place-symbolic meanings found in discourse analysis is an indication of a competing place-frame.

Territorial conflicts often have conflicting place-frames at their core. Some of the examples described in section 2.4.2 illustrate situations stemming from disputes over the symbolic significance of a place as a means of livelihood, which may conflict with or be seen-as incompatible with conservation projects holding a pristine representation of the place. Each side of the confrontation expresses what is perceived and experienced as threatened, the affective lens through which we view and sense our environment. Metaphorical language, as supported by Tuan (1978), is employed to convey this affective sign. Finally, the behavioural component, or the practices perspective on place also contributes to set how places are performed. It is through this perspective of dwelling in a place that various place trajectories and place-making processes can be elucidated.

Taking a complexity perspective drives the exploration of evolving patterns in stable territorial problem-settings, ultimately leading to transformative processes of change. To

tackle the emergence of transformative processes of change discourse dynamics approach to metaphor is employed. This dynamic perspective on metaphor raises new possibilities for investigating generative processes of restructuring conflicting place-frames. According to Donald Schön, 'metaphor refers to both a certain kind of product—a perspective or frame, a way of looking at things—and a certain kind of process—a process by which new perspectives on the world come into existence' (1993:137). Through this process, the affected community may develop a new understanding of their environment and its challenges, seeing an old problem in a new way.

4.3.1.1. Analytic procedure

The object of analysis is process of place-framing and reframing in the non-urbanised areas of delta del Llobregat within the timeframe of 2007-2022, approached through the analysis of discourse dynamics. This study distinguishes two distinct phases in this process, marked by the analytical procedure's design (Fig. 13). The first phase involves hermeneutic processes to identify primary contested place visions, while the second phase, triggered by two disruptive events in 2020, explores patterns of change in relation to the initial period. This examination allows for the exploration of generative features or associations within everyday agency through the lens of metaphorical place-framing.

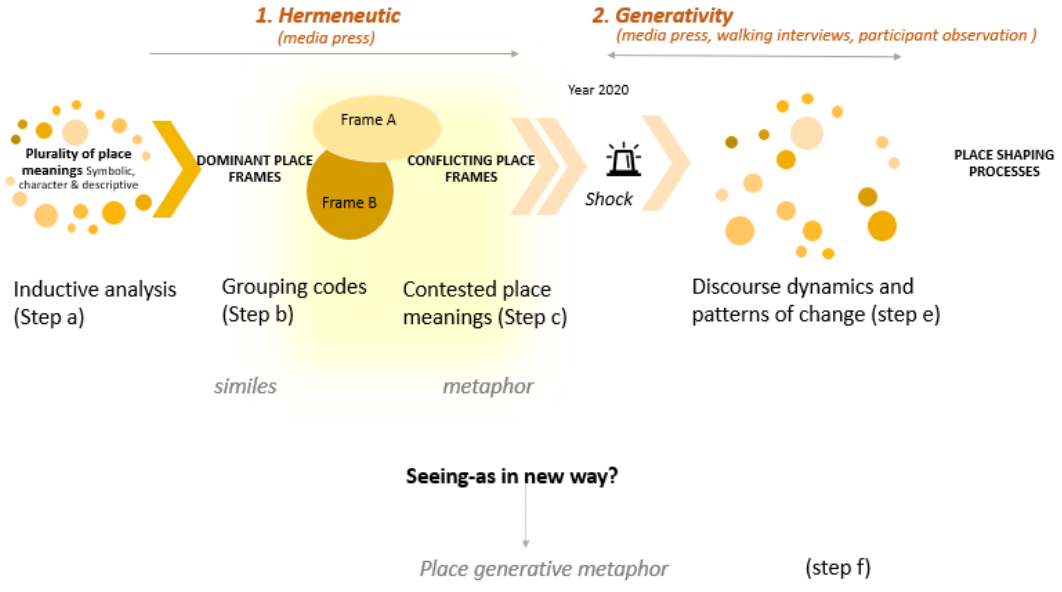


Fig. 13 Workflow: place-based affective dimension as a transformative capacity. Figurative language used in each main step highlighted in grey.

Main steps:

a) Identification of plural and multiple place meanings associated to non-urbanised deltaic areas.

This task was accomplished by conducting an extensive review of press media spanning the period from 2007 to 2020. Identified place descriptors were systematically listed and categorised into three family-codes: place-adjectives (physical attributes of the place, such as 'polluted'), character (functional attributes, such as 'recreational'), and symbolic place meanings (such as 'patrimonial'). Inductive analysis was performed to organize emergent codes from both direct and indirect quotations, employing the Atlasti software. In some cases, place meanings were explicitly extracted from the press articles themselves (e.g., 'degraded'), while in others cases, they were deduced by considering public concerns, shared experiences, or interactions with the setting. Some codes appeared to be repetitive, indicating similar 'place images', for example, 'wild', 'isolated', 'picturesque'. However, in this initial step of the workflow, all identified place descriptors were incorporated as part of an exploratory code exercise. However, in cases where an item press included multiple instances of the same place meaning, it was considered only once. The primary objective of this initial step was twofold: first, to create a comprehensive portrayal of the array of images linked to the study area, and second, to identify recurrent argumentative patterns through code frequency analysis.

b) Codes grouping process based on dominant symbolic meanings

This included a first grouping process by merging symbolic meanings into main categories. Decisions about groupings helped identify patterns and themes in the data. For instance, the quotation from a press article, 'many urban citizens have discovered an escape through the trails and agricultural paths' was coded with the symbolic meaning 'as escape'. This code was grouped with the code 'as park' because both emphasise the recreational values of the place. These symbolic meanings were commonly expressed with similes. In the second phase of the grouping process, place-characters and place adjectives were classified within the primary place-symbolic meaning group. Consequently, place descriptors like 'crowded'[14] or place-character such as 'recreational

[14] Emaneting from the quotation 'The considerable increase in visitors worsens the issues related to accessing Prat beach'

land' were assigned to the primary place-category 'escape'. Occasionally, revisiting the source quotation was needed to better contextualise the place-meaning.

c) Identification of contested place meanings

The analysis of primary contested place meanings arise from negative symbolic representations of places (identified in step a) and the identification of counterarguments (e.g., related to resource management or changes in land use). For example, the symbolic place representation 'as a backyard' of Barcelona holds a negative connotation, and therefore it is identified as a contested place meaning. It refers to a conflicting view of considering non-urbanised deltaic areas as a 'land reserve' for future urban development, driven by capital needs. Metaphorical representations were employed to capture the affective and discursive responses stemming from these contested place meanings. Decisions on the metaphors used were influenced by the figurative language employed. These metaphorical codes framed territorial concerns.

d) Discourse dynamics and patterns of change (after the disruptive events)

The disruptive events were utilised as window of opportunities to identified change in discursive territorial problems-setting description and affective responses. The press analysis covered the timeframe from just prior to the disruptive events (January 2020) to January 2022. Codes were categorised under the main categories identified (step b). The focus was on identifying patterns of change which required an interpretative process. Recursive and iterative processes were employed in the hermeneutic exercise of coding and pattern-finding, as described in Cameron et al. (2009). While certain patterns of change required more qualitative interpretation, others were quantified. Primarily by comparing the frequency of utilization of main place-frames categories in relation to the previous period.

The dynamic and dialogic analysis gained intensity in the aftermath of the disruptive events. Various agents of symbolic meanings interacted through a multitude of channels. Institutional actions, claims for rights, demonstrations, artistic expressions, acts of solidarity by both individuals and groups, along with other modes of engagement, and diverse forms of publication. These encompassed reports of losses, public announcements, new regulations, and the dissemination of pamphlets condemning the situation. Together, these factors drive the discourse of place awareness and their dynamic nature. While the press review served as the primary source for identifying and

distinguishing these discursive actions, it was through participatory observation that non-textual forms of expression, such as embodied and other modes of communication, could be captured and integrated into the discourse analysis.

e) Identification of place generative metaphor

The final step involved a direct search for the emergence of new metaphors (or new SEEING-AS) that contribute to new themes relevant to territorial problem-setting identified in step c. Figurative language is identified by the use of non-literal expressions. However, 'rather than simply redescribing, is that the new description already belongs to what is initially perceived as different, albeit a familiar thing' allowing the process of SEEING-AS (Schön, 1993:141).

Documentary analysis

The documentary analysis conducted in this stage of the thesis builds upon the precedent (see sections 4.1-4.2), with a particular focus on exploring the documentation pertaining to local history. This analysis delves deeper into studies dedicated to the evolution of farming, associationism, administrative regulations, as well as territorial and environmental struggles, which has been summarised in section 3.2. This data was relevant to contextualised today's diversity of place meanings. It also served as a significant input in delineating the contingent historical identity of the place by identifying the succession of key land characters throughout different periods.

Input data also comprised 177 media press reports gathered between 2007 and 2022 drawn from Periòdic Delta[15], the most widely read municipal newspaper in el Prat del Llobregat. The press items (2007-2020) have been digitized from a library-newspaper archive. The articles from the period 2020-2022 have been downloaded the from newspaper website (https://www.periodicdelta.cat/en-paper). The unique inclusion criteria were to be directly related to the study area (non-urbanised deltaic areas). The compilation of media press represented the primary source of data for identifying the diverse array of place meanings associated with the non-urbanised deltaic land (*Place-frames – hermeneutic process*). Press items included interviews and opinion pieces, enabling the identification of some of the key contested-place meanings (*Competing place-frames – hermeneutic process*). In addition, the press news also played a significant

[15] Monthly publication founded in 1977

role in delineating the main social and institutional reactive actions and behaviours following the two analysed disturbance moments.

Participant observation

Participant observation played a crucial role in acquiring insights into the dynamic evolution of socio-spatial dynamics in the area and differentiated affective responses. It involved actively participating in and observing local proceedings, workshops, institutional acts, or contestation events among others. It is worth to mention that during this period the area has being on the top of public debates, transcending the local scale and reaching the category of country issues, a fact that has motivated the proliferation of territorial discussions in which a diversity of local affectations became evident.

Accordingly, through participant observation the evolution of contested place meanings was possible. Not less importantly, this qualitative source of data permitted to gain insights into more than linguistic discourse and to gather insights into other material and embodied practices with important signification to the analysis of emergent senses of place as well as the acceptance significance of emplaced subjectivities.

Walking interviews

To complete data gathering and with the aim to clarified and gain better understanding on main place visons, five walking interviews were conducted between May 2022 and December 2022. Despite being a small number of interviewees, they represented key actors in the territory that allowed to gain detailed data on personal and collective perceptions of awareness. Two of the interview participants are members of social movements, one is a farmer, another is a landowner directly influenced by the airport expansion project, and the fifth is an technician expert in water cycles within the study area. The interviews lasted from 1:30h to 2:30h and were developed in four differentiated areas that were chosen by interviewees.

Chapter 5

5. RESULTS

5.1. Mapping local flooding in the Llobregat Delta during storm Gloria

The initial outcomes of this thesis address complexities associated to the spatial delimitation of flood exposure analysis (see 2.2.1.1) by drawing insights from a recent and exceptional compound climatic event. From January 19th to 23rd, 2020, Storm Gloria had a significant impact on the Catalan coast. Its effects spanned a range of consequences along the coastal fringe, including beach erosion, damage to port infrastructures, and seafront promenades, among others. However, this analysis specifically focuses on documenting the flooding of non-urban areas. Remote sensing techniques (4.1.1) are used to delineate temporary water masses, and parametric calculations (4.1.2) to estimate temporary sea level rise during the event storm.

5.1.1. Temporary water masses (22 January 2020)

The result of the supervised classification of the SAR images obtained from the Sentinel-1B satellite are shown in Fig. 14. The areas in sea blue correspond to permanent water masses. The areas in turquoise designate the temporary water masses detected on 22 January 2022. The grey areas correspond to asphalted urban areas which were excluded from the spatial analysis.

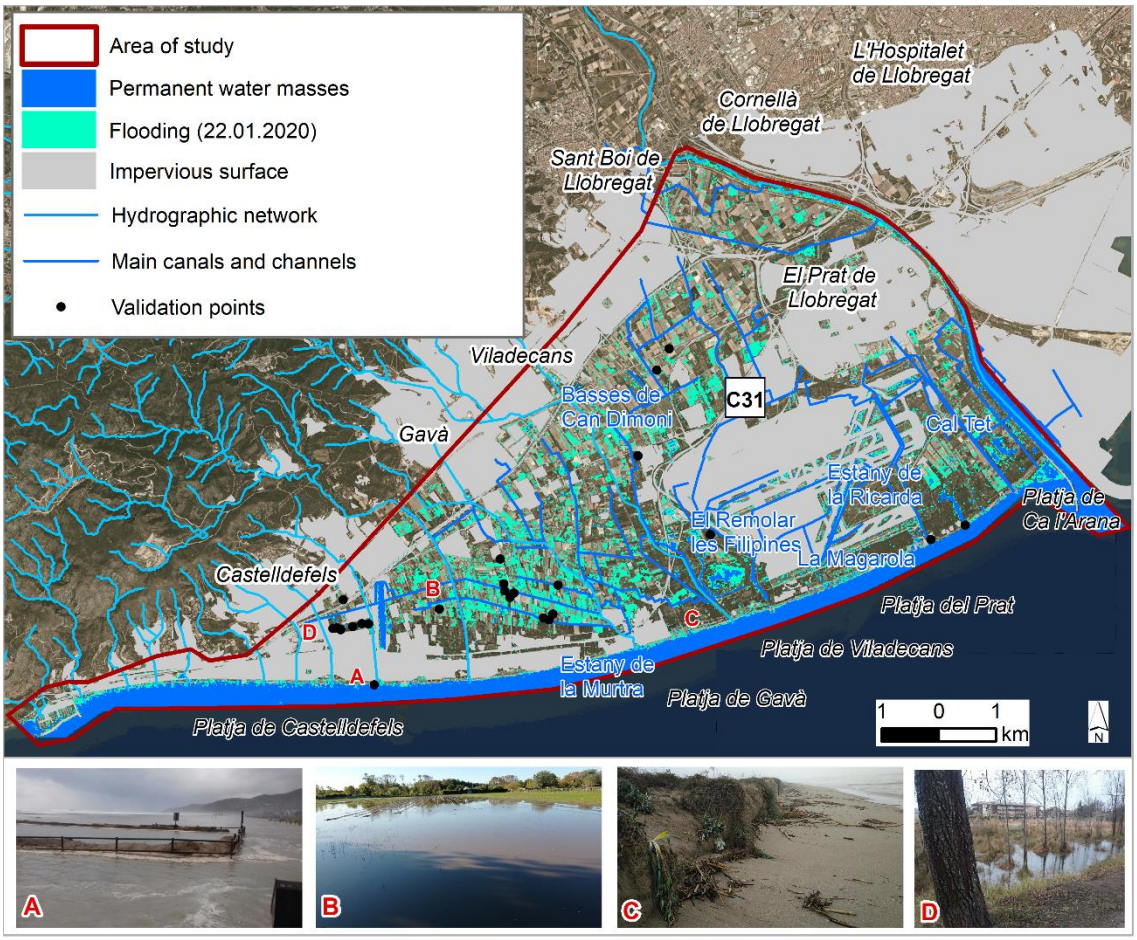


Fig. 14 Flooded areas on 22 January 2022, obtained from a reclassification of SAR images. A) Castelldefels beach flooded, river mouth obstructed. B) Agricultural land (Gavà) flooded (photograph provided by Miquel José). C) Beach dunes destroyed (provided by Consorci dels Espais Naturals); D) Example of TFV, Olla del Rei area (Castelldefels) (provided by Plataforma Salvem l'Olla del Rei). Source: Own production

The map obtained shows fairly generalised flooding over the whole area studies, with a total of 725 ha of temporary water masses. The area with the most continuous and extensive flooding is that containing the channels of the agricultural park, especially the lowest plots, which form part of La Murtra drainage basin (Fig. 14-B). The lagoon reached a maximum level of 1.35msnm on the morning of 22 January (the average annual level is 0.72msnm) (Cuadll, 2020), and these high levels hindered the drainage of the agrarian channels.

Many of the plots in the Remolar-Filipines drainage basin show flooding, especially from the Ral Path to the sea. However, areas further away from the coastal lagoons, such as that between the Can Dimoni ponds and the C-31 trunk road also show flooding. Beyond the water influx stemming from agricultural fields, the integrity of the Remolar lagoon is compromised by drainage water originating from the municipalities of Sant Boi de Llobregat, Viladecans, and El Prat de Llobregat via the Roja stream, Vidaleta canal, and

Les Bogues channel, in addition to water from the airport. Consequently, the expansion of the primary coastal lagoons is observable within the protected Natural Spaces, with the most prominent instance being the Remolar-Les Filipines area.

Ca l'Arana beach[16] was completely flooded. In fact, flooding can be seen on all the beaches, with the widest being most visibly affected, especially Castelldefels (Fig. 14-A). Gavà Mar experienced coastal overtopping that affected the urban area, the total extent of which cannot be appreciated on the map as a result of the urban mask applied and the narrowness of the dry beach at that stretch (behind the developed part of the beach). Fig. 14-C shows the impacts on the coastal dunes of Remolar beach in Viladecans.

Recordings of accumulated precipitation between 20 and 23 January at the Viladecans automatic weather station of the Catalan Meteorological Service was 123.4mm (of which 100.6 mm corresponded to accumulated precipitation on 21 January 2020). This value is close to the 10-year-return-period design rainfall (T_{10}= 126.9 mm) used by the bidimensional hydraulic model for the study of the accumulated impact on the drainage network of the Llobregat delta (ACA, 2008:85)[17].

[16] Created after the diversion of the river, closed to the public and included within the natural spaces of the Consortium for the Protection and Management of the Natural Spaces of the Llobregat Delta

[17] This uses the maximum daily rainfall values proposed in the 'Pla Director d'Aigües Pluvials a l'àmbit de la Entitat Metropolitana i Serveis Hidràulics i Tractament de Residus' (PDAP) for Type A rainfall corresponding to a list of municipalities in the Baix Llobregat region among which are Gavà, Viladecans and El Prat del Llobregat.

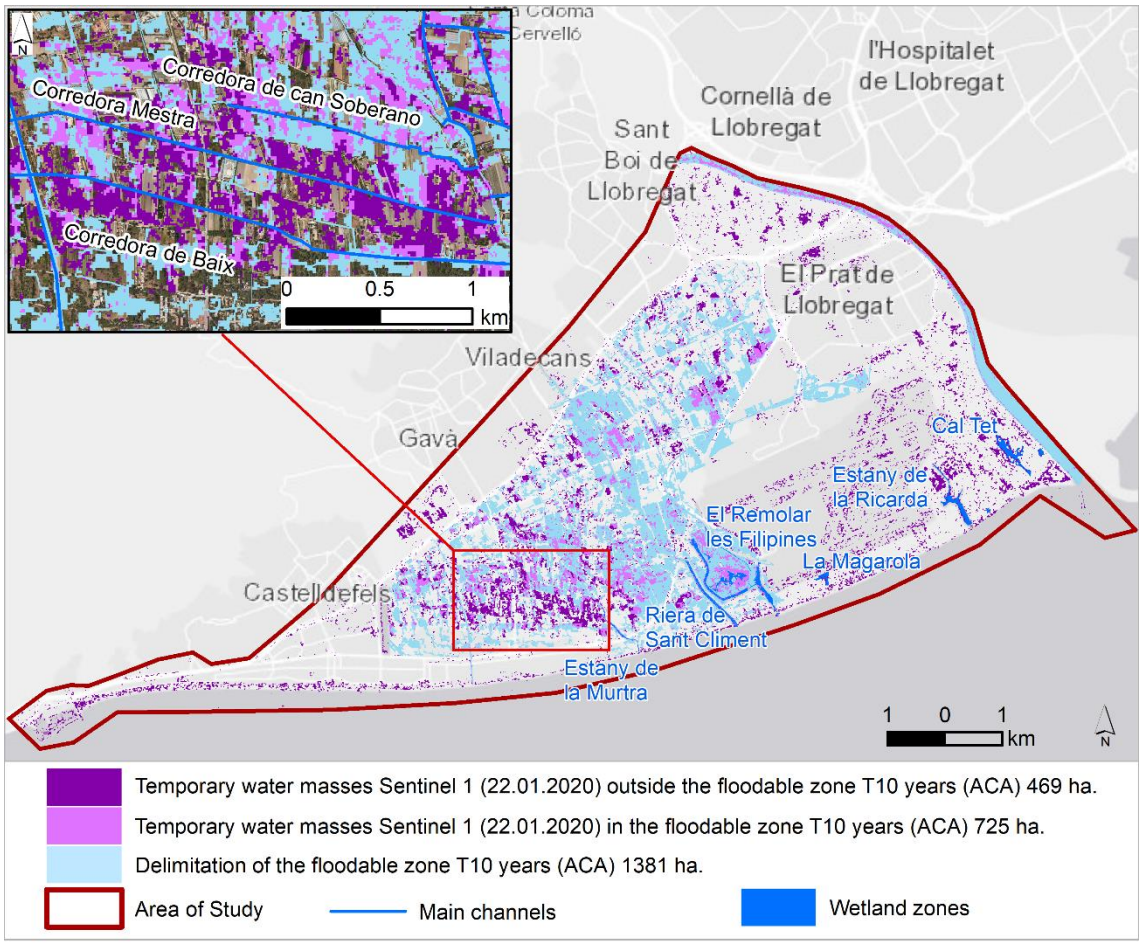


Fig. 15 Comparison between the flooding model for T10 (ACA) and the areas flooded by Storm Gloria (Sentinel 1).

Fig. 15 shows a comparison between the delimitation of the potentially floodable zone for the 10-year return period taken from the ACA viewer (https://sig.gencat.cat/visors/VISOR_ACA.html), and the flooding observed by remote sensing on 22 January 2020. The surfaces simulated as being flooded but which were not flooded during Storm Gloria are shown in blue; lilac shows zones where there is correspondence between the two sources; and those areas not detected by the hydraulic model but detected as being flooded during Storm Gloria are shown in purple. Among the total flooded hectares, as observed by Sentinel-1, 65% (496 ha) did not match the floodable area outlined by the modeled predictions for the 10-year return period.

One of the areas that most stands out is the Gavà-Viladecans channels where many of the agricultural plots that are shown as flooded on the Sentinel-1 map are omitted from the delimitation of the floodable zone. The enlarged image (Fig. 15) shows that most of the plots affected by this omission in the hydraulic model can be found between the Can Soberano corridor and the Baix corridor. Other agricultural areas flooded during Storm gloria and omitted from the model are found in the southern part of the map and belong

to the municipal area of Sant Boi de Llobregat. The agricultural area of the Bunyola/Llacuna de la Ricarda Canal, however, was marked out as being potentially floodable in the ACA study (2008) for the same return period. Finally, the biggest difference can be seen on the sea front since the hydraulic model did not contemplate marine flooding (see 4.2).

		GPS points		
		Flooded	Not flooded	Total
Map	Flooded	11	1	12
	Not flooded	7	5	12
	Total	18	6	24
	Exactitude			66.6%

Tab. 5 Confusion matrix

Validation of the results is constrained by the scarcity of reference points. The accuracy of this classification is 66.6% with most of the errors detected by omission (Tab. 5). In other words, the errors observed correspond to GPS points for coordinates that experience flooding yet are labelled as 'not flooded' on the map. These errors suggest a potential underestimation in recognising flooded regions. However, a more extensive set of ground truth samples would likely identify errors caused by the speckle noise inherent in the SAR images.

Most probably these omissions of water masses are attributed to temporary flooded vegetation (TFV) (Tsyganskaya, et al. 2018) causing underestimations of flooding in regions with dense vegetation cover. In cases where a layer of water is concealed by vegetation, the effectiveness of flood detection using SAR imaging is compromised due to alterations in the backscatter received by the sensor. Fig. 14-D, one of the validation's ground truth (GT) samples, illustrates an occurrence of temporary flooded vegetation (TFV) that go undetected in the Sentinel-1 image.

For the assessment of temporary flooded vegetation's effect on the map derived from Sentinel-1 data, a zonal statistical calculation is conducted. This involved categorising the plots from the cartographic database of the SIGPAC of Baix Llobregat using the codes 'unproductive field[18]', 'fruit trees' and 'forest land'. Of the total number of temporary water masses detected within the agricultural uses defined by SIGPAC, only 5% are in

[18] The assumption underlying this distinction was that unproductive or abandoned plots would likely exhibit denser vegetation due to lack of cultivation

plots with potential vegetation cover. Therefore, the map could be showing a very conservative delimitation of the flooding, detecting those plots that were literally submerged in a layer of water, as shown in Fig. 14-B. The influence of temporary flooded vegetation likely extended to the lower regions of the natural spaces characterized by cane cover or other dense lacustrine vegetation.

5.1.2. The marine component of flooding

Fig. 16 show an estimated evolution of the temporary rise in sea level during Storm Gloria. Combining the parametric wave setup calculations with the recorded tides reveals that the resultant mean sea level due to the maritime storm (R_{low}) was 1.7 metres. Incorporating the wave wash effect (which represents the highest water level resulting from the impact of large waves breaking near the coastline during the storm) leads to a total of 3.9 meters for the maximum water level (R_{high}). These levels remained practically constant for two days. In other words, a marine flooding level of 1.7 metres meant that the beaches became submerged.

The graph also shows how the main component of the increase in seawater in the coastal zone was the result of the resurgence of the wave runup and a storm surge caused mainly by the wind and the effect of the wave runup itself with minimal influence from the meteorological tide arising from low pressure, which ranged from 20 to 30 centimetres 30 (data recorded by the tide gauge of the Port de Barcelona).

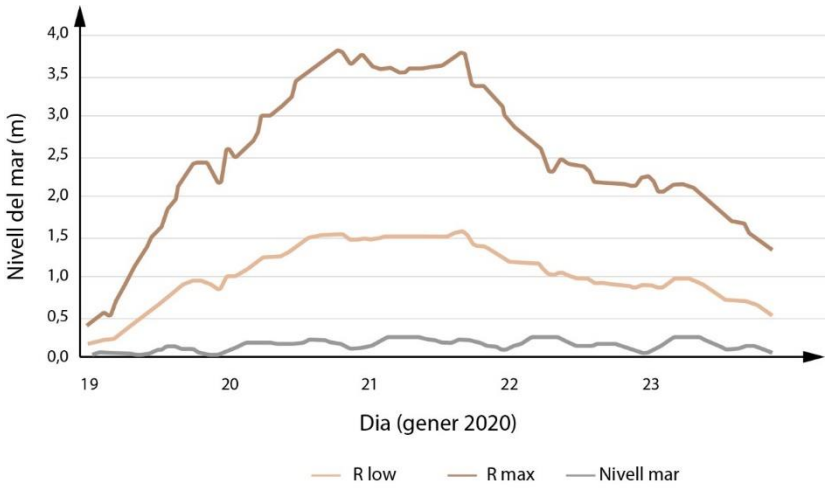


Fig. 16 Estimated evolution of R_{low} and R_{high} during Storm Gloria in the Llobregat delta. Source: own production

Flooding of the beaches system in Fig. 14 is marked with clear speckling which, despite being submerged, is not captured by the sensor as a smooth surface because of the strong waves. The rainwater channels and drains into the sea were blocked (Fig. 14-A) making the drainage of the entire delta system difficult (Palau Robert, 2021). Drainage from La

Murtra lagoon was not complete until 23 January since the storm made it impossible to use the Archimedes' screw properly. (Cuadll, 2020).

