EXPLORING THE USE OF CLIMATE INFORMATION IN PRACTICE

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Para Nina, Paolo y la pequeña Sophia.

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List of Abbreviations

AEMET	Spanish State Meteorological Agency
AR5	Synthesis Report, Fifth Assessment Report IPCC (2014)
CBMP	Cloudburst Management Plan
CI	Climate Information
CoP	Community of Practice
DKK	Danish Krone
DMI	Danish Meteorological Institute
DOT	Territorial Planning Guidelines (from Spanish: Directrices de Ordenamiento Territorial)
EAD	Expected Annual Damage
EU	European Union
e.g.,	For example,
GCM	Global Circulation Models
GDP	Gross Domestic Product
GEUS	Geological Institute Denmark
GIS	Geographic Information System
H2020	Horizon 2020
ICLEI	Local Governments for Sustainability
ICT	Information and Communication Technologies
i.e.	In essence,
IPCC	Intergovernmental Panel on Climate Change
NAP	National Adaptation Plan
NBS	Nature Based Solutions
NGOs	Non-governmental Organisations
OECC	Spanish Climate Change Office
PGOU	General Urban Plan
PNACC	National Climate Action Plan
PTP	Partial Territorial Plan (From Spanish: Plan Territorial Parcial)
PTS	Sectorial Territorial Plan (From Spanish: Plan Territorial Sectorial)
Ramses	Reconciling Adaptation, Mitigation and Sustainable Development for Cities
RCP	Representative Concentration Pathway
SDG	Sustainable Development Goals
SEAP	Sustainable Energy Action Plans
SECAP	Sustainable Energy and Climate Action Plan
Sic.	sic erat scriptum
SRES	Special Report Emissions Scenarios
SWM	Storm Water Management
T10	Return period (10 years).
UK	United Kingdom
URA	Basque Water Agency
WMO	World Meteorological Organisation

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Abstract (English)

The degree of use of climate information in city administrations has traditionally been attributed to factors about people, their embedding institutional contexts, as well as to particular facts about climate information. This dissertation argues that explaining the significance of use of climate information based on facts and factors ignores the social dimensions of usability: how social interactions, people's agency and experiential knowledge and learning shape differences in usability outcomes. This dissertation addresses this conceptual gap by explaining the use of climate information as practice. Based on empirical evidence gathered in three case studies (the city administrations of Bilbao, Donostia/San Sebastian and Copenhagen) the research explains how the use of climate information occurs as a result of multiple practices coordinated and articulated in the context of work. The research brings to evidence how the use of climate information transpires in multiple constellations of practices (*anchoring and enabling practices*), and as a dynamic process of practice change which unfolds as actors learn by interacting with climate information and validate their practical knowledge with key stakeholders. The research shows that the use of climate information is judged by similar normative criteria that orient municipal work, while it also illustrates how usability depends on gaining legitimacy from actors operating in political, strategic and operational arenas. The use of climate information is evidenced as an outcome of people's decisions and interactions in a working context, shedding light on people's agency and recognising that what people do, matters with regard to the outcomes of usability.

This dissertation presents a novel perspective on usability which centres on the social dimensions of the use of climate information. By shedding light on the connection between working practices and the use of climate information, and by explaining how municipal and usability practices change, the findings emerging from this research can inform ex-ante assessments to identify pre-conditions of usability in city administrations, as well as be applicable to undertake ex-post assessments about the impact of climate information in cities.

Abstract (Deutsch)

Erläuterungen zur Nutzung von Klimainformationen in Stadtverwaltungen beziehen sich in der Regel auf Faktoren, die Menschen und die Kontexte, in denen sie agieren, betreffen sowie auf gewisse Fakten zu Klimainformationen. Diese Dissertation argumentiert, dass die Nutzung von Klimainformationen auf Fakten und Faktoren zu beschränken die sozialen Dimensionen der Handlungsrelevanz für Entscheidungsträger (*usability*) ignoriert, da Erstere nicht in der Lage sind zu erklären, wie die Komplexitäten der sozialen Interaktionen, Handlungsmächtigkeit der Menschen (Agency) und erfahrungsbasiertes Lernen Unterschiede in den Ergebnissen der Nutzung von Klimainformationen hervorrufen können. Diese Arbeit nimmt sich der konzeptionellen Lücke an, indem sie die Nutzung von Klimainformationen im Rahmen sozialer Praktiken (*practice*) erklärt. Auf der Grundlage empirischer Erkenntnisse aus drei Fallstudien (aus den Stadtverwaltungen von Bilbao, Donostia/San Sebastian und Kopenhagen) befasst sich die Arbeit damit, wie die Nutzung von Klimainformationen als Resultat mehrerer im Arbeitsablauf koordinierter und artikulierter Praktiken erfolgt. Die Forschungsarbeit zeigt auf, wie sich die Nutzung von Klimainformationen in vielfältigen Konstellationen sozialer Praktiken (*anchoring* und *enabling practices*) zeigt, und sich als dynamischer Prozess der Veränderung der Praktiken entwickelt, während die Akteure durch die Interaktion mit Klimainformationen lernen und ihr praktisches Wissen im Austausch mit wichtigen Interessensgruppen bekräftigen können. Die Arbeit beschreibt, dass die Nutzung von Klimainformationen nach ähnlichen normativen Kriterien beurteilt wird, nach denen auch die Arbeit in den Stadtverwaltungen ausgerichtet ist; sie zeigt jedoch auch, wie die Nutzbarkeit von der Legitimation von Akteuren in politischen, strategischen und operativen Bereichen abhängt. Die Nutzung von Klimainformationen wird als Ergebnis von Entscheidungen und Interaktionen von Menschen in einem Arbeitskontext nachgewiesen, beleuchtet die Handlungsfähigkeit der Menschen und erkennt an, dass das, was Menschen tun, für die Ergebnisse der Nutzung von Klimainformationen von Bedeutung ist.

Diese Dissertation präsentiert eine neuartige Perspektive der Handlungsrelevanz für Entscheidungsträger (*usability*), die sich auf die sozialen Dimensionen der Nutzung von Klimainformationen konzentriert. Indem der Zusammenhang zwischen Arbeitspraktiken und der Nutzung von Klimainformationen beleuchtet und der Wandel kommunaler und Nutzungspraktiken erläutert wird, können die aus dieser Forschung gewonnen Erkenntnisse in Ex-ante-Bewertungen einfließen, um Voraussetzungen für die Nutzung in Stadtverwaltungen

zu identifizieren, sowie anwendbar sein, um Ex-post-Bewertungen über die Auswirkungen von Klimainformationen in Städten durchzuführen.

Summary

This doctoral dissertation is about the use of climate information in local governments, and its aims are to improve our understanding about the mechanisms that enable the use of climate information, and about the consequences that the use of climate information provokes on how people work. The research takes a case study approach based on the municipalities of Bilbao, Donostia/San Sebastian and Copenhagen, and planning and decision-making processes which occur in these cities are seen as windows to inquire how people interact with climate information, centring the research around the question *How does the use of climate information occur in practice?*

While the contribution of climate information to the planning processes of local governments is not yet well established (Lorenz et al., 2017), sufficient evidence suggests that access to and availability of climate information do not necessarily lead to the design of climate adaptation policies or planning processes (O'Brien et al., 2003, Lemos et al., 2012; Lorenz et al., 2017; Vaughan et al., 2014). Climate information is assumed to be usable if it helps to resolve policy problems, or if it fits decision-making processes in practice (Lemos and Rood, 2010). While multiple factors have been attributed to determine when climate information is usable (Lemos and Rood, 2010; Vaughan et al. 2014; Lorenz, 2017), still, there is a discrepancy regarding the influence of factors explaining differences in usability outcomes in different contexts.

In this dissertation, it is argued that explaining usability through facts and factors obscures the social dimension of usability, which demands a deeper comprehension about people's practical interaction with climate information. This dissertation addresses this concern by exploring usability as social phenomena that transpires through social practices in a working context.

The use of climate information is conceptualised as a set of coordinated practices that result as people engage with climate information in a working context. Empirical evidence presented in this dissertation suggest that usability encompasses multiple aspects involved in how people work, learn, assess work and become accountable for how they work. The case studies inform that the use of climate information occurs through an extensive constellation of practices. While some practices are enacted in direct connection with climate information, other non-climate related practices -which are part of the customary work in municipalities- facilitate and enable the use of climate information. Usability could be explained as an interplay of multiple "anchoring" and "enabling" practices. Anchoring practices are practices enacted in direct association with a climate information set, and enabling practices are practices whose reproduction provided an enabling environment for anchoring practices to occur. The constellation of anchoring and enabling practices is referred to as the constellation of usability

practices. Based on the data collected through interviews conducted in the three cities, the research identifies and analyses a total of 24 practices, which inform that climate information is used for five purposes: 1) to increase general awareness about the impacts of climate change; 2) to generate concrete narratives to contextualise climate risk as a policy issue; 3) to support the design of climate sensitive policies; 4) to position climate change as a source of coherence orienting municipal work; and 5) to inform the design of concrete projects.

The case-studies illustrate different drivers of usability: attention to climate information was triggered in the aftermath of an extreme event, legal obligation or increased awareness regarding future risk. However, these impulses were not sufficient for positioning the use of climate information in practice. Usability always required a degree of legitimation and endorsement from key audiences operating in political, strategic or operational arenas. In this context, the use of climate information normally occurred when usability complied with the standards of appropriate practice against three types of normative evaluative criteria: Normative-political, normative-procedural and normative-cultural criteria.

1) In Bilbao, the use of climate information is in a "positioning mode", implying that endorsement is being sought in order to grant usability an official status;
2) In Donostia/San Sebastian, the use of climate information is in an "aligning mode", implying that while climate information has been granted an official status, usability is challenged by the need to coordinate a number of policies, plans and decrees;
3) In Copenhagen, usability is in a "maintenance mode", which recognises that while an official status and legitimacy have been gained, these have to be "maintained" against perceived threats from future changes in climate conditions, urban patterns or changing political agendas.

In persuading, negotiating, accepting or disregarding the use of climate information, learning always emerged; since these decisions occurred through social interactions and were shaped by previous experiences, understandings, rules, meanings and norms. Usability could be observed as an outcome of people's decisions, shedding light on people's agency and recognising that what people do, matters with regard to the course of usability and for how people work.

The case studies highlight two core aspects linking work and usability:
1. Working practices matter for usability because they reflect the values, understandings and experiences that structure a contextual logic of how work is expected to unfold. Hence, they inform us how usability is expected to occur;

2. The use of climate information is subjected to a similar framework of values that circumscribe municipal work in general; and it is therefore exposed to similar assessment criteria that apply to conventional working practices.

Common patterns linking work and usability across the three cities, evidenced that the use of climate information transpires in at least four dimensions: *a) a legitimacy dimension,* which acknowledges that the use of climate information is positioned in practices through purposeful legitimating activities; *b) an outcome dimension*, where the use of climate information is enabled by other practices (customary municipal practices); *c) a consequential dimension,* where the use of climate information provokes new practices to emerge and working practices to change*; d) and a processual dimension*, which recognises that the previous three dimensions are an intrinsic part of a structuration process (Giddens, 1984), where usability results from the interaction between people and climate information, in a mutually constitutive dynamic where the use of climate information is shaped by people's decisions at the same time that it shapes people's decisions; hence, shaping its own context of use.

As the context of work is dynamic, practices are dynamic, too. Changes in practices could be observed through the emergence of new ways of doing things through the transformation of old practices or the emergence of new practices. Change could be linked to changes in the material and knowledge compositions of practices, which shows how learning in practice occurs as people interact with climate information.

The innovation of this research is conceptual; but in addition, it brings practical implications to research in the field concerned with the use of climate information, since it exposes gaps in the conventional understanding of usability and proposes a way forward to its future research by offering a new conceptual perspective on usability. This new perspective is materialised as an analytical framework which is presented at the end of this dissertation and which it brings together the conceptual developments achieved throughout this research.

Introduction

This doctoral dissertation is positioned within a large field of research which is concerned with the application of scientific evidence for decision-making and practice. The dissertation explores the use of climate information for planning decisions in city administrations, and it takes a case-study approach based on three municipalities: Bilbao, Donostia/San Sebastian and Copenhagen. A central aim of this dissertation is to understand how people's practical interaction with climate information is structured, how practical knowledge emerges through the use of climate information, and how this practical knowledge shapes future interactions between municipal officials and climate information. In this context, this research is oriented by the following questions: ***How does the use of climate information occur in practice?*** *How does the use of climate information shape its own context of use? How are such practices enacted and validated collectively? What practices act in legitimating the use of climate information? What type of climate information enables adaptation to become a feature of institutions?*

Climate information has gained great attention among policy-makers and scientists for its presumed contribution to planning processes needed to address the challenges of climate change in cities (IPCC, 2012; Füssel, 2007). However, the contribution of climate information to the planning processes of municipalities has not yet been well established. For instance, based on research in cities in the UK and Germany, Lorenz (et al., 2017) concludes that "*the lack of specific regulation on adaptation at the local government level results in little decision-making or actions taken that would require the use of climate information*" (p. 426). Meanwhile, research undertaken in South-East Asia evidences a narrow scope for the application of climate information at a municipal scale, where the use of climate information is limited to studies of critical infrastructure and building stocks of cities, or for assessing risk variables to map out risk prone areas (Apikul, 2010).

Municipal planning in the context of climate adaptation is an intricated issue. Barriers have been linked to the complex landscape in which municipal decision-making takes place, where a fast convergence of social, political, economic and environmental challenges blur the boundaries of policy problems and solutions, trapping planners in systems of ambiguous causal webs where problem boundaries and causes are unclear (Darwin, 2002 in Lonsdale, 2010). In this context, adaptation to climate change is affected by the "*wicked problems of public policy"* (Rittel and Webber, 1973 in Lonsdale, 2010), where "*the need for forward reasoning is constrained by time and by irrational discount rates applied to the future*" (Levin et al., 2012,

p. 278). Adaptation efforts are affected by "*uncertainty about future climate impacts; ambiguity as to how improvements might be made; and by a problem which has no limits in terms of the time and resources it could absorb*" (Chapman, 2002 in Lonsdale, 2010, p. 60). Additionally, sufficient evidence suggests that cities mandates and responsibilities most of the times do not match powers needed to meet adaptation goals. A UNISDR (2017) extensive analysis of cities around the world revealed that "*lack of financial and/or technical capacities to undertake disaster risk reduction and resilience building actions and limited vested authority in accordance with existing laws and institutional set-up*" limit the capacity of cities to implement disaster risk reduction strategies (p. xiii). Paradoxically, the analysis notices that, while local governments have the highest level of powers to develop a city vision and strategic planning, risk- informed urban plans and disaster management plans; by contrasts, cities have low powers to develop and enforce more meaningful actions, such as imposing building codes (UNISDR 2017). As a result, scholars have made evident that access to and availability of climate information do not necessarily lead to the design of climate adaptation policies or climate sensitive planning processes (O'Brien et al., 2003, Lemos et al., 2012; Lorenz et al., 2017; Vaughan et al., 2014).

Information is "*formatted data... processed for a purpose'... (it) adds value to the understanding of a subject ... is meaningful and useful to human beings"* (Rowley, 2006 p.170). **Climate information** is defined as *"information about past, present and future climate conditions from both local and scientific sources, and the resultant implications on development, people's livelihoods and the environment... It provides a way of analysing the nature and scale of impacts due to past and current climate and the potential future impacts as the climate continues to vary and change"* (Shaka, 2014, p. 7).

The ***usability*** of climate information (a term coined by Lemos and Rood (2010)) is normally associated with instrumental applications of scientific knowledge for making informed decisions (Weiss, 1979). In these terms, climate information will be considered usable if it informs about policy processes (Apikul, 2010), if it helps to resolve policy problems, or if it fits *"decision-making processes and decision environments in practice"* (Lemos and Rood, 2010, p. 674). As "fit" and "applicability" have become the conventional criteria to establish whether climate information is usable, scholars have focussed their research efforts around the identification of facts and factors that make climate information fit and applicable (Lemos and Rood, 2010; Vaughan et al. 2014; Lorenz, 2017, Flagg et al. 2018). These include "*technical factors (e.g., information formatting, timing of release, level of skill); cognitive factors that*

influence the way users perceive the science generated information (e.g., communication, trust, credibility, accessibility, experience); institutions that facilitate or constrain the use of new knowledge; and structural factors that shape the capacity of different decision makers to use projections (e.g., lack of access to knowledge, lack of choice in term of alternative technologies or policy change) or the challenge of framing of climate change as a problem" (Lemos and Rood, 2010, p. 674).

Explaining usability through facts and factors is a perspective that has enjoyed support among scholars, particularly among institutionalists. Schatzki (2005) informs that institutional approaches are rooted in a social ontology of individualism which holds a conviction that social phenomena "*... ultimately consist in and are explained by facts about people — either individual people or groups thereof*" (Schatzki, 2005, p. 466). An ontology of individualism maintains that social phenomena

1) "*consist of individuals and their relations... bound together through interlocking actions (e.g. a market) or individuals who share commonalities and maintain certain interactions (e.g. an ethnicity or a club)*";

2) are *"brought into existence by virtue of people holding certain attitudes and beliefs and performing certain actions"*; and

3) *"can be both, decomposed into and explained by properties of individual people"* .... (ibid. p. 466).

I argue that explanatory models attending the use of climate information have mostly followed an institutional approach based on an ontology of individualism, where usability is attributed to specific characteristics of climate information users, their organizations, the broader institutional and political environment within which they work (as in Lemos and Rood, 2010), or to specific context of use (as in Flagg et al. 2018, Mills et al., 2010). While institutional perspectives have provided essential insights to better understanding usability, they have simultaneously led scholars towards the persistent assumption that usability is to be explained as the result of the characteristics of individuals and the interplay with myriad factors. In this research it is argued that this is problematic for two reasons:

First, facts and factors are subjected to an attribution problem: the weight attributed to factors changes from context to context, from situation to situation. Hence, it is difficult to justify their degree of influence affecting usability outcomes across contexts and situations.