5.2. The quality of vulnerability knowledge in climate risk management

In accordance with the analytical framework detailed in Tab. 4, this chapter takes on a reflexive approach to address the deficiencies in knowledge that impede a constructive representation of the vulnerabilities of the Llobregat delta to climate change. As mentioned previously, the quality assessment exclusively includes the local vulnerability knowledge used in local adaptation plans. Consequently, the analysis does not extend to regional climate projections or proposed adaptation measures.

5.2.1. Contextual uncertainty dimension

Why carry out the assessment at all?

Municipalities are encouraged to engage with the Covenant's European call through the assistance of an intermediate territorial coordinator, in this case, the metropolitan agency. Local authorities agree on the development of the adaptation plan executed by an external consulting firm, but without specific local resources, either for knowledge production or for implementation. Proposed adaptation measures do not have a specific financial budget that needs to be executed. In fact, most of the listed adaptation actions are not new, but the measures already implemented by other municipal or sectorial policies. As quoted in an interview with a local authority, 'are simply reused as adaptation measures in the plans'. This represents a pivotal limitation from the outset.

A second limitation is due to jurisdictional competences. The spatial boundaries of the plans are compromised by the presence of supra-municipal large infrastructures excluded from the assessment (e.g., 50% of the total area of El Prat del Llobregat) while most of the environmental problems aggravating the vulnerability condition of the system are caused by the presence of those same infrastructures (De Roa & Esteban, 2018; Marcé et al., 2012). According to the fieldwork conducted, we identified a need to reach a shared understanding of interests and capacities in managing conflicting and contested uses, a situation reinforced by global environmental change. The fieldwork data exemplifies the extent to which plans are framed by a prescribed normative objective that is poorly aligned with case-specific needs and real-life concerns.

What kind of institutional arrangements govern knowledge-based plans?

When officially joining the Covenant of Mayors, signatories commit to developing a Sustainable Energy and Climate Action Plan within two years. As regards adaptation, local councils must report a risk and vulnerability assessment, as well as commit to a

programme of actions to reduce climate change vulnerability. Additionally, signatories are requested to submit a monitoring report every second year after the adoption of its action plan.

Institutional arrangements governing the knowledge base for climate change adaptation at the municipal scale are based on consulting services commissioned by the metropolitan agency and financed by public grants. This has been a well-established procedure, since the first international call at the Rio Earth Summit in 1992, for local authorities to voluntarily engage with the action plan for sustainable development (LA21), followed by the climate change mitigation plans (called the sustainable energy action plan).

As such, the plans are conceived as an externally driven outcome 'given' to the municipalities involved to fulfil the Covenant mandate. As mentioned by a regional Covenant coordinator during our fieldwork, 'this procedure has quantitatively promoted a significant number of local plans from small agglomerations. But qualitatively those plans, too standardized, have been less helpful in advancing towards climate change adaptation at the municipal scale'. The plans produced by environmental consultancy firms have taken place without deliberative involvement among assessment producers, experts, local practitioners and affected local population. The role of local authorities is limited to residual consultation. In practice, the implementation of this multilevel-governance ends up conceiving local plans as a product and not as a process, which reduces social learning opportunities and context-specific knowledge used, producing local plans that are strongly biased by the metropolitan CC adaptation plan developed at an early stage.

6. It is relevant to the problem addressed?

Although informative, the relevance of the plans' vulnerability outputs for local authorities is insufficient to effectively influence a real decision-making process. In the words of an interviewed local authority, 'the plan sits on a shelf'. Local exposure and vulnerability data contained in revised plans are not 'actionable' knowledge to reduce vulnerability, due to several factors. First, the low precision of areas exposed to coastal risks of flooding (e.g., through concrete representational metrics) inhibits a tailored comprehension of place-based sensitivities. Second, sensitivity representation is additionally hampered by a low examination of the social and ecological states of territorial entities and trade-offs among them. Third, the procedural design neglects self-

exploration of local capacities by the affected population; therefore, there is no space for self-improving the adaptive capacity throughout the process of carrying out the plans (i.e., in which local governance can effectively contribute). Thus, vulnerability assessment falls short of the intended goal of informing decision making and enhancing the adaptive capacity of the local jurisdictional area.

5.2.2. Procedural uncertainty dimension

For whom and how is the assessment framed?

Framed by external actors, the procedural dimension is designed and operationalized as a technical process and is not open to debate. Therefore, the transfer process (from formal guidelines to the specific case study) does not involve a participatory process oriented toward framing the problem in the territorial context. The framing process is conceived through abstract knowledge unlinked to case-specific knowledge, introducing an epistemic uncertainty source from the outset. For example, under climate change adaptation mandates and sustainable development precepts, decisions in the framing phase do not consider the existence of different priorities and values as evidenced in our fieldwork. Differences in the perceptions of local conflicts or risk aversion among stakeholders are not addressed either by encouraging stakeholders to self-identify as interested parties or by reflecting their views and disagreements through secondary sources of information. Using the aquifer subsystem to illustrate this, high levels of groundwater are required to impede seawater intrusion and to reach the levels of quantity and quality required by the EU Water Framework Directive; however, a high phreatic level is incompatible with the optimal functioning of existing transport infrastructures (e.g., the international airport or subway train networks) due to flood risk. This is an example of a non-equivalent representation of the system co-identified with participants in the second workshop. Both high and low levels for the groundwater aquifer can be computed as vulnerability-reduction measures according to a specific pre-analytical choice (epistemic and normative).

By whom and how is the knowledge produced and validated? Is it credible?

The process of scoring exposure, sensitivity, and adaptive capacity by means of qualitative indices (high-low) to risk of coastal inundation is exclusively executed by the consultancy technicians. As such, neither scientific nor lay knowledge is mobilized. The exposure of the deltaic region to coastal inundation is approached without specialized

biophysical knowledge or modelling expertise in the field. Furthermore, characterization of sensitivity and adaptive capacity is addressed without specialized or academic knowledge in the social sciences. Overall, there is a lack of expert competence in ambits of local knowledge (local history, social relations, subordination, governance, etc).

The plans' narrative is external to the target system. A strong reliance on a metropolitan vision of the deltaic zone influences the results of the scoring process. A managerialist bias to approaching adaptive capacity targets protection engineering works as the only inclusion criteria to qualify local adaptive capacity to coastal inundation risk. Other essential factors of the adaptive capacity, such as local governance capacities, as identified in our fieldwork, are not considered. Farmers expressed that their decision-making capabilities were diminished due to their low representativeness within the agrarian park-managing entity (focal group discussion, workshop 2). Similarly, natural-park managers suggest that there are communication concerns with airport authorities (absent interlocutors) generating difficulties in managing everyday situations. In short, the affected population perceived local agency as compromised by the strategic and economic role of the region and its overlapping jurisdictional competence. Additionally, the omission of the negative impact of large infrastructures on local sensitivities, or the non-recognition of vulnerability transfer exerted by large engineering works (e.g., coastal erosion) misrepresents local sensitivity and adaptive capacity states. Consequently, value-*ladenness* results from including only the positive impacts of large infrastructures, while, according to a lecturer in environmental law (workshop 1), environmental redemptive measures stipulated for each large infrastructure need to be revised from and merged into a strategic environmental-impact assessment.

Finally, there is an absence of a validation process, and neither the process nor the outputs (i.e., vulnerability indices) are subject to a peer or extended review, compromising their legitimacy and scientific robustness.

To whom and how is it communicated?

The plan has led to a poor dissemination of the initiative to citizens (based on workshop 3 participants). Additionally, the information contained in both plans is weakened by the low accountability of the shortcomings found in the procedural dimension (e.g., data gaps, non-existence of a validation process, dissenting views, etc.), and the reflexion on their potential impact on disseminated results.

Furthermore, the low accountability of context-sensitive knowledge addressing how vulnerability is produced leads to an institutional *status-quo*-driven plan, reducing opportunities for critical social inquiry and community engagement on vulnerability reduction.

5.2.3. Substantive uncertainty dimension

What to assess?

Decisions taken in the process of establishing system boundaries to describe the local reality in relation to climate change embody several assumptions. The quality of those assumptions is evaluated in relation to their suitability to reach a realistic representation of the system and to capture the current place-based vulnerability condition.

Decisions and underlying assumptions:

The temporal boundary of risk assessment is based on the timeframe stipulated by climate projection models (i.e., time-horizon 2050 and 2100).

Assumption 1: Climate risk occurrence is expected to begin in 2050.

Climatic determinants identified according to levels of confidence.

Assumption 2: Outputs from a regional climate model predict "what climate hazards" a locality is vulnerable to.

The spatial boundary of "what is" vulnerable is conducted through a territorial sectorization of the local jurisdictions according to land use categories.

Assumption 3: Each territorial entity (i.e., land use) behaves with homogeneity under specific climate risks.

The current vulnerability condition is used to estimate 2050 and 2100 climate risks.

Assumption 4: Vulnerability is a static state within the target system.

Adaptive capacity is exclusively equated to the protection capability of the engineering infrastructures.

Assumption 5: The over-engineered Delta (and watershed) enhance the adaptive capacity of the region to coastal inundation.

The main implication of assumptions 1 and 2 is that coastal inundation risk should be approached by means of permanent sea-level-rise inundation (2050-2100 timeframe

horizon). This omits current and near-future climatic determinants of coastal inundation, even though the deltaic region is periodically affected by levant storms causing coastal erosion and flooding. Storms from the east (a frequent meteorological situation on the NW Mediterranean coast) is characterized by acute sea-storms (extreme-height waves), short-term convective rainfall affecting the littoral fringe and usually coupled with a situation of low atmospheric pressure, raising mean sea level by up to 0.6m–1m. Storm Gloria, impacting the study area in January 2020, left a third of the delta plain flooded (Fig. 14). Moreover, historic meteorological and oceanographic data indicate a change in the frequency and intensity of eastern storm events (Pintó et al., 2020). Episodic events are more difficult to predict with high levels of confidence by global climate models. Consequently, the plans do not include behavioural storm changes as a local manifestation of global climate change. Neither do they inquire into the potential of sea-level-rise to aggravate short-term hazards. The result is a low fitness of the hazard definition in the framing phase to current signals of changes perceived at the local scale.

Presuming a homogenous impact within each exposure unit (Assumption 3) leads to an oversimplified sectorial vulnerability approach incapable of identifying the most vulnerable actors. For example, Storm Gloria demonstrated a differential exposure of the deltaic farmers. The assumption that all farmers from the agrarian park are equally vulnerable to coastal inundation risk is an epistemological framing error as identified in our fieldwork and is a source of uncertainty in the effort to diminish local actors' vulnerability.

The static conception of the target system (Assumption 4) leads to an insufficient awareness of historical and projected economic development in the area and how these processes relate to smaller and larger scales. This results in an important data gap to conceptualize the place-based causal model of vulnerability (i.e., strength of interactions linking causal factors) needed to draw a realistic representation of the system sensitivity as well as the identification of possible opportunities and constraints to reducing current and future vulnerability. For example, channelled sections of the Llobregat river have normalised urban expansion occupying and stretching the river floodplain (Martín-Vide et al., 2020). According to social platforms interviewed, the apparent gain in sensitivity of river canalization contributes to the undermining of historical climatic memory and thus diminishes local capacities to react against extreme flash-flood events.

Assumption 5 impacts the quality of the place-based adaptive capacity representation. Metropolitan and regional capacities are biased by large engineering works. The plans ignore current local strategies in preventing flooding, as identified in our workshops, such as the water-crew system managed by farmers to pump water into the sea. Nor is existing differential drainage capacity between different sectors of the coast addressed, a key factor in identifying the most vulnerable targets of flooding. The epistemic uncertainties identified in the problem-framing phase illustrate the inability to reach a realistic SES assessment by underestimating system-based knowledge and lay perspectives.

Is it scientifically robust?

Input data used to characterize vulnerability parameters are based on secondary sources of information: sectorial and regional administrative reports. Primary data and scholarly journals or local documentary sources such as official archival documents (e.g., Environmental Impact Assessments, etc.) are not used. Accordingly, the discordance between the scale of the analysis (local jurisdiction) and the scale of the knowledge used (metropolitan and regional/sectorial scale) is a source of technical uncertainty. Input data on local exposure, and vulnerability to coastal inundation risk, are in most cases partial and filled by proxies with low evidence-based information. Specific attributes and parameters to assess exposure, sensitivity and adaptive capacity to coastal-inundation risk are unidentified. No modelling or mapping techniques and no ethnographic research are used.

Each vulnerability compound receives a qualitative score for coastal-inundation risk. As a result, piecemeal argumentation is the only basis to support decisions made. For example, exposure to marine flooding is qualified as high in the coastal fringe due to the flatness of the delta. The adaptive capacity of coastal-erosion risk is qualified as high, assuming that the annual injection of sand by Barcelona´s Port Authority is enough to reverse the erosion process affecting the region. However, according to evidence-based empirical data (Perelló et al., 2019), and to lay knowledge, the erosion process has accelerated since the measure was put in place in 2005. Each vulnerability compound, including exposure, is aggregated to an overall qualitative indicator based on a geometric aggregation method.

Is the report of outcomes and uncertainties precise?

The communication of exposure, sensitivity and adaptive capacity is performed through general messages that avoid precision. A number of key questions are simply not addressed. These include the following: *What are the main spatial vulnerability hotspots detected in relation to coastal inundation risk? Who is vulnerable and to what extent?* and *What are the main local capacities and/or barriers to foster vulnerability reduction?* Reported vulnerability outputs are used only to establish a ranking of the most prominent risks, with minimal reference to local features.

Uncertainties of place-based vulnerability outputs are unreported, and the reliability of the results goes unquestioned. While statistical uncertainty (measuring the probabilities in a stochastic climate model) is used to identify the likelihood of occurrence for a potential climate hazard, deltaic socioecological system behaviour is treated as if it could be predicted with certainty. Deficiencies in communicating the inherent variability of the system under observation is a source of low reliability for the results obtained.

5.3. Changing place-vision process as a transformative local capacity

If section 5.1 addresses the complexity of characterising exposure to compound climatic events, and section 5.2 explores the complexities of assessing local vulnerabilities to inform climate adaptation policies, this final section is dedicated to a subjective exploration of place complexity and local capacities in identifying changes in the processes of conflicting place framing. The empirical application of the analytical framework detailed in section 4.3.1 is presented below.

5.3.1. Dominant place frames

An initial list of 62 codes referring to place meanings was identified from the press analysis (2007-2020). Out of these codes, 18% were categorized as ‘place symbolic meanings’, 24% as ‘place characters’ and the remaining 58% were categorized under the family code ‘place adjectives’. In Tab. 6, the 12 identified symbolic meanings attributed to non-urbanised deltaic areas are presented and coded with similes. As the initial step in the grouping process, these 12 similes were combined into six dominant place-frame categories. For example, the *id_1* grouped together similar symbolic meanings that emphasise the same place values, coded ‘as a treasure’ (in Tab. 6). As a second step of the grouping process, the remaining codes (place adjectives and place characters) were assigned to main place-frame based on the context-theme of the source quote. Some place-adjectives (e.g., ‘disputed’) refered to one place-frame in certain quotes and to another place-frame in different quotes. Examples of the most common codes included ‘protected’ (appearing in 15 quotes) and ‘birds-land’ (found in 11 quotations).

The most frequent dominant place-frame was ‘as a treasure’ which specifically refers to natural protected areas highly valued in contrast to the surrounding urban environment. This dominant place-frame accounted for 39% of the total quotations. It encompassed expressions that portrayed the land as remaining in a pristine state (like ‘a survivor’), showcasing its intrinsic beauty and ecological significance. Additionally, similar expressions such as ‘jewel’ were used to describe restricted spaces for humans, dedicated to preserving their ecological functions as shelters for birds. For instance, a quote from a reference stated, ‘the beach of ca l'Aranna is a jewel because no one steps on it’. Assigning place-characters to this dominant place-frame, such as ‘birds-land’ contributed to the symbolic place image of ‘like a school of nature’ for many. This characterization extended beyond ornithology to encompass broader ecological contexts. The primary

counterargument within this place frame is ‘natural spaces are not a museum’ (in grey), which is further discussed in section 5.3.2.

Id	Symbolic	Character	Adjectives	Frequency
1	**AS A TREASURE** (Include: As a survivor/ As a school/*As a museum)*	Biodiversity conservation area Birds-land Sustainability education area	Armored; Disputed; Dynamic;Flooded; Fragile; Intervened; Isolated; Impacted; Muddy; Picturesque; Polluted; Protected; Recovered; Restricted; Suffocated; Visited;	39%
2	**AS A PARK** (Include: As a scape)	Recreational outdoor land; Fluvial park	Conflicted; Crowded; Intervened; Suffocated; Recovered; Revalued; Regulated;	16%
3	**AS A LIVELIHOOD** (Include: As a pantry/ *Indian reserve)*	Peri-urban protected agrarian area	Abandoned; Deteriorated; Disputed; Expropriated; Fertile; Flooded; low-viability; Protected; Regulated; Sinister; Speculative; Suffocated; Threatened;	15%
4	***AS A BACKYARD*** *(Include: As a cake)*	Land reserve / Strategic	Empty; Defended; Disputed; Flooded; Wanted; Subservient; Sinister; Speculative; Strategic; Smelly;	15%
5	**AS AN IDENTITY SYMBOL**	Patrimonial landscape	Testimony; Affected; Armored; Protected; Recovered	9%
6	**AS A METROPOLITAN-GREEN LUNG**	Green corridor Water reservoir land/ Lamination area	Armored; Affected; Intervened; Polluted;	6%

Tab. 6 Main symbolic place-frames using figurative language with examples of place meanings attributed to each category. Gray shading represents symbolic meanings expressing territorial concerns, which will be further analysed in Section ***Error! Reference source not found.****.*

The second dominant place-frame was ‘as a park’, which accounted for 16% of the quoted place meanings, thereby emphasizing the recreational character of the area. The ‘park’ image resulted from the most recent territorial transformation (see 3.2.3), where the expansion of major infrastructure projects occurred in conjunction with a ‘cleaning-up’ process and the social revalorization of the area. Surrounded by densely populated cities, deltaic open areas served as an ‘escape’ for many, and they were extensively used for a wide range of recreational activities. These spanned from more traditional pursuits like walks and beach journeys, cycling, footing, and birdwatching, to more unique and distinctive experiences such as ‘rustic-golf’, cruising, plane spotting, and recreational gardens.

The third dominant place-frame refered to agrarian areas ‘as a livelihood’, highlighting the farmscape character and its essential function as a food provider. References to the exceptional fertility of its soils and its proximity to markets as a periurban areas were the

main qualities identified in the place meaning analysis. However, most codes referenced the progressive decline of this economic activity as being ‘protected’ in terms of land use, but not as an attractive and viable productive sector. The absence of generational rejuvenation within the deltaic agriculture sector stood out as one of the most visible indicators of its decline, leaving the remaining farmers akin to ‘the last of the Mohicans’. The primary symbolic counterargument found was ‘as an Indian reserve’ (a territorial concern further discussed in Section 5.3.2.).

The fourth dominant place-frame was coded under the simile ‘like a backyard’ (from Barcelona). This image alluded to its unofficial character as a ‘land reserve’ for future developmental needs, aligning with its strategic significance on a regional scale due to its role as a communication hub. Codes such as ‘wanted’, ‘strategic’ or ‘speculative’ were recurrent. Under this frame, undeveloped areas were ‘empty’ spots. This place frame, which also grouped the place symbol ‘as a cake’ clearly incorporates a territorial concern. Both similes grouped within this place-frame (‘backyard, and ‘cake’) are indicative of a territorial conflict, which will be further discussed in Section5.3.2.

The fifth dominant place-frame mostly referred to the agrarian domains, invoke a sense of identity, heritage, and cultural legacy (see 3.2.1). Clearly, this symbolic representation characterizes the area as a ‘patrimonial landscape’. Some quotes addressed the importance of preserving architectonic symbols of the agrarian legacy, while others referred to iconic food products of the region, such as the artichoke or the black-legged chicken.

The sixth dominant place-frame was captured by the simile ‘as a metropolitan green lung’ with specific emphasis on its character as a strategic water supply and green corridor area. The ecosystem functions of biodiversity connectivity and the land's role as a ‘water reservoir’ (i.e., facilitating essential water recharge while mitigating stormwater runoff) were asserted to oppose urbanisation projects. Among the most prominent was the proposal in 2012 for a macro leisure and gaming complex named ‘Eurovegas’ occupying the agricultural park. The descriptive code ‘intervened’ was quite frequent in this category, usually referring to intricate water cycles and the reliance on human (often costly) interventions.

The territorial boundaries associated with each symbolic place representation was significant and revealed a segmented image of the territory (see Fig. 17). Most of the

quotes pertained to either the agrarian park, the natural areas, or the non-urbanised resting zones (beach areas, the river park, and a few undeveloped municipal areas). Only residual quotes incorporated an integrated perspective of the deltaic area. Fig. 17 illustrates which place-frames correlate exclusively to specific locations within the study area and which ones adopt a more integrated picture of the territory.

The place frame id_1 ‘as a treasure’ denoted exclusively protected natural areas. This category also included references to the deep aquifer. On the other hand, place-frames id_3 and id_5 referring to the place as a livelihood and an identity symbol were entirely attributed to the agrarian areas. The representation of the place 'as a park' is composed primarily of quotes referencing the beach and the river park, but also included the natural areas and traditional agrarian paths.

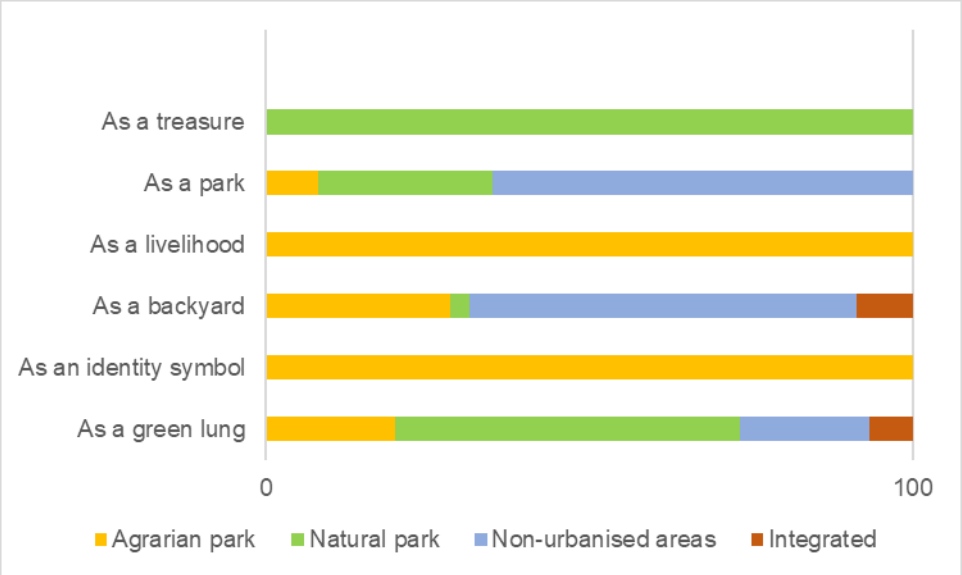


Fig. 17 Diagrammatic representation of the distribution of figurative language categories across the territorial boundaries concerned.

The place-frames id_4 ‘as a backyard’ and id_6 ‘green lung’ presented a less fragmented territorial picture. However, neither provided a truly integrated view of the area, each accounting for less than 10%. Overall, the territorial boundaries associated with each symbolic place representation were significant in framing place, revealing main contested framings and territorial ‘problem-settings’.

5.3.2. Conflicting place frames

Most of the symbolic meanings listed in Tab. 6 carry a positive place connotation, except for three (highlighted in grey)[19]. These three similes, which express territorial concerns through symbolic counterarguments, are then transformed into three metaphorical sentences, each addressing a different conflicting place-frame. The first focuses on the economic viability of agrarian activity, the second on the ecological integrity and functionality of natural areas, and the third on the reduction of non-urbanized deltaic areas.

M.1. The agrarian park is an Indian reserve (identified in id_3, Tab. 6)

This metaphor encapsulated the ongoing dispute between the farmers and the management of the agrarian park, and by extension, the public administration, highlighting the perceived lack of political commitment to actively promote and ensure the continuity of peri-urban agricultural activity as an economic viable sector. For example, by improving field drainage. It served as a poignant symbol of the frustrations and tensions arising from the perceived disconnect between the needs and aspirations of the affected farming community and the actions of the authorities responsible for supporting and fostering their livelihoods. Figurative language that supports this metaphor includes quotes from farmers like ‘we are like the last of the Mohicans here’ and analogies comparing the elderly farmers to their neighboring ‘duck reserve’. It established a parallel between the perceived low social value of farmers' permanency and the contrasting general interest in protecting the ducks of the natural park (id_1).

Affected farmers argued that the promotion of the bucolic agrarian scenery as a patrimonial landscape (id_5) has taken precedence over necessary interventions for agricultural viability (id_3). This promotion has been carried out through various means, including the establishment of a network of cycling paths which had encouraged new interactions with the setting, and consequently new symbolic meanings such as ‘Escape’ (id_2) from the urban environment. The challenging coexistence of tractors and agricultural machinery on one hand, and cyclists and other ‘tourists’ on the other, further intensified the sense of farmers working in an Indian reserve and being relegated to a secondary role in their own territory. In short, this metaphorical language draws attention to the complexities and tensions arising from the intersection of different interests and

[19] In reality, there are four, but two are grouped within the same frame (id_4).

activities within this place, amplifying the farmers' feelings of displacement and vulnerability.

M.2. The natural park is a museum (identified in id_1, Tab. 6)

This territorial concern arised from park managers and ecological local groups about the low commitment (and resources) to keep the natural areas 'alive' and in good ecological status. Despite their 'protective' status, these areas are experiencing a decline in biodiversity. The source domain of the metaphor, *a museum*, denotes reverence akin to how museums handle *precious items*, and it brings forth notions related to preservation, conservation, education, and controlled access.

Despite the success of the natural park in making this remaining natural place known (evidenced by a remarkable increase in visits and social appreciation of the space) the concern lies in the aim of 'conserving' a natural legacy merely as a *landscape painting*. The challenge lies in a real commitment to keep alive the ecological functions of wetlands given their territorial context of a metropolitan delta. Some of the quotes made direct accusations of illegal hunting by farmers (id_3) and also denounced illegal activities and the violation of the agreements established within the Plan for the Protection of the Natural Areas of the airport environment, which was signed with the airport expansion (id_4).

A recurrent pattern of argumentation found in the press analysis in relation to the simile 'as a treasure' and the concern expressed 'is a museum' also came from local 'visitors' who critiqued the excess of regulatory measures and controlled access in the natural areas, contradicting the image of freedom and wilderness that was held in the past (see 3.2.)

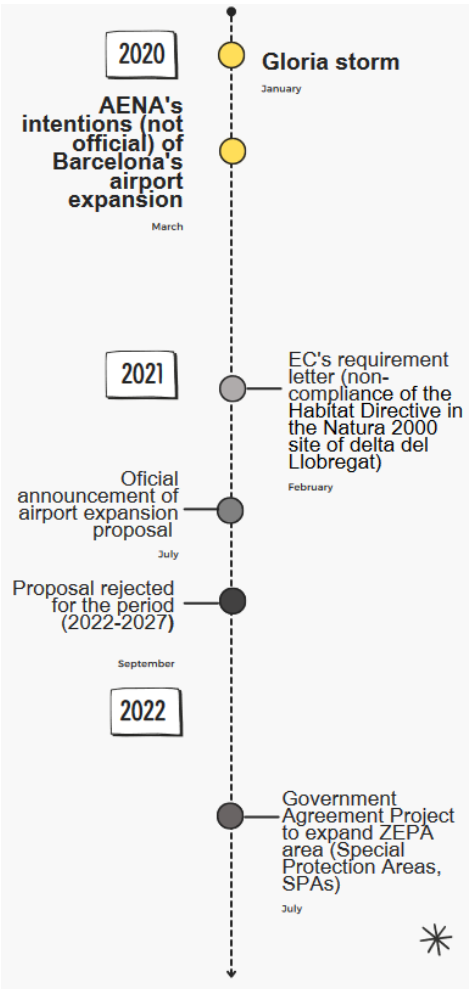
M.3. The deltaic land is a piece of cake (identified in id_4, Tab. 6)**.**

The similes 'as a backyard' and 'as a cake' conformed the place framing id_4. Both place symbols denote the subordination of this territory concerning metropolitan needs. The metaphor 'a piece of cake' better encapsulates the figurative language used to refer to this territorial concern. This metaphor highlights the *tempting* nature of these metropolitan deltaic spaces for future major investments, especially in the transport-logistics sector, and beyond. Quotes such as 'another *bite* in the territory' or 'these spaces are very *tasty* for major investors' belonged to this metaphorical thinking. The connotation of *consuming* these places is evident in the case of this delta, as it has been 'taken away' or expropriated by supra-municipal large infrastructures of general interest. El Prat is a

striking example, where 50% of the municipal territory falls outside its jurisdictional competences.

The notion of a cake as a source metaphor also indicated how it was divided and by whom. Something that concerns all actors implicated in the non-urbanised deltaic lands. The metaphor highlights an affective human reaction of always being on alert to prevent more parts of the territory from being *depleted* – a kind of 'latent social reactivity'. However, this figurative expression shadows the fluxes (and conflicts) between the different territorial *portions* (deltaic land uses) expressed in the two previous conflicting-frames.

5.3.3. Place shaping: generative frame metaphor



The Gloria storm and the initial leaks of the Airport manager's (Aeropuertos Españoles y Navegación Aérea - AENA) intentions for the airport expansion (not yet official in March'20) occurred almost simultaneously. However, the arrival of COVID-19 overwhelmed the press in the following months. Yet, during this period (2020-2022), a total of 95 press articles referring to the study area have been accounted, thus more than in the previous longer period (2007-2019).

Fig. 18 Setting the context. Chronological diagram. In yellow the two shoks or disruptive events. Source: own production.

The Gloria storm had substantial adverse impacts on agricultural areas, resulting in crop losses, as well as on natural spaces, causing diffuse contamination. Moreover, the entire

deltaic beach system experienced a drastic regression, with severe impacts on coastal dunes. In a sense, this event exacerbated some of the primary unsustainable patterns and challenges of the study area. Nevertheless, the Gloria storm was only mentioned in 2% of the quotes identified in the press analysis. Revised press items did not generate in-depth discussions about the broader sustainability issues or interconnected concerns related to the delta. The few argumentation that occurred concern shoreline impacts (beach retreat), primarily prompting a call to revisit the effectiveness of EIA measures (see 3.2.3). Secondly, they served as a reflexive lesson on enhancing coastal management through nature-based solutions as a climate change resilience measure. In the revised local press, there is no article that provided information about actions taken by either the agricultural community or the consortium responsible for managing the natural protected areas, except for the reporting of economic losses.

Drawing from data collected through walking interviews and participant observations, it became evident that the impacts of the flood event worsen the conflicting place-frames M1 (The agrarian park is an Indian reserve) and M2 (The natural park is a museum), as described in section 5.3.2. Affected farmers underscored the disregard for public investments in agricultural drainage systems, criticising a constrained political commitment to resolving an historical drainage problem that is not excessively costly to fix (Palau Robert, 2021). This highlights how the viability of the agriculture sector is not considered a public concern. The quotation extracted from a farmer, ‘they want the agricultural lands to become swamps again’ reflected the sector's perception that society values more conservation strategies than the maintenance of traditional deltaic horticulture. Additionally, reinforcing the role of agrarian fields as buffer zones, the interviewee representing a social movement used the storm as evidence to support their call for the cessation of further land sealing in deltaic areas, emphasizing its significance as runoff mitigation zones.

On the other hand, the managers of the natural spaces denounced that the flooding of wetland areas exacerbated pollution spreading. In short, the local responses to the Gloria storm did not provide a window of opportunity for debating or negotiating historical problems. It also exacerbated the conflicting relationship between farmers and the natural park regarding drainage management.

The official airport expansion plan sparked the rise of a significant latent threat from the past (3.2) and constituted 60% of the quotes identified in the local press analysis[20]. The airport proposal had a direct impact on a protected wetland area, and it also indirectly impacted agricultural areas through compensations measures. The debate generated many reactions, especially during the period from June 2021 to October 2021. The principal place-frames mobilised were id_1 as a treasure, id_4 as backyard, id_6 green lung, and to a lesser extent id_3 as a livelihood.

In relation to id_1, the most significant points referred to the vulnerability of these areas, their designation as protected zones and the irreversibility of projected impacts. A recurrent claim addressed was the precarious state of the protected natural areas due to legal negligence resulting from non-compliance with environmental measures agreed upon in the last airport expansion. A fact endorsed by the European Commission requirement notification (see 3.2.3). The airport announcement revived the historical place-frame to be 'as a backyard', the uncomfortable feeling of being a peripheral area ready and available to strategic regional needs. Figurative language among this territorial concern (M3) was very frequent, such as 'the insatiable airport' or 'this is the recipe proposed by the airport'. In this sense, it remained consistent with the conflicting place-frame M3 analysed in the previous period (see 5.3.2). However, a powerful counterargument emerged: the claim of the centrality of these places.

The transition towards emphasising the centrality of non-urbanised deltaic areas within the context of a densely populated metropolitan region was reflected in the place-frame id_6, known as 'as a green lung'. The airport economic and strategic justifications were offset by the significance of having '*green infrastructure* for the greater good'. The term 'green infrastructure' constitutes a metaphorical expression, drawing a comparison between the functional purpose of built-up infrastructure (such as the airport) and the essential functions of natural and semi-natural areas. Well-being and concepts associated with caregiving (for both humans and territorial equilibrium) were recurring patterns of argumentation.

The 'green infrastructure' concept acted as a generative metaphor in the sense that founds common grounding among the prevailing conflicting place-frames (5.3.2), especially reconciliating territorial concerns of agriculture viability and ecological functions. Rather

[20] This percentatge also covering the subsequent proposition of Spatial Protected Areas

than competing place visions it acknowledged shared place functions such as flood control, recreational and landscape utilization, food sovereignty, ecological roles, and various others. This perspective extended beyond the ‘them and us’ viewpoint (see Fig. 17) emphasizing the interlinkages and interdependencies of both agrarian and natural protected areas.

This shift was also evident in the use of language, from sectorised toponyms such as 'the natural park' or 'agrarian park' to more integrative place references like ‘the delta’, ‘territory’, ‘our ecosystem’, or the ‘Baix Llobregat region’. Over fifty percent of the quotes encompassed this more unified perspective of the study area (Fig. 19). Additionally, a relatively substantial portion of the references, a 9% (leveled as ‘others’ in Fig. 19) surpassed the deltaic territory to directly address climate emergency and economic development models. In fact, the local leitmotif of the protest actions ‘For the delta, for the climate, for life’ reveals how concern transcended deltaic territorial conflicts.

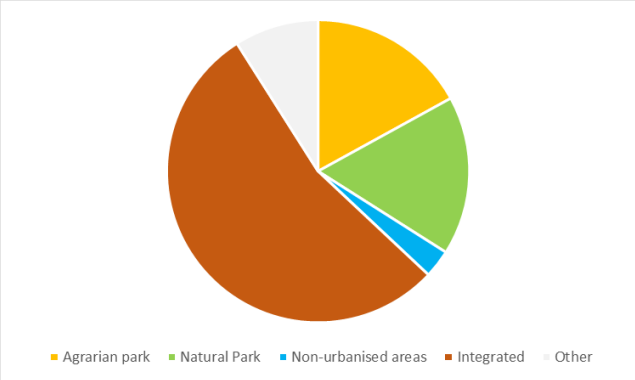


Fig. 19 Territorial boundary frame according to the language used. Source: own production

The proposal for airport expansion did not come to fruition (at least within the DORA 2022-2027 period). However, a year later, in response to the EC's requirement letter regarding the Habitat Directive, the Catalan authorities published a Government Agreement Project to extend the Special Protection Area for Birds (Fig. 18). More concretely, the proposition entailed transforming the land designated as an IBA (Important Birds Area) into a ZEPA zone (Special Protection Area for Birds), while concurrently suggesting an expansion of the LIC (Sites of Community Interest). This strategy would result in the ZEPA zone expanding from its current 935 hectares to 2,381 hectares, with most of it falling within the jurisdiction of the agrarian park.

The measure found support among a wide range of airport expansion opponents but cancelled part of the consensus that had been achieved by elevating both agrarian and natural areas as central components of the delta land. It has led to the resurgence of conflicting positions among local actors, making it difficult to reach a consensus on a common trajectory for the place. The agrarian community, although being the primary group impacted by the ZEPA expansion, did not perceive themselves as active participants in the exchange of information and the negotiation process. This led to an exacerbation of feelings of displacement and the undervaluation of the agrarian activity role in society, which amplified the concern express in conflicting place-frame M1.

To conclude, place-frames are always evolving; there is no final moment of resolution when place-frames are produced. Likewise, the adaptive capacities of a community depend on the dynamics within this network of relationships, which experience both progress during favourable moments and setbacks along the way. The results presented cover a specific timeframe, which does not encompass all the actors involved or the nuances related to the new conflict surrounding the expansion of protected areas.

Chapter 6

6. Discussion

6.1. Research originality and common ground among the three objectives

The starting point of this dissertation is to explore local response capacities to climate change from a pluralistic approach rooted in three academic perspectives on uncertainty and complexity. This exploration is conducted through a case study on climate change adaptation to flooding in the Delta del Llobregat. The originality of my approach to the analysis of the local response, different from traditional cope, adaptive or transformative capacity analytical frames (Cardona et al., 2012; Folke, 2006), stems from a relational approach to uncertainty which allows me to address it from technical, political, and affective complementary perspectives. They nicely convey a transition from a 'matters of fact', to a 'matters of concern', to a 'matters of care' (Puig de la Bellacasa, 2017), and serve as analogues to the main climate change discourse presented in the theoretical chapter based on Leichenko & O'Brien (2019).

The first perspective deals with uncertainty related to local-level flood spatial data and embraces the complexity as discussed in the literature on climate risk management. The second one addresses uncertainty in relation to adaptation policy and conceptualizes complexity from the lens of post-normal science. The third one addresses uncertainty in relation to subjective place-framing processes and understands complexity from collective awareness and transformative change. Other theoretical entry points could have been used within one of the three uncertainty-response relationships. These are only possible approximations that I have chosen, driven by the needs of the case study. Importantly, this classification does not imply that each theoretical background exclusively corresponds to the assigned order of change. For instance, climate risk management could be approached through second-order science, and post-normal science exercise could lead to transformative outcomes.

This triadic approach organizes the thesis into three distinct themes, which are conceptually distant and methodologically diverse. In spite of this, they are presented together in this research as an articulated example of interconnected orders of response change capacity. These levels of change correspond to Bateson's (1972) learning levels and subsequent models rooted in organizational theory (Argyris & Schön, 1978). As demonstrated in this thesis, these seminal works can offer valuable contributions to the

ongoing discussions surrounding incremental and transformative approaches in climate change research. Departing from differing theoretical foundations, the three objects of analysis deal with complexity, giving rise to a set of commonalities, the most prominent of which are: place-based and bottom-up approaches, reflective stances in relation to adaptation barriers, and emphasis on process over ends.

Place-based and bottom-up approaches

I adopted a multifaceted bottom-up approach to comprehend and influence change in complex situations. First, I illustrate the effectiveness of place-based strategies in dealing with flood exposure to compound climatic events. The results obtained in my study highlight the underestimation of flood risks by traditional top-down risk assessment methods, as they usually consider one driver or hazard at a time. Consequently, this finding lends support to Zscheischler et al.'s (2018) call for a paradigm shift in impact assessments, favouring system-centric approaches as complementary to scenario-led ones.

Second, addressing the uncertainty of local vulnerability assessments strengthens the importance of context-specific knowledge in adaptation planning, contributing to bottom-up approaches in vulnerability analysis as in Ribot (2014). This is increasingly encouraged in the field of social science (Lövbrand et al., 2015), because in fact, 'knowledge of vulnerabilities and climate change impacts on human well-being is less advanced than the knowledge of climate systems' (Goosen et al., 2014; quoted by Räsänen et al., 2017, p.31). Consequently, the results obtained emphasize the necessity for 'genuine' bottom-up approaches in municipal climate change adaptation policy. The findings from the uncertainty assessment demonstrate how low-quality local vulnerability knowledge hampers the identification of local risks and, consequently, community adaptive responses.

Third, a deeper bottom-up approach is undertaken, delving into the normative and affective constructions of place and community responses in the face of change. Through this inner approach, I demonstrate that transformative shifts can be achieved not by solely focusing on 'material' solutions (or assets) but by addressing the social construction of the problem definition itself. Findings from the case study represent a clear empirical and analytical input to deliberate transformative change literature aligned with inclusive discourse on climate change (Leichenko & O'Brien, 2019), affective adaptation

(Nightingale et al., 2022), and care approximations of uncertainty instead of control (Stirling, 2019).

Overall, the findings from the three bottom-up approaches demonstrate how a place-based approach enhances the community process of making sense of the production and utilization of knowledge for adaptability and transformation. 'Place-based' perspectives on sustainability science are not new, as many studies have pointed in this direction in the last years (Dessai & Hulme, 2004; Grenni et al., 2020; Horlings et al., 2020; Hulme, 2008). My study contributes to this literature by demonstrating how insufficient bottom-up approaches act as barriers to adaptation in local municipalities, even when local adaptation plans have been promoted. This approach echoes the precursor concept of 'eco-development' coined by Sachs (1974) which laid the foundation for 'local sustainable development' (Estenssoro, 2015; Freire Vieira, 2009). In this sense, similar to how, back in the 1970s, eco-development challenged universal development paths and advocated a pluralistic approach tailored to address specific issues in each ecoregion, the current concept of place-based adaptation and transformation seeks to transcend the standardised 'making and governing global kinds of knowledge' (Hulme, 2008, 2010). Findings from this multifaceted bottom-up approach demonstrate how, in fact, standardised and top-down climate governance and knowledge are main sources of adaptation barriers.

Reflective stances in relation to adaptation barriers

Focusing on uncertainty as a barrier, but approaching uncertainty from a reflective stances, allows a better alignment with response-ability and deliberate transformative changes. We do not only need more precise data on future climate projections at the local level, but from a reflective stances approach, uncertainty can contribute 'to processes of institutional change, rather than solely viewing it as a problem for decision-making' (van der Sluijs et al., 2006:6). Such a reflexive approach to adaptation policy is considered a way to enhance adaptive capacity (Preston et al., 2015; Westling et al., 2014) and to rethink (or transform) knowledge governance of complex issues at a local scale. In this sense, the vulnerability KQA endorsed in this research performs a double-loop exercise (Argyris & Schön, 1978) or 'knowing about knowing' (Bawden, 1997; quoted by Sterling, 2003:131) both based on Bateson's second learning level (Bateson, 1972).

Reflective stances are also included in the metaphorical place-frame analysis. Labelling societal dynamics and collective action as transformative or not is a highly contested issue (Fazey, Moug, et al., 2018; Galafassi et al., 2018; Hestad et al., 2021). Rather than assessing 'transformative solutions' using impact-change indicators such as gains in social learning and empowerment, this inquiry evaluates transformative changes in the way we perceive the underlying territorial 'problem-setting'. This problem-setting, is usually kept tacit and significantly shapes our responses is the result of conflicting frames (Schön, 1993), in this case, conflicting place-frames.

Emphasis on process over ends

Adopting a process perspective in climate risk management is crucial for moving beyond a sector-specific risk approach and gaining a more comprehensive understanding of risk interactions. However, I fully deploy the emphasis on process research approach in the political and affective approximations. In contrast to technical uncertainty assessments, the KQA evaluates context-specific knowledge used in the development of vulnerability indices. But additionally, its role within socioeconomic and political process makes it possible to critically assess the usefulness of the knowledge base used for vulnerability reduction strategies in specific contexts. This perspective focuses on the process through which the assessment is generated, by revising quality criteria specific to each knowledge-production phase and knowledge dimension. Introducing a 'process' uncertainty dimension addresses the gap identified in Locatelli et al. (2017), which highlights the necessity for more in-depth analysis of policy processes to understand why policy-relevant research results often fail to influence policy development.

As regards the affective uncertainty-response approximation, I adopt a process-oriented and relational perspective on place (Cresswell, 2005; Massey, 2005). A process-based approach to understanding place is essential for identifying potential trajectories. This perspective allows me to conceive transformations of place-visions, as demonstrated in the empirical case study. By transcending otherness and rivalries that are not well-aligned with sustainable and shared futures, such transformations become possible. Dynamic discourse analysis using metaphorical framing has been demonstrated to align with place-framing process research. This represents a novel application of the methodology proposed by Cameron et al. (2009) and Cameron & Larsen-Freeman (2007) to the context of geographical and territorial processes.

6.2. Contribution of results to the case study's response capacity (to flood)

The first research question asked in this dissertation is about the availability of flood exposure data at the municipal level reliant on geographical particularities as well as accounting for interconnected and compounded climatic hazards. Using a 'lleventada' storm as a reference for a compound climatic event, the results indicate that the existing delineation of flood-prone areas, while informative at the watershed level, lacks the precision required to identify reliable adaptation measures for reducing local vulnerabilities to extreme rainfall-wave events.

The map of the local flood extent from storm Gloria fills a significant gap, as it represents the first published cartographic effort in this area, highlighting a recurrent issue of inundations in agricultural areas. The impact of Storm Gloria extended across the entire Catalan coastline (Guillén, 2020; Pelegrí et al., 2020; Pintó et al., 2020). So far, previous coastal flood mapping efforts primarily focused on the Ebre delta (Amores et al., 2020; ICGC, 2020). The only existing document with cartographic data on the flood extent in the Llobregat delta is unpublished[21] and pertains solely to the Viladecans area (SGM, 2021). Therefore, the map created in my research contributes to highlight a recurrent and locally known situation of high exposure to flooding in agricultural plots (El Pais, 2020) which impacts the economic viability of a declining and already debilitated primary sector (Sempere, 2004).

Furthermore, the relevance of this local cartographic product lies in enabling a review of the existing graphical delineation of flood-prone areas within the 'Hazard and Flood Risk Maps of the River Basin District of Catalonia (MAPRI)'[22]. The spatial comparison between the map that I obtained using remote sensing data and the delineation of the floodable zone for the 10-year return period (accessible in the ACA viewer) reveals zone discrepancies. One of the deltaic sectors that present the most obvious discrepancies between the two cartographic sources is the eastern section of the case study[23], where the hydraulic model-based map from ACA does not identify any floodable zones at all. According to ACA officials consulted, this error is attributed to the map's exclusive focus on river sections with recognized high flood risk (such as Riera Roja, Sant Climent, and

[21] Document accessible through a request to the Viladecans municipal authority
[22] Second cycle, approved on July 16, 2020.
[23] Encompassing the Ricarda drainage basin and the southeastern sector of El Prat

Riera de Canyars), thereby excluding other flood-prone zones stemming from different streams or originating from in-situ precipitation events[24].

The second main zonal discrepancy corresponds to the agrarian sector of Gavà-Viladecans. In this case, both maps show areas of widespread flooding; however, it appears that the spatial distribution of these areas is inverted between the two cartographic sources. The results obtained in the study of the agrarian area in Viladecans (SGM, 2021) also confirm this spatial disagreement. Local deltaic factors not included in the watershed ACA model such as slope, relative height to the water table, granulometry (input of silts and clays), distance to the channels, or the functional state of the canal network are suggested in the study SGM (2021) as the main causes of these discrepancies. Beyond these local factors, the results of this dissertation also point to sea level oscillations as an additional contributing factor affecting delta flooding, which is not considered in the hydraulic ACA model-based map.

Integrating temporal sea level changes is especially relevant in deltaic plains due to the 'bathtub effect' (river mouth blockage), especially along the Mediterranean low coastlines less accustomed to large daily sea level fluctuations (Day et al., 1995) and on dissipative beaches where the storm surge component is significantly higher (Mendoza & Jiménez, 2005). The estimated sea flood level (R_{low}) during Storm Gloria was 1.7 meters (and could have been much higher in the event of a synoptic low-pressure situation). The map generated in this study affirms the findings of earlier research that caution against underestimating the potential impact of marine flooding when solely considering the permanent rise in mean sea level (Barnard et al., 2019; Vitousek et al., 2017; Wahl et al., 2015) and ignoring inter-risk interactions (Simpson et al., 2021). However, temporal sea-level oscillations and flood compound risks are not considered in the municipal local climate change adaptation plans, which only account for permanent sea level rise projections.

The absence of spatial data on complex issues at the municipal level poses challenges for local climate change adaptation policies. These plans rely on the compilation of spatial data derived from sector-specific risk directives. Accordingly, while the scale of the

[24] The technicians I consulted have informed me that this error will be corrected in future revisions of the cartographic material published in the viewer. Therefore, the comparison presented in Fig. 15 corresponds to the official cartographic products available at the time of data extraction (February 2022). However, it is worth to mention that some of these areas were not excluded in a previous ACA study (2008).

assessment (municipality boundaries) matches the scale of decision-making (Cash & Moser, 2000), the knowledge base mobilized to undertake such assessment is not pertinent to the scale of the assessment, leading to an insufficient relevance in the advocacy arena.

This situation is addressed in the **second research question** inquired in this dissertation, which interrogates the implications of the knowledge quality for governance of complex issues and its effects on municipal adaptive capacity. Through ground-testing a KQA tool and extensive documentation, along with fieldwork, the results indicate that the 'low quality' of local vulnerability knowledge, as assessed in two plans from the case study, is a significant factor limiting the impact of these plans on shaping urban development pathways aligned with concrete adaptation efforts. By 'low quality' I mean deficiencies in the vulnerability assessment in achieving the objectives pursued (i.e., local risks identification) as a function of its context of application, its procedural design, and the content of the knowledge used and produced.

The inadequate alignment of the hazard definition with current indicators of changes observed at the local scale, such as alterations in the frequency and intensity of eastern storm events[25], highlights the limited effectiveness of the local plans in informing territorial authorities and the affected population to adapt to changing conditions. Not only is the climate hazard framing questioned, but the context-specific knowledge needed to characterize vulnerability is replaced with broad regional descriptions, omitting a lay critique of expertise. Adding insight from the contextual and procedural dimensions of knowledge reveals how the vulnerability assessment of the plans reviewed is lessened by a process of information transfer to the municipal adaptation plans from a higher administrative level. The same approach used to build the adaptation plan of the metropolitan region of Barcelona is transposed to the municipality scale with minor changes of purpose, procedural design, and data sources.

This situation is primarily attributed to the dominant governance framework that influences the production and dissemination of the knowledge required by local authorities to adhere to the mandates of the European Commission Covenant of Mayors Initiative on Adaptation to Climate Change. As a Covenant signatory, both municipalities receive support from their territorial coordinator to develop their corresponding plan

[25] as indicated by historical meteorological and oceanographic data (Pintó et al., 2020)

(Sauer et al., 2021). While it is beneficial to share climate hazard data for the same climatic region (Hernandez et al., 2020), local authorities still face the challenges of reporting vulnerability and risk assessments for their jurisdictional territories.

In the case studies analysed here, this is resolved by the metropolitan agency acting as an intermediary government level with the Covenant, promoting a standardised vulnerability assessment authored by consultancy firms. However, the normalization of procedures occurs in isolation from their social context. The analysis of the institutional setting for conducting adaptation research at the municipal scale detects that organizational support has not promoted a genuine community engagement with Covenant mandates. Vulnerability assessments are unsupported by place-based participative or transdisciplinary approaches of knowledge production, and as such they exclude a shared vision, negotiation, and exploration.

The relative lack of geographical sensitivity reflected in the understanding of local vulnerability reduces the detailed awareness of local risk required by local authorities. This, in turn, diminishes local-governance capacity for climate adaptation in the policy arena (low implementation) and, indeed, more broadly in the advocacy arena (lessening collective response-ability awareness). Major gaps detected in the plans reviewed are understanding how climate change might affect the everyday life of target populations (Hackmann et al., 2014) or produce awareness of the diverse and dynamic response possibilities of a specific community (Lövbrand et al., 2015).