For example, before embarking on field trip for data collection it was assumed that the difference in the uptake and use of climate information among the case studies explored in this dissertation (Bilbao, Donostia-San Sebastian and Copenhagen) was going to be attributable to

different institutional contexts. However, although institutional contexts were very similar in Bilbao and Donostia; still, as it will be explained extensively throughout this dissertation, the outcomes of usability were comparatively different in both cities. On the other hand, it was taken for granted that a large difference in terms of access to information, capacity building schemes[1] and technological environments would explain differences in usability outcomes between Copenhagen and the other two Spanish cases[2]. Nevertheless, the institutional network supporting the use of climate information is in all three cases considerably robust, and access to capacity building schemes was widely accessible. Also, while the difference in the size of GDP in each city was large[3], expensive regeneration projects have taken place on a massive scale in Copenhagen as much as in Bilbao in the last decades, and regeneration projects can be used as a proxy indication of urban innovations which are attributed to factors enabling adaptation to climate change (Balaban et al., 2013). Another observation was that while legislation was assumed to be a decisive factor explaining differences in usability; nevertheless, both Spain and Denmark have been very skilful in aligning their environmental, social and climate legislation according to European standards. While developing local adaptation plans is compulsory by law in Denmark, the two Spanish cases have also developed adaptation plans following EU standards. Finally, it was assumed that internationalisation could play a decisive role in usability outcomes; however, the three cities actively participate in international fora (Covenant of Mayors, Resilient City Networks and participate in Horizon 2020 projects as beneficiaries)[4]. As these observations suggest, institutional, legal and resource factors could not fully explain differences in usability outcomes across the three cities. However, what became evident from the interviews it was that people's forms of interaction were different across the case studies and to a large extent this resulted in differences in usability outcomes. The interviews highlighted that the way in which people work and how decisions regarding the use of climate information were made, resulted fundamentally from normative frameworks that orient expectations of how work is to be performed, and also from whether knowledge that emerged from experience in using climate information could be made valid among decision-makers. These observations suggest that intending to explain usability through facts and factors would have led to conceptual propositions with a limited scope of application, since they could not have explained how social phenomena manifests in the use of climate information.

[1] Moon (2005) suggests that factors such as training (among others) influence the adoption of geographical information system (GIS) in local governments.
[2] In the field of IT, Brudney and Selden (1995) suggest that "professionalization" of staff is a major driver for adopting innovations.
[3] Castan-Broto (2013) suggests that city wealth and population density do not accurately predict innovation in urban adaptation to climate change.
[4] Lin (2001) emphasises that diffusion through urban networks has an institutional transformational capacity.

A second problem emerges when trying to explain usability outcomes through particular factors, since such perspectives ignore how learning processes unfold and contribute to climate information becoming involved in planning decisions and transform the way in which people make decisions.

Explaining usability through facts and factors could not embrace the complexity behind the reasoning that applies in situations in which myriad aspects converge and define each other (Gherardi, 2012) and influence people's judgement to either use or disregard climate projections for planning. In other words, adopting Giddens (1984) angle, such perspectives ignore the role of people's agency in making a difference to usability outcomes.

Against this background, the core contention of this dissertation is that our understanding of how usability takes place will be incomplete if left to be explained only through ontologies of individualism because of 1) an attribution problem regarding *facts and factors that define use*, and 2) because they fall short of explaining how experiential knowledge and learning shapes usability.

In this context, the contribution of Practice Theory to exploring these problems lays on one of the central possibilities offered by Practice Theory, which is described by Welch and Warde (2017) as *„accounting for how very general ideas are incorporated into practice… how such understandings are transmitted, translated and appropriated by practices, how they inform and shape practices and in turn how they are themselves conditioned by practices"* (p. 195). With this context in mind, the goals of this research are to improve our understanding of the processes and mechanisms whereby the use of climate information is adopted and acted upon; and also, about the intended and unintended effects that the use of climate information provokes on the way in which people work and make decisions.

The dissertation is structured as follows:

- Chapter 1 -Theoretical and Conceptual frameworks- describes the theories that lead this research. The theoretical framework is oriented by theories of practice which predominantly focus on socio-material relationships as well as on the role of practical knowledge and normativity in shaping practices. The chapter presents also the Conceptual Framework, where concepts are discussed and interrelated in order to provide a perspective to understand and explain the use of climate information in practice. The Conceptual Framework departs from a central premise presented in Practice Theories, which posits that human interaction with material entities are mutually constitutive. I build on this premise and position climate information as a material entity, and propose a relational framework

to explain the interaction between municipal officials and climate information, integrating the aspects of legitimation, knowledge creation and normativity.

- Chapter 2 -Methodology-, describes the methodology used for applying the conceptual framework to each case study in order to identify and explore the practices. The chapter presents also the methods for case study selection, primary and secondary data collection and data analysis.
- Chapter 3 -Case Studies-, is constructed around the practices identified in each municipal administration. Practices are presented through narratives explaining how practices unfold in connection with normativity, experiential knowledge and human-material interactions.
- Chapter 4 -Discussion-, presents the central reflections that emerge from the analysis undertaken in the three case studies. The analysis is applied to respond each of the research questions.
- Chapter 5 -Conclusions-, presents the five concluding observations that emerge from this research.
- Chapter 6 -Innovation-, describes the innovation of this research and presents an analytical framework to study the use of climate information as practice.
- Chapter 7 -Research limitations and future research- presents the limits of this research and suggests future research steps.

Chapter 1. Theoretical and Conceptual Frameworks

1.1. Theoretical framework: Practice theory

Giddens's Structuration Theory (1984) is a departing point to discuss Practice Theories (Shove et al. 2012). Giddens sought to move beyond the conceptual limits posed by the dualism between structures and agents that problematize social theory (Jones et al. 2004). His work offers a middle way between naturalistic sociology (strong on structure, but weak on action) and interpretive sociology ('strong on action, but weak on structure') (ibid). The first tradition "*sees social phenomena as manifesting the operation of relatively enduring social laws by which objective, external social structures act on relatively passive human agents... (while the later) sees society as primarily an effect of human agency*" (p. 300). Giddens asserts that naturalism "*erroneously attributes purpose, reasons and needs to society rather than to individuals*" while Interpretive sociology has "*little to say on issues of 'constraint, power and large-scale social organisation'* (ibid). In Structuration Theory, Giddens proposes that structure and human agency should rather be understood as a mutually constitutive duality: *"While not made by any single person, society is created and recreated afresh, ... by the participants in every social encounter. The production of society is a skilled performance sustained and 'made to happen' by human beings"* (Jones et al., 2004, p. 20). For Giddens, structure is "*both medium and outcome of the reproduction of practices... a continuous ongoing process rather than a static property of social systems...(and).... a virtual order of transformative relations... orienting the conduct of knowledgeable human agents'* (Giddens, 1984, p. 17*).*

There is no unified theory of practice (Schatzki, 2002). The broad diversity of contributors – from Heidegger's and Wittgenstein's work (on understanding and rule-following); to Foucault, Pierre Bourdieu and Anthony Giddens, provide some examples of the wealth and diversity of this theoretical field (Rouse (2007-A).

> Researchers using a practice approach align with the idea that "*matters such as social order, knowledge, institutions, identity, power inequalities and social change result from and transpire through social practices*" (Nicolini, 2017, p. 98).

Practice scholars differ in their approaches to explain the social. Rouse (2001) highlights a dichotomy in practices: practices can be seen as the patterns of behavioural regularity that *"people learn and are assumed as the best ways…toward the fulfilment of their purposes"* (Turner, 2001 in Alexander, 2015, p.93); or as normative regularities (Rouse, 2001) where *"actors share a practice if their actions are answerable to norms of correct or incorrect practice"* (p. 189). Based on Rouse (2001), Schatzki (2001) makes a division between practices

as organized nexuses of activity (cooking), and practices as set of activities linked by common understandings and abilities (Rouse, 2001; Schatzki, 2001 in Alexander, 2015). These differences highlight approaches to see practices as performances or as entities. Schatzki's ideas of ***practices-as-entities*** as "*nexus of doings and sayings linked through understandings, explicit rules and teleoaffective structures*" (Schatzki, 1996 in Higginson, 2015, p. 953) can complement conceptualisations offered by practices seen as a performance as "*moments of integration between elements that occur when practices are enacted in particular local situations*" (ibid. p. 953). A practice-as-entities approach proposes that practices are enacted when the entities materials, competences and meanings are integrated (Shove, 2012). Shove considers that practices are defined by interdependent relations between these elements. For Shove, *Meanings* refer to interpretations and symbolic associations which are relatively uncontested, but also relative, situated and emergent; *Material entities* reflect and structure inequalities of access and hence the social distribution of different practices (Shove, 2012); but material entities can also include artefacts or *"scientifically-generated objects"* (Knorr-Cetina, 2001 in Alexander, 2015, p. 93), or be conceptualised as infrastructures that help humans to be competent practitioners (Gherardi 2012). *Competences* refer to competent participation in practices and with how people handle rules (Gherardi, 2012). Competence highlights another feature of practices: practices involve specialized knowledge and expertise.

Authors who embrace a ***practice-as-performance*** standpoint sustain that "*the basic unit of analysis is not a single scene of action or a specific situation or instance of the accomplishment of a practice; but rather, a chain, a sequence or a combination of performances plus their relationships –what keeps them connected in space and time*" (Nicolini, 2017, p. 101). This view centres on the idea that capacities and resources come together to enact practices "*as a publicly available accomplishment based on the situated assembling of a number of discursive and non-discursive practice*" (Nicolini 2012, p. 221). This perspective assumes that "*representing a practice requires that we capture and convey the actual work that goes into a practice … which is assembled collaboratively...(through)... relationships in time and space*" (ibid, p. 219).

Emerging from these distinctions and research emphases, different approaches are used for defining practices. For instance, "*Practices are loci –spatial and temporal- in which working, organising, innovating or reproducing occurs... a practice is a connection-in-action: that is, as an interweaving of elements which are shaped by being interconnected*" (Gherardi, 2012, p. 2-3). Reckwitz (2002) conceptualises practices as "*interdependencies between forms of bodily activities, forms of mental activities, things and their use, a background knowledge in the form*

of understanding, know-how, states of emotion and motivational knowledge" (Reckwitz, 2002 in Shove, 2012, p. 6). Schatzki conceptualises practices as "*a set of doings and sayings organized by a pool of understandings, a set of rules… and common and collective ends, projects, emotions and beliefs"* (Schatzki, 2001 p. 53).

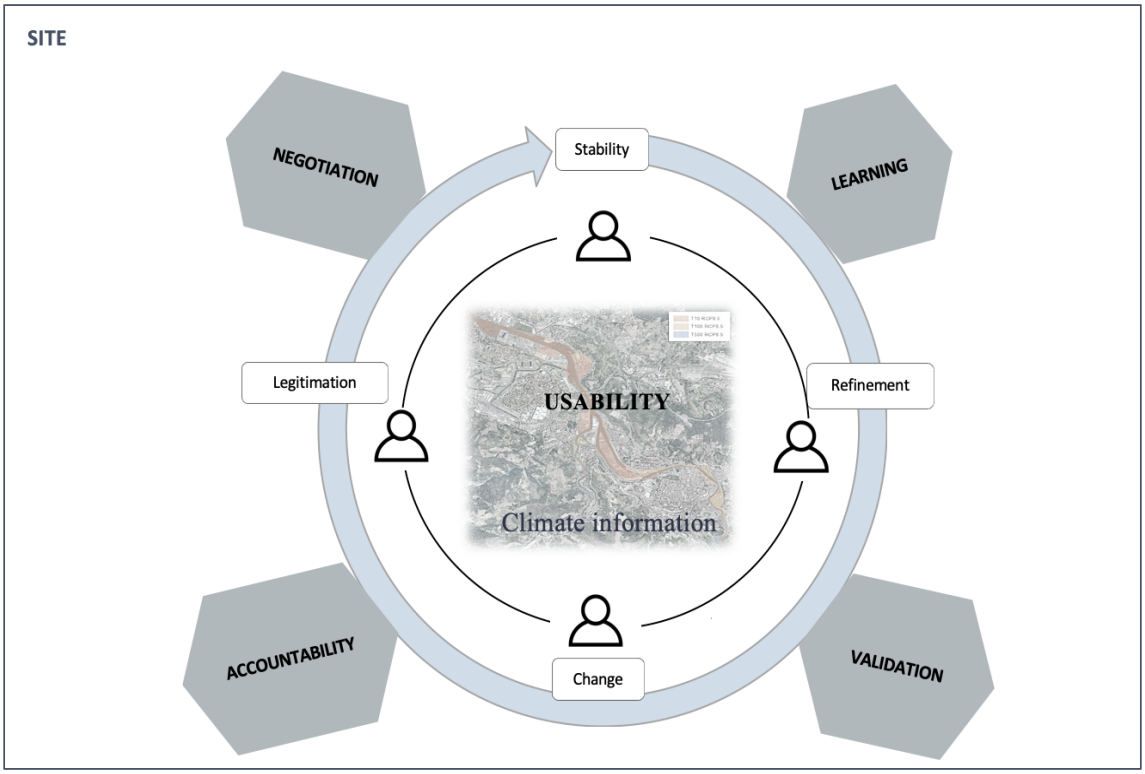
1.2. Conceptual framework

The examples and conceptualisations presented in this dissertation propose the idea of usability as practice as informed by core conceptualisations in practice theories:

Table 1: Usability as practice

Conceptualising usability as practice
As a constellation of practices, usability is best understood as a complex operation (Shove, 2012) which results from a chain and sequence of multiple performances (Nicolini, 2017) linked through understandings and explicit rules (Schatzki 1996), experiential knowledge and norms (Gherardi, 2012). Usability depends on the synchronisation of multiple practices (Gherardi, 2012) which are enacted through the integration of material entities, competences and meanings (Shove, 2012) and only if they "*are answerable to norms of correct or incorrect practice"* (Rouse, 2001, p. 189) in a working context.

Figure 1: The dynamic of usability practices.



Icons by Microsoft PowerPoint. Background map: I-Hobe, 2018.

The conceptual framework developed in this dissertation proposes that climate information is a material entity, and that usability occurs as climate information is provisionally linked to different working practices occurring in the context of municipal work. Since practices are dynamic, usability is assumed to be dynamic too. Ongoing social interactions between people and climate information are immersed in processes of learning by doing and legitimation, which result in stability and change. The normativity of work manifests through the implementation of municipal competences vis-à-vis planning needs in the context of climate adaptation.

This perspective is further developed through the following conceptual components:

1.2.1. Component 1: Usability

A distinction exists between practices as entities versus practices as textures. Practices-as-textures highlight a mutually influential interconnection among practices within a field -or "texture" of practices- that recognises that practices are dependent on other practices (Gherardi, 2012). This also refers to those practices synchronised to give rise to complex operations (Shove, 2012), such as those involved in the use of climate information. In these terms, usability is seen not as a single practice, but rather as the result of an unfolding connection among a set of practices that are coordinated and synchronized at the workplace.

1.2.2. Component 2: Climate information

In the constellation of practices within which usability takes place, climate information is conceptualised as a material entity. Material entities can range from a table and a chair (Schatzki, 2002) to more complex constructs embodied in the concept of technologies. Material entities give *"meaning to the doings and sayings of a practice"* (Schatzki, 2002, in Splitter et al. 2018, p. 6). Technologies are defined as "*an identifiable, relatively durable entity, a physically, economically, politically, and socially organized phenomenon in space-time"* (Orlikowski, 2000, p. 408). Conceptualised in terms of material entities and technologies, climate information highlights two features: first, climate information does not only represent data that has gained meaning (in line with Rowley, 2006); but also, climate information grants meaning to working practices. Second, conceptualised as a technology, climate information highlights "*material and cultural properties that transcend the experience of individuals and particular settings*" (Orlikowski, 2000, p. 408). These features position climate information not as a static material representation of theoretical knowledge; but instead, as an entity that it is shaped, while at the same time it shapes human action through ongoing interaction (Orlikowski, 1992).

Conceptualising climate information in these terms follows Orlikowski's Structuration Model of Technology (1992). The model centres on *"the social processes through which technologies*

are... used and institutionalized within organizations; the intended and unintended consequences of... using specific technologies; the conditions under which human actors reinforce or change the features or use habits of specific technologies; and the conditions under which human actors use technology to reproduce or transform their organizations" (Orlikowski, 2004, p. 317). This perspective highlights the "*nature and influence of human agency in technological use"* (Orlikowski, 1992, p. 398) and posits that socio-material interactions follow the structuration model presented by Giddens (1984): "*through their regularized engagement with a particular technology... users repeatedly enact a set of rules and resources which structures their ongoing interactions with that technology"* (Orlikowski, 1992, p. 407).

1.2.3. Component 3: The site

For Schatzki, "*the social site is a specific context of human coexistence: the place where, and as part of which, social life inherently occurs*" and it is composed of practices and social orders (Schatzki 2002: xi). Schatzki (2005) treats organizations as *"constellations of individual practices and arrangements forming a heterogeneous network linking to other practices and arrangements around it"* (Splitter et al 2018, p.12). For Schatzki (2002) "*practice-arrangement bundles generally form the 'frame' or context in which activities are performed and in which entities and activities gain their meaning"* (in Splitter et al., 2018, p. 7). Seen as a constellation of practices occurring at the workplace, the Site is conceptualised as the articulation of work applied to coordinate the use of climate information in each city administration.

The articulation of work includes *"...agreements on what has to be done, standards, resources used, places where work is coordinated, other actors, etc."* (Gherardi, 2012, p. 13). This perspective involves acknowledging that since work is not coordinated through one single activity, neither can usability be linked to one single activity. The coordination of work results from several collective activities which are relational; occurring at different levels, at different moments and in different situations (Gherardi, 2012): "*It is not enough that the work has been divided among specialised and coordinated tasks; that division must be constantly and cooperatively reproduced*" (2012, p. 13). Collective activities reflect how coparticipation, obligations and commitments from others are central features to practices (Blue et al. 2017). The articulation of work denotes all the work that is needed in order to "*establish, maintain and change the arrangements necessary to work both within one's own organisational unit and among different units"* (Gherardi, 2012, p. 11). People's work relates, depends and impacts on other people, "*which demands coordination of multiple activities in different times and places"* (p. 10). Synchronising work entails *"all decisions that constitute articulation that occur*

through agreements that have to be reached, maintained and revised through a constant process comprising diverse interaction strategies, like negotiation, discussion, education, persuasion, threat or coercion" (Gherardi, 2012, p. 13). Collaboration is therefore the result of practices deriving from common understandings, affects, meanings and significance (Hui et al., 2017).

Exploring the use of climate information entails two aspects being taken into consideration: 1) Gherardi (2012) explains that structuration processes occurring in workplaces do not follow a script; but instead, they occur on the go. Thus, solving problems, contingencies and answering to contexts brings experiential knowledge to the forefront of the analysis (ibid); and 2) usability is understood as a collective endeavour that demands coordination and synchronisation; therefore, it acknowledges the normative dimension that regulates people's interactions.