To redress this situation, academic literature is increasingly adopting place-based approaches and integrating adaptive capacity into the context of people's everyday life (López-Marrero & Yarnal, 2010). To achieve both objectives, the present empirical proposal situates flood and adaptation capacities within the broader framework of people's evolving territorial concerns, thereby setting the context for the **third research question**, which explores the role of subjective constructions of place visions in addressing community responses to change and uncertainty. And more concretely, it focuses on process of competing place-framing situations among local population and processes of transforming the 'problem' territorial setting.

In this context, the selected case study, an 'open area' in an expanding metropolitan area such as Barcelona, serves as a catalyst for territorial conflicts (Nel·lo, 2003; Paül, 2009). Instead of ignoring these conflicts in the local response analysis, they serve as the entry

point to examine the main contested place meanings and their affective transformative agency. Interestingly, one of the results from the analysis of local adaptation plans shows that conflicting views about places have significant implications for local climate change adaptation. More concretely, the post-normal approach to uncertainty has revealed the presence of non-equivalent representations of the system of concern, leading to contradictory climate change adaptation measures. This evidence is noted in the context of flood risk, where both high and low groundwater aquifer levels are computed as vulnerability-reduction measures depending on specific pre-analytical choices (epistemic and normative).

The third question delves deeper into these aspects, shifting from technical and political perspectives to a more subjective, affective-driven examination of local place bonds and their implications for response capacities. The proposed analysis focuses on a place-making process: first, identifying primary place-frames derived from dominant symbolic meanings and the main territorial concerns resulting from competing place-frames. Second, describing community responses influenced by two disruptive events that intensify these concerns. Third, evaluating local responses in terms of place-making. Finally, eliciting transformative change in the place-making process's ability to reframe competing place-frames.

The two selected disruptive events differ significantly in nature. The first is the same climate extreme discussed in objective 1, the Gloria storm, while the second is a land-use planning proposal, the expansion of Barcelona's International Airport. However, in accordance with similar models, the term 'shock' or 'disruptive community-level environmental stimulus' can encompass a wide range of events, including climatic disasters, planning decisions, or even the mere potential or perception of a substantial environmental change (Mihaylov et al., 2020). The main finding is the limited community response resulting from the extreme climatic event. A sense of fatalism is apparent regarding the climate event, which, at best, leads to technical proposals (such as improving drainage, fortifying dunes to protect against beach erosion, or mitigating diffuse pollution in natural areas). However, it does not delve into addressing the underlying unsustainable patterns of development in the delta. Nor do they consider how these proposed 'technical' solutions interact with ongoing delta engineering interventions or with various territorial expectations regarding a deltaic water management.

Interestingly, place images remain consistent, and no transformative agency in terms of place-making is generated to reshape the primary competing place framings. Instead, it exacerbates contested place visions, intensifying the coexistence challenges between agriculture and coastal wetland and generating frustration among stakeholders. The flood event exacerbates the complex and challenging water management situation, driven by divergent water demands in terms of both quality and quantity.

On the other hand, the reaction to the proposed expansion of the airport generated a much greater response in comparative terms to the extreme climatic episode. AENA's announcement awakened a latent reactive agency, as noted by Paül (2009), present in the case study, which had been forged through many past struggles originating from pre-existing groups or in response to unresolved situations. Not only in quantitative terms the response-ability is higher but also in transformative terms. The results obtained through the discourse dynamic approach identify a shift in the use of language towards integrative references to non-urbanised deltaic areas. This is a first indicator of some source of generativity in quotidian agency.

In a similar case study conducted in Alicante, Spain, where ZEPA areas coexist with agricultural activity, Ricart & Rico-Amorós (2021) found that part of the water conflict arised from varying stakeholder interpretations of the socio-ecological system, whether as a ‘wetland’ or a ‘pond’. The study further recommend that transformative management should aim to address these symbolic interpretations in order to mitigate confrontation. The results from the Llobregat delta advance this inquiry by highlighting the significance of innovative metaphoric framings as means to reconcile opposing viewpoints and facilitate a transition to more collaborative approaches.

The results show how the concept of ‘green infrastructure’ is particularly apt in this context, as it highlights the socioecological functions arising from the symbiotic relationship between agrarian and wetland areas. This inclusive perspective on socioecological functions holds relevance not only in the mitigation of extreme flooding situations but also in contexts marked by water scarcity and pollution, such as in the work by Ricart & Rico-Amorós (2022). Additionally, according to our results this ‘new’ place-framing successfully brings about a revaluation of these territories, transforming them from peripheral to central positions. The affective response, a sense of undervaluation that is finally addressed give rise to a new entity. It's worth mentioning that the concept of 'green infrastructure' is considered generative, not because it is invented within the case

study, but because it is embraced by local stakeholders and has demonstrate potential to generate alternative place-visions.

Furthermore, the intrinsic multifunctionality of green infrastructure allows to move away from the conventional environmental metaphor of ‘a park’ where the focus is on soil preservation and recreational amenities (Princen, 2010:62). Instead, it transcends this limited 'recreational' and human-centric perspective, embracing a more holistic, ecological, and interconnected approach, which includes considerations such as metabolic flows within a deltaic framework. However, the territorial implementation of functional green infrastructure in specific metropolitan areas, like Barcelona, is not readily apparent (Marull et al., 2022). To enhance the planning and management of deltaic green infrastructure, it is essential for future research to explore the synergistic and connecting roles played by the historical network of corridors and irrigation channels within the territory. Also, Llausàs et al. (2019) underline the potential of green infrastructure as a conceptual and management framework that aligns with historical irrigation channels.

6.3. Theoretical and methodological contribution, limitations, and further research

The map obtained through SAR-remote sensing imagery contributes to coastal flood risk mapping research and practice at the local scale, and adds to the increasing number of studies stressing the importance of compound flooding in coastal zones (Bevacqua et al., 2019; Wahl et al., 2015; Zscheischler et al., 2018) and their potential increase under the influence of climate change (MedECC, 2020). The results of remote sensing flood map illustrate the exposure of compound extreme rainfall-wave events in an NW Mediterranean deltaic region under current conditions. This is a significant finding, especially considering that the Catalan coast has a high probability of experiencing these compound extreme events (Sanuy et al., 2021). However, it's worth noting that these events are still poorly considered in climate risk management (Zscheischler et al., 2018), as evidenced in this dissertation by the qualitative assessment of uncertainties in two local adaptation plans within the study area.

The complexity of compound climate events, exacerbated in coastal zones, demands for bottom-up approaches, something that is presented as a paradigm shift in climate impact

analyses, traditional driven by top-down or scenario-led approaches (Zscheischler et al., 2018). Sanuy et al. (2023) contribute to this effort for the NW Mediterranean region by analysing the occurrence and characteristics of compound extreme events of heavy rainfall episodes and coastal storms along the Catalan coast. By shifting the focus to the resulting local flooding, rather than solely considering the compound-climate occurrences, as previously undertaken by Sanuy et al. (2023), the bottom-up exposure map can contribute to gaining a deeper understanding of the local factors that redistribute hazard exposure. Therefore, the approach aligns with 'robust adaptation' approaches to climate change (Wilby & Dessai, 2010), i.e., bottom-up approaches to deal with uncertainty toward reducing the risk of *not knowing*. As far as no modelling efforts of compound events are available for small and medium-sized coastal towns, maps based on current experiences of extreme events and the intersection of fluvial, pluvial, and marine flooding can complement data on local risk management.

The exclusion of urban areas in this study has limited the results obtained, as they do not encompass all flooding in the delta area, which was significant in certain urban areas like Castelldefels (Palau Robert, 2021). Yet, giving priority to non-urban areas, which are the case study in this dissertation, enhance our comprehension of the vulnerabilities of often-neglected areas and sectors in risk assessments. Future enhancements of the resulting map should increase the number of validation points, with particular attention to addressing issues in flooded areas with dense vegetation. A noteworthy correlation has been identified between the detection of non-flooded plots using Sentinel-1 images and the presence of forested or abandoned areas covered by denser vegetation. The omission errors related to TFV, which are specific to flooded areas with vegetation cover, might have led to an underestimation of the extension of flooding areas.

Despite its limitations, the map lays the groundwork for further exploration of local explanatory factors that influence the extent of local flooding. Delving into these factors not only contributes to incorporating local sensitivities and potential responses, which are clearly aligned with local adaptation plans strategies, but also holds particular significance in enhancing the overall quality of knowledge used in local adaptation plans. Coastal town and cities have to be prepared to effectively respond to and recover from the increasingly intense and frequent extreme events (CADS, 2021; MedECC, 2020).

The Llobregat delta hydrology is characterised by shallow gradients, high water tables and a complex and controversial drainage system (Queralt & Isla, 2018; Sans & Panareda,

2012). Understanding and dealing with these vulnerabilities and geographical particularities are essential for local climate change adaptation strategies. To achieve this, it is crucial to involve those who are familiar with the territory in collective exploration of the dynamics and socioecological interdependencies (Mathevet & Bousquet, 2014; White et al., 2010), and thereby move towards new paradigms that increase the capacity to find responses from the perspective of the local community. This can be seen, for example, in sustainable approaches to stormwater management (Nóblega-Carriquiry, 2022), as well as in the roles, governance, and maintenance of the agricultural irrigation and drainage network.

To enhance the relevance of this context-specific knowledge in local adaptation strategies, the originality of the approach presented in this dissertation lies in the introduction of an uncertainty assessment analytical framework tailored to evaluate the quality of vulnerability knowledge in climate risk-based management. Focusing on uncertainty as an 'adaptation barrier', most references point to climate data and its predicted behaviour at the local scale. But this research is grounded on the argument that the predicted socioecological response for specific places is complex and uncertain, as is the climate system. Therefore, (i) awareness of contextual complexities in place-based vulnerability knowledge is a critical component in effective adaptation plans and, consequently, (ii) uncertainty evaluation is also needed in the vulnerability component of the risk equation. But, at the same time, (iii) wider views of uncertainty able to include the human dimension of uncertainty needed to address vulnerability assessments.

The uncertainty approach falls within the realm of the post-normal view of science for governing complex local issues. Far from trying to evaluate or judge the truth of a vulnerability assessment, it questions its usefulness within a particular decision-making process. Accordingly, this work adds to the academic literature on the theory and practice of KQA tools by, first, conceptually enhancing the KQA framework of analysis through the integration of a pivotal issue affecting environmental science for policy: the role of knowledge governance in local environmental management. And second, by advancing a practical application of knowledge quality in the policy field of climate change adaptation.

The first contribution addresses a significant gap in the KQA tool initially proposed by Maxim & van der Sluijs (2011). I refer to how institutional settings shape the quality of knowledge produced and used in environmental policies. This gap is evident in the central

quadrant of the KQA matrix of environmental science for policy, which lacks any uncertainty typology. Furthermore, this aspect is not addressed in other post-normal qualitative uncertainty assessment proposals, such as the Guidance for Uncertainty Assessment and Communication (Petersen et al., 2013). The importance of including knowledge governance as a source of uncertainty in quality criteria analysis aligns with the post-normal call for a reflexive approach to uncertainty.

By tailoring the reformulated KQA tool to local adaptation plans, I could carry out an examination of the institutional arrangements governing knowledge-based plans. This has permitted detection of how knowledge governance that sustains the adaptation plans in small agglomerations is anchored to traditional procedures and insights that are poorly aligned with collaborative knowledge construction in a context of accelerated threats and uncertainty. The relevance of these findings, beyond the case study, embraces the prominent role of intermediate regional parties in the development of plans for towns engaged in a global multilevel climate governance, such as the Covenant.

Melica et al. (2018) highlights how the collaboration between Covenant regional coordinators and local governments has received scarce academic attention in mitigation-plan development. I add that, to a lesser extent, research has focused on the assisting role of those intermediate parties in reporting local vulnerabilities (and associated uncertainties) to effectively support the adaptation processes of smaller agglomerations. This has become particularly relevant with the Paris Agreement, as an increasing number of local jurisdictions are now committing to municipal climate adaptation for the first time.

This dissertation provides relevant contributions to the literature on the evaluation of adaptation plans, through a multidimensional approach to uncertainties, well-suited for vulnerability assessments within the domain of policy analysis. Low fact-based data and the credibility of vulnerability assessments identified through the KQA tool have been partially identified as key causal factors in the academic literature on plan evaluation (Baker et al., 2012; Guyadeen et al., 2019; Olazabal et al., 2019; Woodruff & Stults, 2016). The novelty of my research is the focus on the quality of the context-specific knowledge used within climate risk approaches. The analysed plans do not provide the necessary level of detail, in terms of spatial resolution and local processes, to diagnose specific sensitivities and potential adaptive capacities emerging from the local reality. Even more relevant, the planning process itself does not provide opportunities for

generating this missing knowledge or fostering social learning processes that enhance local adaptive capacity.

Revised plans, while supposedly locally-driven, reproduce vulnerability representations that are rooted in global climate narratives and are biased against context-sensitive knowledge and local concerns. The instinct to reproduce global kinds of knowledge in climate-change research (Hulme, 2010) is also present in revised policy documents. Evidence for this bias is the low contribution of academic skills in the production of local vulnerability assessments. This is also shown by the scant attention paid to cultural and place-based narratives of change (Krauß & Bremer, 2020), insufficient identification of social values at risk (Meo et al., 2021) or an inadequate appreciation of individuals' place attachments and risk perceptions (Bousquet; et al., 2022).

The KQA vulnerability framework serves as a valuable tool for not only assessing vulnerability but also for examining the way uncertainties are reported within the context of climate adaptation. The findings from the reviewed case studies highlight a troubling trend: there is a lack of confidence in the vulnerability measures used to identify significant local risks, and, concurrently, vulnerability uncertainties are not effectively communicated. This dual challenge of low confidence in vulnerability measures and a lack of transparency in communicating uncertainties points to a critical issue in the realm of climate adaptation. It highlights the need for a more robust approach to assessing vulnerabilities and uncertainties in policy adaptation strategies to effectively respond to local risks and challenges.

The poor treatment and communication of uncertainties reflects a biophysical knowledge bias (i.e., only climate uncertainty influence risk assessment), as well as the expected low impact of those adaptation strategies on influencing a local development pathway. Similar to findings by Millard-Ball (2013), revised plans recodify existing local sustainable strategies into adaptation measures. Based on a managerial approach, the plans scrutinised are commended and shaped by the societal inertias of governmental environmental research agendas. Thus, in line with Eriksen et al. (2015), the approaches and knowledge used in the plans examined simply reproduce subjectivities, thereby serving to protect current development patterns and processes and, in fact, closing down opportunities for transformational adaptation.

In the third objective, I contribute to the expanding body of literature on the role of subjective values in climate adaptation processes. To address local response-ability in the face of global climatic threats, perceptive and normative dimensions of human relationships with the environment, such as people's values and social perceptions of places are integral components (Adger et al., 2011; Mortreux & Barnett, 2017). In the analysed case study, this is particularly relevant as it involves the complex coexistence between agriculture and coastal wetland management. This challenge is amplified by the metropolitan nature of the deltaic area and the presence of major infrastructures such as the Port and the International Airport of Barcelona.

The original analytical framework designed to address the third objective brings together sense of place literature and place-framing research. The aim is to address a surprisingly unattended issue: the significance of competing place meanings in understanding local response capacity and its implications for transformative changes. The results obtained demonstrate that while conflicts over place meanings and claims can stall processes of change (incompatible visions of what a place ought to be), they may also have generative potential (Ingalls et al., 2019). And it is precisely this generative power and its possibilities to promote common (affective) interest that guide the transformative potential of place-framing processes as articulated in the analytical proposal presented in this dissertation. While the framework incorporates societal dynamics concerning plural and contested place meanings in coastal management and climate change adaptation, as in Köpsel & Walsh (2018), it goes beyond solely addressing policy inclusivity. Instead, the emphasis here is on analysing the contested place-frames as a key element in activating local transformative adaptation processes.

Accordingly, similar to Murphy (2015), this framework connects place-making with sustainability transitions from a geographical standpoint. However, instead of emphasising the role of political and power processes in shaping place discourses (Pierce et al., 2011; Williams, 2014), the novelty of this framework lies in envisaging the affective component stemming from competing place-frames and place-making process. It focuses on the capacity to enrich the affective dimension of place awareness, or, in the words of Schön (1993), its ability for ‘frame restructuring process’. As such, and following Schön, this generative process is evaluated by means of metaphorical language of competing place-frames and discourse dynamics perspective. The assessment of

territorial metaphorical framing and transformative capacities involves connecting approximations of shifting paradigms to shared and routine ways of understanding places.

While the use of metaphors is commonly employed in environmental and sustainability discourse analysis (Asplund, 2011; Espluga Trenc, 2023; Princen, 2010; Taddei & Fallot, 2023; Wibeck, 2011; Wilk, 2010) and they have gained traction in sustainability transformations and meaning-making approaches related to climate change (Mangat & Dalby, 2018; Linnér & Wibeck, 2019; Riedy, 2022) this research explores their potential for generative capacity in territorial conflicts linked to the affective dynamics in discourse. The results affirm the usefulness of metaphors for framing complex territorial issues and analysing patterns of change. Metaphors help illustrate what falls within the frame and the vision of a place, as well as what remains excluded from the perspective of each contested place. Additionally, as noted by Berg et al. (2019) metaphor is one of the more subtle ways in which affectivity becomes tangible in discourse. This characteristic has become essential in identifying the common ground between key territorial concerns. Findings from the empirical case study show a shared affective sign from the three different place-visions analysed: a sense of undervaluation.

The green infrastructure place metaphor simultaneously and effectively alleviates this affective sign across all involved parts. This empirical case study contributes to the literature and planning of green infrastructure (Benedict & McMahon, 2012) by highlighting the conciliatory and generative role it plays in addressing territorial and water conflicts between peri-urban agriculture and protected wetland areas.

The discourse dynamics method, strongly recommended to address complex systems (Cameron & Larsen-Freeman, 2007), has demonstrated promising results when applied to territorial processes. A similar analytical perspective addressing changes in figurative language over time is performed in Height et al. (2023) in relation to weeds management. The authors suggest that metaphors of care and healing might shift management policies toward collaborative practices and a shared biosecurity responsibility. Similarly, the results from the place-framing discourse dynamics study in the Llobregat delta have shown that the approach to care can serve as a means to reconcile conflicting place frames.

This conceptual framework, which links senses of place with transformative change processes through metaphorical place-framing, not only encourages further exploration

of these connections but also contributes to the growing literature on changing senses of place (Raymond, Manzo, et al., 2021) and affective adaptation to effective transformation (Nightingale et al., 2022). In particular, it forwards the development of new metaphors supporting local place-framing transformative responses to global challenges.

In terms of data collection and analysis, certain improvements could enhance the robustness of the results of the place-framing research. Future studies could consider expanding the press analysis to include regional newspapers to incorporate multiscale framing. This expansion would help reduce the potential bias towards the municipal perspective of El Prat, which may not align with the viewpoints of other concerned municipalities. It's also worth considering that external factors, such as the influence of COVID-19, may have somewhat mitigated the reactions to the Gloria storm, which could have affected the results obtained.

Overall, the application of a relational approach to uncertainty, as explored through the three research questions, contributes to a better understanding and management of complexity at the local level, which, in turn, enhances local response capacities in the face of change.

Chapter 7

7. Conclusions

The underlying motivation of this dissertation is to better understand what deactivates local responses in the face of complex global issues, such as climate change. To do so, I use a relational approach of uncertainty. The results of this research show, through the analysis of the Llobregat delta as a case study, that local responses to climate change are not supported by pluralistic and bottom-up approaches. The lack of a 'real' bottom-up approach is revealed in terms of the limitations identified in the local data availability within risk assessment, as well as through the effectiveness of municipal climate change adaptation policy. In both cases, this gap is analysed in terms of uncertainty attitudes (reduction and recognition respectively) and their implications for local responsiveness.

Concretely, empirical findings based on the flooding of extreme event that took place in January 2020 in the delta del Llobregat demonstrate that, first, available flood-prone risk maps do not account for the hydraulic particularities of the delta. This is exacerbated by the prevailing sectorised approach to risk assessment, which makes it challenging to address the uncertainty associated with the complexity of climatic compound events. This situation results in an undervaluation of local flood exposure and a limited recognition of current vulnerabilities. Second, these technical challenges in analysing local-scale risk complexity have managerial and political implications at the municipal level. Uncertainties in place-based exposure and vulnerability assessments within climate change adaptation plans are hardly addressed, generating a false sense of objectivity and certainty, as if climate (hazard) behaviour were the only unstable factor in the risk equation.

By identifying uncertainties in the local exposure and vulnerability assessments within the domain of policy analysis, I emphasize the importance of context-specific knowledge within climate risk-based approaches. Beyond the known challenges of vulnerability-metrics validation, this research demonstrates the suitability of a knowledge quality approach for vulnerability assessments in policy processes. In contrast with technical uncertainty assessments, the KQA critically assesses the usefulness of the knowledge base used for vulnerability reduction strategies in specific contexts. Addressing the procedural and contextual dimensions of knowledge has permitted a critical analysis of how established concepts and vulnerability representations come about, to what extent they are designed in accordance with problem-focused knowledge strategies, and how they are shaped by existing economic and political institutional arrangements.

Findings of the present vulnerability KQA operationalization in two municipalities have identified how knowledge governance sustaining adaptation plans in small agglomerations is anchored to traditional procedures and insights that are poorly aligned with collaborative knowledge construction in a context of accelerated threats and uncertainty. The knowledge governance design of local adaptation is based on the multi-governance concept advocated by the European Commission but, in practice, intermediate institutional actors exercise a prominent role in shaping local vulnerability and risk assessments, a field of research that has been poorly addressed in academic literature. In my case study, regional intermediary parties, such as AMB, drive the plans for local adaptation at the technical and economic levels. This knowledge-for-governance process undermines the perception of climate change as a social process, leading to a dilution of municipal and community genuine commitment. The modest recognition of adaptation as a political process is affirmed by the minimal response and discussion arising from the effects of an extreme climate event, especially when compared to the debate and contestation generated by an airport expansion proposal.

The dismissing detachment and neutrality in favour of a normative commitment to transformative change cannot be achieved uniquely by technical and political means. It also needs to address matters of care, rooted beliefs, and perceptions of human-environment relationships. It is in this context where the concept of response-ability fully deploys. Nevertheless, the practice of relationality, rooted in interdependence and connection, faces difficulties in situations of conflict, where a strong sense of rivalry and otherness emerges. Results demonstrate how segmented visions, such as through place-framing processes, can be restructured and transformed based on shared affective signs that transcend alterity. This is supported by conducting a metaphorical territorial framing analysis in non-urbanised areas of the Llobregat delta. The approach allowed the identification of the main disputed place-framings, which clearly indicated local rivalries and a plurality of territorial expectations with difficulty to reach consensus. Most significantly, it led to the recognition of a shared affective-sense common to all conflicting place frames. The transformative potential emerges from recognizing this shared affective response and is built upon generative, place-based metaphors (such as green infrastructure). The metaphor encompasses expanded affective awareness facilitating a restructuring of territorial concerns.

In summary, in a context of accelerated and non-linear changes, this research emphasizes the need for a system-centric approach to reduce scenario-led uncertainties in local risk assessments. This uncertainty reduction is important for attaining a more genuine approximation to local flood exposure. The study also sheds light on the qualitative sources of uncertainty and the pivotal role of reflexivity in reevaluating institutional frameworks and in facilitating knowledge processing of complex issues at the local scale. This, in turn, have the potential to foster a more democratic and effective implementation of municipal adaptation strategies. Finally, drawing from the foundations of response-ability, this research encourages a sense of interconnectedness rooted in an affective stance. This wholeness perspective, exemplified through place-framing processes, attempts to go beyond the limits of dualism and rationalism, seeking to deliberately transform current frames and inertias that contribute to the global crisis.

REFERENCES

ACA. (2008a). *Estudi d'impacte acumulat i d'avaluació d'alternatives sobre la xarxa de drenatge i les zones humides generats per l'execució de les infraestructures del delta del Llobregat. Tom 1*.

ACA. (2008b). *Estudi d'impacte acumulat i d'avaluació d'alternatives sobre la xarxa de drenatge i les zones humides generats per l'execució de les infraestructures del delta del Llobregat. Tom 2*.

ACA. (2019). Annex 07 Incidència del canvi climàtic en el risc d'inundació. In *Revisió i actualització de l'avaluació preliminar del risc d'inundació del districte de conca fluvial de Catalunya (2n cicle)* (pp. 1–52).

Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, *16*(3), 268–281. https://doi.org/10.1016/j.gloenvcha.2006.02.006

Adger, W. N., Barnett, J., Chapin, F. S., & Ellemor, H. (2011). This must be the place: Underrepresentation of identity and meaning in climate change decision-making. In *Global Environmental Politics* (Vol. 11, Issue 2, pp. 1–25). https://doi.org/10.1162/GLEP_a_00051

Adger, W. N., Brown, I., & Surminski, S. (2018). Advances in risk assessment for climate change adaptation policy. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *376*(2121), 1–13. https://doi.org/10.1098/rsta.2018.0106

Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D. R., Naess, L. O., Wolf, J., & Wreford, A. (2009). Are there social limits to adaptation to climate change? *Climatic Change*, *93*(3–4), 335–354. https://doi.org/10.1007/s10584-008-9520-z

Adger, W. N., & Vincent, K. (2005). Uncertainty in adaptive capacity. *Comptes Rendus - Geoscience*, *337*(4), 399–410. https://doi.org/10.1016/j.crte.2004.11.004

Ahmed, S. (2014). The cultural politics of emotion: Second edition. In *The Cultural Politics of Emotion: Second Edition*.

Albaladejo, M. J. (2015). La preservació del medi natural en un context metropolità. *Materials Del Baix Llobregat*, *21*, 53–57.