As a situational activity, work involves several decisions being taken in order to be performed. The performance of work is linked to the practical knowledge that emerges from everyday people's interaction and their experience from dealing with emerging challenges: "*knowledge... is knowledge acquired from everyday experience, interaction with other people, the coordination of multiple activities with time and places and technologies…. (and)… it must be activated because it comprises the practical solution to problems*" (2012, p. 10). In these terms, knowledge is understood as an activity rather than as an object, and can therefore be analysed as a situated activity (Gherardi, 2012): *"Knowledge emerges from the context of its production and is anchored by (and in) material supports; therefore, practical knowledge is contextual as opposed to being decontextualized and theoretical*" (ibid. p. 253). Practical knowledge is thus situated and reproduced in each practice, constituting the continuation of competence and skill which is to be achieved throughout time and contexts (Gherardi, 2012). Hence, knowing and practising are mutually constitutive phenomena, and knowledge becomes an ongoing social accomplishment that changes in every enactment -entailing that knowing is not stable or permanent (ibid).

Gherardi (2012) stresses that while the interactions behind the articulation of work "*are customarily established... through a series of collaborative and competitive strategies*" (p. 11), these strategies require negotiation and persuasion, and once established they do not last forever and are often interrupted (ibid).

Normativity "*of sense, consensus as well as prescription*" (p. 4) are central to practices because they constitute "*the aesthetic and ethical judgements on what is thought to be a correct or*

incorrect way of practising within the community of its practitioners" (p. 70). Thus, "*practices allow us to see how normativity emerges from situated action"* (p. 87). In the normative sense, Rouse (2001) explains that "*actors share a practice if their actions are answerable to norms of correct or incorrect practice*" (p. 189). For Rouse (2007-A), normative accountability is what characterises the performance of practices, and not so much regularities or commonalities among the activities (in Gherardi 2012, p. 70). Schatzki (2002) refers in these terms to "practical intelligibility" to specify the existence of orientation regarding the appropriate activities in a given situation. In these terms, acting appropriately requires sufficient bodily capabilities, abilities and the proper use of material entities (Splitter et al 2018). In these terms, knowing and normativity become complements of one another since knowing is knowing how to participate in a practice (ibid).

1.2.4. Component 4: Legitimacy

The concept of legitimacy is carefully explained given different perspectives regarding this particular concept between Practice Theory and other more classical sociological theories. From a classical sociological perspective, social practices are characterised as "*being oriented to maxims or rules, and thus legitimacy emerges out of conformity with both general social norms and formal laws*" (Deephouse and Suchman 2008, p. 50). This view is further sustained by Parsons (1956, 1960) "*congruence of an organization with social laws, norms and values*" and later by Scott (1995) "*cultural alignment, normative support, or consonance with relevant rules or laws*' (ibid p. 54). Legitimacy is normally conceptualised in Suchman's (1995) terms as a normative construct that reflects the "*shared value premises that structure collective assessments of the good and the bad* (1995, p. 574).

However, Practice theory –and particularly through the works of Reckwitz (2019, in Hui 2019) contest the classical sociological norm-orientated model of social action (a universally applicable set of norms orienting society), arguing that assuming *"the identity of the social with normative orders or orders of knowledge... (results) in an understanding of affects as non-social, non-cultural phenomena occurring within an individual body or individual psyche"* (p.117). Welch (et al., 2015) explains that *"social order and action is a feature of, and established through, the field of human practices" (p.2).* From this perspective, norms are by no means universal and static.

However, empirical evidence emerging from the case studies suggests that usability practices have a purposeful orientation in response to the specific social problems that are characteristic to political, strategic or operational arenas. This concern led to acknowledging the usefulness

of specific features from Suchman's (1995) legitimacy framework, which are carefully integrated in this framework. These features include:

a) The multifaceted character of legitimacy implies that it will operate differently in different contexts, and how it works "*may depend on the nature of the problems for which it is the purported solution*" (Suchman 1995, p. 573). It is in these terms that the use of climate information is conceptualised as a subject of legitimation "*whose acceptability is being assessed*" (Johnson, 2004, p. 10–11 in Deephouse 2008); highlighting thus the idea that legitimacy "*emerges out of the subject's relation to other rules, laws, norms, values and cognitive frameworks..."* (p. 72).

b) Legitimacy can be gained, maintained or need to be repaired (Suchman 1995). Different strategies emerge addressing each of these needs, which reflect two characteristics of legitimacy: 1) legitimacy is only provisional: "*legitimacy is a continually unfolding process in which different scenarios can be identified at different points in time*" (Deephouse et Al. 2016, p. 4); 2) legitimacy changes with time as *"organizations, sources (of legitimacy), and criteria change over time"* (ibid. p. 4). In this context, Suchman (1995) explains that *"legitimacy is possessed objectively, yet created subjectively... legitimacy is socially constructed in that it reflects a congruence between the behaviours of the legitimated entity and the shared (or assumedly shared) beliefs of some social group; thus, legitimacy is dependent on a collective audience, yet independent of particular observers"* (1995, p. 574).

Chapter 2. Methodology

2.1. Qualitative paradigm

Analysing usability practices demands understanding the emergence and validation of practical knowledge in socio-material interactions, and understanding the role that working norms play on usability outcomes. The guiding analytical procedure adopted in this dissertation rests on a constructionist epistemology, which views knowledge as a compilation of human-made constructions (Raskin, 2002), while meaning and experience are assumed to be *"socially produced and reproduced, rather than inhering within individuals"* (Burr, 1995, in Braun and Clarke, 2006, p.16).

The ontological position is guided by the works of Schatzki (2002, 2005) and Giddens (1984). Shatzki's Ontology of Sites (2002, 2005) acknowledges *"just one level of social reality –the level of social practices-",* which situates human activity and all social phenomena within intertwined practices (Schatzki, 2005, in Splitter et al. 2018, p. 2-3). A site's ontology (Schatzki, 2005) orients the conceptual lens to see the case studies in this research as sites, composed of *"constellations of individual practices and arrangements"* (Splitter et al., 2018, p.12) which occur within the boundaries of public administrations. In this context, the site's perspective is informed by a work-place study approach (Gherardi, 2012) which focuses on people's activities and on visualising the knowledge embedded in the use of technologies in working environments (ibid).

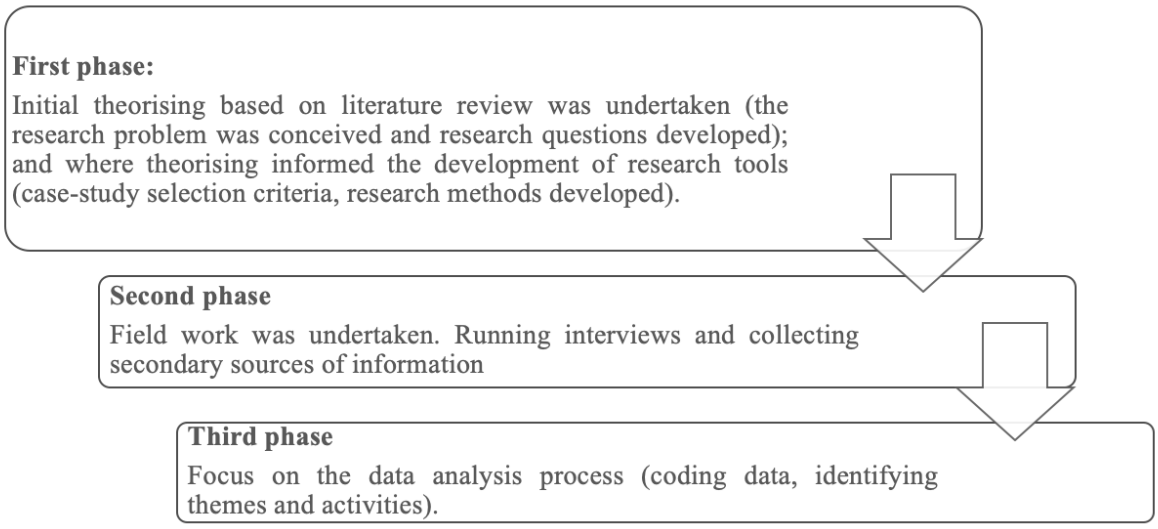
Gidden's Structuration Theory explains that "*human activity and the social structures which shape it are recursively related*" (Shove 2012, p. 3). Orlikowski's (1992) Structuration model of technology –rooted in Gidden's Structuration Theory- establishes the relationship between humans-materials as a mutually shaping relationship, where practical knowledge and learning emerge through the use of material entities. Thus, Structuration theory provides an ontological framework to explore the dynamics of knowledge generation, continuity and change through the interaction between people and climate information.

2.2. Research design

The research takes a case study approach and focuses on the city administrations of Bilbao, Donostia-San Sebastian and Copenhagen. A municipal perspective presented the challenge of identifying the practices that are coordinated to enable the use of climate information in a working environment. It also presented the task of identifying the effects provoked by climate information on working practices. Thus, the research methods needed to satisfy two central aspects. On the one hand, to allow the researcher to identify and investigate the practices that shed light on how climate information is used. On the other hand, to identify and explain the

activities whereby the use of climate information becomes provisionally legitimised as part of planning and decision-making.

Three phases mark the development of this research:



The initial phase of the research took a deductive approach, since the research question was clearly established based on a theoretical framework previous to field work being undertaken. However, as data was collected, the research began moving swiftly towards a more inductive approach in which conceptualisations initially developed theoretically had to be recalibrated in order to better explain the social phenomena being observed. This was a turning point in the research: empirical data was displaying new shades to the previous theoretical propositions and new important themes were emerging. What was being seen in the case studies could not all just simply be fitted within initially theorised categories/codes, and new categories had to be defined and previous categories re-calibrated. The research was thus starting to take a more inductive approach, a stage in which it was simply necessary to maintain sufficient flexibility to let data drive the analysis vis-à-vis initial theoretical conceptualisations and the research questions.

2.2.1. Literature review

The literature review unfolded from a general to a more specific search process. Initially, prominent literature review and benchmark papers provided a general descriptive map of the crucial debates regarding the use of climate information and practice theory. This literature set resulted from an on-line search, specifying terminology such as “use of science in policy”, “use climate information”, “usability”, or “urban climate change”. Benchmark papers were advised by different colleagues; or were identified as the researcher participated in colloquiums, conferences, summer/winter schools and seminars; or were linked to consultancy work previously undertaken by the researcher. These papers provided a wealth of literature sources,

and based on the discussions exposed in prominent literature reviews, specific papers were selected. As a snowball effect, the sources of information multiplied rapidly, and the way to keep information manageable was by setting a research question at the early stages of this research. While the question experienced modifications, in essence, it searched to understand the particular phenomena exposed previously in the research problem.

Table 2: Topics covered by literature review

Research aspects	Topics and most prominent authors
The use of climate projections	Lemos and Rood (2010) who establish the conceptual difference between usefulness and usability of climate information
Urban perspectives on the use of climate information	Vaughan and Dessai (2014)
Progression from data to information	Rowley (2006)
Practice Theory	Gidden's (1984) Structuration Theory, Orlikowski's (1992) Structuration model of technology and Gherardi's (2012) work on practice theory in work-places. Schatzki (2000, 2002, 2005), Nicolini (2012), Shove (et al., 2012) and Hui, (et al., 2017).
Use of science-use in practice and policy and science-policy interaction	Weiss, 1979; Nutley et al., 2009
Urban adaptation to Climate change	Urban Resilience (Satterthwaite et al., 2007), Climate Adaptation (Adger, 2006), and more recently on Transformation (O'Brien et al., 2015) and Mainstreaming Framework (Gupta, et al., 2010).
Management theory	Theory of Absorptive Capacity (Cohen and Levinthan, 1990) to Roger's (1971) Diffusion of Innovations Theory, and Geels' (2001) Technological Transition Framework
Governance theory	Issues regarding the distribution of power for decision-making and institutions and processes of institutionalisation emerged as central considerations in the context of public administrations (Young, 2008; Ostrom 2010; Lankford, 2010)

While it was considered important to explore the potential contributions from different theoretical perspectives to the question of usability, the epistemological and ontological position adopted by the researcher led the research to engage critically with the literature that explained social phenomena through factors and causal relationships (prominent among Management and Institutional theorists). Practice theories were therefore central to constructing a conceptual framework and to design the data collection methods.

2.2.2. Case study selection

Municipalities are defined as administrative structures with specific competences to manage and organise the territory within their jurisdictions, to deliver services and to enforce mandates through administrative functions and attributions that are based on legal decrees (own definition). Municipal officials are defined as public officials working in a municipality whose

activities and decision-making capacity are shaped within the scope of administrative competences (own definition).

The case studies were selected using purposive sampling in order to directly answer the research questions; while the research questions provided the guidelines as to which cases had to be sampled (Bryman, 2012). The criteria for selecting city administrations were the following:

- the city has an active membership in a European climate network (Covenant of Mayors, ICLEI, Climate Alliance); or, it has participated actively in international research projects (Horizon 2020);
- the city's experience using climate information can be tracked for at least 4 years, as presented in formal or informal documents (reports, meeting minutes, scientific papers);
- the cities were quick and responsive to the need to run elite interviews with high and middle-rank officials.

Cities complying with these three criteria were considered. As a result, the case study selection included the cities of Bilbao and Donostia/San Sebastian in the Basque Country of Spain and Copenhagen in Denmark. The cities provided a good sample not only because they fulfilled the initial criteria; but also, because they share some similarities: they are either provincial, regional or country capitals, relevant financial and industrial centres and with the goal of becoming European centres of innovation. Additionally, these cities display a large cultural diversity in which to examine differences in working cultures.

2.2.2.1. Generalizability and external validity

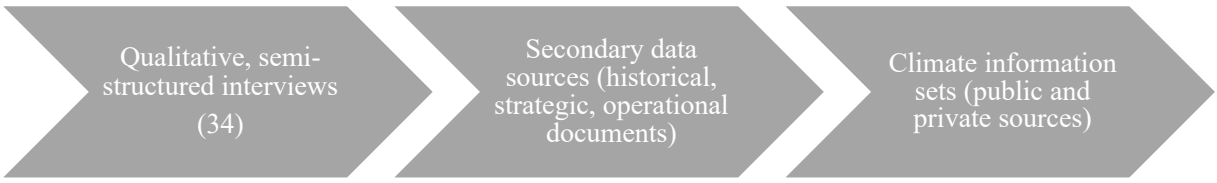
While one or a few case studies cannot be representative of the reality of all local governments, the particular case studies outlined in this research deliver consistency to the criteria for generalizability and external validity. The three case studies are critical cases where the use of climate information occurs in practice; hence, they offer lessons that can be useful to other cities. They are also representative cases that characterise a broader category of cities and provide a suitable context for the research questions to be answered (Bryman, 2012). In order to comply with the requirements of reliability and avoid using data only as illustrative material (Meyer, 2014 in Pohlmann, 2018), data and data interpretation are presented in the case study chapters, while data collection methods are presented in detail in Annexes 2 and 3.

2.3. Data collection methods

Data collection methods were designed to explicitly search for the data that could answer the research questions. Given the researcher's previous experience in working with climate adaptation in local governments, a base of experiential knowledge guided the exploration of

theoretical foundations. However, an open perspective was always kept in order not to bias observations according to past experience; and rather, allow past experience to promote a critical view and a method for identifying biases that could emerge from opinions expressed by interviewees.

The following data collection methods were undertaken



2.3.1. Qualitative semi-structured interviews:

A list of theoretical themes emerged from the literature review which were described in an excel file. Each theme was then analysed and clustered in thematic areas, yielding a total of 23 thematic areas[5], which centred around issues of responsibilities and decision-making power; normativity, working culture and experiential knowledge. Thematic areas oriented the generation of theoretical codes that were used to label aspects of interest in the literature being revised. The theoretical codes were defined as: 1) Practice; 2) Opportunity; 3) Challenge; 4) Climate information; 5) Decision-making; 6) Know-how, learning; 7) Practice effect; 8) Change and stability; and 9) Norms and Legitimation.

Thematic areas became thematic questions, broad enough to be designed as questions for a semi-structured interview. Thus, interview questions could be sustained by, and linked to theoretical foundations. The process was organised in an excel file which allowed for tracking the theoretical foundation of each question, which later facilitated the analytical process. The links between research questions and thematic areas can be seen in Annex 1. The interviews were organised as semi-structured interviews with 15 semi-structured questions. Questions were designed in such a way as to induce interviewees to reflect about the specific activities they associate with the use of climate information.

Municipal officials interviewed were either directors of a municipal department or part of the technical team involved in the design of policies, projects or implementation and maintenance of infrastructures. Complementing interviews to stakeholders at the regional level, from NGOs, research centres and companies were also carried out in order to fully grasp the constellation of

[5] Sub-thematic areas: Scoping practices; Activities within practice; Regularity of practice; Repetitions of practice; Materiality & performance; Modes of ordering as Stabilisation mechanism; Performance & connectivity; Materiality and connectivity; Meanings; Competences & membership; Planning Arenas (Political; Managerial; Strategic; Operational); Combinative capabilities; Knowing; Priority granting; Norms; Accountability; Monitoring; Power relations; Changes in prescription; Changes in how the technology is perceived; Expectation formation; Cumulativeness and Changing mechanisms in institutions".

actors delivering climate information to local governments. However, their role as external providers is presented in a descriptive rather than analytical fashion. In this context, while reference to citizens and neighbours is stated through the research, their role is integrated in the social orders framework but only as informed by municipal officials, since no direct interview to neighbours took place. The resulting interview questions can be seen in Annex 2. A list of interviewees can be found in Annex 3.

A total of 34 interviews were undertaken. Interviews lasted for approximately 80-90 minutes each. The interviews were recorded and added up to a total of nearly 43 hours. In the Spanish cases, interviews were run in Spanish, while in Copenhagen, the interview language was English. Interviews were fully transcribed paying particular attention to verbal and non-verbal utterances (longer-time laps before answering, coughs, exclamation, annoyance, humour, surprise or irony). For the Spanish case studies, transcription was done in Spanish while the Danish case was fully transcribed in English. ©Google-translate was used to translate quotations that were taken directly from any of the Spanish cases. Ensuring the correct interpretation was a task undertaken by the researcher, whose mother language is Spanish. The full transcription was coded in an excel file following the in-vivo method. It is important to notice that each time direct quotations are presented throughout the dissertation, these follow the format (for example): "*text in Italic*" (BA5), where in this case "B" represents the city (in this case "Bilbao"), "A" represents the first interviewee, and "5" represents the section in the interview that was selected from the transcription.

2.3.2. Secondary data collection

Previous to field work, diverse sources of secondary data were analysed and catalogued in an excel file. These were documents available in the web and mostly looked at climate adaptation plans, legal decrees, and other information considered relevant to each case study. During the field work, secondary data collection was integrated as advised by the interviewees. Secondary data was classified as:

2.3.1.1. Historical documents: The focus was placed on documents that provided an account of how practices and policies have changed: meeting minutes, communiques and web resources; project and policy reports. These documents were used during the interviews in order to inquire about the context where such change happened and to reconstruct the trajectory of events.

2.3.1.2. Strategic documents: Documents describing the functional division of labour (changes in administrative competences, duties and responsibilities); strategic documents where goals are set –such as for instance, climate adaptation plans, reports to the Covenant of Mayors[6], etc;

[6] https://www.covenantofmayors.eu

2.3.1.3. Procedural / legal documents: Official documents such as local ordinances, law, construction codes, planning standards; legal projects (updating existing planning tools), etc.

2.3.1.4. Climate data sets: Documents that provided explicit mention of climate information (climate projections) or reference to climate information was implicit within other forms of risk estimation (e.g., hydrological models including climate data, financial assessments). In the interview process, explicit reference to climate information sets used by the municipality were quoted in order to facilitate the understanding of the concept of climate information and usability. Climate information considered for each case study is presented in Annexes 6 and 8.

2.4. Data analysis

2.4.1. Coding

Coding is a form of qualitative data analysis that places an emphasis on how participants use specific words or phrases (Manning, 2017). Coding facilitates labelling segments of data with a description of what each segment is about: topics that are recurrent, expressions that provide hints on certain categories and boundaries, metaphors, similarities or differences in relation to certain topics (Bryman, 2012).

Coding was applied to identify boundaries in the activities undertaken by municipal officials. In this context, investigating practices represented the methodological challenge of isolating and analysing practices, observing their connectivity, relationships and circuits of reproduction in a way that provided a coherent account to explain the motives, aims and aspirations that dictated the rationale for using climate information. But boundaries between practices are not clear. Indeed, in the flow of action, practices change (Shove, 2012). Similarly, boundaries change throughout time and are not naturally defined, since they relate to perception, ideas or interests (Higginson, 2015). Therefore, boundary making is an exercise subject to the practitioner's sense-making of practices (Schatzki, 2005 in Pohlmann, 2018). Following Gherardi's (2012) advice, because practices are undertaken by practitioners, interviewees where directly asked where they would set the boundaries for each practice or activity mentioned during the interviews. The boundaries of each practice were established according to thematic activities. Thematic activities emerged from questions such as *"how and when would you use climate information?" and "what activities can be associated to this particular use?"*. As all data was coded, tagged and labelled, new thematic activities started to emerge in the data which could not be accommodated within the theoretical codes initially developed. As these new thematic activities were judged as being important to represent a complete picture of the observed reality, new codes were thus created. Following Braun and Clarke (2006), the empirical codes emerging from the data were compared to the theoretical codes elaborated from

the literature review in order to better understand their implications in the larger theoretical context. Afterwards, relationships between thematic activities could be established and be framed as categories. All theoretical themes, theoretical codes, empirical codes and themes were organised in an excel file. The progression from theoretical themes and theoretical codes to empirical categories can be seen in Annex 5.

In order to avoid subjectivity regarding the activities involved in a practice, a range of people within the municipality and from other organisations were interviewed and whenever discrepancies in opinions were expressed, they were explicitly inquired about, so that sources of subjectivity could be identified. In general, however, no discrepancy was found. Instead, interviewees provided varying perspectives according to their participation in these activities, offering thus a more diverse context for understanding practices.

2.5. Applying the conceptual framework

Once all data was coded and themes were identified, the conceptual framework was applied to identify, describe, understand, systematise and explain the different practices. A total of 24 practices were identified across the three case studies and were analysed according to seven aspects: 1) activities within the practice; 2) norms orienting the practices; 3) experiential knowledge needed to perform the practice; 4) the material entities accompanying the practice; 5) rules structuring the practice; 6) the effect of the practice on other practices and 7) the role of the practice.

2.5.1. Characterising Practices

Data collected suggested that the use of climate information was distributed throughout an extensive constellation of practices; and while some practices were enacted in direct connection with climate information, other non-climate related practices that were part of the customary work of municipalities seemed to be enabling or supporting the use of climate information. Hence, usability could not be positioned as a single practice; instead, it could be better explained by looking at clusters of practices. Schatzki (2002, 2012) highlights the notion that practices are always linked in one or several ways arranged through specific relations forming '*practice-arrangement bundles'* (Splitter et al., 2018, p. 6). From this perspective, the following features were identified for each practice constellation:

2.5.1.1. Relationships across practices: It refers to how practices connect with each other (Shove, 2012). Practices can connect by sharing meanings or material entities in relations of co-dependence, collaboration, competition, or establishing *"the terms and conditions on which other practices interact*" (Shove 2012, p. 91); generating patterns of interdependence (Blue et

al. 2017) if the bundles draw on the same elements of a practice (Schatzki 2016 in Splitter, 2018); or being prefigured by material entities. Practices can relate to each other through causal relations, through physical proximity and through physical structures (Schatzki 2013, in Splitter, 2018).

2.5.1.2. The role of practices: It refers to the mechanisms whereby practices are stabilised or whereby practices change. Gherardi (2012) describes three different mechanisms: limitation (through changes in or enforcement of legislation, standards, methodologies); rhetorical closure (forces that operate closing conceptual debates); and anchorage in materiality (technologies can change procedures, techniques that increase efficiency, etc).

2.5.1.3. Effects: it refers to the outcomes of the connectivity of practices. In the context of working practices, effects include synchronisation of work, periodicity, coordination, sequencing (Southertorn, 2006 in Blue 2017, p. 31); rhythm (Shove, 2012); or producing new divisions of labour (changing the trajectory of municipal competences), making practices to co-adapt or to transform (ibid).

Table 3: Summary of concepts. Characterising practices

Relationships	Co-dependence, interdependence, collaboration, competition, linking, prefiguration, causality or physical proximity.
Roles	Limitation, rhetorical closure, anchorage in materiality.
Effects	Synchronisation, periodicity, coordination, sequencing, rhythms, divisions of labour, co-adaptation and transformation.

Figure 2: Perspective of a practice constellation dissentangled according to seven structuring aspects.

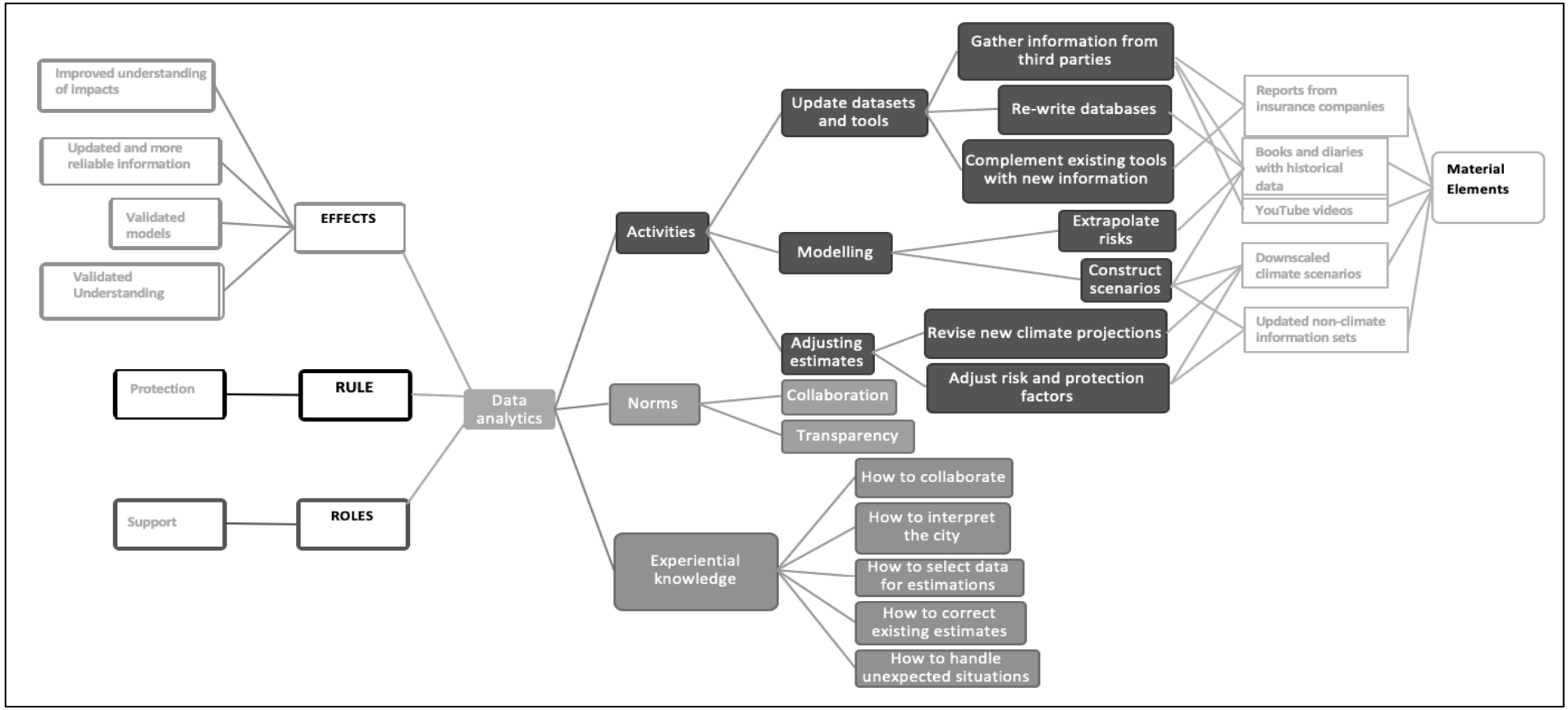


Figure 2 displays the seven key aspects used for exploring each practice constellation. In this exmaple and departing from the right side, the practice constellation of „Data Analytics" is shown to be composed of *activities and adjacent activities*, each of which is linked to a material entity. The constellation is shaped by two *normative* criteria, which suggest that „Data analytics" are practices enacted in a working context where *collaboration and transparency* are key. *Experiential knowledge* shows crucial features that competent practitioners must know about in order to perform practices well. On the left side, the *Effects* of the practice constellation are the changes provoked by this practice constellation on other working practices. This constellation is also ordered in the context of legal *rules* (in this case, data protection principles which are established by law); while *the role* of this practice constellation is to support other practices by -for instance-, ensuring the provision of data (either climate or sectorial non-climate data) to (for example) run specific analyses.

Each practice was then systematised in a fact-sheet format.

Table 4: Example of a practice fact-sheet.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
Aligning	Indicators	Socially accepted techniques. Indicator management must be light and not too demanding.	Knowing how to construct and manage indicators.	Limitation by standardising methods	It promotes common evaluation standards.

Describing practices means adopting specific conceptual perspectives to understand the meaning of each activity and its form of relation to other activities. All practices are presented following this format.

While the use of climate information manifested differently in the three case studies, patterns of use could be established across all three cities. For example, climate information could be observed resulting from coordinated and purposeful action to attend specific needs and interests; usability would result in the structuration of communities of practice within the municipality, generating innovative forms of coordination across departments, helping break institutional silos, etc. The use of climate information occurred as a collective undertaking, and as such, conflicting and diverging viewpoints were indeed part of such interactions. And while seemingly diffuse, nevertheless, these interactions unfolded around issues of shared interest and concern (Clarke, 2008) according to the specific functions and attributions that result from the division of administrative competences. In order to capture how shared interests and concerns shaped usability, once practices were defined, they were then systematised according to two variables: “arenas” and “categories”.

Table 5: Practices conceptualised according to the interphase between Arenas and Categories

ARENAS/ CATEGORIES	CATEGORY 1: REFLECTING	CATEGORY 2: NARRATING	CATEGORY 3: ARTICULATING	CATEGORY 3: DESIGNING
POLITICAL ARENA	Practice 1	Practice 4	Practice 7	Practice 10
STRATEGIC ARENA	Practice 2	Practice 5	Practice 8	Practice 11
OPERATIONAL ARENA	Practice 3	Practice 6	Practice 9	Practice ...24

2.5.2. Arenas

In a municipal context, social problems (aims, issues, challenges and interests) are defined according to executive functions (e.g. environmental protection) and attributions (clusters of decision-making, strategic management, and territorial planning (Lorenz, 2016)). Social problems determine action: they are cemented in specific discourses which determine how

practices connect (Blue et al. 2017), since discourses *"do not only represent the world, they act and intervene in it"* (Nicolini, 2012, p. 5,), and *"inform and legitimize ways of doing strategy"* (Wittinghton, 2006, p. 620).

Planning for climate change was an issue of common concern in the three municipalities; however, commitment to action would vary greatly across the three administrations. On the one hand, the use of climate information had to be responsive to the implementation of administrative competences; and on the other hand, commitment to using climate information was shaped by issues of concern intrinsic to the political, strategic and operational aspects of decision-making and public administration. These three aspects are positioned as arenas (Clarke, 2008; Abers, et al., 2013), since they define the criteria to appraise usability, define who will decide as to whether or not climate information will be used and how it will be used; and outline the form of interactions and collaboration to use climate information. In other words, in thinking in terms of arenas one can recognise how decisions about the use of climate information are not purely technical, operational, strategic, or political. Decisions consider all these aspects, but to a different degree according to the arena in which they are contextualised. From this perspective, the use of climate information was shaped by the evaluative criteria emerging from these three Arenas:

Table 6: Arenas

ARENA	DESCRIPTION
In a **POLITICAL** arena	the use of climate information is weighted against the trade-offs between what is politically desired/acceptable.
In a **STRATEGIC** arena	the use of climate information is assessed in terms of its contribution to facilitate rating the order of priorities of actions and the use of resources for achieving goals and designing plans and strategies in the context of climate change.
In an **OPERATIONAL** arena	the use of climate information is weighted against the trade-offs between what is technically needed and feasible to do. It refers to how the use of climate information connects resources, competences and expertise for the execution of specific operations.

2.5.3. Categories

Categories represent the purpose of different groups of practices. Practices could be systematised according to whether they were enacted to: 1) increase a general awareness about the impacts of climate change; 2) generate concrete narratives that allow contextualising climate information within specific policy issues; 3) support the design of climate sensitive policies; 4) support climate change becoming the source of coherence for the structuration of communities of practice; and 5) to inform about the design of concrete projects.

In general terms, four categories could be identified:

Table 7: Categories

CATEGORY	DESCRIPTION
REFLECTING	It refers to the activities designed to increase awareness regarding the implications of climate change in terms of citizens' and urban safety, as well as the smooth and uninterrupted delivery of municipal services
NARRATING	Stresses that climate information demands a translation process in order to shed light on decision-making processes that are sensitive to climate change. Because narratives emerge as storylines where urban dynamics are blended with climate risks, narratives facilitate positioning the use of climate information in specific policy areas.
DESIGNING	Climate information shapes activities of more advanced stages of adaptation process and provides more precise technical and financial information to appraise, weigh up and prioritise adaptation options. It includes also to the range of activities needed to overcome administrative, physical and technical aspects to implement projects associated with reducing risk against projected climate conditions.
ARTICULATING	It refers to activities designed to establish climate change as a knowledge object in order to orient the activities of diverse stakeholders.

These categories were in line with the traditional division of research application in policy, informing that climate information was being applied conceptually (research used for general enlightenment), or instrumentally (applied in direct ways); (Weiss 1979, in Walsh 2019).

Table 8: Differences in the application of scientific research

Conceptual use of research	Instrumental use of research
1) increasing general awareness about the impacts of climate change 2) generating concrete narratives that allowed contextualising climate information to specific policy issues;	3) becoming the source of coherence for the structuration of communities of practice; 4) supporting the design of climate sensitive policies; 5) informing the design of concrete projects

However, while it has been documented that typological applications of research evidence are useful for understanding policy change processes (as in Weiss, 1979), their efficacy falls short when cultural and socio-political factors hinder application (Allen et al., 2015). Against this context, in the three case studies it could be evidenced how cultural and socio-political aspects were involved in shaping usability. Practices involved in the use of climate information were linked to norms, practical knowledge, cultural and political aspects of work. A central reflection of this is that practices were being enacted purposefully to attend specific concerns expressed in each arena, revealing that for climate information to be used, audiences with the power to enable usability had to be persuaded. Climate information was thus observed as a subject in need of endorsement in order to be used; hence, the legitimacy dimension gained prominence in the conceptual framework.

It is important to stress that categories represent conceptual boundaries aimed at facilitating the systematisation of information. Indeed, a practice associated to one category could also share features with other categories.

2.5.4. Actors: exploring social interactions in social orders

Social orders "*are the arrangements of people, artifacts, organisms, and things through and amid which social life transpires"* (Schatzki, 2002, p. 22); which "*are established, maintained, demarcated, altered or destroyed... within the influence of social practices*" (Schatzki, 2002 in Pohlmann, 2018, p. 70). In designing a Social Orders' schema, actors operating within the municipal frontier were characterised according to how they established agreements to synchronise work. These dynamics were characterised following Corbin and Strauss (1993, in Gherardi, 2012),

- *"**through the arrangements** people make within the same operational units or across them;*
- ***through the strategies** of interaction by which arrangements in working environments are made; and*
- ***through the position** assumed by each participant towards both the work and the process of working things out"* (p. 13).

Since municipal work is also responsive to other stakeholders who operate in the municipal landscape (citizens and companies), these actors were also included in this characterisation. Actors operating beyond the municipal frontier who were relevant to this research included actors involved in the provision of climate information to municipalities, or citizens whose participation was explicitly informed as being central for implementing climate adaptation projects. These actors are characterised using a multi-level governance and polycentric approach. Multi-level governance and polycentric governance frameworks are an accepted way to portray constellations where actors operate on different levels and are engaged in self-organisation and mutual adjustment (Ostrom, 2010) and interact coherently for a common governance goal (Morrison et al. 2019). A core assumption of these frameworks is that actors operate as networks *"facilitating the generation, acquisition, and diffusion of different types of knowledge and information*" (Cunningham, 2015, p. 895). Lankford (et al., 2010) features polycentric models as decentralised, formally independent centres of decision-making and governance systems interacting in the distribution of resources. Following Lankford (et al., 2010, p. 14) climate information/service providers are characterised as independent agents mediating the use of climate information through the provision of information. Different functions could be linked to these actors: information providers, translators, regulators, distributors, facilitators, and users.