Allan, C. (2023). Helping scientists reflect on their relationship with rivers via frames. *River Research and Applications*, *May*, 1–9. https://doi.org/10.1002/rra.4154

AMB. (2015a). *Pla local d'adaptació al canvi climàtic del Prat del Llobregat (PLACC 2016-2020)*. Direcció de Serveis Ambientals de l'AMB. https://www.elprat.cat/sites/default/files/documentos_descargables/3_4_3_pla_adaptacio_canviclimatic_prat_0.pdf

AMB. (2015b). *Pla local d'adaptació al canvi climàtic Viladecans (PLACC 2016-2020)*. Direcció de Serveis Ambientals de l'AMB. https://seuelectronica.viladecans.cat/images/documents/plans/PACCViladecans.pdf

AMB. (2018). *Pla d'adaptació al canvi climàtic de Gavà (2020-2030)*. https://www.gavaciutat.cat/documents/20142/0/PLACC+GAVA+2019-30.pdf/617f1856-87b5-e90f-17c8-94a21d20901a

Amores, A., Marcos, M., Carrió, Di. S., & Gomez-Pujol, L. (2020). Coastal impacts of Storm Gloria (January 2020) over the north-western Mediterranean. *Natural Hazards and Earth System Sciences*, *20*(7), 1955–1968. https://doi.org/10.5194/NHESS-20-1955-2020

Anguelovski, I., & Carmin, J. A. (2011). Something borrowed, everything new: innovation and institutionalization in urban climate governance. *Current Opinion in Environmental Sustainability*, *3*(3), 169–175. https://doi.org/10.1016/J.COSUST.2010.12.017

Anselme, B., Durand, P., Thomas, Y. F., & Nicolae-Lerma, A. (2011). Storm extreme levels and coastal flood hazards: A parametric approach on the French coast of Languedoc (district of Leucate). *Comptes Rendus Geoscience*, *343*(10), 677–690. https://doi.org/10.1016/J.CRTE.2011.07.006

Arendt, H. (1958). *The Human Condition*. University of Chicago Press.

Argyris, C., & Schön, D. A. (1978). *Organizational Learning: A Theory of Action Perspective*. Addison-Wesley.

Armitage, D., Berkes, F., Dale, A., Kocho-Schellenberg, E., & Patton, E. (2011). Co-management and the co-production of knowledge: Learning to adapt in Canada's Arctic. *Global Environmental Change*, *21*(3), 995–1004. https://doi.org/10.1016/J.GLOENVCHA.2011.04.006

Armitage, D., & Plummer, R. (2010). Adapting and Transforming: Governance for Navigating

Change. In D. Armitage & R. Plummer (Eds.), *Adaptive Capacity and Environmental Governance* (pp. 287–302). Springer Series on Environmental Management. https://doi.org/10.1007/978-3-642-12194-4_14

Asplund, T. (2011). Metaphors in climate discourse: An analysis of Swedish farm magazines. *Journal of Science Communication*, *10*(4). https://doi.org/10.22323/2.10040201

Baker, I., Peterson, A., Brown, G., & McAlpine, C. (2012). Local government response to the impacts of climate change: An evaluation of local climate adaptation plans. *Landscape and Urban Planning*. https://doi.org/10.1016/j.landurbplan.2012.05.009

Ballesteros, C., Jiménez, J. A., & Viavattene, C. (2018). A multi-component flood risk assessment in the Maresme coast (NW Mediterranean). *Natural Hazards*, *90*(1), 265–292. https://doi.org/10.1007/S11069-017-3042-9/FIGURES/10

Banathy, B. (1991). *Systems design of education*. Educational Technology Publications.

Banchini, S., Chelleri, L., Trujillo, A. J., & Breton, F. (2009). New Directions in Beach Management in the Barcelona Metropolitan Area Coastal Systems (Catalonia, Spain). In *Beach management. Principles & practice* (pp. 349–357). Earthscan, London.

Barnard, P. L., Erikson, L. H., Foxgrover, A. C., Hart, J. A. F., Limber, P., O'Neill, A. C., van Ormondt, M., Vitousek, S., Wood, N., Hayden, M. K., & Jones, J. M. (2019). Dynamic flood modeling essential to assess the coastal impacts of climate change. *Scientific Reports 2019 9:1*, *9*(1), 1–13. https://doi.org/10.1038/s41598-019-40742-z

Barreteau, O. (2003). Our companion modelling approach. In *JASSS* (Vol. 6, Issue 2).

Barriendos, M., Gil-Guirado, S., Pino, D., Tuset, J., Pérez-Morales, A., Alberola, A., Costa, J., Balasch, J. C., Castelltort, X., Mazón, J., & Ruiz-Bellet, J. L. (2019). Climatic and social factors behind the Spanish Mediterranean flood event chronologies from documentary sources (14th–20th centuries). *Global and Planetary Change*, *182*, 102997. https://doi.org/10.1016/J.GLOPLACHA.2019.102997

Bartunek, J. M., & Moch, M. K. (1987). First-Order, Second-Order, and Third-Order Change and Organization Development Interventions: A Cognitive Approach. *The Journal of Applied Behavioral Science*, *23*(4), 483–500. https://doi.org/10.1177/002188638702300404

Bateson, G. (1972). The Logical Categories of Learning and Communication. *Steps to an Ecology of Mind,* 279–308.

Bawden, R. (1997). Leadership for Systemic Development. In Center for Systemic Development (Ed.), *Resource Manual for Leadership and Change*. University of Western Sydney.

Beck, U. (1992). *Risk society. Towards a New Modernity*. Sage Publications Ltd.

Benages-Albert, M., Di Masso, A., Porcel, S., Pol, E., & Vall-Casas, P. (2015). Revisiting the appropriation of space in metropolitan river corridors. *Journal of Environmental Psychology*, *42*, 1–15. https://doi.org/10.1016/J.JENVP.2015.01.002

Béné, C., Headey, D., Haddad, L., & von Grebmer, K. (2016). Is resilience a useful concept in the context of food security and nutrition programmes? Some conceptual and practical considerations. *Food Security*, *8*(1), 123–138. https://doi.org/10.1007/s12571-015-0526-x

Benedict, M. A., & McMahon, E. T. (2012). *Green infrastructure: linking landscapes and communities*. Island Press.

Berchon, A., & Bousquet, F. (2021). *Théâtre-forum de la complexité. En mouvement, entre soi et le monde*. Editions Chronique Sociale. https://www.decitre.fr/livres/theatre-forum-de-la-complexite-9782367177946.html#resume

Berg, A. L., von Scheve, C., Ural, N. Y., & Walter-Jochum, R. (2019). Reading for affect: A methodological proposal for analyzing affective dynamics in discourse. In A. Kahl (Ed.), *Analyzing Affective Societies: Methods and Methodologies* (pp. 45–62). Routledge.

Berkes, F., Colding, J., & Folke, C. (2003). Navigating Social–Ecological Systems. *Navigating Social-Ecological Systems*, 1–30. https://www.cambridge.org/core/books/navigating-socialecological-systems/95AC131C7A4F5D9259AD4EABDDDE993F

Berroeta, H., Carvalho, L. P. de, & Castillo-Sepúlveda, J. (2021). The place-subjectivity continuum after a disaster: Enquiring into the production of sense of place as an assemblage. In C. M. Raymond, L. C. Manzo, D. R. Williams, A. Di Masso Tarditti, & T. von Wirth (Eds.), *Changing Senses of Place. Navigating global challenges* (pp. 43–52). Cambridge University Press.

Bevacqua, E., Maraun, D., Vousdoukas, M. I., Voukouvalas, E., Vrac, M., Mentaschi, L., & Widmann, M. (2019). Higher probability of compound flooding from precipitation and storm surge in Europe under anthropogenic climate change. *Science Advances*, *5*(9), 1–8. https://doi.org/10.1126/sciadv.aaw5531

Birkmann, J., & Mechler, R. (2015). Advancing climate adaptation and risk management. New

insights, concepts and approaches: what have we learned from the SREX and the AR5 processes? *Climatic Change*, *133*(1), 1–6. https://doi.org/10.1007/S10584-015-1515-Y/METRICS

Blaikie, P. (1995). Changing environments or changing views? A political ecology for developing countries. *Geography*, *80*(348), 203–214. https://www.jstor.org/stable/40572665

BOE. (2005). *Resolución de 5 de mayo de 2000, de la Secreteria General de Medio Ambiente, por la que se formula declaración de impato ambiental sobre el Plan Director del puerto de Barcelona, de la Autoridad Portuaria de Barcelona (2005)*.

Bombana, B., & Ariza, E. (2018). Clarifying some assumptions of coastal management: Analysis of values and uncertainties embedded in beach quality indexes. *Ecological Indicators*, *91*, 376–385. https://doi.org/10.1016/j.ecolind.2018.03.066

Bombana, B., & Ariza, E. (2019). A double-loop process for beach quality index construction: Approaching the complexity of the Catalan coast. *Journal of Environmental Management*, *240*, 177–189. https://doi.org/10.1016/j.jenvman.2019.03.100

Bousquet;, F., Quinn, T., Jankowski, F., Mathevet, R., Barreteau, O., & Dhénain, S. (2022). *Attachement et changement dans un monde en transformation*. Éditions Quae. https://www.quae.com/produit/1697/9782759233496/attachement-et-changement-dans-un-monde-en-transformation

Bousquet, F., Botta, A., Alinovi, L., Barreteau, O., Bossio, D., Brown, K., Caron, P., D'Errico, M., Declerck, F., Dessard, H., Kautsky, E. E., Fabricius, C., Folke, C., Fortmann, L., Hubert, B., Magda, D., Mathevet, R., Norgaard, R. B., Quinlan, A., & Staver, C. (2016). Resilience and development: Mobilizing for transformation. *Ecology and Society*, *21*(3). https://doi.org/10.5751/ES-08754-210340

Bousquet, F., Quinn, T., Therville, C., Mathevet, R., Barreteau, O., Bonté, B., & Guerbois, C. (2021). Social and ecological systems resilience and identity. In M. Ungar (Ed.), *Multisystemic Resilience: Adaptation and Transformation in Contexts of Change* (pp. 705–724). Oxford University Press. https://doi.org/10.1093/oso/9780190095888.003.0037

BR. (2019). *Estratègia Delta del Llobregat*. https://www.bcnregional.com/wp-content/uploads/2019/10/AE01_ESTRATEGIA_DELTA_LLOBREGAT_V1.pdf

Brehm, J. M., Eisenhauer, B. W., & Stedman, R. C. (2013). Environmental Concern: Examining

the Role of Place Meaning and Place Attachment. *Society and Natural Resources*, *26*(5), 522–538. https://doi.org/10.1080/08941920.2012.715726

Breiman, L. (2001). Random Forests. *Machine Learning*, *45*, 5–32.

Bremer, S., & Meisch, S. (2017). Co-production in climate change research: reviewing different perspectives. *Wiley Interdisciplinary Reviews: Climate Change*, *8*(6), e482. https://doi.org/10.1002/WCC.482

Breton, F., Esteban, P., & Miralles, E. (2000). Rehabilitation of metropolitan beaches by local administrations in Catalonia: new trends in sustainable coastal management. *Journal of Coastal Conservation*, *6*(1), 97–106. https://doi.org/10.1007/bf02730473

Breton, F., & Sauri-Pujol, D. (1997). Toward a redefinition of resources and hazards in coastal management: Examples from the lowland coastal areas of catalonia, Spain. *Coastal Management*, *25*(4), 363–385. https://doi.org/10.1080/08920759709362330

Brooks, N. (2003). *Vulnerability, Risk and Adaptation: A Conceptual Framework Climate change and variability in the Sahel View project Climate, Migration and Conflict View project*. https://www.researchgate.net/publication/200032746

Brooks, N., Clarke, J., Ngaruiya, G. W., & Wangui, E. E. (2020). African heritage in a changing climate. *Azania*, *55*(3), 297–328. https://doi.org/10.1080/0067270X.2020.1792177

Brown, G., & Raymond, C. M. (2007). The relationship between place attachment and landscape values: Toward mapping place attachment. *Applied Geography*, *27*(2), 89–111. https://doi.org/10.1016/j.apgeog.2006.11.002

Brown, K., & Westaway, E. (2011). Agency, Capacity, and Resilience to Environmental Change: Lessons from Human Development, Well-Being, and Disasters. *Https://Doi.Org/10.1146/Annurev-Environ-052610-092905*, *36*, 321–342. https://doi.org/10.1146/ANNUREV-ENVIRON-052610-092905

Brugnach, M., Dewulf, A., Pahl-Wostl, C., & Taillieu, T. (2008). Toward a relational concept of uncertainty: About knowing too little, knowing too differently, and accepting not to know. *Ecology and Society*. https://doi.org/10.5751/ES-02616-130230

Cadoret, A. (2017). L'attachement aux lieux dans les conflits liés à l'environnement sur le littoral : une ressource pour leur régulation. *VertigO*, *Volume 17 Numéro 1*. https://doi.org/10.4000/vertigo.18436

CADS. (2021). *Un litoral al límit. Recomenacions per a una gestió integrada de la costa catalana*. Generalitat de Catalunya. moz-extension://4a73bf45-a2be-4f0f-a2cb-fa27832bcb0c/enhanced-reader.html?openApp&pdf=http%3A%2F%2Fcads.gencat.cat%2Fweb%2F.content%2FDocuments%2FInformes%2F2021%2Finforme-Un-Litoral-al-Limit.pdf

Cameron, L. (2016). Using metaphor for peace-building, empathy, and reconciliation. In *The Routledge handbook of metaphor and language* (pp. 426–442).

Cameron, L., & Larsen-Freeman, D. (2007). Complex systems and applied linguistics. *International Journal of Applied Linguistics*, *17*(2), 226–240. https://doi.org/10.1111/j.1473-4192.2007.00148.x

Cameron, L., Maslen, R., Todd, Z., Maule, J., Stratton, P., & Stanley, N. (2009). The discourse dynamics approach to metaphhor and metaphor-led discourse analysis. In *Metaphor and Symbol* (Vol. 24, Issue 2). https://doi.org/10.1080/10926480902830821

Campmany, J. (2009). L'abocador del Garraf i el desviament del Llobregat, dos projectes clau en el naixement de la consciència ecologista. *Materials Del Baix Llobregat*, *2009*(15), 19–29.

Capmany, J. (2009). L'abocador de Gavà i el desviament del Llobregat, dos projectes clau en el naixement de la consciència ecologista. *Materials Del Baix Llobregat*, *15*, 19–29.

Cardona, O. D., Van Aalst, M. K., Birkmann, J., Fordham, M., Mc Gregor, G., Rosa, P., Pulwarty, R. S., Schipper, E. L. F., Sinh, B. T., Décamps, H., Keim, M., Davis, I., Ebi, K. L., Lavell, A., Mechler, R., Murray, V., Pelling, M., Pohl, J., Smith, A. O., & Thomalla, F. (2012). Determinants of risk: Exposure and vulnerability. In *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change* (Vol. 9781107025, pp. 65–108). Australia. https://doi.org/10.1017/CBO9781139177245.005

Carrera, J., Vàzques-Suñé, E., Abarca, E., Capino, B., Gàmez, D., Simó, A., Niñerola, J. M., & Queralt, E. (2004). Les aigües subterrànies del Baix Llobregat. In Narcís Prat & E. Tello (Eds.), *El Baix Llobregat història i actualitat ambiental d'un riu* (pp. 72–89). Centre d'Estudis Comarcals del Baix Llobregat.

Carrozza, C. (2015). Democratizing Expertise and Environmental Governance: Different Approaches to the Politics of Science and their Relevance for Policy Analysis.

Http://Dx.Doi.Org/10.1080/1523908X.2014.914894, *17*(1), 108–126. https://doi.org/10.1080/1523908X.2014.914894

Casellas, A. (2010). La geografía crítica y el discurso de la sostenibilidad . Perspectivas y acciones. *Documents d'anàlisi Geogràfica*, *56*(3), 573–581. https://raco.cat/index.php/DocumentsAnalisi/article/view/224987

Cash, D., & Clark, W. C. (2001). From Science to Policy: Assessing the Assessment Process. In *John F. Kennedy School of Government, Harvard University, Faculty Research Working Paper Services, RWP01–045*. https://doi.org/10.2139/ssrn.295570

Cash, D. W., & Moser, S. C. (2000). Linking global and local scales: Designing dynamic assessment and management processes. *Global Environmental Change*. https://doi.org/10.1016/S0959-3780(00)00017-0

Centemeri, L. (2015). L'apport d'une sociologie des attachements pour penser la catastrophe environnementale. *Hal*. https://hal.science/hal-01163221

Chapin, F. S., & Knapp, C. N. (2015). Sense of place: A process for identifying and negotiating potentially contested visions of sustainability. *Environmental Science and Policy*, *53*, 38–46. https://doi.org/10.1016/j.envsci.2015.04.012

Chateau, Z., Devine-Wright, P., & Wills, J. (2021). Integrating sociotechnical and spatial imaginaries in researching energy futures. *Energy Research and Social Science*, *80*(January). https://doi.org/10.1016/j.erss.2021.102207

Chuvieco, E. (2010). *Teledetección ambiental: La observación de la tierra desde el espacio* (3ra ed.). Ariel Ciencias.

Cinner, J. E., Adger, W. N., Allison, E. H., Barnes, M. L., Brown, K., Cohen, P. J., Gelcich, S., Hicks, C. C., Hughes, T. P., Lau, J., Marshall, N. A., & Morrison, T. H. (2018). Building adaptive capacity to climate change in tropical coastal communities. *Nature Climate Change*, *8*(2), 117–123. https://doi.org/10.1038/s41558-017-0065-x

Clark, W. C., & Majone, G. (1985). The Critical Appraisal of Scientific Inquiries with Policy Implications. *Science, Technology & Human Values*. https://doi.org/10.1177/016224398501000302

Codina, J. (1966). *Delta del Llobregat. La gent del fang. El Prat: 965-1965* (Montblanc). https://books.google.es/books/about/Delta_del_Llobregat.html?id=YsRVGQAACAAJ&red

ir_esc=y

Codina, J. (1971). *Inundacions al delta del LLobregat (Flooding at the Llobregat delta)*. R. Dalmau.

Conde, F. C., & De Mata Muñoz, M. (2019). Flood monitoring based on the study of Sentinel-1 SAR images: The Ebro River case study. *Water (Switzerland)*, *11*(12), 2454. https://doi.org/10.3390/w11122454

Cote, M., & Nightingale, A. J. (2012). Resilience thinking meets social theory: Situating social change in socio-ecological systems (SES) research. *Progress in Human Geography*, *36*(4), 475–489. https://doi.org/10.1177/0309132511425708

Craye, M. (2006). Reflexively dealing with uncertainty and complexity in policy-related knowledge: What can it Mean? In *In Interfaces between science and society* (pp. 54–63). Routledge.

Cresswell, T. (2005). *Place: a short introduction*. Blackwell.

Cuadll. (2020). *Evolució del nivell d'aigua dela Murtra durant el temporal Glòria* (p. 2).

Daré, W., Hassenforder, E., & Dray, A. (2021). Observation manual for collective serious games. In *Observation manual for collective serious games*. https://doi.org/10.19182/agritrop/00144

Davenport, M. A., & Anderson, D. H. (2005). Getting from sense of place to place-based management: An interpretive investigation of place meanings and perceptions of landscape change. *Society and Natural Resources*, *18*(7), 625–641. https://doi.org/10.1080/08941920590959613

Day, J. W., Post, D., Hensel, P. F., & Ibanez, C. (1995). Impacts of sea-level rise on Deltas in the Gulf of México and Mediterranean. *Estuaries*, *18*(4), 636–647.

De Roa, E., & Esteban, P. (2018). Els reptes actuals i futurs per a la conservació de la biodiversitat en el delta del Llobregat. In J. Germain i Otzet & J. Pino i Vilalta (Eds.), *Els sistemes naturals del delta del Llobregat* (pp. 679–689). Institut d'Estudis Catalans.

Deffontaines, P. (1949). Le delta du Llobregat. Étude de géographie humaine. *Revue Géographique Des Pyrénées et Du Sud-Ouest. Sud-Ouest Européen*, *20*(3), 137–174. https://doi.org/10.3406/RGPSO.1949.1258

Deleuze, G., & Guattari., F. (1988). *A thousand plateaus: Capitalism and schizophrenia* (Bloomsbury).

Dessai, S., & Hulme, M. (2004). Does climate adaptation policy need probabilities? *Climate Policy*, *4*(2), 107–128. https://doi.org/10.1080/14693062.2004.9685515

Dessai, S., O'Brien, K., & Hulme, M. (2007). Editorial: On uncertainty and climate change. In *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2006.12.001

Dessai, S., & van der Sluijs, J. (2007). *Uncertainty and climate change adaptation: A scoping study*. Copernicus Institute for Sustainable Development and Innovation, Utrecht.

Devine-Wright, P. (2009). Rethinking NIMBYism: The role of place attachment and place identity in explaining place-protective action. *Journal of Community and Applied Social Psychology*, *19*(6), 426–441. https://doi.org/10.1002/casp.1004

Devine-Wright, P. (2013). Think global, act local? The relevance of place attachments and place identities in a climate changed world. *Global Environmental Change*, *23*(1), 61–69. https://doi.org/10.1016/j.gloenvcha.2012.08.003

Devine-Wright, P., & Quinn, T. (2020). Dynamics of place attachment in a climate changed world. In *Place Attachment* (pp. 226–242). Routledge. https://doi.org/10.4324/9780429274442-14

Di Masso, A., & Dixon, J. (2015). More Than Words: Place, Discourse and the Struggle over Public Space in Barcelona. *Qualitative Research in Psychology*, *12*(1), 45–60. https://doi.org/10.1080/14780887.2014.958387

Di Masso, A., Dixon, J., & Durrheim, K. (2021). Place attachment as discursive practice: The role of language, affect, space, power, and materiality in person-place bonds. In L. C. Manzo & P. Devine-Wright (Eds.), *Place Attachment* (2nd ed., pp. 77–92). Routledge. https://doi.org/10.4324/9780429274442-5

Di Masso, A., Williams, D. R., Raymond, C. M., Buchecker, M., Degenhardt, B., Devine-Wright, P., Hertzog, A., Lewicka, M., Manzo, L., Shahrad, A., Stedman, R., Verbrugge, L., & von Wirth, T. (2019). Between fixities and flows: Navigating place attachments in an increasingly mobile world. *Journal of Environmental Psychology*, *61*, 125–133. https://doi.org/10.1016/j.jenvp.2019.01.006

Di Masso Tarditti, A., Berroeta Torres, H., Pradillo Caimari, C., & Aleu Barnadas, L. (2022).

Gentrificación y desposesión de lugar: Dinámicas subjetivas del desplazamiento simbólico y la micro-segregación. *Anuario de Psicología*, *52*(1). https://doi.org/10.1344/anpsic2022.52/1.33268

Dilling, L., & Lemos, M. C. (2011). Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy. *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2010.11.006

Diputació Barcelona. (2018). *Guia per redactar els Plans d'Acció per l'Energia Sostenible i el Clima a la província de Barcelona*. https://www.diba.cat/documents/102577937/126719106/Metodologia+PAESC_MAIG_18.pdf/b0f51601-1866-4783-a547-e80c828eb20d

Dow, K., Berkhout, F., Preston, B. L., Klein, R. J. T., Midgley, G., & Shaw, M. R. (2013). Limits to adaptation. In *Nature Climate Change* (Vol. 3, Issue 4, pp. 305–307). Nature Publishing Group. https://doi.org/10.1038/nclimate1847

Eakin, H., & Luers, A. L. (2006). Assessing the Vulnerability of Social-Environmental Systems. *Annual Review of Environment and Resources*, *31*(1), 365–394. https://doi.org/10.1146/annurev.energy.30.050504.144352

EC and EEA. (2019). *Urban AST step 0-0 — Climate-ADAPT*. https://climate-adapt.eea.europa.eu/knowledge/tools/urban-ast/step-0-0

El-Zein, A., & Tonmoy, F. N. (2015). Assessment of vulnerability to climate change using a multi-criteria outranking approach with application to heat stress in Sydney. *Ecological Indicators*, *48*, 207–217. https://doi.org/10.1016/j.ecolind.2014.08.012

El-Zein, A., & Tonmoy, F. N. (2017). Nonlinearity, fuzziness and incommensurability in indicator-based assessments of vulnerability to climate change: A new mathematical framework. *Ecological Indicators*, *82*, 82–93. https://doi.org/10.1016/J.ECOLIND.2017.06.034

El Pais, 06/02/2020. (2020). El Gloria aquí pasa un poco cada año. *El Pais*. https://elpais.com/ccaa/2020/02/05/catalunya/1580926953_290651.html

Engle, N. L. (2011). Adaptive capacity and its assessment. *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2011.01.019

Enqvist, J. P., Campbell, L. K., Stedman, R. C., & Svendsen, E. S. (2019). Place meanings on the

urban waterfront: a typology of stewardships. *Sustainability Science*, *14*(3), 589–605. https://doi.org/10.1007/s11625-019-00660-5

Enqvist, J. P., West, S., Masterson, V. A., Haider, L. J., Svedin, U., & Tengö, M. (2018). Stewardship as a boundary object for sustainability research: Linking care, knowledge and agency. In *Landscape and Urban Planning* (Vol. 179, pp. 17–37). Elsevier. https://doi.org/10.1016/j.landurbplan.2018.07.005

Eriksen, S., & Kelly, P. M. (2006). *Mitigation and Adaptation Strategies for Global Change (2007) 12: 495-524 DEVELOPING CREDIBLE VULNERABILITY INDICATORS FOR CLIMATE ADAPTATION POLICY ASSESSMENT*. https://doi.org/10.1007/s11027-006-3460-6

Eriksen, S., Nightingale, A. J., & Eakin, H. (2015). Reframing adaptation: The political nature of climate change adaptation. *Global Environmental Change*, *35*, 523–533. https://doi.org/10.1016/j.gloenvcha.2015.09.014

Eriksen, S., & Selboe, E. (2015). Transforming toward or away from sustainability? How conflicting interests and aspirations influence local adaptation. In K. OBrien & E. Selboe (Eds.), *The Adaptive Challenge of Climate Change* (pp. 118–139). Cambridge University Press. https://doi.org/10.1017/CBO9781139149389.008

ESA. (2022). *Sentinel-1 SAR User Guide*. https://sentinel.esa.int/web/sentinel/user-guides/sentinel-1 1-sar

Escobar, A. (2016). Thinking-feeling with the Earth: Territorial Struggles and the Ontological Dimension of the Epistemologies of the South | Enhanced Reader. *Revista de Antropología Iberoamericana*, *11*(1), 11–32.

Espluga Trenc, J. (2023). Percepcions i metàfores sobre el canvi climàtic. De les narratives mediàtiques desmobilitzadores als moviments socials emergents. *Papers*, *65*(Ciutats enfront l'emergència climàtica: claus per una transició justa), 205–221.

Esteban, P., Fabró, I., & Melero, J. A. (1996). Museu del Prat. In *Centre d'Interpretació del Delta del Llobregat*. Ajuntament del Prat del Llobregat.