Chapter 3. Case studies: description and implementation

The three case studies are described and analysed based on the previously described conceptual framework and are presented in the following order: Bilbao, Donostia/San Sebastian and Copenhagen.

3.1. The Spanish cities:

At the national level, the Spanish National Adaptation Plan (PNACC) is the reference framework for the development of adaptation policies. The Spanish Climate Change Office (OECC) is the body in charge of developing, implementing and monitoring the PNACC[7]. In the context of the PNACC, several sectoral studies have been generated on the impacts on, the vulnerability of and the adaptation to climate change based on regionalized climate scenarios. These scenarios result from Euro-CORDEX and VALUE projects; as well as the national projections developed by the State Meteorological Agency (AEMET) and by the Santander Meteorological Group (CSIC - University of Cantabria)[8]. The OECC works in close collaboration with the Autonomous Communities and Local Administrations.

3.1.1. Climate change in the Basque Country

At the regional level, *Autonomías* (or regional administrations) have competence for environment and climate change adaptation. Each Regional Administration elaborates and implements Adaptation Strategies and Plans in coordination with the Spanish National Climate Change Adaptation Plan (McGuinn et al. 2013; Reil et al. 2016). Mostly, regional frameworks regarding adaptation centre on elaborating sectorial information, systematic climate observations; and research of the climate system (McGuinn et al. 2013). KLIMA 2050 (Basque Government, 2015) is the Basque country's core strategic document dealing with climate change adaptation and mitigation. Approved in 2015, the strategy advocates increasing efficiency and territorial resilience and it offers tools and technical guidance to municipalities to develop local adaptation plans and to implement adaptation actions.

3.1.1.1. Actor constellation in the management of climate information in the Basque Country

The constellation of institutions that play a role in the management of climate information in the Basque Country is vast and actors have a diversity of roles (see Annex 7).

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[7] A diverse set of institutions support the coordination of adaptation strategies: The Working Group on Climate Change Impacts and Adaptation (GTIA) coordinates adaptation strategies developed at national level with regional institutions; The National Climate Council (CNC) draws proposals for the development of scientific evidence of impacts and adaptation strategies; The Coordination Commission of Climate Change Policies (CCPCC) –where local entities are also represented- follows up on adaptation measures; The Environmental Sector Conference, which is a political high-level cooperation body with a multilateral composition that brings representatives of all Ministries representing the Administrations of the Autonomous Communities (Climate-adapt, country profile Spain). Source: https://climate-adapt.eea.europa.eu/countries-regions/countries/spain

[8] Adaptecca Platform, checked 3rd July 2020

Figure 3: Roles of stakeholders in the provision of climate information

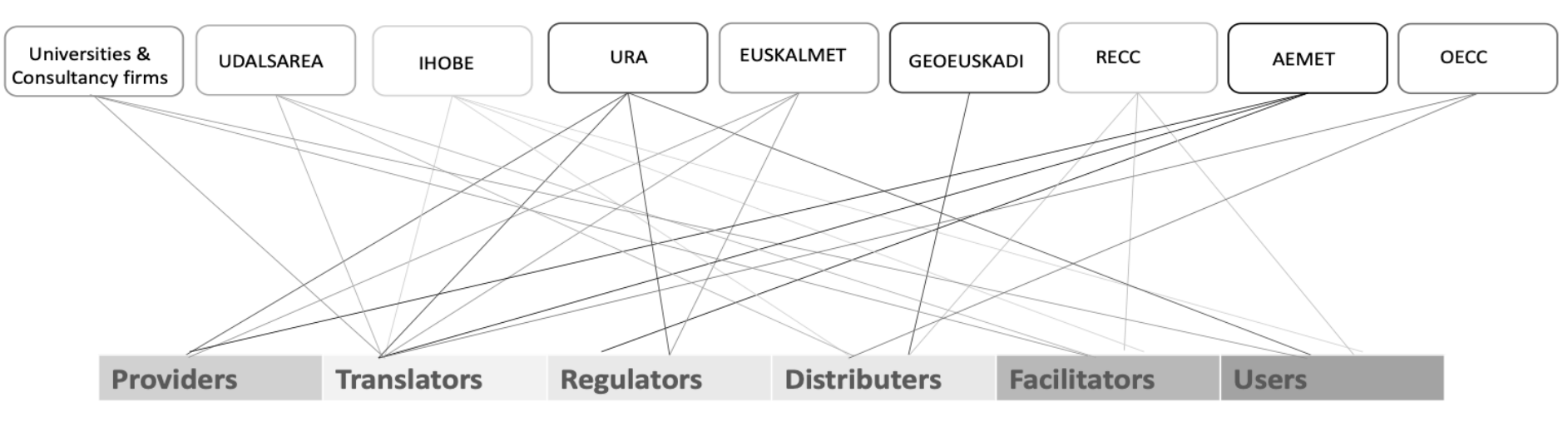


Table 9: Roles taken by different actors in the management and use of climate information

	Universities and Consultancy firms	UDALSAREA	IHOBE	URA	EUSKALMET	GEOEUSKADI	RECC	AEMET	OECC
Provider				Return periods for flood events on a 10, 100- and 500-years scale	Climate data that feeds into regional scenarios; whether forecasts			Atmospheric climate data	Coordinates compilation of atmospheric data
Translator	Through H2020 projects (RESIN, RAMSES)	Generates and follows up on indicators	Development of high-resolution regional climate change scenarios for the Basque Country	hazard and risk mapping of all the flood-risk areas of the Basque Country	Provides early warns			Regional CC scenarios ARC5	Through the Adaptecca platform

Regulator			Coordinates KLIMA2050 strategy	Indicates appropriate use of return periods	establish and validate the minimum technical requirements for information sets to be acceptable (e.g. comply with ARC4 SRES or ARC5 and Euro-cordex scenario/data)			establish and validate the minimum technical requirements for information sets to be acceptable (e.g. comply with ARC4 SRES or ARC5 and Euro-Cordex scenario/data)	
Distributer	Showcase options for use	Platform for dissemination of best practices	Develop technical guidelines for adaptation for local governments	Return periods in consistency with RCPs (not yet official)		Provides permanent access to data catalogues and GIS portals	development of guidelines for the preparation of local plans		Through the Adaptecca platform
Facilitator	Capacity building	Facilitates interaction between municipalities and other actors	Coordinates capacity building schemes				establishment of adaptation strategies and plans		
User	Develop own models		Develop technical guidelines for adaptation for local governments	Return periods in consistency with RCPs (not yet official)			development of guidelines for the preparation of local plans		

The institutions described in figure 3 and table 9 play different roles. From a polycentric perspective, the interaction between these institutions is characterised by non-binding agreements; meaning that collaboration is established voluntarily or regulated by specific contracts, such as in the case of the provision of specific tools (guidance and knowledge products) or through collective participation in research projects (H2020). There is a strong regional approach to collaboration, since most of the interactions are coordinated under the KLIMA2050 strategy. As a result, collaboration unfolds supported by the coordination work of some specific institutions, such as IHOBE, UDALSAREA or RECC; and collaboration occurs in the framework of specific goals, such as for instance, developing capacity building schemes, downscaling projections and generating vulnerability scenarios, etc.

3.1.2. Municipal planning in Spain

Commitment among municipalities in Spain regarding climate action is well reflected in the 335 signatories of Spanish municipalities to the Covenant of Mayors for Climate and Energy, (out of a total of 1817 municipalities in Europe as of end of 2019) (Reil et al. 2016). However, contrasting perspectives are featured contrary to this display of commitment. An analysis undertaken by Sanz (et al., 2019) assessed the concrete progress in climate adaptation activities among 54 cities in Spain, all of which are signatories of the Covenant of Mayors. They found that while most cities have adaptation plans which enjoy official endorsement, these were only published in the last few years and only 11 cities[9] displayed concrete progress in urban planning that considered climate risks and exposure. Attributed barriers included the lack of financial resources, scientific and technical support, as well as equity concerns. Municipalities in Spain are not obliged by law to develop local adaptation plans, this being a decisive element – according to the authors- of the slow development in this field in Spain. The relevance of European programmes such as the Compact and the Covenant of Mayors are identified as being pivotal in advancing climate adaptation planning (ibid) as they demand the development of Sustainable Energy Action Plans (*SEAP)* and the Adaptation Plan (*SECAP*). The technical guidelines specify that municipalities should prepare their adaptation plans considering at least a) current hazard risk level; b) expected change in intensity; c) expected change in frequency; and d) timeframe in which the risk frequency/intensity is expected to change (Bertoldi, 2018, p. 35).

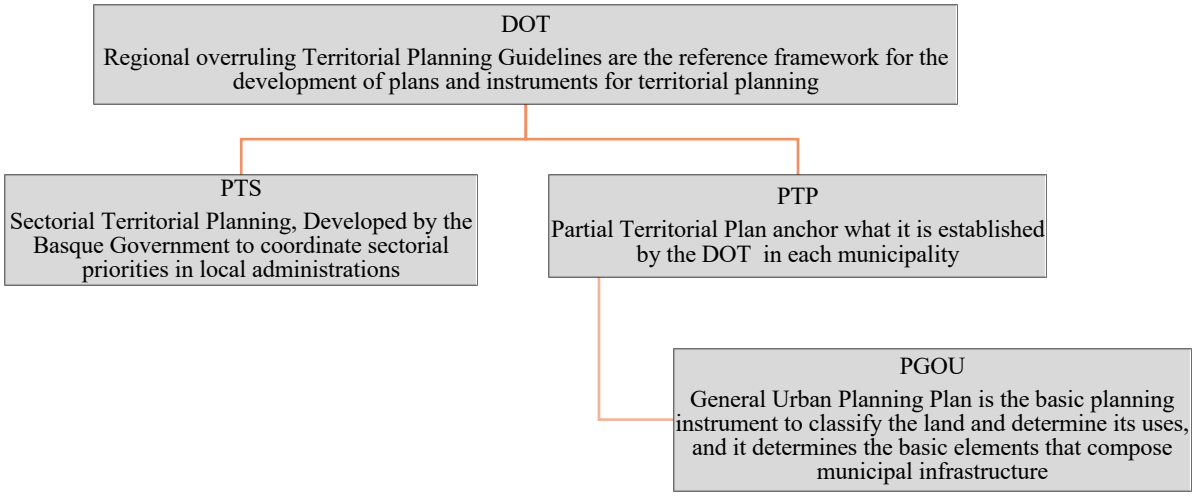
3.1.3. Hierarchical territorial planning structure

National law 4/1990 of territorial planning is the core legal instrument that distributes competences over the use of land and planning at the regional and municipal level. The law establishes that the Territorial Planning Guidelines or DOT (an acronym for “Directrices de Ordenacion del Territorio”) will be the highest overarching regional planning tool that dictates the principles of planning in each Spanish region. The DOT state the guidelines on climate change adaptation, call for improved resilience, and demand thematic mapping of impacts and vulnerability (Diputación Foral de Bizkaia, 2019-A). A step closer to the local administration, the Partial Territorial Plan or PTP (an acronym for “Plan Territorial Parcial”), coordinates municipal urban plans at the supra-municipal level and it articulates the deployment of other sectoral policies and the action of private actors (Tecnalia, 2018-A). Because of this, it is considered the most appropriate framework in which to accommodate climate resilience. The Sectorial Territorial Plan or PTS (an acronym for “Plan Territorial Sectorial”) coordinates the

[9] Barcelona, Cordoba, Girona, Guadalajara, Lleida, Madrid, Murcia, Donostia, Valencia, Vitoria-Gasteiz, Zaragoza.

agendas of different sectors in the territory[10]. At the most local level, the General Urban Plan or PGOU (an acronym for "Plan General de Ordenamiento Urbano") is the benchmark instrument in the integration of climate change as a criterion for urban planning and adaptation, with implications for development planning (Tecnalia, 2018-B).

Figure 4: Planning instruments in the Basque Country (Law /1990)



Source: Basque Government (2019)

3.2. Case study Bilbao

The use of climate information in Bilbao is illustrated in eleven practice constellations, grouped in three categories -Reflecting, Narrating and Designing. The use of climate information in Bilbao is strongly influenced by the perceived need to grant usability an official status, under the assumption that usability needs to be sustained by administrative competences. In these terms, the use of climate information in Bilbao is characterised as being in a "positioning mode": endorsement is being sought from decision-makers whose standing regarding the use of climate information is ambiguous and conditional to fulfilling sectorial needs. Usability being in a "positioning mode" reflects challenges of initial stages of usability, where minimum degrees of institutionalisation must be built.

3.2.1. The site of Bilbao

At the time when field work was carried out, Bilbao was in a vibrant process of revising and updating its territorial planning instruments (Territorial Planning Guidelines (DOT), the Partial

[10] The PTP has a higher regime level tan the PTS; therefore, in case of clashes between sectorial and local policies, unless indicated through specific constitutional mechanisms, the PTP will guide development. For instance, water management would fall under the PTS as water is managed through sectorial mechanisms; while land use would be rest on the indications of the PTP (ibid). If construction is to be allowed in a flood-prone area, then potential clashes may require specific constitutional mechanism to resolve disputes (ibid).

Territorial Plan of the Functional Area of Bilbao Metropolitan (PTP), and the General Urban Planning Plan of Bilbao (PGOU)) and appraising opportunities to integrate climate information into planning, e.g. identifying areas prone to be affected by heat islands, floods, sea-level rise and drought. Bilbao's municipal administration, political authorities and research agencies were engaged in discussions regarding the promotion of green infrastructure and nature-based solutions to reduce the heat island effect and to protect the city against current and projected floods and sea-level rise (Diputación Foral de Bizkaia, 2019-B). This momentum provided a strong case to explore the Site of Bilbao in terms of the work invested by municipal officials in articulating the integration of climate information into planning instruments, highlighting the endeavour of attaining official status to modify administrative competences that would enable usability.

Concrete proposals to update territorial planning instruments were discussed under the umbrella project *ACCION-LurrAdapt: Adaptation to Climate Change in the Regional Planning Instruments of the Municipalities of the Basque Country*[11] (LurrAdapt from here on) (IHOBE, 2019-D). LurrAdapt -mandated by IHOBE[12]- follows the goals stated by the Basque Climate Change Strategy KLIMA2050[13] and it promotes the inclusion of climate information into Bilbao's planning territorial instruments, Local Agenda 21 and the Environmental Impact Assessment framework. Lurr-Adapt takes stock of the experience gathered over the past 10 years[14] by different institutions which engaged in downscaling climate models, promoted science-policy dialogue, and designed capacity building schemes.

3.2.1.1. Bilbao, the transformed city

The city of Bilbao is located on the Atlantic coast of the Basque Country in the Bay of Biscay. The Bay of Biscay is typified as a high-risk area (Reil et al., 2016). Natural and geographic conditions -high precipitation, strong slopes and steep valleys- increase the risk of floods, while high exposure and vulnerability result from low-lying areas being densely urbanised (Ibisate et al., 2000). Bilbao has been affected by river and pluvial floods 39 times in the last 6 centuries (Reil et al. 2016). Most events occurred at the end of the 19th century as the river was reshaped and channelled. Today, flooding is still the most common threat to the city (ibid).

Bilbao is a city of roughly 350 thousand inhabitants, and the larger metropolitan area comprises more than 1 million inhabitants[15]. Bilbao, emerged as a small trading and fishing village in

[11] The original name in Spanish is *"Accion-Lurr-Adapt Adaptación al Cambio Climático en los Instrumentos de Ordenación del territorio de la CAPV en el marco de la revisión de las Directrices de Ordenación del Territorio".*
[12] The municipality of Bilbao act as project beneficiary.
[13] Goal 3: risks and impacts of river and tidal floods and urban heat island effect in summer periods should be attended by public policy and planning instruments at local scales. Particular emphasis is given to the detection of vulnerable areas.
[14] A full list of reports used and mentioned in this section can be seen in Annex 7.
[15] Instituto Nacional de Estadistica, 2018

medieval times; and by the year 1900 it had become an industrial, mining and port city whose economy had by 1960 strongly developed based on heavy manufacturing, provoking an increase in the demand for labour, raising the number of inhabitants by 410,000 in 1970 (Plöger, 2007). The industry -steel, shipyards, and machine engineering- was badly affected by the 70s and 80s oil[16] and industrial crises, which pushed several industries out of business, resulting in unemployment rates of up to 25% in 1985, while the proportion of manufacturing jobs dropping to 27%, provoking a serious population decline (ibid). During the prosperous years of industrialisation, Bilbao's Metropolitan area was deeply affected by environmental degradation leaving a total of 340 hectares of obsolete industrial wastelands covered with rusting old industrial buildings, brownfields and disused infrastructure (ibid). In 1983, the city experienced the worst ever recorded river flood which destroyed large parts of the city, leaving a toll of more than 30 casualties and submerging the old town under 2 metres of water, adding to the economic burden of an already depressed city. Because of pollution in nearby preindustrial sites, the flood water was deeply severely contaminated.

The urgency to provide a permanent solution to Bilbao's decay was met by a large political consensus during the 1980s. A regeneration strategy was underway by 1990, supported by the particular autonomous status of the Basque Country which allowed the allocation of resources from its own taxes[17]. The strategy was catalysed by a facilitator agency called "Bilbao Metropoli-30" which worked as a public-private partnership to form a knowledge-based high-tech sector and to renew the city with a strong environmental intervention (river cleaning, industrial land recycling and implementation of Agenda 21) (ibid). Ministry of Economic Development granted lands to the city administration where the port and striving industries existed previous to the economic crisis.

Today, Bilbao seeks to portray itself as a prominent European Atlantic city, promoting itself as a competitive node connected to a global, post-industrial urban network. The node demanded key urban interventions to foster "opportunity areas" to take place. Thus, during the 1990s Bilbao experienced a deep urban transformation, including a large-scale revitalisation and decontamination of abandoned harbours, transport infrastructure and industrial sites. Improving

[16] The 1973 oil crisis began in October 1973 when the members of the Organization of Arab Petroleum Exporting Countries proclaimed an oil embargo. The embargo was targeted at nations perceived as supporting Israel during the Yom Kippur War. The initial nations targeted were Canada, Japan, the Netherlands, the United Kingdom and the United States with the embargo also later extended to Portugal, Rhodesia and South Africa. By the end of the embargo in March 1974, the price of oil had risen nearly 400%, from US$3 per barrel to nearly $12 globally; US prices were significantly higher. The embargo caused an oil crisis, or "shock", with many short- and long-term effects on global politics and the global economy. It was later called the "first oil shock", followed by the 1979 oil crisis, termed the "second oil shock". Source: "1973 oil crisis", Wikipedia (checked 29.07.2020).

[17] The City of Bilbao receives half of its annual income of €475 million from the provincial government, 37 per cent from own taxes and the remainder from other sources such as the EU (Bilbao Ayuntamiento, 2007 in Plöger 2007)

environmental conditions thus became a central requirement for the new developments in the city. The responsibility to ensure environmental improvements was given in 1992 to the public development agency "Bilbao Ria 2000". The agency had to coordinate a constellation of political and economic actors, because decision-making affecting environmental conditions in the city was distributed across different administrative levels (urban planning by local government; fiscal power in provincial government; and land ownership in central government authorities) (ibid). The model implemented by Ria 2000 was straightforward and simple: turning old land into new developments that could later be sold at a profit, so that the investment could be paid for entirely by the private buyer and financial surpluses could be generated through housing taxes. The new financial strategy would provide a financial surplus that could later be invested in future urban regeneration. Thus, Bilbao's urban transformation would produce zero debt and regenerate the economy (BB25).

While fiscal autonomy provides great independence in decision-making, it also presents the need to always ensure a minimum tax basis is provided. While nowadays this challenge still applies, since most of the public land has already been turned into new developments and the remaining land belongs to private owners, then surpluses cannot be transferred to public coffers (BB24), making the financial model introduced in the 1990s not be applicable anymore.

Thus, Bilbao in 2020 is a city that must strive to attract private investments; and for that, it must be perceived as a modern, economically dynamic and attractive city for investors and talented entrepreneurs while offering a wide range of services so that private funds circulate in the city. Consequently, urban development today is oriented by the need to boost economic activities in the city, generating employment and finding new areas to develop infrastructure for new economic activities (BB61). The consequences of the urban sprawl have generated a concentration of services in the city, causing an over-demand for space (Plöger 2007). However, as the city reached the limits of its physical expansion capacity, it had no other option but to renovate and construct over old industrial sites (BA53), increasing the risk of climate change: "*Most of this urban expansion during the mid-20th century occurred in flood prone areas along the estuary, which increased the vulnerability of the city. After the dramatic floods in 1983, several infrastructure measures were implemented, but the risk still remains"* (Scussolini et al. 2013, p. 25).

The transformation of Bilbao was shaped by two central aspects: history and the physical space.

3.2.1.2. History and the definition of risk

History plays a central role in understanding how practices unfold because practices have a *historical-cultural anchoring* (Gherardi, 2012), which entails that "*practical knowledge is*

mediated by what happened in the past and has been learned from experience and in experience" (p. 25). While urban transformation created an urban development paradigm ("*history determines our form of development*" (BA29)), the 1983 flood shaped the urban risk management paradigm (BB14). The risk of floods dispersing contaminants from former industrial sites which could host new urban developments generated the need for more stringent environmental standards and precautions to be put in place, which resulted in positioning flood projections as a core aspect of urban development. The depth of impact of the 1983 flood –a one in 500 years event- became part of the *Bilbainos'* collective memory (BC44), and the risk of river, sea and pluvial flood prevails in managing urban risk. In this context, Shove (2012) explains that popular imagination is constructed from old concepts with "*recognisable qualities born of prior practice-based associations*" (p. 54). Indeed, the sad, long history of floods has resulted in proofing the city against floods, creating a self-perception of confidence to deal with such events:

- *"Our emergency department has very effective protocols to respond to floods..." (BA32); "our network of potable water and sanity is very strong, it has been digitalised, we know where we encounter problems and how to answer to those problems. We have worked out a good way of responding" (BA34).*

In the context of climate change this becomes relevant as far as collective memory determines that climate change is almost exclusively contemplated on the basis of flooding; *("especially due to those which occurred in 1983, which had settled our mind-set" (BB14)):*

- *"The results of the (climate change) vulnerability analysis were not surprising because ... it was based on the risks of floods... there is enough culture here... the areas flooded and the risks are already known and emerge almost without work, because the same sites are being flooded every day, so it's pretty obvious..." (BB42).*

However, large floods which are part of the collective memory of Bilbao's residents provoke the fact that new threats such as heat waves remain in silence, unattended or not considered as a problem (BC46, BC47, BB22):

- *"The heat island effect is less integrated in our thinking as planners and decision-makers… we are not Seville either…while floods are clearly part of our collective memory" (BB105); "we have... the plan for low temperatures, which includes alerts for snow, frosts.... but we will have one day of snow throughout the winter! But we don't have specific alerts ...for heat…. Every year there are more days with temperatures of 40 degrees and the population is aging" (BC45).*

3.2.1.3. Space as a physical limit to urban development

Bilbao is a city with little space for further urban expansion. The city has become consolidated and all new developments take place on top of former industrial sites. Space acts as a limiting factor in Bilbao's urban development (BA16, BB4), while the use of the few sites available is highly conditioned by sectorial agendas (BB48). This results in implications for how flood protection strategies are conceived: the use of grey infrastructure –e.g., storm water collection tanks- (BA55) are considered a more efficient solution per unit of space compared to green solutions which are considered to require more space and incur in extra maintenance costs (BA57). At the same time, grey infrastructure supports the need to generate housing taxes, because while it could in absolute terms be considered financially more costly than green infrastructure, investment costs are a factor of the property costs; and hence, the price of properties is higher, the taxes are also higher and these costs are paid for by the private buyers *(BA59).* Furthermore, this approach is considered consistent with risk-management strategies and the integration of uncertainty to future flood risk, because protection standards are already integrated in the design of infrastructure *(BA61).*

While most exposed areas to heat waves and to floods are the richest areas of the city (heat waves are mostly concentrated in the old town, where most services are located; while the low-lying areas by the river -which are the most exposed to floods- concentrate services, green areas, sports facilities, and host some of the most expensive properties *(BB104)*), increased frequency and magnitude of extreme climate events is not considered a risk decreasing property value in these areas because the offer of public services prevails in how housing value is defined:

- *"...even with climate change, it is there where you have a concentration of services, the best houses, all the usual comfort of a city lie in these areas" (BB105).*

3.2.1.4. Social Orders: Actors articulating work in practice

Integrating climate change as part of planning tools has proven to be a complex endeavour. Integrating climate considerations demands modifications that are founded on legal decrees and therefore, are not achievable without the endorsement of actors positioned at different governance levels. For instance, the Partial Territorial Plan allows the coordination of municipal urban plans at a supra-municipal level, including sectoral policies (Diputación Foral de Bizkaia, 2019-b). Furthermore, given that changing mandates at a supra-municipal level results in implications for the work in all municipal areas, reaching consensus on the terms of how modifications are to be drafted must occur under the consideration of the diverse set of administrative competences across departments.

The interviews suggest that the Departments of Environment, Urban Development and Bilbao-Tic were the most active departments pursuing the introduction of climate information as part of planning tools and administrative competences. The interviews suggest that endorsement is to be provided by three sets of actors whose endorsement is central to the use of climate information: 1) politicians; 2) the departments of Public works and Public services; and 3) neighbours**.** What becomes relevant in this analysis is to understand what is valuable to legitimators at specific points in time and how legitimacy-seekers respond to that. This is explained in the Social Orders Schema, presented below:

Table 10: Social orders in case study Bilbao

	Politicians	**Other municipal areas: Public works / services**	**Environmental Department**	**Urban Planning**	**Bilbao tic**	**Neighbours**
Standing (actor's perception of their capacity to control and influence these processes)	Ambiguity: integrating climate considerations into planning and decision-making clashes with economic development imperatives: *"... No politician is going to be against (climate change)" (BA36); "We have problems with the flooding on the estuaries, but who is going to say that we cannot build there?" (BA41)*	Conditionality: can accept the use of climate information providing it can be associated with accepted procedures and administrative competences: *"... Each one gives answers according to what the day brings ... The water manager says "well, if water rises more times, then I will apply the protocol more times" (BA35).*	It comprehends the importance of climate information and currently explores traditional working mechanisms (such as indicators, specific project proposals or project assessments) to integrate climate information into its administrative competences.	Comprehends the importance of climate information and currently explores whether through existing legal mechanisms (demanding specific studies on risk and vulnerability within specific project proposals) it can integrate climate information into its administrative competences.	Bilbao-tic plays a key role in the management of non-climate information; it perceives the importance of climate information as a challenge in terms of information and data management (volumes and quality). Needs to ensure that all parties understand the value of sharing data and information, concerned about privacy and sensitive data.	Urban development and sustainability principles cannot go against people's way of living. *"... we have an aging problem... the current policy is to attract young people and talent" (BA89); ".... young people are more sensitive to the environment... a young city is noisier..." (BA90).*
Strategies (arrangements to work things out)	Politicians agree on signing up to agreements that display their endorsement towards sustainable development, within which climate change considerations are part of (BA37, BB78).	Acceptance to using climate information is dealt with on a case-to-case basis. *"Public Works will see if they accept the results of the (study), because they will assess the maintenance (costs)" (BB71)*	It explains how climate considerations can be pragmatically added to the work of other municipal areas and how this adds value to its work *(BC26).*	Proposes small modifications that are manageable and which do not cause too much fear of radical change. Makes use of official mandates for land protection or risk reduction strategies *(BB29).*	Explains through demonstration projects the value of having access to data -generating data catalogues and posting information in GIS formats, or running workshops.	Public audiences and consultation provide spaces for democratic processes where neighbours can discuss project proposals or changes to the legislation. *(GB12, GB13)*
Arrangements (people in the same party to perform work)	Politicians must respond to citizens' formal accountability demands, through formal communications (BE26). Coordination with each department is thus central.	Their flexibility in negotiating the use of climate information can be vast, but boundaries are clearly established based on administrative competences.	Meets up regularly to explore possibilities of integrating climate considerations into planning.	Collaborates internally through specific exercises (generating urban sustainability indicators) and participates sporadically in capacity building schemes s *(BB97, BB85).*	Capacity building schemes; interaction with experts from data companies; participates in conferences, helps keeping awareness regarding how to improve data management.	Through deliberation taking place in public consultation processes and by collectively drafting pre-proposals for urban projects and legislation.

Relational ties which are relevant for coordinating the integration of climate information in planning tools and municipal practices could be identified among these actors:

1. Relations of **causality** (one entity's actions or intention led to another entity performing an action (Pohlmann 2018:73) could be established between

Table 11: Relation of causality

Actor 1 (Leads)	Actor 2 (Reacts)	Relation
Politicians	Municipal Departments	Political agendas influence to a large extent strategic and operational goals: • *"... we are a city council, there is a political head that defines the basic lines of work and we simply try to contribute to our political leaders" (BC8); "... you have to show to the politician... that there is benefit. The general benefit, not only economic" (BA86).*
Neighbours	Municipal Departments	Obligation to run binding consultation processes with citizens demands that the administration provides transparency and communicates the pros and cons of specific initiatives. • *"..... When the transformation occurred, there was no citizen participation law. This was introduced in 2006 ... now we must integrate participation in all urban planning and it can affect us in several ways" (BB57); ".... I need to present something that the neighbour receives positively ... an urban design which we have to adapt to the citizens" (BA28).*
Neighbours	Politicians	Accountability is a legal right for citizens and politicians must respond. • *"There are also public appearances where politicians must answer questions from the public regarding petitions ... that is... official" (BA124).*
Public works & service departments	Environmental and Urban department	Administrative competences specify attributions which limit other parties' actions. Controlling budgets and application of protocols have been previously described as examples of this (as in BB71)

2. Relations of **spatiality** (connections through activities among entities (ibid)) could be established between:

Table 12: Relation of Spatiality

Actor 1 (Leads)	Actor 2 (Reacts)	Relation
Environmental department	Other departments	Meetings provide opportunities to explore, negotiate and persuade others to integrate sustainability considerations in infrastructure projects. • *"We look for project opportunities to introduce sustainability criteria" "BA11); "..... When mobility develops a project...we explain how it can be improved in a sustainable way" (BA9).*

3. Relations of **prefiguration** (entities may facilitate, restrict, or enable actions of other elements (ibid)) could be established between

Table 13: Relation of Prefiguration

Actor 1 (Leads)	Actor 2 (Reacts)	Relation
Politicians	Urban planning	Politicians enable and restrict: *"... I have the plans on the table waiting for them (politicians) to be approved. I work at the technical level and we need political support for the plans. It is a political determination*" (BA95).

The Social Orders framework highlights the interconnection between actors' interests and their power to exert agency and influence the course of action regarding the use of climate information. The framework reveals that actors' positions regarding the use of climate information can be ambiguous, when instrumental interests conflict with resilience-oriented land-use planning. The diversity of standings adopted by actors illustrates how decisions as to whether or not to use climate information depends on factors that stretch beyond technical aspects of information. Multiple information inputs (financial, political and technical) come into consideration in decision-making, and climate information is only one more.

The strategies undertaken by these actors suggest that the use of climate information can be part of a broader strategy designed to comply with specific interests (politicians may want to display caring for people's welfare by signing sustainability commitments, and climate information comes into this strategy indirectly by the supply of a scientific-technical background); or to enable specific decisions which may benefit from climate information sets (revising flood-return periods).

Arrangements and relationships highlight how social interactions at the workplace are oriented by normative criteria which apply to different situations: working in a municipal context is shaped by forms of accountability and hierarchies. But it is also shaped by technical standards and administrative competences, which suggest that the use of climate information cannot connect freely with the constellation of municipal working practices if these aspects are not well positioned.

3.2.1.5. Administrative competences

Work in local governments is structured around official mandates and administrative competences. Official mandates specify the rules regarding the implementation of functions, stipulating application of administrative and operative procedures and methodologies, forms of assessment and accountability methods that provide consistency to how working is expected to be practised (BB43). As local administrations are rapidly becoming aware that challenges presented by climate change affect the traditional form of implementing attributions and

functions across municipal areas, understanding the significant role played by administrative competences in providing order to the implementation of work becomes central.

- *"... all areas are affected by climate change … (working) requires you to have knowledge of all areas… how development is being considered..." (BC69).*

Administrative competences have the power of determination over the way in which social interactions take place at the workplace. For example, the use of public space is regulated by administrative competences distributed among different departments; thus, administering public space underlines the role of collaboration.

- *"...the only pure and simple competence we have is (to control) noise. The others are distributed among different institutions, including from within the city council itself" (BA2). "We relate to other departments ... but relationships go in people .... (BA107);*

By determining functions and attributions over resources and decisions, administrative competences articulate the rules that structure how urban planning is hierarchically organised and synchronised. For example, infrastructure developments are framed within project stages that consider design, implementation and maintenance, and each stage is legally governed by mandates that are organised hierarchically and determine specific attributions:

- *"As the DOT indicate how and how much the city should develop (BB65); "(then), the General Plan, proposes a rough development ... of measures "(BB85); "...it tells you about (land) uses; then it comes to the Special Plan, which.... with the magnifying glass... makes a very detailed analysis and there you can define and quantify (adaptation) measures..." (BB86); "and it indicates risks and corrective measures" (BB66); "... then the Urbanization Project -which is the last step- is where the physical elements and materials...are defined..." (BB87).*

Urban planning in Bilbao is described as an increasingly complex task to undertake. Throughout the years, urban planning has received the input of several other disciplines, transforming it from a single (architecture) into a multi-disciplinary practice, subjected to an increasing amount of supra-municipal obligations (BB31) and a complex distribution of overlapping administrative competences (BB50); and where financial and economic motivations are also involved (BB32). Hence, planning in Bilbao has to be aligned with a series of legal mandates from higher level institutions, which sometimes present contradictions to the planning goals of municipal areas:

- *".... the tracks for the new train are now going to be placed underground. Then a large surface will appear above ... with a possible heat island effect ... so a measure must be taken to alleviate thermal comfort .... which must be approved by both the city council*

and the ministry. The ministry does not want to plant even a tree because the roots can harm further down ... (and) it will want the urbanization to be as cheap as possible... and the money is public ... then the one who pays is the problem" (BB17 & BB20).

Administrative functions shape the goals of departments and these goals can affect the implementation of projects. For instance, while integrating green areas may be desired from an urbanisation perspective, additional costs may make projects in these areas to be counterproductive to the goals of other departments:

- *".... we (urban development) ... can tell them (Department of Works and Services) ...to plant more trees, but... since they maintain the trees, it is an issue linked to the municipal budget...." (BB47); "... and that is an indicator for the city council, that the materials are not causing extra costs... That is where the great crusade is when it comes to putting measures of adaptation to climate change that have to do with physical things" (BB88).*

Negotiating the goals that orient projects or programmes is thus a core feature in the working routines of municipal officials (BB71; BB101).

3.2.1.6. Official rules and practices

The power of determination among administrative competences makes municipal officials in Bilbao to acknowledge that the use of climate information demands granting usability with a degree of officialization:

- *".... something official... is done systematically, with a methodology and it is the same for everyone..." (BB43); ".....(for example) air quality, noise, health impacts.... (operate within) specific values, associated alerts, clear estimates, determined origins, etc. There is a working standard that allows measurement" (BC2).*

The perception that official mandates have the power of determination and provide the only way as to how municipal activity takes place is a dominant paradigm in Bilbao's administration:

- *"We don't do more than what URA (Water Agency) or other agencies indicate: raise the flood-protection wall, open a canal to let water flow through, etc. but all this is given by the agencies, it is all official and that is what we can do and do" (BB50).*
- *While at the European level several Directives consider climate change adaptation, given that these have not yet been made official, they are hardly usable (BB14);*
- *"While we have heat maps for the city, these are not normative so we are not obliged to consider them..." (BB62).*

Official mandates can restrict action; but they also provide clarity regarding the distribution of roles and responsibilities structured within administrative competences. Official mandates can thus facilitate interaction among people by standardizing the way in which work is expected to

unfold[18]. This is particularly important in situations where the absence of clear rules can provoke inefficiencies or disagreements such as in the case of operatizing climate change frameworks, and in these cases, official mandates become highly desired (BC59). However, the three quotations above suggest that official mandates can be interpreted differently: while technical standards (as in BB50) offer little space for interpretation; nevertheless, they are not immune to effects provoked by the course of practices or policy windows. For example, when the IPCC scenarios were released in the AR5 report (2014), URA updated the return periods estimated for floods in the study *"Estimation of the effect of climate change on floods over Bilbao's estuary"* [19] by integrating RCP4.5 and RCP8.5 scenarios[20] into existing hydro-meteorological models. The new models are expected to become the base-line orienting infrastructure development as Planning tools are legally updated.