Esteban, P., Laredo, S., Pino, J., & Valverde Martínez, A. (2018). El context deltaic: situació, origen geològic i història del poblament humà. In J. Germain i Otzet & J. Pino i Vilalta (Eds.), *Els sistemes naturals del delta del Llobregat* (pp. 27–41).

Estenssoro, F. (2015). The Ecodevelopment as concept precursor of sustainable development

and its influence in Latin America. *Universum*, *30*(1), 81–99. https://doi.org/10.4067/s0718-23762015000100006

European Comission. (2013). *The EU strategy on adaptation on climate change*. http://ec.europa.eu/environment/nature/ecosystems/strategy/index_en.htm

Fagerholm, N., Raymond, C. M., Olafsson, A. S., Brown, G., Rinne, T., Hasanzadeh, K., Broberg, A., & Kyttä, M. (2021). A methodological framework for analysis of participatory mapping data in research, planning, and management. In *International Journal of Geographical Information Science* (Vol. 35, Issue 9, pp. 1848–1875). https://doi.org/10.1080/13658816.2020.1869747

Failing, L., Gregory, R., & Harstone, M. (2007). Integrating science and local knowledge in environmental risk management: A decision-focused approach. *Ecological Economics*, *64*(1), 47–60. https://doi.org/10.1016/J.ECOLECON.2007.03.010

Farrell, K. N. (2010). *Making good decisions well: A theory of collective ecological management*. Shaker Verlag.

Fazey, I., Carmen, E., Chapin, F. S., Ross, H., Rao-Williams, J., Lyon, C., Connon, I. L. C., Searle, B. A., & Knox, K. (2018). Community resilience for a 1.5 °C world. *Current Opinion in Environmental Sustainability*, *31*, 30–40. https://doi.org/10.1016/J.COSUST.2017.12.006

Fazey, I., Moug, P., Allen, S., Beckmann, K., Blackwood, D., Bonaventura, M., Burnett, K., Danson, M., Falconer, R., Gagnon, A. S., Harkness, R., Hodgson, A., Holm, L., Irvine, K. N., Low, R., Lyon, C., Moss, A., Moran, C., Naylor, L., … Wolstenholme, R. (2018). Transformation in a changing climate: a research agenda. In *Climate and Development* (Vol. 10, Issue 3, pp. 197–217). Taylor & Francis. https://doi.org/10.1080/17565529.2017.1301864

Fazey, I., Schäpke, N., Caniglia, G., Patterson, J., Hultman, J., van Mierlo, B., Säwe, F., Wiek, A., Wittmayer, J., Aldunce, P., Al Waer, H., Battacharya, N., Bradbury, H., Carmen, E., Colvin, J., Cvitanovic, C., D'Souza, M., Gopel, M., Goldstein, B., … Wyborn, C. (2018). Ten essentials for action-oriented and second order energy transitions, transformations and climate change research. In *Energy Research and Social Science*. https://doi.org/10.1016/j.erss.2017.11.026

Feola, G. (2015). Societal transformation in response to global environmental change: A review of emerging concepts. *Ambio*, *44*(5), 376–390. https://doi.org/10.1007/S13280-014-

0582-Z/FIGURES/2

Feola, G., Goodman, M. K., Suzunaga, J., & Soler, J. (2023). Collective memories, place-framing and the politics of imaginary futures in sustainability transitions and transformation. *Geoforum*, *138*, 103668. https://doi.org/10.1016/j.geoforum.2022.103668

Ferret, J. (1985). *L'aprofitament de les aigües subterrànies del Delta del Llobregat, 1933-1983*. Comunitat d'usuaris d'aigües de l'àrea oriental del Delta del riu Llobregat.

Festinger, L. (1957). *A Theory of Cognitive Dissonance*. Stanford University Press.

Field, C. B., Barros, V., Stocker, T. F., Dahe, Q., Jon Dokken, D., Ebi, K. L., Mastrandrea, M. D., Mach, K. J., Plattner, G. K., Allen, S. K., Tignor, M., & Midgley, P. M. (2012). Managing the risks of extreme events and disasters to advance climate change adaptation: Special report of the intergovernmental panel on climate change. In *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change* (Vol. 9781107025). https://doi.org/10.1017/CBO9781139177245

Filipponi, F. (2019). Sentinel-1 GRD Preprocessing Workflow. *Proceedings 2019, Vol. 18, Page 11*, *18*(1), 11. https://doi.org/10.3390/ECRS-3-06201

Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, *16*, 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society*, *15*(4). https://doi.org/10.5751/ES-03610-150420

Ford, J. D., Knight, M., & Pearce, T. (2013). Assessing the "usability" of climate change research for decision-making: A case study of the Canadian International Polar Year. *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2013.06.001

Freire Vieira, P. (2009). Do preservacionismo ao desenvolvimento territorial sustentável. *Política & Sociedade*, *8*(14), 27–78. https://doi.org/10.5007/2175-7984.2009v8n14p27

Fresque-Baxter, J. A., & Armitage, D. (2012). Place identity and climate change adaptation: A synthesis and framework for understanding. *Wiley Interdisciplinary Reviews: Climate Change*, *3*(3), 251–266. https://doi.org/10.1002/wcc.164

Funtowicz, S. O., & Ravetz, J. R. (1990). Uncertainty and Quality in Science for Policy. In *Uncertainty and Quality in Science for Policy*. Springer. https://doi.org/https://doi.org/10.1007/978-94-009-0621-1_3

Funtowicz, S. O., & Ravetz, J. R. (1993). The Emergence of Post-Normal Science. In *Science, Politics and Morality* (pp. 85–123). Springer Netherlands. https://doi.org/10.1007/978-94-015-8143-1_6

Füssel, H. M. (2007). Vulnerability: A generally applicable conceptual framework for climate change research. *Global Environmental Change*, *17*(2), 155–167. https://doi.org/10.1016/J.GLOENVCHA.2006.05.002

Gaillard, J. C. (2010). Vulnerability, capacity and resilience: Perspectives for climate and development policy. *Journal of International Development: The Journal of the Development Studies Association*, *22*(2), 218–232.

Galafassi, D., Tàbara, J. D., & Heras, M. (2018). Restoring our senses, restoring the Earth. Fostering imaginative capacities through the arts for envisioning climate transformations. *Elementa*, *6*(2008). https://doi.org/10.1525/elementa.330

Gallopín, G. C. (2002). Planning for resilience: Scenarios, surprises, and branch points. In C. S. Holling & L. Gunderson (Eds.), *Panarchy: understanding transformations in human and natural systems*. Island Press.

Gallopín, G. C. (2006). Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change*, *16*(3), 293–303. https://doi.org/10.1016/j.gloenvcha.2006.02.004

Gancille, J.-M. (2019). *Ne plus se mentir. Petit exercice de lucidité par pemps d'effondrement écologique*. Rue De L´Échiquier.

Garcia-Lozano, C. (2019). *Els sistemes dunars de la costa catalana. Evolució històrica, estat actual i potencial de restauració* [Universitat de Girona]. http://hdl.handle.net/10803/668331

GENCAT. (2017). *Pla de gestió del districte de conca fluvial de Catalunya i Programa de mesures.* http://aca.gencat.cat/web/.content/30_Plans_i_programes/10_Pla_de_gestio/02-2n-cicle-de-planificacio-2016-2021/destacat/01_Document_sintesi_PdG_2ncicle_ca.pdf

Gerber, J. (1997). Beyond dualism - The social construction of nature and the natural and social

construction of human beings. *Progress in Human Geography*, *21*(1), 1–17. https://doi.org/10.1191/030913297671906269

Germain, J. (2018). Iniciatives de conservació del delta del Llobregat. In J. Germain & J. Pino (Eds.), *Els sistemes naturals del delta del Llobregat* (pp. 653–677). Treballs de la Institució Catalana d'Història Natural, 19.

Gerritsen, A. L., Stuiver, M., & Termeer, C. J. A. M. (2013). Knowledge governance: An exploration of principles, impact, and barriers. *Science and Public Policy*, *40*(5), 604–615. https://doi.org/10.1093/scipol/sct012

Gibbons, M., Limoges, C., Nowtony, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. Sage.

Gibson-Graham, J. K. (2011). A feminist project of belonging for the Anthropoce. *Gender, Place and Culture*, *18*(1), 1–21. https://doi.org/10.1080/0966369X.2011.535295

Goffman, E. (1974). *Frame Analysis*. Harper & Row.

Gómez-Inglada, M. (2021). *La formació d'una ciutat. El Prat del Llobregat*. Arxiu municipal del Prat del Llobregat.

González-Hidalgo, M., & Zografos, C. (2017). How sovereignty claims and "negative" emotions influence the process of subject-making: Evidence from a case of conflict over tree plantations from Southern Chile. *Geoforum*, *78*, 61–73. https://doi.org/10.1016/j.geoforum.2016.11.012

Gorostiza, S., Honey-Rosés, J., & Lloret, R. (2015). *Rius de sal*. Edicions del Llobregat. Centre d'Estudis del Baix Llobregat.

Gorostiza, S., & Saurí, D. (2019). Naturalizing pollution: a critical social science view on the link between potash mining and salinization in the Llobregat river basin, northeast Spain. *Philosophical Transactions of the Royal Society B*, *374*(1764). https://doi.org/10.1098/RSTB.2018.0006

Gracia, V., & Calafat, A. (2019). El hemidelta Sur del Llobregat: Un sistema natural controlado por la acción humana The southern lobe of the Llobregat delta: A natural system controlled by human activity. *X Jornadas de Geomorfología Litoral: Libro de Ponencias*, 265–269. https://doi.org/10.20350/digitalCSIC/8956

Graham, S., Barnett, J., Fincher, R., Hurlimann, A., Mortreux, C., & Waters, E. (2013). The social values at risk from sea-level rise. *Environmental Impact Assessment Review*. https://doi.org/10.1016/j.eiar.2013.02.002

Graham, S., Barnett, J., Fincher, R., Mortreux, C., & Hurlimann, A. (2015). Towards fair local outcomes in adaptation to sea-level rise. *Climatic Change*, *130*(3), 411–424. https://doi.org/10.1007/s10584-014-1171-7

Grenni, S., Soini, K., & Horlings, L. G. (2020). The inner dimension of sustainability transformation: how sense of place and values can support sustainable place-shaping. *Sustainability Science*, *15*(2), 411–422. https://doi.org/10.1007/s11625-019-00743-3

Guillén, J. (2008). Els riscos litorals a Catalunya. In J. M. Vilaplana (Ed.), *Informe RISKAT. Els Riscos naturals a Catalunya* (pp. 1–26). Consell Assessor per al Desenvolupament Sostenible. Generalitat de Catalunya. moz-extension://4a73bf45-a2be-4f0f-a2cb-fa27832bcb0c/enhanced-reader.html?openApp&pdf=http%3A%2F%2Fcads.gencat.cat%2Fweb%2F.content%2FDocuments%2FPublicacions%2Fels_riscos_litorals_a_catalunya.pdf

Guillén, J. (2020). Impacte sobre la franja litoral. In E. Berdalet, C. Marrasé, & J. L. Pelegrí (Eds.), *Resum sobre la Formació i Conseqüències de la Borrasca Glòria (19-24 gener 2020)* (pp. 15–24). Institut de Ciències del Mar, CSIC. https://doi.org/10.20350/digitalCSIC/12496.

Gunderson, L., & Holling, C. S. (2002). *Panarchy: Understanding Transformations in Systems of Humans and Nature* (L. Gunderson & C. S. Holling (eds.)). Island Press.

Gurney, G. G., Blythe, J., Helen, A., Adger, W. N., Curnock, M., Faulkner, L., James, T., & Marshall, N. A. (2017). Redefining community based on place attachment in a connected world. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(38), 10077–10082. https://doi.org/10.1073/pnas.1712125114

Guyadeen, D., Thistlethwaite, J., & Henstra, D. (2019). Evaluating the quality of municipal climate change plans in Canada. *Climatic Change*. https://doi.org/10.1007/s10584-018-2312-1

Hackmann, H., Moser, S. C., & St. Clair, A. L. (2014). The social heart of global environmental change. In *Nature Climate Change* (Vol. 4, Issue 8, pp. 653–655). https://doi.org/10.1038/nclimate2320

Haque, M. M., Bremer, S., Aziz, S. Bin, & van der Sluijs, J. (2017). A critical assessment of knowledge quality for climate adaptation in Sylhet Division, Bangladesh. *Climate Risk Management*, *16*, 43–58. https://doi.org/10.1016/j.crm.2016.12.002

Haraway, D. (2016). *Staying with the trouble: Making kin in the Chthulucene*. Duke University Press.

Hardt, M. (2007). Foreword: What Affects Are Good For. In P. T. Clough & J. O. M. Halley (Eds.), *The affective turn: Theorizing the social* (pp. ix–xiv). Duke University Press. https://doi.org/10.1515/9780822389606-002/HTML

Harrison, P. A., Dunford, R. W., Holman, I. P., & Rounsevell, M. D. A. (2016). Climate change impact modelling needs to include cross-sectoral interactions. *Nature Climate Change 2016 6:9*, *6*(9), 885–890. https://doi.org/10.1038/nclimate3039

Harvey, B., Cochrane, L., & Van Epp, M. (2019). Charting knowledge co-production pathways in climate and development. *Environmental Policy and Governance*, *29*(2), 107–117. https://doi.org/10.1002/eet.1834

Harvey, D. (1996). *Justice, Nature and the Geography of Difference.* Blackwell Publishers. http://bibliotecadigital.mineduc.cl//handle/20.500.12365/17640

Height, K., Jefferson, R., & Graham, S. (2023). Obnoxious Plants and Pestiferous Growths: how figurative language reinforces the management of weeds in Victoria, Australia. *Australian Geographer*, *54*(2), 137–154. https://doi.org/10.1080/00049182.2022.2116969

Hernandez, Y., Naumann, G., & Barbosa, P. (2020). Measuring the effectiveness of the Covenant of Mayors on the reporting of climate hazards by Municipalities. *Heliyon*. https://doi.org/10.1016/j.heliyon.2020.e05043

Hestad, D., Tàbara, J. D., & Thornton, T. F. (2021). The role of sustainability-oriented hybrid organisations in the development of transformative capacities: The case of Barcelona. *Cities*, *119*, 103365. https://doi.org/10.1016/J.CITIES.2021.103365

Hill, C., Dunn, F., Haque, A., Nicholls, R. J., Amoako-Johnson, F., Appeaning, A., Raju, P. V., & Addo, K. A. (2020). Hotspots of Present and Future Risk Within Deltas: Hazards, Exposure and Vulnerability. In R. J. Nicholls, W. N. Adger, C. W. Hutton, & S. E. Hanson (Eds.), *Deltas in the Anthropocene*.

Hinkel, J. (2011). " Indicators of vulnerability and adaptive capacity": Towards a clarification of

the science-policy interface. *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2010.08.002

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annu.Rev.Ecol.Syst.*, *4*, 1–23.

Honig, B. (1995). *Feminist Interpretations of Hannah Arendt*. Penn State University Press.

Horlings, L. G., Roep, D., Mathijs, E., & Marsden, T. (2020). Exploring the transformative capacity of place-shaping practices. *Sustainability Science*, *15*(2), 353–362. https://doi.org/10.1007/S11625-020-00787-W/FIGURES/2

Hügel, S., & Davies, A. R. (2020). *Public participation, engagement, and climate change adaptation: A review of the research literature*. https://doi.org/10.1002/wcc.645

Hulme, M. (2008). Geographical work at the boundaries of climate change. *Transactions of the Institute of British Geographers*, *33*(1), 5–11. https://doi.org/10.1111/j.1475-5661.2007.00289.x

Hulme, M. (2010). Problems with making and governing global kinds of knowledge. *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2010.07.005

Ibáñez, C., Alcaraz, C., Caiola, N., Prado, P., Trobajo, R., Benito, X., Day, J. W., Reyes, E., & Syvitski, J. P. M. (2019). Basin-scale land use impacts on world deltas: Human vs natural forcings. *Global and Planetary Change*, *173*, 24–32. https://doi.org/10.1016/j.gloplacha.2018.12.003

ICC. (2010). *Llibre Verd: Estat de la zona costanera a Catalunya*. https://territori.gencat.cat/ca/01_departament/documentacio/territori-i-urbanisme/ordenacio_territorial/llibre_verd_estat_de_la_zona_costanera/

ICGC. (2020). *Efectes temporal Gloria Delta de l'Ebre*. https://betaserver.icgc.cat/delta/#11.18/40.7102/0.681

IHCantabria. (2020). *Elaboración de la metodología y bases de datos para la proyección de impactos de cambio climático a lo largo de la costa española*. https://www.miteco.gob.es/es/costas/temas/proteccion-costa/tarea_4_pima_adapta_mapama_digitalweb-comprimido_tcm30-523734.pdf

Ingalls, M. L., Kohout, A., & Stedman, R. C. (2019). When places collide: power, conflict and meaning at Malheur. *Sustainability Science*, *14*(3), 625–638.

https://doi.org/10.1007/s11625-019-00689-6

IPCC. (2012). Managing the risks of extreme events and disasters to advance climate change adaptation: Special report of the intergovernmental panel on climate change. In C. B. Field, V. Barros, T. F. Stocker, Q. Dahe, D. Jon Dokken, K. L. Ebi, M. D. Mastrandrea, K. J. Mach, G. K. Plattner, S. K. Allen, M. Tignor, & P. M. Midgley (Eds.), *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change* (Vol. 9781107025). Cambridge University Press. https://doi.org/10.1017/CBO9781139177245

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (eds.)). Cambridge University Press. https://doi.org/doi:10.1017/9781009325844.

Irwin, A. (2021). Risk, science and public communication: Third-order thinking about scientific culture. In *Routledge Handbook of Public Communication of Science and Technology* (3rd Editio, pp. 147–162). Taylor and Francis. https://doi.org/10.4324/9781003039242-9

Ison, R., Röling, N., & Watson, D. (2007). Challenges to science and society in the sustainable management and use of water: investigating the role of social learning. *Environmental Science and Policy*, *10*(6), 499–511. https://doi.org/10.1016/j.envsci.2007.02.008

Jasanoff, S. (2004). *States of Knowledge: The Co-Production of Science and Social Order*. Routledge.

Jasanoff, S. (2015). Science and technology studies. In *Research Handbook on Climate Governance* (pp. 36–48). Edward Elgar Publishing Ltd.

Joint Research Centre. (2018). How to develop a Sustainable Energy and Climate Action Plan (SECAP)' - Baseline Emission Inventory (BEI) and Risk and Vulnerability Assessment (RVA). In *Publication Office of the European Union …*. https://doi.org/10.2760/118857

Jones, R. N., & Preston, B. L. (2011). Adaptation and risk management. *Wiley Interdisciplinary Reviews: Climate Change*, *2*(2), 296–308. https://doi.org/10.1002/wcc.97

Kelly, P. M., & Adger, W. N. (2000). Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climatic Change*, *47*(4), 325–352.

https://doi.org/10.1023/A:1005627828199

Kern, K. (2019). Cities as leaders in EU multilevel climate governance: embedded upscaling of local experiments in Europe. *Environmental Politics*, *28*(1), 125–145. https://doi.org/10.1080/09644016.2019.1521979

Kettle, N. P., Dow, K., Tuler, S., Webler, T., Whitehead, J., & Miller, K. M. (2014). Integrating scientific and local knowledge to inform risk-based management approaches for climate adaptation. *Climate Risk Management*. https://doi.org/10.1016/j.crm.2014.07.001

Kirchhoff, C. J., Lemos, M. C., & Dessai, S. (2013). Actionable knowledge for environmental decision making: Broadening the usability of climate science. *Annual Review of Environment and Resources*. https://doi.org/10.1146/annurev-environ-022112-112828

Kønig, N., Børsen, T., & Emmeche, C. (2017). The ethos of post-normal science. *Futures*, *91*, 12–24. https://doi.org/10.1016/j.futures.2016.12.004

Köpsel, V. (2018). *New Spaces for Climate Change: The Societal Construction of Landscapes in Times of a Changing Climate*. Springer.

Köpsel, V., & Walsh, C. (2018). "Coastal landscapes for whom? Adaptation challenges and landscape management in Cornwall." *Marine Policy*, *97*(June), 278–286. https://doi.org/10.1016/j.marpol.2018.05.029

Köpsel, V., Walsh, C., & Leyshon, C. (2017). Landscape narratives in practice: implications for climate change adaptation. *Geographical Journal*, *183*(2), 175–186. https://doi.org/10.1111/geoj.12203

Kovacic, Z. (2015). *Complexity theory in quality assessment: Case studies in sustainability science for governance* [Universitat Autònoma de Barcelona]. https://dialnet.unirioja.es/servlet/tesis?codigo=117467&info=resumen&idioma=SPA

Kovacic, Z. (2017). Investigating science for governance through the lenses of complexity. *Futures*, *91*, 80–83. https://doi.org/10.1016/j.futures.2017.01.007

Krauß, W., & Bremer, S. (2020). The role of place-based narratives of change in climate risk governance. *Climate Risk Management*. https://doi.org/10.1016/j.crm.2020.100221

Kunreuther, H., Gupta, S., Bosetti, V., Böttcher Austria, H., Cullen, H., Jasanoff, S., Elgizouli, I., Linnerooth-Bayer, J., Gupta, S., Bosetti, V., Cooke, R., Dutt, V., Ha-Duong, M., Held, H.,

Llanes-Regueiro, J., Patt, A., Shittu, E., Pichs-Madruga, R., Sokona, Y., … Minx, J. (2014). Integrated Risk and Uncertainty Assessment of Climate Change Response Policies. In O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel, J. C. Minx, & T. Z. and J. C. M. C. von Stechow (Eds.), *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Lakoff, G. (1993). The contemporary theory of metaphor. In A. Ortony (Ed.), *Metaphor and Thought* (2nd ed.). Cambridge University Press.

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. University of Chicago.

Larson, B. M. H. (2008). Entangled biological, cultural and linguistic origins of the war on invasive species. *Body, Language and Mind*, *2*, 169–196. https://doi.org/10.1515/9783110199116.2.169

Latour, B. (2004). Why has critique run out of steam? From matters of fact to matters of concern. *Critical Inquiry*, *30*(2), 225–248. https://doi.org/10.1086/421123

LaVanguardia. (2021). Pacto para ampliar el aeropuerto. *La Vanguardia*. https://www.lavanguardia.com/opinion/20210509/7439875/pacto-ampliar-aeropuerto.html

Lavola. (2014). *Programa municipal d'adaptació al canvi climàtic de Castelldefels*. https://www.seu-e.cat/documents/8627323/0/PACCC/92cae4e9-d4d8-4f45-b5ef-5e6d2df2bdd6

Lefebvre, H. (1991). *The producyion of space*. Blackwell.

Leichenko, R., Mcdermott, M., Bezborodko, E., Brady, M., & Namendorf, E. (2014). *Economic Vulnerability to Climate Change in Coastal New Jersey: A Stakeholder-Based Assessment*. https://doi.org/10.1142/S2345737614500031

Leichenko, R., & O'Brien, K. (2008). Environmental Change and Globalization: Double Exposures. In *Environmental Change and Globalization: Double Exposures*. https://doi.org/10.1093/acprof:oso/9780195177329.001.0001

Leichenko, R., & O'Brien, K. (2019). *Climate and society: transforming the future*. Poity press. https://www.wiley.com/en-us/Climate+and+Society%3A+Transforming+the+Future+-p-

9780745684383

Lemos, M. C., Kirchhoff, C. J., & Ramprasad, V. (2012). Narrowing the climate information usability gap. In *Nature Climate Change*. https://doi.org/10.1038/nclimate1614

Lemos, M. C., & Morehouse, B. J. (2005). The co-production of science and policy in integrated climate assessments. *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2004.09.004

Lenton, T. M. (2013). Environmental Tipping Points. *Https://Doi.Org/10.1146/Annurev-Environ-102511-084654*, *38*, 1–29. https://doi.org/10.1146/ANNUREV-ENVIRON-102511-084654

Lewicka, M. (2011). Place attachment: How far have we come in the last 40 years? *Journal of Environmental Psychology*, *31*(3), 207–230. https://doi.org/10.1016/j.jenvp.2010.10.001

Linnér, B. O., & Wibeck, V. (2019). Sustainability transformations: Agents and drivers across societies. In *Sustainability Transformations: Agents and Drivers across Societies*. https://doi.org/10.1017/9781108766975

Lippard, L. (1997). The Lure of the Local: Sense of Place in a Multicultural Society. *The New Press*.

Llausàs, A., Ribas Palom, A., Ricart, S., & Pavón, D. (2019). Los regadíos históricos como infraestructura verde periurbana: de la degradación a la revalorización. El Baix Ter como caso de estudio. *XXVI Congreso de La Asociación Española de Geografía. Crisis y Espacios de Oportunidad. Retos Para La Geografía.*

Lloret, R. (2004). La qualitat de l'aigua del riu Llobregat. Un factor limitant del passat, un element calu per al futur. In Narcís Prat & E. Tello (Eds.), *El Baix Llobregat història i actualitat ambiental d'un riu* (pp. 92–141). Centre d'Estudis Comarcals del Baix Llobregat.

Locatelli, B., Aldunce, P., Fallot, A., Le Coq, J. F., Sabourin, E., & Tapasco, J. (2017). Research on climate change policies and rural development in Latin America: Scope and gaps. *Sustainability (Switzerland)*, *9*(10), 1–17. https://doi.org/10.3390/su9101831

López-Bustins, J. A., & Martín-Vide, J. (2020). Causes meteorològiques i contextualització climàtica de la precipitació del temporal Glòria. *Treballs de La Societat Catalana de Geografia*, *89*, 39–54. https://doi.org/10.2436/20.3002.01.190

López-Marrero, T., & Yarnal, B. (2010). Putting adaptive capacity into the context of people's

lives: A case study of two flood-prone communities in Puerto Rico. *Natural Hazards*, *52*(2), 277–297. https://doi.org/10.1007/s11069-009-9370-7

Lövbrand, E., Beck, S., Chilvers, J., Forsyth, T., Hedrén, J., Hulme, M., Lidskog, R., & Vasileiadou, E. (2015). Who speaks for the future of Earth? How critical social science can extend the conversation on the Anthropocene. *Global Environmental Change*, *32*(2), 211–218. https://doi.org/10.1016/j.gloenvcha.2015.03.012

Maiese, M. (2017). Transformative Learning, Enactivism, and Affectivity. *Studies in Philosophy and Education*, *36*(2), 197–216. https://doi.org/10.1007/S11217-015-9506-Z/METRICS

Mangat, R., & Dalby, S. (2018). Climate and wartalk: Metaphors, imagination, transformation. *Elementa*, *6*. https://doi.org/10.1525/elementa.313

Manzo, L. C. (2005). For better or worse: Exploring multiple dimensions of place meaning. *Journal of Environmental Psychology*, *25*(1), 67–86. https://doi.org/10.1016/j.jenvp.2005.01.002

Manzo, L. C., & Devine-Wright, P. (2021). *Place Attachment: Advances in Theory, Methods and Applications - Google Llibres* (2nd ed.). Routledge. https://books.google.es/books?hl=ca&lr=&id=KBMHEAAAQBAJ&oi=fnd&pg=PP1&ots=JGbPQLIp1p&sig=qS7Ky5Bbd_K8V21K_K9vXN1yc0k#v=onepage&q&f=false

Marcé, R., Honey-Rosés, J., Manzano, A., Moragas, L., Catllar, B., & Sabater, S. (2012). The Llobregat River Basin: A Paradigm of Impaired Rivers Under Climate Change Threats. In S. Sabater, A. Ginebreda, & D. Barceló (Eds.), *The Llobregat: The Story of a Polluted Mediterranean River*. Handbook of Environmental Chemistry. https://doi.org/10.1007/698_2012_152

Marqués, M. A. (1984). *Les formacions quaternàries del delta del Llobregat* (I. d'Estudis Catalans (ed.)).