Map 1: Comparing impacts from projected floods: return periods of 500 years and RCP 8.5

URA's current estimates of 500-year return period flood risk without climate projections (left) and IHOBE's climate projections for urban flood risk (right). Exposed areas under a 500-year return period and an RCP 8.5 are almost similar.

Official rules can also orient action, but are questionable –interpretation is negotiated (as in BB14); or, they can suggest specific action but since there are no enforcement mechanisms that penalise diversion from the rule, they are not obligatory (as in BB62).

In a case-study context such as Bilbao where the use of climate information is assumed to be determined by official rules, understanding how the application of rules results from situated interpretation to enable the use of climate information, becomes of central importance. The debate regarding the role of official rules in the stabilisation of practices, as well as perspectives regarding rule following and rule interpretation are well established in sociology and are particularly relevant for the course of practices. According to Wittgenstein (1953), rules are not self-interpreting: "*Given only a rule, the possibility always remains open to follow the rule in*

[18] Young (2008) makes this observation in the context of institutions.
[19] SENER. Estimación del efecto del cambio climático en la frecuencia y magnitud de las crecidas fluviales en la CAPV. nota técnica nº1. Estimación del efecto del cambio climático en la inundabilidad de la ría de Bilbao. URA.
[20] http://www.uragentzia.euskadi.eus/mapas-de-peligrosidad-y-riesgo/demarcacion-cantabrico-oriental/u81-0003421/es/

deviant ways...there is a way of grasping a rule which is not an interpretation, but which is exhibited in what we call "obeying the rule and going against it" in actual cases" (Wittgenstein 1953 in Rouse 2007, p. 502). In contrast to this view, Giddens (1984) (in the context of bureaucracies) portrays rules as formulations which are '*codified interpretations of rules rather than rules as such*" (Jones et al., 2004, p. 21). Schatzki asserts that "*while rules shape an actor's activity to a certain degree, both applicability and meaning of rules are always interpreted by actors"* (Schatzki, 2005 in Pohlmann, 2018, p. 76). From this viewpoint, in any practice, the rule is interpreted by the practitioner: "*The rule is, at any given time, what the practice has made of it*" (Tylor, 1993 in Orlikowski, 2002, p. 58). Heidegger emphasises that interpretation can only emerge when prior understanding of the situation allows a particular knowing to be articulated: "*all interpretation (including linguistic assertion) draws upon a more basic understanding or competence that is not explicitly articulated... interpretation is only possible against the background of a prior understanding of the situation*" (ibid 502-503). According to Heidegger, it is this particular "*background understanding or competence (that) makes it possible to obey rules and articulate and grasp meanings*" (Rouse, 2007-A, p. 503). Heidegger positions this background understanding as a competence, in that 1) it is necessary to have a general understanding about the situation; 2) a person must activate competences and understanding as to how to proceed and act in particular situations; and 3) there is a personal interpretation of how to carry out an action or activity correctly (ibid). According to Rouse (2007-A), these elements would reflect a "*profound human understanding that it is expressed in any practice and which is more fundamental than any explicit interpretation of that understanding*" (ibid p. 503).

Having established the relevance played by administrative competences in shaping practices and the perspective regarding the interpretative dimension of rules, the next section engages more profoundly with the processes that evidenced the construction of *"profound human understandings"* (Rouse, 2007-A, p.503) in the case study Bilbao, by focusing on how practical knowledge, norms and meanings became interwoven in a work-place context to result in the use of climate information.

3.2.1.7. The art of working in Bilbao: weaving normativity with practical knowledge

The convergence of normativity and experiential knowledge is evidenced when practitioners perform work according to the sets of values, senses and meanings that shape expectations regarding how work is expected to unfold in Bilbao. The paradigm of urban development that emerged from the transformation process in Bilbao has given form to discourses that shape perceptions as to how the city is normatively conceived. Discourses frame the specific

repertoire of "*ideas, concepts and categories through which meaning is given to social and physical phenomena*" (Hajer, 2005, p. 300). Discourses underline categories such as innovation and entrepreneurship (BA29) and these categories shape Bilbao's economic development paradigm.

During Bilbao's transformation, economic development was strategically devised in order to increase public revenues through taxes collected from selling new properties on highly valued land-plots (BA89; BA59; BB59; BB84). In order to "*convert the city into an active city*" (BA93), portraying the city as an innovation and technological hub in Spain (BA93) was central, leading to policies being designed to attract young talented entrepreneurs (BA89). Sustainability values played a central role in this attraction model because they are conventionally associated with a high quality of life and dynamic economic environments (Reil et al., 2016), which are acknowledged to be relevant among the youth (BA105); and therefore, become a priority for policy-makers (BA21, BA5).

Bilbao's urban transformation model is regarded as a success case internationally, and today's urban development model *"is just the continuation of the model that emerged in 1992"* (BA50). Bilbao's model is an uncontested narrative which permeates all aspects of planning, decision-making and public administration (BA60), since it is sustained by collectively accepted values which define urban development and guide the expectations regarding the outcomes of work. This narrative shapes a specific professional vision that influences administrative and political processes and working routines. A professional vision entails "*socially organized ways of seeing and understanding events that are answerable to the distinctive interests of a particular social group*" (Goodwin, 1994 in Gherardi, 2012, p. 62).

Knowing what this narrative is about, is therefore not trivial:

- *"... (with the transformation) .... an identity is generated, with certain values that shape urban planning dynamics, growth style, it is a brand .... and (you have to) know how to follow that brand..." (GC2).*

Following Bilbao's brand implies that municipal officials must *know how* to operatize Bilbao's brand within their administrative competences. The difference between *knowing what* the brand is about versus *knowing how* to implement it, suggests that experience and competences are required to operatize the normative framework that orients work in Bilbao.

In view of the discursive components that guide Bilbao's brand, knowing how to *taste the city* -applying specific sensorial knowledge to comprehend the city- is central. Sensorial knowledge is explained by Gherardi (2012) as a type of knowledge *"...which develops through learning how to use all five senses professionally... (which) become professionally trained; that is,*

disciplined by the practices in which they are embedded" (p. 61). The way in which municipal officials comprehend the city emerges from their daily engagement with the city through the specific administrative competences involved in their professions. Through experience, municipal officials calibrate the lens to observe and explain how the urban systems function; they anticipate challenges and prioritise decisions.

- *"... (the management of) noise .... demands one to look at regulations and be aware of them. Then you have to know the problems of the city at an environmental level. Pollution... conservation..."(BC5); "... problems of gender violence, we must regulate the space to avoid danger zones, regulating the design; It is a rather complex thing that comes from urban planning, but also complex things that have an impact on urban planning and that are not easy for us to translate" (BB6).*

Shove (2012) explains that "*space is itself defined by what goes on with it"; hence, streets, squares, buildings and playgrounds are used in different ways, through different performances*" (p. 133). The city can thus be observed through a lens of urban pollution and noise; from traffic and waste collection, from equity and justice; from risk or cultural development. Consequently, tasting the city is not about purely observing; but also, about understanding how the space is used in practice, how administrative competences shape the use of public spaces and how the use of public space shapes administrative competences.

The articulation of work occurs among people and it demands collaboration (Gherardi, 2012). Knowing how to work in Bilbao demands understanding how the norms that orient working relations are prescribed according to expected behavioural patterns, and knowing how to follow the expected pattern of behaviour that regulate how people interact with one another.

- *"...in an organization like ours, there is a very important part that is taking care of relationships, communications between people, knowing what to ask, who to ask, all that, the part of communications in a transversal project is very important and you have to know how to relate to people..." (BC11).*

Knowing how other people work is not only about learning the myriad tasks described in a contract's terms of reference or in administrative competences. It involves also learning about what becomes sensitive, controversial and conflicting to other parties, so that controversies are accounted for as work unfolds. These mechanisms are reflected in the following example, where ensuring transparency and providing trust to the management of sensitive information is central:

- *"... In the end, all the data is a bit sensitive... because they leave you a little exposed..." (BC21); "... the idea is that when going to request certain data that may be sensitive, ...*

we do not access to the database, but that we simply are given a script or a program so that we simply extract the data we need" (BC58).

Knowing how colleagues work seems to respond to understanding how colleagues apply judgement to deal with specific situations. For instance, in the context of dealing with floods:

- *"... the water manager may say: well, as the water rises more often, then I will have to implement the protocol more often.... in my case, I will have to make larger pipes ... each one is giving answers according to what they experience from day to day" (BA35).*

Comprehending the rhythm of sequences and timings that influence the pace of work also emerged as a relevant normative aspect. Rhythms are understood as an outcome of the trajectory of practices: *"rhythm... is in essence a matter of understanding how some practices flourish and others fade; how qualities of frequency, duration and sequence emerge"* (Shove, 2012, p. 96). Shove explains that "*for any one individual, enacting a practice is a matter of weaving it into an existing rhythm and of honouring temporal injunctions inscribed in concepts of proper performance*" (ibid, p. 127). Respecting the fact that working routines have rhythms that should not be disturbed, seems to be important in Bilbao; and the way of not disturbing them is to ensure that progress occurs in view of colleagues' workloads, administrative timings and procedural complexities.

- *"We are holding each other at our rhythms..." (BA71); "... what is expected is to be able to solve things little by little" (BC8); "... as long as we can within our capacity" (BA71); "... small steps are being taken, which have emerged little by little..." (BB18).*

Following this rhythm means that achievements are to be reached gradually, beginning from what is less energy demanding, so that the pace of progress does not affect administrative processes, planning procedures and decision-making dynamics, nor people's working capacity. The implications brought about by gradual rhythmical progress suggest that new initiatives should avoid disruptive change, and rather be designed around what demands less energy, financial resources and time:

"... (we want to) ... create indicators that allow data to be taken automatically without too much effort" (BC7); "...There are things that are easily measurable, (and that) we can easily get" (BC34); "... The Area of Services and quality of life have already captured data, so it will be easier to start from there" (BC56); "...We have the indicators for .... Barcelona...but they are very complex conceptually" (BB102).

Sensitive issues emerge when proposed changes divert from official mandates. In the following example, a municipal official is asked how she knows how much pressure she can exert on her director in order to push for changes in urban planning processes to account for climate

extremes. From facial gesticulation, she can interpret a negative connotation linked to proposals that are not ruled or normed.

- *"... I know that I am measured when, for example... I propose something, and if the director pulls a cross face, then I know I'm going too far... he pulls a cross face if (a proposed change) is not official..." (BB82).*

Learning that level of sensitivity, to "read between the lines," displays actors' practical knowledge to judge how to navigate alongside rules and schemas and guide future performances. Complying with the normativity of work in Bilbao seems to be highly dependent on what is obligatory, and in the absence of specific rules that orient the use of climate information, promoting change calls in for experience-based competences. Provoking changes within restrictive official mandates seems to be an achievement in terms of weaving norms with experiential knowledge: progress slowly, negotiate intermediate goals which do not disturb the pace of work. For instance, studies of heat islands could be considered official within the new Urban General Plan through a process that followed such characteristics:

- *"…. heat island areas are not official, but were accepted because… (we proposed them in) only two areas…" (BB74); "… here it has been an intermediate thing: we did not have policies that forced us, but we had some official things that gave us guidelines, and in a limited way we have included a series of things that represent a small step within the city council" (BB81).*

The normative logic of "keeping things simple" is also reflected in how cautiously climate information has been introduced in Bilbao's Climate Adaptation Plan and in the recent review of Bilbao's Urban Master Plan (Diputación Foral de Bizkaia, 2019-B): while climate scenarios are explicitly recognised as threats to urban development, given that these documents orient the agendas of municipal departments and institutional activities, they are drafted stating commitments more generally in order to facilitate building a consensus:

- *"... The adaptation plan ... has a series of commitments that do not complicate us too much... it is very general …" (BB100); "… the climate change plan indicates…. generalities, (BB45); "...when you see the adaptation plan, you see general measures that are not linked to climate projections exposed in the very same plan... the plan does not say, for "x" risk in this area we do "Y"" (GE13).*

This sub-section has examined the central aspects that explain how normativity and experiential knowledge converge to shape working dynamics in Bilbao. Overall, municipal officials operate with a professional vision that articulates a common understanding regarding how urban development is to take place and which is rooted in values of innovation, entrepreneurship and

economic activities. The interplay between experiential knowledge and normativity is reflected in how this vision is operatized in practice. Knowing what provides sense, consensus and prescriptions is different to knowing how to reflect them in practice. From this perspective, in the following section the practices involved in the use of climate information in Bilbao are exposed and disentangled.

3.2.2. Using climate information in practice

While a wealth of reports provide input regarding climate projections and inform about risks and vulnerabilities in Bilbao[21], the interviews indicated that these have still not been consolidated within official frameworks or administrative competences. In spite of the institutional call for mainstreaming adaptation –as for instance in Bilbao 2050 and Lurr-Adapt Project-, the use of climate information occurred opportunistically; on the boundaries of official mandates; and distributed through different activities taking place in irregular time spans and articulated -many times- through informal channels. Different departments made use of some climate information sets at different points in time; and with varying degrees of detail and specificity in order to serve different purposes.

- *"(through) research projects... we have identified precipitation projections and have identified how climate change will impact on different aspects, such as sanitary systems and river flow... these are small projects that allow us to include climate considerations in urban development... the other way is to integrate climate considerations into urban design projects... we push climate projections to be included in that design stage (BA45).*

Data collected suggested that the use of climate information was shaped around: 1) increasing a general awareness and reflexive thinking; 2) generating concrete narratives that allowed contextualising climate information to specific policy issues; or 3) directly factorizing climate information into the design of projects and programmes. These issues manifested differently according to each of the arenas and the practices of using climate information played out differently accordingly. Eleven practices were identified.

[21] Specified in Annex 5

Table 14: Arenas and categories informing the use of climate information in Bilbao

Arenas	Category 1: Reflecting	Category 2: Narrating	Category 3: Designing
Political arenas: The use of climate information is weighted against the trade-offs between what is politically desired/acceptable.	1) Complying with exclusive environments: obtaining standards and establishing comparisons 2) Visibilising trends 3) Bonding 4) Scouting 5) Testing boundaries		
From a strategic arena, the use of climate information is assessed in terms of its contribution to facilitate rating the order of priorities of actions and the use of resources for achieving goals and designing plans and strategies in the context of climate projections.		6) Coding 7) Aligning to traditional measurement procedures	
From an operational arena, the use of climate information is weighted against the trade-offs between what is technically needed and feasible to do. Refers to how climate information connects resources, competences and expertise for the execution of specific operations.			8) Outsourcing 9) Data storing 10) Collecting real-time data, requesting and sharing information 11) Data analytics: From tracking trends to creating possibilities

3.2.2.1. Reflecting category

Characteristics: In a reflecting category, practices illustrate how awareness about climate change increases as comprehension about climate risk is facilitated by linking it to social problems defined by audiences with the power to enable usability.

3.2.2.1.1. Political arena

A political arena departs from the dominant perception that the use of climate information must be dependent on official mandates. The understanding of what is official in Bilbao refers to procedures, methods or mandates that are either legally binding, or are recommended by an official authority as a good procedure (BB97), or that result from an accepted methodology,

and can thus be applicable as a standard practice to all decisions (BB43). In these terms, while decision-making and urban planning occur within a formal and structured policy-environment, climate change is described as a poorly institutionalised policy subject. Practices in Bilbao are subjected to a large and diverse set of obligations mediated by administrative competences distributed through supramunicipal institutions (BB14) and sectorial agendas that makes urban planning to be a strictly regulated practice where conforming to legal obligations is central (BB31; BB14; BB50). This picture contrasts with the very few official mandates that enable the use of climate information (BB107) resulting in usability being immersed in a complex interplay of two policy systems: a poorly institutionalised policy subject (climate change) and a highly official and structured decision-making environment.

While in spite of a high degree of officialization, the current policy window in which legal amendments are being proposed to integrate climate considerations into planning and decision-making instruments, suggests that official structures can be subjected to change. In this context, practices featured in this category inform one that such changes do not occur linearly, but rather result from the endorsement by key actors with the power to allow climate information to become a feature of decision-making. Hence, practices in this category illustrate the multiple activities carried out to fulfil the demands of such key actors.

Practice 1: Complying with exclusive environments: obtaining standards and establishing comparisons

Suchman (1995) notices that among institutions operating in highly institutionalised environments -such as local governments-, gaining legitimacy over a specific matter takes place (among other ways) by obtaining standards. Standards are useful for evidencing effective and appropriate strategic/administrative performance and have the power to position Bilbao within privileged categories. Selecting specific environments and conforming to established standards has helped positioning the use of climate information in Bilbao. Two acts were central: first, the acquisition of labels such as membership to the Covenant of Mayors, and signing Bilbao's Agenda 21, both of which entail the voluntary commitment regarding climate change adaptation; and second, Bilbao has also been a beneficiary of H2020 projects such as "*Reconciling Adaptation, Mitigation and Sustainable Development for cities" RAMSES* (Tapia et al. 2016), RESIN and Econoadapt (Reil et al. 2016) which reflect the fact that Bilbao belongs to a privileged group of European cities. Engagement in H2020 or gaining specific certification results from work undertaken collectively and normally by thematic task forces. Further details about the functioning of these task forces is described along with other practices later in this section. However, in the course of explaining the use of climate information, the lessons that

emerge from the practice of "Complying with exclusive environments" is the positive effect it provokes on awareness levels by providing a framework to establish a comparison between Bilbao and other cities. This is illustrated in three examples:

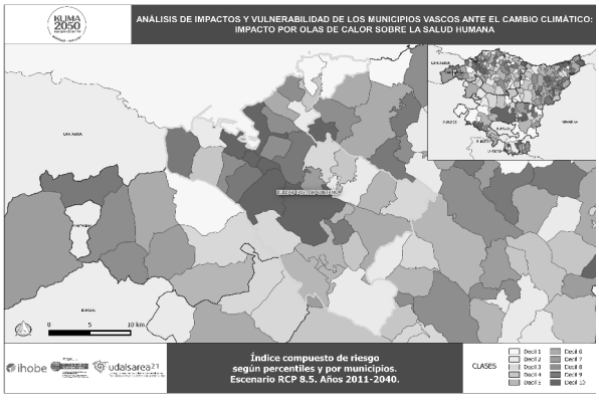
1) Comparisons offer a pragmatic way to highlight challenges faced by Bilbao and to see how things could be done better (BC27): IHOBE (2019-A) provides a detailed comparison across the 251 municipalities of the Basque Country and specifies the level of exposure to, sensitivity about and coping capacity for heat waves and floods (pluvial, fluvial and due to sea- level rise) and their effect on economic activities. A large diversity of risks and vulnerability exist across municipalities in the Basque Country, but also within the Metropolitan area of Bilbao, as it is shown below.