Marshall, N. A., Park, S. E., Adger, W. N., Brown, K., & Howden, S. M. (2012). Transformational capacity and the influence of place and identity. *Environmental Research Letters*, *7*(3), 034022. https://doi.org/10.1088/1748-9326/7/3/034022

Martín-Vide, J. P., Prats-Puntí, A., & Ferrer-Boix, C. (2020). What controls the coarse sediment yield to a Mediterranean delta? The case of the Llobregat River (NE Iberian Peninsula). *Natural Hazards and Earth System Sciences*, *20*(12), 3315–3331.

https://doi.org/10.5194/NHESS-20-3315-2020

Martin, D. G. (2003). “Place-framing” as place-making: Constituting a neighborhood for organizing and activism. *Annals of the Association of American Geographers*, *93*(3), 730–750. https://doi.org/10.1111/1467-8306.9303011

Marull, J., Larota-aguilera, M. J., & Pino, J. (2022). Reptes i oportunitats de la infraestructura verda metropolitana en el context de la crisi socioecològica actual. *Papers: Regió Metropolitana de Barcelona: Territori, Estratègies, Planejament, 68*, 10–13.

Massey, D. (2005). *For Space*. Routledge.

Massey, D. (2013). *Space, Place, and Gender*. John Wiley & Sons.

Masterson, V. A., Stedman, R. C., Enqvist, J., Tengö, M., Giusti, M., Wahl, D., & Svedin, U. (2017). The contribution of sense of place to social-ecological systems research: A review and research agenda. *Ecology and Society*, *22*(1). https://doi.org/10.5751/ES-08872-220149

Masterson, V. A., Tengö, M., & Spierenburg, M. (2017). Competing Place Meanings in Complex Landscapes: A Social–Ecological Approach to Unpacking Community Conservation Outcomes on the Wild Coast, South Africa. *Society and Natural Resources*, *30*(12), 1442–1457. https://doi.org/10.1080/08941920.2017.1347975

Mateu, J. (1990, June). Vertidos clandestinos de residuos en el Prat. *El Delta, 135*, 19.

Mathevet, R., & Bousquet, F. (2014). *Résilience & environnment. Penser les changements socio-écologiques*. Buchet Chastel.

Mathevet, R., Bousquet, F., & Raymond, C. M. (2018). The concept of stewardship in sustainability science and conservation biology. *Biological Conservation*, *217*, 363–370. https://doi.org/10.1016/j.biocon.2017.10.015

Maxim, L., & van der Sluijs, J. (2011). Quality in environmental science for policy: Assessing uncertainty as a component of policy analysis. *Environmental Science and Policy*, *14*(4), 482–492. https://doi.org/10.1016/j.envsci.2011.01.003

Mayors Adapt. (2014). *Mayors Adapt. The Covenant of Mayors Initiative on Adaptation to Climate Change*. https://climate-adapt.eea.europa.eu/metadata/portals/mayors-adapt-the-covenant-of-mayors-initiative-on-adaptation-to-climate-change

McManus, S. (2011). Hope, Fear, and the Politics of Affective Agency. *Theory & Event*, *14*(4). https://doi.org/10.1353/tae.2011.0060

Measham, T. G., Preston, B. L., Smith, T. F., Brooke, C., Gorddard, R., Withycombe, G., & Morrison, C. (2011). Adapting to climate change through local municipal planning: Barriers and challenges. *Mitigation and Adaptation Strategies for Global Change*, *16*(8), 889–909. https://doi.org/10.1007/s11027-011-9301-2

MedECC. (2020). *Climate and Environmental Change in the Mediterranean basin. Current situation and risks for the future. First Mediterranean Assessment Report* (W. Cramer, J. Guiot, & K. Marini (eds.)). moz-extension://4a73bf45-a2be-4f0f-a2cb-fa27832bcb0c/enhanced-reader.html?openApp&pdf=https%3A%2F%2Fwww.medecc.org%2Fwp-content%2Fuploads%2F2021%2F05%2FMedECC_MAR1_complete.pdf

Melica, G., Bertoldi, P., Kona, A., Iancu, A., Rivas, S., & Zancanella, P. (2018). Multilevel governance of sustainable energy policies: The role of regions and provinces to support the participation of small local authorities in the Covenant of Mayors. *Sustainable Cities and Society*. https://doi.org/10.1016/j.scs.2018.01.013

Mendoza, E., Jimenez, J., & Mateo, J. (2011). A coastal storms intensity scale for the Catalan sea (NW Mediterranean). *Natural Hazards and Earth System Science*, *11*(9), 2453–2462. https://doi.org/10.5194/nhess-11-2453-2011

Mendoza, E. T., & Jiménez, J. A. (2005). Factors controlling vulnerability to storm impacts along the Catalonian coast. *29th International Conference on Coastal Engineering*, 3087–3099. https://doi.org/10.1142/9789812701916_0249

Meo, B., Graham, S., Ariza, E., Casellas, A., & Delfino, D. (2021). The resident and visitor gaze: A comparison of coastal social values at risk due to sea-level rise. *Environmental Science & Policy*, *123*, 202–209. https://doi.org/10.1016/J.ENVSCI.2021.05.017

Mihaylov, N. L., Perkins, D. D., & Stedman, R. C. (2020). Community responses to environmental threat: Place cognition, attachment, and social action. In L. C. Manzo & P. Devine-Wright (Eds.), *Place Attachment. Advances in theory, methods and applications* (2nd ed., pp. 160–176). Routledge. https://doi.org/10.4324/9780429274442-10

Milagro, J. M. (1989). Per una raó diferent a la de 1891, després d'un segle, el Llobregat quedarà desviat: de la necessitat de sanejament del delta, a l'ampliació del port de

Barcelona. *Espais: Revista Del Departament de Política Territorial i Obres Públiques*, 13–20. https://raco.cat/index.php/Espais/article/view/91230

Millard-Ball, A. (2013). The Limits to Planning: Causal Impacts of City Climate Action Plans. *Journal of Planning Education and Research*. https://doi.org/10.1177/0739456X12449742

Mitrofanenko, T., Snajdr, J., Muhar, A., Penker, M., & Schauppenlehner-Kloyber, E. (2018). Biosphere Reserve for All: Potentials for Involving Underrepresented Age Groups in the Development of a Biosphere Reserve through Intergenerational Practice. *Environmental Management*. https://doi.org/10.1007/s00267-018-1059-9

Montasell i Dorda, J. (2006). Els espais agraris de la regió metropolitanan de Barcelona. *L'Atzavara*, *14*, 73–89.

Moore, J. W. (2016). Introduction. Anthropocene or capitalocene. Nature, history and the crisis of capitalism. In *Anthropocene or capitalocene. Nature, history and the crisis of capitalism* (pp. 1–13). https://orb.binghamton.edu/sociology_fac/1

Moriggi, A., Soini, K., Bock, B. B., & Roep, D. (2020). Caring in, for, and with nature: An integrative framework to understand green care practices. *Sustainability (Switzerland)*, *12*(8), 1–23. https://doi.org/10.3390/SU12083361

Mortreux, C., & Barnett, J. (2017). Adaptive capacity: exploring the research frontier. In *Wiley Interdisciplinary Reviews: Climate Change* (Vol. 8, Issue 4, p. 467). https://doi.org/10.1002/wcc.467

Moser, S. C. (2005). Impact assessments and policy responses to sea-level rise in three US states: An exploration of human-dimension uncertainties. *Global Environmental Change*, *15*(4), 353–369. https://doi.org/10.1016/j.gloenvcha.2005.08.002

Moser, S. C., & Dilling, L. (2012). Communicating Climate Change: Closing the Science-Action Gap. In *The Oxford Handbook of Climate Change and Society*. https://doi.org/10.1093/oxfordhb/9780199566600.003.0011

Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.1007887107

Moser, S. C., & Pike, C. (2015). Community engagement on adaptation: Meeting a growing capacity need. *Urban Climate*, *14*, 111–115.

https://doi.org/10.1016/J.UCLIM.2015.06.006

Murphy, J. T. (2015). Human geography and socio-technical transition studies: Promising intersections. *Environmental Innovation and Societal Transitions*, *17*, 73–91. https://doi.org/10.1016/j.eist.2015.03.002

Musacchio, L. R. (2009). Pattern: Process metaphors for metropolitan landscapes. *Ecology of Cities and Towns: A Comparative Approach*, 484–502. https://doi.org/10.1017/CBO9780511609763.029

Najam, A., & Muñoz-Cabre, M. (2009). Rio+20: Another World Summit? *Sustainable Development Insights*, *2*, 1–8. https://www.researchgate.net/publication/282957039

Nel·lo, O. (2003). *Aquí, no! Els conflictes territorials a Catalunya*. Ediciones Empuries.

Neumann, B., Vafeidis, A. T., Zimmermann, J., & Nicholls, R. J. (2015). Future coastal population growth and exposure to sea-level rise and coastal flooding - A global assessment. *PLoS ONE*, *10*(3), 131375. https://doi.org/10.1371/journal.pone.0118571

Nicholls, R. J., Adger, W. N., Hutton, C. W., & Hanson, S. E. (2020). Delta Challenges and Trade-Offs from the Holocene to the Anthropocene. In R. J. Nicholls, W. N. Adger, C. W. Hutton, & S. E. Hanson (Eds.), *Deltas in the Anthropocene* (pp. 1–22). Springer Nature. https://doi.org/10.1007/978-3-030-23517-8

Nicholls, R. J., Hoozemans, F. M. J., & Marchand, M. (1999). Increasing flood risk and wetland losses due to global sea-level rise: regional and global analyses. *Global Environmental Change*, *9*(SUPPL.), S69–S87. https://doi.org/10.1016/S0959-3780(99)00019-9

Nightingale, A. J. (2016). Adaptive scholarship and situated knowledges? Hybrid methodologies and plural epistemologies in climate change adaptation research. *Area*, *48*(1), 41–47. https://doi.org/10.1111/AREA.12195

Nightingale, A. J., Eriksen, S., Taylor, M., Forsyth, T., Pelling, M., Newsham, A., Boyd, E., Brown, K., Harvey, B., Jones, L., Kerr, R. B., Mehta, L., Naess, L. O., Ockwell, D., Scoones, I., Tanner, T., & Whitfield, S. (2019). Beyond Technical Fixes: climate solutions and the great derangement. *Https://Doi.Org/10.1080/17565529.2019.1624495*, *12*(4), 343–352. https://doi.org/10.1080/17565529.2019.1624495

Nightingale, A. J., Gonda, N., & Eriksen, S. (2022). Affective adaptation = effective transformation? Shifting the politics of climate change adaptation and transformation

from the status quo. *Wiley Interdisciplinary Reviews: Climate Change*, *13*(1), 1–16. https://doi.org/10.1002/wcc.740

Nóblega-Carriquiry, A. (2022). Contributions of Urban Political Ecology to sustainable drainage transitions. *Documents d'Anàlisi Geogràfica*, *68*(2), 363–391. https://doi.org/10.5565/rev/dag.701

Norgaard, K. M. (2011). Living in denial: Climate change, emotions, and everyday life. In *Living in Denial: Climate Change, Emotions, and Everyday Life*. https://doi.org/10.2134/jeq2012.0004br

Nowotny, H., Scott, P., & Gibbons, M. (2003). Introduction: `Mode 2' Revisited: The New Production of Knowledge. *Minerva 2003 41:3*, *41*(3), 179–194. https://doi.org/10.1023/A:1025505528250

O'Brien, K. (2012). Global environmental change II: From adaptation to deliberate transformation. *Progress in Human Geography*, *36*(5), 667–676. https://doi.org/10.1177/0309132511425767

O'Brien, K. (2018). Is the 1.5°C target possible? Exploring the three spheres of transformation. *Current Opinion in Environmental Sustainability*, *31*, 153–160. https://doi.org/10.1016/J.COSUST.2018.04.010

O'Brien, K., Eriksen, S., Nygaard, L. P., & Schjolden, A. (2007). Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy*, *7*(1), 73–88. https://doi.org/10.1080/14693062.2007.9685639

O'Brien, K., & Leichenko, R. (2019). Toward an integrative discourse on climate change. In *Dialogues in Human Geography*. https://doi.org/10.1177/2043820619829933

O'Brien, K., Sygna, L., & Haugen, J. E. (2004). Vulnerable or resilient? A multi-scale assessment of climate impacts and vulnerability in Norway. In *Climatic Change*. https://doi.org/10.1023/B:CLIM.0000024668.70143.80

O'Brien, K., & Wolf, J. (2010). A values-based approach to vulnerability and adaptation to climate change. *Wiley Interdisciplinary Reviews: Climate Change*, *1*(2), 232–242. https://doi.org/10.1002/wcc.30

Olazabal, M., Galarraga, I., Ford, J., Sainz De Murieta, E., & Lesnikowski, A. (2019). Are local climate adaptation policies credible? A conceptual and operational assessment

framework. *International Journal of Urban Sustainable Development*. https://doi.org/10.1080/19463138.2019.1583234

Ostrom, E. (1990). Governing the commons: the evolution of institutions for collective action. In *Cambridge University Press* (Vol. 32, Issue 2). https://doi.org/10.2307/3146384

Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change*, *19*(3), 354–365. https://doi.org/10.1016/j.gloenvcha.2009.06.001

Palacios, D. (2019). La erosión en las playas del Área Metropolitana de Barcelona. La perspectiva del gestor. In R. Durán, J. Guillén, & G. Simarro (Eds.), *X Jornadas de Geomorfología Litoral: libro de ponencias* (pp. 101–104). Barcelona: Instituto de Ciencias del Mar.

Palau Robert. (2021). *Aprenem del Glòria al Delta: Mapes de risc d'inundació i component marina*. Sicom TV. Solidaritat i Comunicació. https://www.youtube.com/watch?v=nU6R-17QuSY

Park, S. E., Marshall, N. A., Jakku, E., Dowd, A. M., Howden, S. M., Mendham, E., & Fleming, A. (2012). Informing adaptation responses to climate change through theories of transformation. *Global Environmental Change*, *22*(1), 115–126. https://doi.org/10.1016/J.GLOENVCHA.2011.10.003

Parry, M., Palutikof, J., Hanson, C., & Lowe, J. (2008). Squaring up to reality. *Nature Climate Change*, *1*(806), 68–71. https://doi.org/10.1038/climate.2008.50

Paterson, S. K., Pelling, M., Nunes, L. H., de Araújo Moreira, F., Guida, K., & Marengo, J. A. (2017). Size does matter: City scale and the asymmetries of climate change adaptation in three coastal towns. *Geoforum*, *81*, 109–119. https://doi.org/10.1016/J.GEOFORUM.2017.02.014

Patt, A. (2013). Climate risk management. Laying the groundwork for successful adaptation. In S. C. Moser & M. T. Boykoff (Eds.), *Successful adaptation to climate change: Linking science and policy in a rapidly changing world*. Taylor & Francis Group.

Patt, A., Klein, R. J. T., & de la Vega-Leinert, A. (2005). Taking the uncertainty in climate-change vulnerability assessment seriously. *Comptes Rendus - Geoscience*, *337*(4), 411–424. https://doi.org/10.1016/j.crte.2004.11.006

Patt, A., Schröter, D., Klein, R., & De la Vega-Leinert, A. C. (2012). Vulnerability research and assessment to support adaptation and mitigation: Common themes from the diversity of approaches. In A. Patt, D. Schröter, A. C. De la Vega-Leinert, & R. Klein (Eds.), *Assessing Vulnerability to Global Environmental Change: Making Research Useful for Adaptation, Decision Making and Policy*. Earthscan. https://doi.org/10.4324/9781849770514

Patt, A., & Weber, E. U. (2014). Perceptions and communication strategies for the many uncertainties relevant for climate policy. *Wiley Interdisciplinary Reviews: Climate Change*. https://doi.org/10.1002/wcc.259

Paül, V. (2009). «Defensors de la terra!» Una anàlisi dels conflictes territorials recents al Baix Llobregat (2001-2005)". In *Constructors de consciència i de canvi. Una aproximació als moviments socials des del Baix Llobregat* (pp. 581–624). Edicions del Llobregat/Arxiu Comarcal del Baix Llobregat.

Pearson, K. R., Bäckman, M., Grenni, S., Moriggi, A., Pisters, S., & Vrieze, A. de. (2018). *Arts-based methods for transformative engagement: A toolkit*. SUSPLACE. https://doi.org/10.18174/441523

Pelegrí, J. L., García-Ladona, E., & Salat, J. (2020). Característiques sobre el litoral català. In E. Berdalet, C. Marrasé, & J. L. Pelegrí (Eds.), *Resum sobre la Formació i Conseqüències de la Borrasca Glòria (19-24 gener 2020)* (pp. 5–14). Institut de Ciències del Mar, CSIC.

Pelling, M., & High, C. (2005). Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental Change*, *15*(4), 308–319. https://doi.org/10.1016/J.GLOENVCHA.2005.02.001

Pelling, M., O'Brien, K., & Matyas, D. (2015). Adaptation and transformation. *Climatic Change*, *133*(1), 113–127. https://doi.org/10.1007/S10584-014-1303-0/FIGURES/2

Pereira, A. G., & Funtowicz, S. (2009). Introduction. In A. G. Pereira & S. Funtowicz (Eds.), *Science for Policy*. Oxford University Press.

Perelló, M. X., Durán, R., Valero, L., & Guillén, J. (2019). Evolución geomorfológica de la costa del delta del Llobregat mediante datos LIDAR Geomorphological evolution of the Llobregat Delta coast based on LIDAR data (2008 to 2017). In R. Durán, J. Guillén, & G. Simarro (Eds.), *X Jornadas de Geomorfología Litoral: libro de ponencias* (pp. 177–180). Barcelona: Instituto de Ciencias del Mar.

Petersen, A. C., Janssen, P. H. M., van der Sluijs, J., Risbey, J. S., Ravetz, J. R., Wardekker, J. A., & Martinson Hughes, H. (2013). Guidance for uncertainty assessment and communication. In *PBL 2nd edition*. http://pblweb.prolocation.net/sites/default/files/cms/publicaties/550032001.pdf

Pierce, J., Martin, D. G., & Murphy, J. T. (2011). Relational place-making: The networked politics of place. *Transactions of the Institute of British Geographers*, *36*(1), 54–70. https://doi.org/10.1111/j.1475-5661.2010.00411.x

Pino, J., & Isern, R. (2018). El paisatge funcional i el mosaic dels ecosistemes terrestres. In J. Germain i Otzet & J. Pino i Vilalta (Eds.), *Els sistemes naturals del delta del Llobregat* (pp. 97–112).

Pintó, J., Garcia-Lozano, C., Sardá, R., Roig-Munar, F. X., & Martí, C. (2020). Efectes del temporal Glòria sobre el litoral. *Treballs de La Societat Catalana de Geografia*, *89*, 89–109. https://raco.cat/index.php/TreballsSCGeografia/article/view/375410

Poli, C. (2011). Sustainable Development: From Fallacy to Fraud. In *Mobility and Environment* (pp. 15–42). Springer Netherlands. https://doi.org/10.1007/978-94-007-1220-1_2

Pomés, J. (2001). L'agricultura en la transformació de la comarca. In M. Domenech (Ed.), *Descobrim el Baix Llobregat* (Vol. 5). Consell comarcal del Baix Llobregat.

Porcuna-Ferrer, A., Calvet-Mir, L., Guillerminet, T., Alvarez-Fernandez, S. Labeyrie, V., Porcuna-Ferrer, E., & Reyes-García, V. (2023). So many things have changed": Situated understandings of climate change impacts among the Bassari, south-eastern Senegal. *Environmental Science & Policy*, *148*.

Prats-Puntí, A., Martin-Vide, J. P., & Boix-Ferrer, C. (2021). Regressió del delta del Llobregat. Efecte de les obres d'enginyeria al riu d'ençà del segle XIX. *Cuadernos de Geografía*, *107*, 123–148. https://doi.org/10.7203/CGUV.107.21307

Preston, B. L., Rickards, L., Fünfgeld, H., & Keenan, R. J. (2015). Toward reflexive climate adaptation research. *Current Opinion in Environmental Sustainability*, *14*, 127–135. https://doi.org/10.1016/J.COSUST.2015.05.002

Preston, B. L., Westaway, R. M., & Yuen, E. J. (2011). Climate adaptation planning in practice: An evaluation of adaptation plans from three developed nations. *Mitigation and Adaptation Strategies for Global Change*. https://doi.org/10.1007/s11027-010-9270-x

Preston, B. L., Yuen, E. J., & Westaway, R. M. (2011). Putting vulnerability to climate change on the map: A review of approaches, benefits, and risks. In *Sustainability Science*. https://doi.org/10.1007/s11625-011-0129-1

Princen, T. (2010). Speaking of sustainability: The potential of metaphor. *Sustainability: Science, Practice, and Policy*, *6*(2), 60–65. https://doi.org/10.1080/15487733.2010.11908050

Puig de la Bellacasa, M. (2017). *Matters of care: Speculative ethics in more than human worlds*. University of Minnesota Press.

Queralt, E., & Isla, E. (2018). L'aigua al delta. In J. Germain i Otzet & J. Pino i Vilalta (Eds.), *Els sistemes naturals del delta del Llobregat* (pp. 43–70).

Quinn, T., Bousquet, F., & Guerbois, C. (2019). Changing places: The role of sense of place in perceptions of social, environmental and overdevelopment risks. *Global Environmental Change*, *57*, 101930. https://doi.org/10.1016/J.GLOENVCHA.2019.101930

Quinn, T., Bousquet, F., Guerbois, C., Heider, L., & Brown, K. (2019). How local water and waterbody meanings shape flood risk perception and risk management preferences. *Sustainability Science*, *14*(3), 565–578. https://doi.org/10.1007/S11625-019-00665-0/FIGURES/4

Ratsimandresy, A. W., Sotillo, M. G., Carretero Albiach, J. C., Álvarez Fanjul, E., & Hajji, H. (2008). A 44-year high-resolution ocean and atmospheric hindcast for the Mediterranean Basin developed within the HIPOCAS Project. *Coastal Engineering*, *55*(11), 827–842. https://doi.org/10.1016/J.COASTALENG.2008.02.025

Ravetz, J. R. (2006). Post-Normal Science and the complexity of transitions towards sustainability. *Ecological Complexity*, *3*(4), 275–284. https://doi.org/10.1016/j.ecocom.2007.02.001

Raymond, C. M., Fazey, I., Reed, M. S., Stringer, L. C., Robinson, G. M., & Evely, A. C. (2010). Integrating local and scientific knowledge for environmental management. *Journal of Environmental Management*, *91*(8), 1766–1777. https://doi.org/10.1016/J.JENVMAN.2010.03.023

Raymond, C. M., Manzo, L. C., Williams, D. R., Di Masso Tarditti, A., & von Wirth, T. (2021). *Changing Senses of Place: Navigating Global Challenges* (C. M. Raymond, L. C. Manzo, D.

R. Williams, A. Di Masso Tarditti, & T. von Wirth (eds.)). Cambridge University Press.

Raymond, C. M., Williams, D., Di Masso, A., Manzo, L. C., & Wirth, T. von. (2021). Introduction: Senses of place in the face of global challenges. In C. Raymond, L. c. Manzo, D. R. Williams, A. Di Masso, & T. von Wirth (Eds.), *Changing Senses of Place: Navigating Global Challenges* (pp. 1–18). Cambridge University Press. https://doi.org/10.1017/9781108769471

Reckien, D., Flacke, J., Olazabal, M., & Heidrich, O. (2015). The influence of drivers and barriers on urban adaptation and mitigation plans-an empirical analysis of European Cities. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0135597

Reckien, D., Salvia, M., Heidrich, O., Church, J. M., Pietrapertosa, F., De Gregorio-Hurtado, S., D'Alonzo, V., Foley, A., Simoes, S. G., Krkoška Lorencová, E., Orru, H., Orru, K., Wejs, A., Flacke, J., Olazabal, M., Geneletti, D., Feliu, E., Vasilie, S., Nador, C., … Dawson, R. (2018). How are cities planning to respond to climate change? Assessment of local climate plans from 885 cities in the EU-28. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2018.03.220

Relph E. (1997). Sense of place. In H. S (Ed.), *Ten geographical ideas that have changed the world* (pp. 205–226). Rutgers University Press.

Renaud, F. G., Syvitski, J. P. M., Sebesvari, Z., Werners, S. E., Kremer, H., Kuenzer, C., Ramesh, R., Jeuken, A. D., & Friedrich, J. (2013). Tipping from the Holocene to the Anthropocene: How threatened are major world deltas? *Current Opinion in Environmental Sustainability*, *5*(6), 644–654. https://doi.org/10.1016/j.cosust.2013.11.007

Reyes-García, V., Fernández-Llamazares, Á. McElwee, P., Molnár, Z., Öllerer, K., Wilson, S. J., & Brondizio, E. S. (2019). The contributions of Indigenous Peoples and local communities to ecological restoration. *Restoration Ecology*, *27*(1), 3–8.

Ribas, A., Olcina, J., & Sauri, D. (2020). More exposed but also more vulnerable? Climate change, high intensity precipitation events and flooding in Mediterranean Spain. *Disaster Prevention and Management: An International Journal*, *29*(3), 229–248. https://doi.org/10.1108/DPM-05-2019-0149

Ribot, J. (2011). Vulnerability before adaptation: Toward transformative climate action. In *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2011.07.008

Ribot, J. (2014). Cause and response: vulnerability and climate in the Anthropocene. *Journal of Peasant Studies*. https://doi.org/10.1080/03066150.2014.894911

Ricart, S., & Rico-Amorós, A. M. (2021). Water for food, water for birds: How to manage conflicting rural-natural interfaces? Deepening on the socio-ecological system of El Hondo Natural Park (Alicante, Spain). *Journal of Rural Studies*, *86*, 24–35. https://doi.org/10.1016/j.jrurstud.2021.05.019

Ricart, S., & Rico-Amorós, A. M. (2022). Can agriculture and conservation be compatible in a coastal wetland? Balancing stakeholders' narratives and interactions in the management of El Hondo Natural Park, Spain. *Agriculture and Human Values*, *39*(2), 589–604. https://doi.org/10.1007/s10460-021-10271-5

Riedy, C. (2022). Discursive entrepreneurship: ethical meaning-making as a transformative practice for sustainable futures. *Sustainability Science*, *17*(2), 541–554. https://doi.org/10.1007/S11625-021-00978-Z/FIGURES/3

Rist, G. (2002). El desarrollo: historia de una creencia occidental. In *El Desarrollo: Historia de una Creencia Occidental*. Los Libros de la Catarata. https://www.catarata.org/libro/el-desarrollo-historia-de-una-creencia-occidental_45649/

Rittel, H. W. J. (1972). On the Planning Crisis: Systems Analysis of the First and Second Generations. In *Bedriftsokonomen* (pp. 390–96). https://doi.org/10.4324/9780203851586-21

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, *4*(2), 155–169.

Roda, R. (2015). El Consorci del parc agrari del Baix Llobregat. *Materials Del Baix Llobregat*, *21*, 19–26.

Sachs, I. (1974). Ambiente y estilo de desarrollo. *Comercio Exterior, XXIV*, 360–368.

Safra de Campos, R., Nii Ardey Codjoe, S., Adger, W. Neil, Mortreux, C., Hazra, S., Siddiqui, T., Das, S., Atiglo, D. Y., Alam Bhuiyan, M., Hasan Rocky, M., & Abu, M. (2020). Where people live and move in Deltas. In *Deltas in the Anthropocene*.

Sallenger, A. H. (2000). Storm impact scale for barrier islands. *Journal of Coastal Research*, *16*(3), 890–895.

Sánchez-Arcilla, A., Gracia, V., & Sierra, J. P. (2016). Sistemes costaners i dinàmica litoral. In *Tercer informe sobre el canvi climàtic a Catalunya* (Institut d, pp. 189–210).

Sánchez-Juny, M., & Dolz Ripollés, J. (2004). El riu, un camí d'aigua. In Narcís Prat & E. Tello, (Eds.), *El Baix Llobregat història i actualitat ambiental d'un riu* (pp. 30–49). Centre d'Estudis Comarcals del Baix Empordà.

Sanchez Rodriguez, R., Ürge-Vorsatz, Di., & Barau, A. S. (2018). Sustainable Development Goals and climate change adaptation in cities. *Nature Climate Change 2018 8:3*, *8*(3), 181–183. https://doi.org/10.1038/s41558-018-0098-9

Sans, J., & Panareda, J. M. (2012). Le canal de la rive droite du fleuve Llobregat Paysages et biodiversité de l'espace métropolitain de Barcelone (Espagne). In C. Aspe (Ed.), *De l'eau Agricole à l'eau Environnementale : Résistance et Adaptation Aux Nouveaux Enjeux de Partage de l'eau en Méditerranée* (pp. 175–186). Quae.

Sans, J., & Panareda, J. M. (2016). *Els paisatges de l'aigua al delta del Llobregat*. Institut d'Estudis Catalans.

Santasusagna Riu, A., & Tort Donada, J. (2020). El temporal Glòria: consideracions sobre la seva afecció a la Costa Central Catalana. *Treballs de La Societat Catalana de Geografia*, *89*, 191–220. https://raco.cat/index.php/TreballsSCGeografia/article/view/375414

Sanuy, M., Peña, J. C., Assimenidis, S., & Jiménez, J. A. (2023). Synoptic weather patterns conducive to compound extreme rainfall-wave events in the NW Mediterranean. *Hydrology and Earth System Sciences Discussions*, 1–21. https://doi.org/10.5194/hess-2023-104

Sanuy, M., Rigo, T., Jiménez, J. A., & Llasat, M. C. (2021). Classifying compound coastal storm and heavy rainfall events in the north-western Spanish Mediterranean. *Hydrology and Earth System Sciences*, *25*(6), 3759–3781. https://doi.org/10.5194/hess-25-3759-2021

Sardar, Z. (2010). Welcome to postnormal times. *Futures*, *42*(5), 435–444. https://doi.org/10.1016/j.futures.2009.11.028

Sauer, I. J., Roca, E., & Villares, M. (2021). Integrating climate change adaptation in coastal governance of the Barcelona metropolitan area. *Mitigation and Adaptation Strategies for Global Change*, *26*(4), 1–27. https://doi.org/10.1007/s11027-021-09953-6

Saurí, D., & Palau-Rof, L. (2017). Urban drainage in barcelona: From hazard to resource? *Water*

Alternatives, *10*(2), 475–492. www.water-alternatives.org

Scannell, L., & Gifford, R. (2010). Defining place attachment: A tripartite organizing framework. *Journal of Environmental Psychology*, *30*(1), 1–10. https://doi.org/10.1016/j.jenvp.2009.09.006

Schneider, F., Giger, M., Harari, N., Moser, S., Oberlack, C., Providoli, I., Schmid, L., Tribaldos, T., & Zimmermann, A. (2019). Transdisciplinary co-production of knowledge and sustainability transformations: Three generic mechanisms of impact generation. *Environmental Science and Policy*, *102*, 26–35. https://doi.org/10.1016/j.envsci.2019.08.017

Schneider, F., Kläy, A., Zimmermann, A. B., Buser, T., Ingalls, M., & Messerli, P. (2019). How can science support the 2030 Agenda for Sustainable Development? Four tasks to tackle the normative dimension of sustainability. *Sustainability Science*. https://doi.org/10.1007/s11625-019-00675-y

Schneider, F., Tribaldos, T., Adler, C., Biggs, R. (Oonsie), de Bremond, A., Buser, T., Krug, C., Loutre, M. F., Moore, S., Norström, A. V., Paulavets, K., Urbach, D., Spehn, E., Wülser, G., & Zondervan, R. (2021). Co-production of knowledge and sustainability transformations: a strategic compass for global research networks. *Current Opinion in Environmental Sustainability*, *49*, 127–142. https://doi.org/10.1016/J.COSUST.2021.04.007

Schön, D. A. (1993). Generative Metaphor: A Perspective on Problem-Setting in Social Policy. In A. Ortony (Ed.), *Metaphor and Thought* (2nd ed., pp. 254–283). Cambridge University Press.

Scoones, I., & Stirling, A. (2020). Uncertainty and the politics of transformation. In I. Scoones & A. Stirling (Eds.), *The politics of uncertainty* (pp. 1–30). Routledge.

Sebastien, L. (2016). L'attachement au lieu, vecteur de mobilisation collective ? *Norois*, *238–239*, 23–41. https://doi.org/10.4000/norois.5846

Selimovic, J. M. (2019). Everyday agency and transformation: Place, body and story in the divided city. *Cooperation and Conflict*, *54*(2), 131–148. https://doi.org/10.1177/0010836718807510

Semino, E., & Demjén, Z. (2017). *The Routledge handbook of metaphor and language* (E. Semino & Z. Demjén (eds.)). Taylor & Francis.

Sempere, J. (2004). La pagesia del delta del Llobregat:un futur incert. *Documents d'Anàlisi Geogràfica*.

Sempere Roig, J. (2009). Les reivindicacions pageses al Baix Llobregat a la segona meitat del segle XX: de la presa de consciència fins al projecte de parc agrari. In *Constructors de consciència i de canvi. Una aproximació als moviments socials des del Baix Llobregat* (pp. 373–404). Edicions del Llobregat/Arxiu Comarcal del Baix Llobregat.

Sen, A. (1982). *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford University Press.

Serra, P., Saurí, D., & Salvati, L. (2018). Peri-urban agriculture in Barcelona: outlining landscape dynamics vis à vis socio-environmental functions. *Landscape Research*, *43*(5), 613–631. https://doi.org/10.1080/01426397.2017.1336758

SGM. (2021). *Estudi sobre els episodis recents d'inundacions i entollament de la zona agrícola a Viladecans*.

Shove, E. (2010). Beyond the ABC: Climate Change Policy and Theories of Social Change. *Environment and Planning A: Economy and Space*, *42(6)*, 1273–1285. https://doi.org/https://doi.org/10.1068/a42282

Siders, A. R. (2019). Adaptive capacity to climate change: A synthesis of concepts, methods, and findings in a fragmented field. *Wiley Interdisciplinary Reviews: Climate Change*, *10*(3). https://doi.org/10.1002/WCC.573

Simonet, G., & Leseur, A. (2019). Barriers and drivers to adaptation to climate change—a field study of ten French local authorities. *Climatic Change*. https://doi.org/10.1007/s10584-019-02484-9

Simpson, N. P., Mach, K. J., Constable, A., Hess, J., Hogarth, R., Howden, M., Lawrence, J., Lempert, R. J., Muccione, V., Mackey, B., New, M. G., O'neill, B., Otto, F., Pö, H.-O., Reisinger, A., Roberts, D., Schmidt, D. N., Seneviratne, S., Strongin, S., … Trisos, C. H. (2021). *A framework for complex climate change risk assessment*. https://doi.org/10.1016/j.oneear.2021.03.005

Singh, N. (2017). Becoming a commoner: The commons as sites for affective socio-nature encounters and co-becomings. *Ephemera: Theory & Politics in Organization*, *17*(4), 751–776.

Slaby, J., Mühlhoff, R., & Wüschner, P. (2019). Affective Arrangements. *Emotion Review*, *11*(1), 3–12. https://doi.org/10.1177/1754073917722214

Soja, E. (1999). Thirdspace: Expanding the scope of the geographical imagination. *Human Geography Today*, *260*.

Solé i Perich, L. (2005). El Risc d'inundacions al delta del Llobregat. Viure contra l'aigua? *Treballs de La Societat Catalana de Geografia*, *0*(42), 223-264–264. https://doi.org/10.2436/tscg.v0i42.37098

Solnit, R. (2020). *Hope in the Dark: Untold Histories, Wild Possibilities*. Haymarket Press. https://doi.org/10.1215/9781478007135-086

Stedman, R. C. (2002). Toward a social psychology of place: Predicting behavior from place-based cognitions, attitude, and identity. *Environment and Behavior*, *34*(5), 561–581. https://doi.org/10.1177/0013916502034005001

Stedman, R. C. (2008). What do we" mean" by place meanings? Implications of place meanings for managers and practitioners. In *Understanding concepts of place in recreation research and management* (pp. 61–83). General Technical Report PNW-GTR-744. U.S. Department of Agriculture Forest Service Pacific Northwest Research Station. https://doi.org/10.2737/PNW-GTR-744

Stedman, R. C. (2016). Subjectivity and social-ecological systems: a rigidity trap (and sense of place as a way out). *Sustainability Science*, *11*(6), 891–901. https://doi.org/10.1007/s11625-016-0388-y

Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. (2015). The trajectory of the Anthropocene: The Great Acceleration. *Http://Dx.Doi.Org/10.1177/2053019614564785*, *2*(1), 81–98. https://doi.org/10.1177/2053019614564785

Steffen, W., Rockström, J., Richardson, K., Lenton, T. M., Folke, C., Liverman, D., Summerhayes, C. P., Barnosky, A. D., Cornell, S. E., Crucifix, M., Donges, J. F., Fetzer, I., Lade, S. J., Scheffer, M., Winkelmann, R., & Schellnhuber, H. J. (2018). Trajectories of the Earth System in the Anthropocene. *Proceedings of the National Academy of Sciences of the United States of America*, *115*(33), 8252–8259. https://doi.org/10.1073/pnas.1810141115

Sterling, S. (2003). *Whole systems thinking as a basis for paradigm change in education:*

explorations in the context of sustainability. University of Bath.

Sterling, S. (2010). Transformative learning and sustainability. *Learning and Teaching in Higher Education*, *11*(5), 17–33.

Stirling, A. (2019). Sustainability and the politics of transformations: From control to care in moving beyond modernity. In *What Next for Sustainable Development?: Our Common Future at Thirty* (pp. 219–238). Edward Elgar Publishing Ltd. https://doi.org/10.4337/9781788975209.00023

Stockdon, H. F., Holman, R. A., Howd, P. A., & Sallenger, A. H. (2006). Empirical parameterization of setup, swash, and runup. *Coastal Engineering*, *53*(7), 573–588. https://doi.org/10.1016/j.coastaleng.2005.12.005

Stockdon, H. F., Sallenger, A. H., Holman, R. A., & Howd, P. A. (2007). A simple model for the spatially-variable coastal response to hurricanes. *Marine Geology*, *238*(1–4), 1–20. https://doi.org/10.1016/j.margeo.2006.11.004

Taddei, A., & Fallot, A. (2023). *Collection de metaphores du sol*. Cabanera.

Tarazona, Y., Zabala, A., Pons, X., Broquetas, A., Nowosad, J., & Zurqani, H. A. (2021). Fusing Landsat and SAR Data for Mapping Tropical Deforestation through Machine Learning Classification and the PVts-β Non-Seasonal Detection Approach. *Canadian Journal of Remote Sensing*, *47*(5), 677–696. https://doi.org/10.1080/07038992.2021.1941823

Tate, E. (2013). Uncertainty Analysis for a Social Vulnerability Index. *Annals of the Association of American Geographers*, *103*(3), 526–543. https://doi.org/10.1080/00045608.2012.700616

Tavus, B., Kocaman, S., Gokceoglu, C., & Nefeslioglu, H. A. (2018). Considerations on the use of Sentinel-1 data in flood mapping in urban areas: Ankara (Turkey) 2018 floods. *International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences*, 578–571.

Termeer, C. J. A. M., Dewulf, A., & Biesbroek, G. R. (2017). Transformational change: governance interventions for climate change adaptation from a continuous change perspective. In *Journal of Environmental Planning and Management* (Vol. 60, Issue 4, pp. 558–576). https://doi.org/10.1080/09640568.2016.1168288

Thiault, L., Jupiter, S. D., Johnson, J. E., Cinner, J. E., Jarvis, R. M., Heron, S. F., Maina, J. M.,

Marshall, N. A., Marshall, P. A., & Claudet, J. (2021). Harnessing the potential of vulnerability assessments for managing social-ecological systems. *Ecology and Society*, *26*(2). https://doi.org/10.5751/ES-12167-260201

Thibodeau, P. H. (2017). The function of metaphor framing, deliberate or otherwise, in a social world. *Metaphor and the Social World*, *7*(2), 270–290. https://doi.org/10.1075/msw.7.2.06thi

Thibodeau, P. H., Fleming, J., & Lannen, M. (2019). Variation in methods for studying political metaphor Comparing experiments and discourse analysis. In J. Perrez, M. Reuchamps, & P. H. Thibodeau (Eds.), *Variation in Political Metaphor* (pp. 177–194). John Benjamins. https://doi.org/https:// doi.org/10.1075/dapsac.85

Tobaruela, P., & Sans, J. (2003). *El delta del Llobregat. Terres d'oblit.* Publicacions de l'Abadia de Montserrat.

Tonmoy, F. N., El-Zein, A., & Hinkel, J. (2014). Assessment of vulnerability to climate change using indicators: a meta-analysis of the literature. *Wiley Interdisciplinary Reviews: Climate Change*, *5*(6), 775–792. https://doi.org/10.1002/WCC.314

Tribó i Traveria, G. (2004). El primer tren a la comarca i l'impuls a la comercialització agrícola. *Estudis d'història Agrària*, *17*, 931–938.

Tschakert, P., & Tuana, N. (2012). Situated Resilience: Reframing Vulnerability and Security in the Context of Climate Change. *Progress in Human Geography*, *36*(4), 475–489. https://doi.org/10.1177/0309132511425708.10

Tuan, Y. F. (1977). *Space and place: The perspective of experience*. University of Minnesota Press.

Tuan, Y. F. (1978). Sign and Metaphor. *Annals of the Association of American Geographers*, *68*(3), 363–372. https://doi.org/10.1111/j.1467-8306.1978.tb01200.x

Tuan, Y. F. (1980). Rootedness and sense of place. *Landscape*, *24*, 3–8. https://doi.org/10.20630/CHIRIKAGAKU.68.1_1

Umpleby, S. A. (2016). Second-order cybernetics as a fundamental revolution in science. *Constructivist Foundations*, *11*(3), 455–465. https://web.p.ebscohost.com/abstract?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=1782348X&AN=116949356&h=hTlD5jJFKpZB%2ByaNbV11YXRPssjN95Vuy

O2OAhunr1AeDJNNraZmrrj%2FMrDXCuRAOnUHR4hZseDebuHY2gWwww%3D%3D&crl=c&resultNs=AdminWebAuth&resultLoca

Paris Agreement, (2015). https://unfccc.int/sites/default/files/resource/parisagreement_publication.pdf

UNFCCC. (2015). *Adoption of the Paris agreement* (p. 31). United Nations Framework Convention on Climate Change (UNFCCC).

van Bree, L., & van der Sluijs, J. (2014). Background on Uncertainty Assessment Supporting Climate Adaptation Decision-Making. In T. Capela Lourenço, A. Rovisco, A. Groot, C. Nilsson, H.-M. Füssel, L. Van Bree, & R. B. Street (Eds.), *Adapting to an Uncertain Climate: Lessons From Practice* (pp. 17–40). Springer International Publishing. https://doi.org/10.1007/978-3-319-04876-5_2

van den Hove, S. (2007). A rationale for science–policy interfaces. *Futures*, *39*(7), 807–826. https://doi.org/10.1016/J.FUTURES.2006.12.004

van der Sluijs, J., Douget, J.-M., Janssen, P., O'Connor, M., & Petersen, A. C. (2006). Tools to Assess Uncertainty in a Deliberative Perspective. A Catalogue. *Cahier Du C3ED*, *n.06-02*, 1–35. http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&ved=0CE0QFjAG&url=http%3A%2F%2Fwww.researchgate.net%2Fpublication%2F242310444_Tools_to_Assess_Uncertainty_in_a_Deliberative_Perspective._A_Catalogue%2Flinks%2F02e7e52a34eb207462000000.pdf&ei=pP

van der Sluijs, J., Petersen, A. C., Janssen, P. H. M., Risbey, J. S., & Ravetz, J. R. (2008). Exploring the quality of evidence for complex and contested policy decisions. *Environmental Research Letters*. https://doi.org/10.1088/1748-9326/3/2/024008

Van Kerkhoff, L., & Lebel, L. (2006). Linking knowledge and action for sustainable development. *Annual Review of Environment and Resources*, *31*, 445–477. https://doi.org/10.1146/annurev.energy.31.102405.170850

Vidal, T., & Pol, E. (2005). La apropiación del espacio: Una propuesta teórica para comprender la vinculación entre las personas y los lugares. *Anuario de Psicologia*, *36*(3), 281–297. https://raco.cat/index.php/AnuarioPsicologia/article/view/61819

Vide, J. M., & Barriendos, M. (2004). El riu, un camí d'aigua. Avingudes i sequeres. El marc

climàtic històric i instrumental. In Narcis Prat & E. Tello (Eds.), *El Baix Llobregat història i actualitat ambiental d'un riu* (pp. 14–29). Centre d'Estudis Comarcals del Baix Llobregat.

Vila, J. A. (2009). Trenta anys de lluita contra el desviament del riu Llobregat (1971-2001). In *Constructors de consciència i de canvi. Una aproximació als moviments socials des del Baix Llobregat* (pp. 405–455). Edicions del Llobregat/Arxiu Comarcal del Baix Llobregat.

Vitousek, S., Barnard, P. L., Fletcher, C. H., Frazer, N., Erikson, L., & Storlazzi, C. D. (2017). Doubling of coastal flooding frequency within decades due to sea-level rise. *Scientific Reports*, *7*(1), 1–9. https://doi.org/10.1038/s41598-017-01362-7

Vogel, C., Moser, S. C., Kasperson, R. E., & Dabelko, G. D. (2007). Linking vulnerability, adaptation, and resilience science to practice: Pathways, players, and partnerships. *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2007.05.002

Vogel, C., & O'Brien, K. (2022). Getting to the heart of transformation. *Sustainability Science*, *17*(2), 653–659. https://doi.org/10.1007/s11625-021-01016-8

Wahl, T., Jain, S., Bender, J., Meyers, S. D., & Luther, M. E. (2015). Increasing risk of compound flooding from storm surge and rainfall for major US cities. *Nature Climate Change*, *5*(12), 1093–1097. https://doi.org/10.1038/nclimate2736

Walker, W. E., Harremoës, P., Rotmans, J., van der Sluijs, J., van Asselt, M. B. A., Janssen, P., & Krayer von Krauss, M. P. (2003). Defining Uncertainty: A Conceptual Basis for Uncertainty Management in Model-Based Decision Support. *Integrated Assessment*. https://doi.org/10.1076/iaij.4.1.5.16466

Watts, M. (1991). Entitlements or Empowerment? Famine and Starvation in Africa. *Review of African Political Economy*, *18*(51), 9–26. https://doi.org/10.1080/03056249108703903

West, S., Haider, L. J., Masterson, V., Enqvist, J. P., Svedin, U., & Tengö, M. (2018). Stewardship, care and relational values. *Current Opinion in Environmental Sustainability*, *35*, 30–38. https://doi.org/10.1016/J.COSUST.2018.10.008

West, S., Haider, L. J., Stålhammar, S., & Woroniecki, S. (2020). A relational turn for sustainability science? Relational thinking, leverage points and transformations. *Https://Doi.Org/10.1080/26395916.2020.1814417*, *16*(1), 304–325. https://doi.org/10.1080/26395916.2020.1814417

West, S., van Kerkhoff, L., & Wagenaar, H. (2019). Beyond "linking knowledge and action":

towards a practice-based approach to transdisciplinary sustainability interventions. *Policy Studies*, *40*(5), 534–555. https://doi.org/10.1080/01442872.2019.1618810

Westley, F. R., Tjornbo, O., Schultz, L., Olsson, P., Folke, C., Crona, B., & Bodin, Ö. (2013). A theory of transformative agency in linked social-ecological systems. *Ecology and Society*, *18*(3). https://doi.org/10.5751/ES-05072-180327

Westling, E. L., Sharp, L., Rychlewski, M., & Carrozza, C. (2014). Developing adaptive capacity through reflexivity: lessons from collaborative research with a UK water utility. *Critical Policy Studies*, *8*(4), 427–446. https://doi.org/10.1080/19460171.2014.957334

White, I., Kingston, R., & Barker, A. (2010). Participatory geographic information systems and public engagement within flood risk management. *Journal of Flood Risk Management*, *3*(4), 337–346. https://doi.org/10.1111/J.1753-318X.2010.01083.X

Wibeck, V. (2011). Images of environmental management: Competing metaphors in focus group discussions of swedish environmental quality objectives. *Environmental Management*, *49*(4), 776–787. https://doi.org/10.1007/s00267-012-9816-7

Wilby, R. L., & Dessai, S. (2010). Robust adaptation to climate change. *Weather*. https://doi.org/10.1002/wea.543

Wilk, R. (2010). Consumption embedded in culture and language: Implications for finding sustainability. *Sustainability: Science, Practice, and Policy*, *6*(2), 38–48. https://doi.org/10.1080/15487733.2010.11908048

Williams, D. R. (2014). Making sense of "place": Reflections on pluralism and positionality in place research. *Landscape and Urban Planning*, *131*, 74–82. https://doi.org/10.1016/j.landurbplan.2014.08.002

Williams, D. R., & Miller, B. A. (2021). Metatheoretical moments in place attachment research: Seeking clarity in diversity. In L. C. Manzo & P. Devine-Wright (Eds.), *Place Attachment: Advances in Theory, Methods and Applications* (2on ed., pp. 12–28). Routledge. https://doi.org/10.4324/9780429274442-1

Williams, D. R., & Stewart, S. I. (1998). Sense of place: an elusive concept that is finding a home in ecosystem management. *Journal of Forestry*, *96*(5), 18–23. https://doi.org/10.1093/JOF/96.5.18

Woodruff, S. C., & Stults, M. (2016). Numerous strategies but limited implementation guidance

in US local adaptation plans. *Nature Climate Change*. https://doi.org/10.1038/nclimate3012

Yohe, G., & Leichenko, R. (2010). Adopting a risk-based approach. *Annals of the New York Academy of Sciences*, *1196*(New York City Panel on Climate Change 2010 Report), 29–40.

Yung, L., Freimund, W. A., & Belsky, J. M. (2003). The Politics of Place: Understanding Meaning, Common Ground, and Political Difference on the Rocky Mountain Front. *Forest Science*, *49*(6), 855–866.

Ziervogel, G. (2008). Feeling Stressed: integrating climate adaptation with other priorities in South Africa. *Environ*, *50*, 32–41. https://doi.org/10.4135/9781446212868.n11

Ziervogel, G., Archer van Garderen, E., & Price, P. (2016). Strengthening the knowledge–policy interface through co-production of a climate adaptation plan: leveraging opportunities in Bergrivier Municipality, South Africa. *Environment and Urbanization*, *28*(2), 455–474. https://doi.org/10.1177/0956247816647340

Ziervogel, G., Cowen, A., & Ziniades, J. (2016). Moving from Adaptive to Transformative Capacity: Building Foundations for Inclusive, Thriving, and Regenerative Urban Settlements. *Sustainability 2016, Vol. 8, Page 955*, *8*(9), 955. https://doi.org/10.3390/SU8090955

Ziervogel, G., Enqvist, J., Metelerkamp, L., & van Breda, J. (2022). Supporting transformative climate adaptation: community-level capacity building and knowledge co-creation in South Africa. *Climate Policy*, *22*(5), 607–622. https://doi.org/10.1080/14693062.2020.1863180

Zscheischler, J., Westra, S., Van Den Hurk, B. J. J. M., Seneviratne, S. I., Ward, P. J., Pitman, A., Aghakouchak, A., Bresch, D. N., Leonard, M., Wahl, T., & Zhang, X. (2018). Future climate risk from compound events. *Nature Climate Change*, *8*(6), 469–477. https://doi.org/10.1038/S41558-018-0156-3