Table 15: Relative position of Bilbao to the remainder of the municipalities considering 4 impact chains in RCP 8.5 (2011-2040)

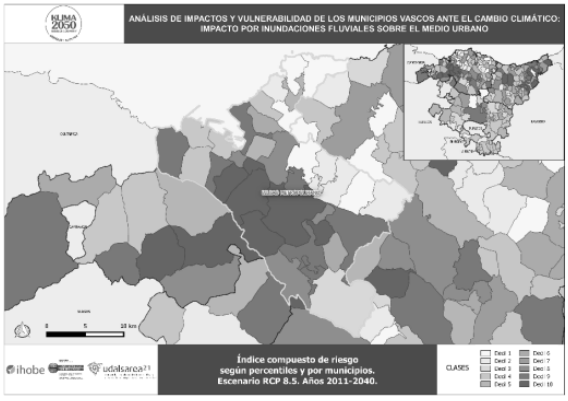
Impact chain	Vulnerability	Risk
Heat waves on human health	6	10
River floods on city	8	10
Sea-level rise on city[22]	6	9
Drought on agriculture	1	1

Source, IHOBE, 2019-A

Map 2: Comparison of impacts and vulnerability from heat waves and sea-level rise on municipalities in the Basque Country



Heat waves on human health. Higher risk/vulnerability percentiles highlighted in darker colour (RCP 8.5, 2011-2040). Source: IHOBE 2017-D



Sea-level rise (RCP 8.5, year 2050). River flow on human settlements (RCP 8.5 2011-2040). Higher risk/vulnerability percentiles highlighted in darker colour. Source: IHOBE 2017-D

[22] Based on a study carried out by AZTI "Assessment of the impact of the climatic components of sea level rise on the Basque coast" currently in progress and taking as reference the data provided by the Joint Research Center (2017) for the Gulf of Bizkaia, in the that certain increases in elevation are estimated for the years 2050 and 2100, and under the emission scenarios of the Fifth Assessment Report of the IPCC. It is expected that, under the RCP 4.5 scenario, it will rise +18 cm in 2050 and +53 cm in 2100. In the RCP 8.5 scenario, it would increase, respectively, +22 cm and +80 cm.

2) Comparisons facilitate finding reference models that provide inspiration (BB74). Inspired by the city of Stuttgart (partner city in a H2020 project), municipal officials in Bilbao saw how climate maps regulate urban development and how the use of these maps are applied on the same way that noise is managed in Bilbao (BB13). Noise can be managed because legislation regarding noise control transfers entire competences to the municipality to draft noise maps, to define thresholds and to apply control measures (BB11), and noise management rests on official mandates and specific administrative competences (BA13).

3) In the same context, another reported example refers to the indicators of urban sustainability used by Barcelona, which provided ideas as to how to improve information management systems by linking municipal service delivery to indicators visible in GIS systems (BB96).

A common feature of these examples is that comparability helps generating pragmatic ideas as to how progress regarding the inclusion of climate information into administrative functions can be pursued. The examples presented above suggest that the use of climate information benefits from it being associated to concrete working practices that, for instance, mimic evaluation and administration procedures that already enjoy an official status because they can be located within the administrative set of competences that guide work.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
1. Complying with exclusive environments: Obtaining standards and establishing comparisons	Climate projections (Ramses and Resin projects); indicators and climate maps from other cities. IHOBE (2019-A); Udalsarea21 indicators for climate change	Bilbao as a well-positioned urban centre.	Selecting specific environments and conforming to established standards; Linking procedures undertaken in other cities to local working procedures.	Stabilisation by rhetorical closure: these practices highlight specific attributes and desired. Practices facilitate comprehensibility of endorsing audiences.	Recognition about the relevance of using climate information. Display ways to integrate climate information into administrative functions. Highlight deficits and challenges.

Practice 2. Visibilising trends

While climate information is assumed to be usable, providing it can be granted an official status (BB107), demonstrating imminent officialization can work as a tool to persuade specific audiences. The following example shows how different hints revealed a seemingly unavoidable forthcoming legal obligation to identify the risks heat islands have on new infrastructure projects. Demonstrating imminent officialization provided additional power to the repertoire of claims to support the use of climate information:

- *Q. You tried to convince your director about considering the heat islands in this part of the city, how did you do it? "...The strategy was (to explain): this is something that is coming, it is going to be more and more regulated and we cannot ignore it... the guidelines of the (adaptation) plan already have it there... there are people who are putting these things in urban planning and we cannot be left behind, it comes in the future very clearly..." (BB44).*

Comment BB44 expresses the tension caused by an increasing number of regulations projected to emerge or deal with high temperatures in the city. The persuasion aspect lies not so much on the projected increased exposure to high temperatures; but rather, on the projected increase of legal requirements that appear to be unavoidable. Being able to observe trends and to project them into the future, to select the appropriate repertoire of arguments and to associate them with relevant legal working structures are all ways to characterise how experiential knowledge is manifested through this practice. Experiential knowledge in this sense is about knowing how to tap on the possibilities offered by the policy environment: an imminent change in legal obligations and increasing regulations.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
2. Visibilising trends	Adaptation Plan and other demonstration documents	Anticipating future obligations	Making trends visible	Limitation by legal decree: to anticipate and adapt to projected administrative changes.	Anticipates challenges to current working practices.

Practice 3. Bonding

The formation of a coalition between municipal departments and external institutions (technical, scientific or other municipalities) is a practice that has helped to build buy-in among top-level municipal officials regarding the integration of climate projections in new urban developments. Two aspects are central to this practice. First, scientific pedigree acts as an endorsement currency to legitimation claims; second, scientists can facilitate convincing political audiences by providing robust explanations and evidence-based advice. Interaction between these aspects is illustrated in the following examples:

a) The convergence of a policy window, available (credible) information and assistance from scientists helped to promote the inclusion of climate information into a formalised and indicative planning structure. As the supramunicipal planning instrument DOT explicitly called for climate risk to be included into territorial planning, a policy window emerged and allowed

the inclusion of climate considerations into the General Urban Plan (BB80) to be discussed. As risk maps and vulnerability studies became available from participation in H2020 project Resin, there was clarity regarding which scientific and technical inputs could be integrated into the new version of the General Urban Plan (BB16, BB75). A coalition with external experts helped municipal officials in Bilbao to pragmatically demonstrate that planning could benefit from climate information. Deliberation between technical municipal officials and political decision-makers centred around concrete ways in which to consider floods and urban heat islands with regard to urban development, and not so much on whether these were relevant issues:

- *"... the climatologist from the city of Stuttgart was brought here to talk and (he) gave us tips on how to integrate climate change into the plan and showed that things could be done. That was quite important, until today we cannot believe it. It is another weight" (BB79).*

b) Coalitions are established with private companies to demonstrate more clearly the value that projects can potentially deliver:

- *"... We form coalitions with interested companies that can put ideas into effect... The implementation step, you need to see it" (BA99); "... it is not the same to present an idea... with a company that can carry out the idea into effect and that is telling you what it is going to look like, the pros and cons, the problems and possible solutions.... something concrete" (BA100).*

The practice of bonding highlights the role of scientific pedigree and experts as endorsing currency to validate the integration of climate information.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
3. Bonding	DOT; Climate Adaptation Plan; Climate information from Resin project	Deliberation oriented by technical & scientific information	Tapping on policy window; demonstrating practical benefits to decision-making.	Limitation by scientific standards;	Facilitating buy-in

Practice 4. Scouting

The word "scouting" is used here to refer to processes of exploring and recognising how other departments evaluate the performance of work, which is reported to be a central aspect to facilitate collaboration across municipal departments. This is illustrated as it follows:

The Environmental Department designs sustainability criteria (knowledge products) and constantly revises project proposals drafted by other municipal areas in order to identify whether sustainability criteria can be incorporated as ex-ante evaluation into the design stage

of project development (e.g., increasing infiltration areas in new parks and roads) (BA11, BA18, BA45). However, including such criteria varies from project to project, and there is a need to constantly monitor what criteria could become relevant in each context. Monitoring takes place through meetings where deliberation and decisions regarding urban development take place. The Environmental Department has appointed a municipal official whose role it is to attend these meetings (BA19), as keeping track of progress is of central strategic relevance to better understanding of how decisions are judged or what becomes important to other departments (BA97). Such inputs become valuable for devising strategies to position the use of climate information in the agendas of other municipal departments.

These meetings can result in the establishment of task forces oriented by commitments to collaborate across departments (BB78). These meetings include 1) a "petit-committee", which is a formal trans-departmental meeting that take place every 5-6 weeks, where management plans, budgets and important issues regarding the progress of projects and initiatives are discussed (BA119); 2) in the month of June, when budgets are discussed, departments find space for meetings where climate considerations can be presented, as they would figure in the following year's budget (BA122); 3) Per-request meetings take place in the context of collaboration in international projects, which are normally coordinated by one area. Participatory workshops are organised afterwards in order to share experiences with other municipal departments (BB10; BB83; BB39).

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
4. Scouting	Specific knowledge products	Collaboration is permitted following normative criteria such as working rhythms, dedicated spaces for collaboration.	Competences to identify possibilities to collaborate and establish collaboration mechanisms.	Support collaboration	Increased understanding regarding how decisions are judged or what becomes important for decision-makers in other departments.

Practice 5. Testing boundaries

Municipal officials can take advantage of emergent policy windows (such as the updating process of the General Urban Plan) and test the boundaries of what is accepted practice in Bilbao by learning how decision-makers apply judgement, and balance expectations and demands through equilibrium learnt in practice. In other words, they can exert pressure and act on the boundaries of what is traditionally conceived as accepted practice, as long as they comply with working norms. In the following example, endorsement by higher-level political actors can be achieved providing requested changes do not cause much trouble:

The new General Plan contemplated drafting a climate change chapter. As the Resin project provided climate projections, a consultancy firm was hired to build on these results and help to draft a proposal which was later negotiated by the municipal council (BB67):

- *"... As it is a minimum thing, it couldn't go wrong... As it is not a very difficult thing… it is a thing that is restrained and accessible… something had to be done because a public policy has to be ready in the coming years, so we tried to do something just to start; then nobody objected to it; but it is also clear that we did not propose anything too ambitious... areas to be developed in the future (in risk of) floods...are an opportunity because something new will be done; hence, a study is required there" (BB68); "... the heat island areas are not official, but they (the directors) have accepted them because.... they were only two areas in which new urban regeneration (projects) will take place that fit in the red zone… but had it been a more systematic, more global thing... I don't know ..." (BB70); "This is now law, because it is regulated in the General Urban Plan and a plan is normative, you have to comply with it..." (BB72). "... We do not know what these studies will be or what repercussions they will have" (BB16); "These are pilot cases to see how far we can go. As we cannot start globally, because it is very complicated as you deal with too many flanks, we started by doing pilot experiments to test how far we can go" (BB19).*

The process of integrating flood-risk areas and heat islands into the General Urban Plan illustrates how municipal officials face confrontation and devise activities strategically in order to generate opportunities to integrate climate considerations into planning. In the absence of an official framework that explicitly supports a consideration of flood and heat islands, integrating climate considerations into the General Urban Plan unveils a critical legitimation strategy: testing the boundaries of what is accepted among decision-makers. In this context, it becomes visible how normativity and experiential knowledge become central to attaining usability, and how these two aspects are pragmatically manifested in technical, institutional and deliberative processes. This practice highlights how the use of climate information in Bilbao occurs within spheres of experimentation of what is considered acceptable practice in public administrations.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
5. Testing boundaries	Climate projections emerging from Resin project.	Slow progress without disturbance	how to maintain balanced requirements.	Shed light on where boundaries lie	It makes legitimation strategies co-adapt to newly discovered boundaries and normative aspects.

3.2.2.2. Narrating category

Characteristics: Climate information helps to distribute roles within administrative competences. Climate information indicates what is supposed to be done: it indicates which decision-making processes are sensitive to climate change. Climate information specifies the strategic distribution of resources and helps to rate priorities between what is feasible according to available resources.

3.2.2.2.1. Strategic arena

From a strategic perspective, climate information indicates what is supposed to be done (BA44): climate information supports understanding risk and identifying vulnerable groups and exposed infrastructure; thus, directing attention towards specific areas of concern. A strategic arena highlights that climate information demands a translation process in order to broaden the understanding regarding the type of actions that are supposed to be taken to reduce risk and to shed light on decision-making processes that are sensitive to climate change. Because narratives emerge as storylines where urban dynamics are blended with climate risks, narratives facilitate positioning the use of climate information in specific practices.

Practice 6. Coding

A core characteristic highlighted by the strategic arena is that climate information seems to be usable providing it can be aligned with municipal working routines.

- *"The normal working routine does not allow me to introduce climate information...I see that it is useful... but it only makes sense if it responds to our working routines... because in our daily routines we have no space to connect it to our work" (GB20).*

Alignment with working routines is described in terms of specifying which activities and decision-making processes are sensitive to climate change, indicating that municipal officials can act upon what is normed and regulated within administrative structures:

- "*Climate change cannot run alone....it must be integrated with ongoing processes, in activity maps and see which activities will become more affected by climate change and how we can give valuable input by using climate information" (GA22); "All flood and pollution issues are regulated by laws, so we can work on it. But issues of heat islands are not regulated... there are no regulations, (no indication of) areas in which (for instance) there are so many degrees you have to revegetate with x%, regulate certain initiatives-..." (BB27); "... Heat Islands... are questioned… because they are not (within) official maps..." (BB43).*

Climate information must be contextualised to provide a common understanding of how climate variability affects the delivery of municipal services and jeopardises the status of Bilbao as a

leading European city. This contextualisation process is associated with two concepts: on the one hand, Shove (2012) explains it in terms of "coding", whereby contextualisation occurs through the practical process of standardisation and recontextualization. Standardisation suggests that concepts can be *"...defined, taught and learned regardless of the situation*" (p. 50); recontextualization allows associating actions with concepts of different connotations, creating specific categories that reflect social meaning (ibid). Contextualisation is also associated with the transition from data to information as described in Rowley (2006), where particular emphasis is given to the addition of meaning which gives significance to data as it has been *"processed for a purpose and... (it has been) interpreted and understood by the recipient"* (p.170).

It has largely been established in the adaptation literature that given that climate impacts are contingent on societal and geographical factors that determine vulnerability and exposure, decision-making for resilience construction (particularly in the case of cities) demands a combination between climatic and non-climatic information in conjunction (Lourenço et al., 2016). Räsäner (et al. 2017) points out that climatic as much as non-climatic information is a key to risk management in urban areas. Lemos and Rood (2010) argue that climate information should be integrated with other kinds of knowledge so that climate risk management can be mainstreamed into decision-making. Mills and colleagues (2010) highlight the fact that climate information needs to be "urbanised" in order to serve particular planning purposes, which demand different modelling tools to generate appropriate data in response to specific urban climate contexts; while Giordano (2018) observes that the use of climate information demands high volumes of meta-information.

In this context, the practice of Coding refers to the practical process of adding meaning and significance by recontextualising and standardising climate data and associating it with urban development concepts that are based on existing narratives, so that it can be taught and learned regardless of the situation of use (own definition adapted from Shove 2012, p. 50).

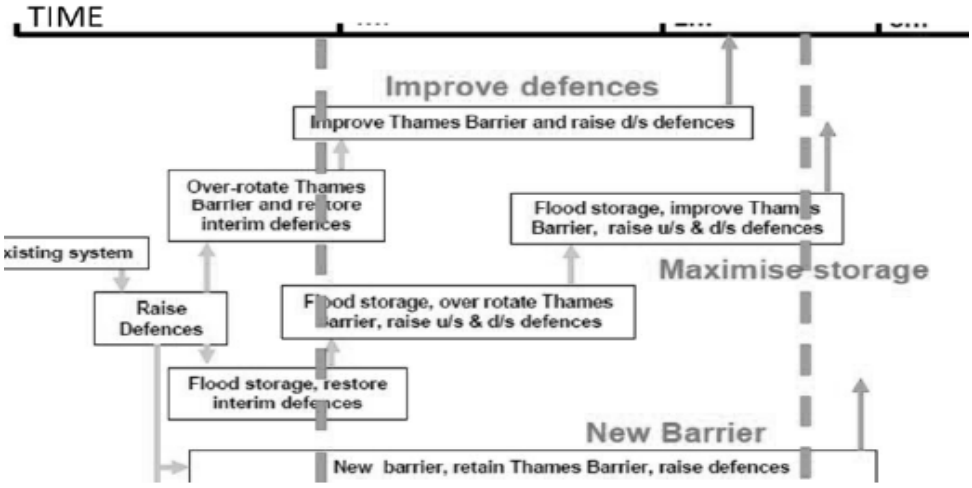
Different material entities support Coding. For example, the ACCESIT Project (Tecnalia 2018-C) produced impact chains which shed light on the potential cascading effects provoked by climate change on people, infrastructure and on the flow of resources and energy in the city[23]. Because risks highlighted by impact chains are transversal, impact chains facilitate collective

[23] The impact chains display the threat provoked by costal floods, river floods projected floods due to extreme precipitation under a RCP 8.5. to year 2100 and showing a T100. In exploring the flood impact chain on transport, both, physical and institutional measures are considered for attending three levels of action: individual, infrastructure and city level (Tecnalia, 2018-C p. 56).

reasoning and support making visible the connection between risks on the implementation of administrative competences particular to each municipal area.

- *"All this information is completed with other valid information, mainly to characterize the sensitivity and adaptive capacity of critical infrastructures... such as vulnerability / risk studies or adaptation to the climate change... history of flood incidents, damages, costs, etc... information from Bilbao is being collected... (and) reviewed... then, a proposal of indicators is collected to carry out the analysis of risks and consequences of transport infrastructures in the face of the threat of flooding" (Tecnalia 2018-C, p.34).*

Figure 5: Example of an adaptation pathway for infrastructure development.



Source: Tecnalia 2018-C, p. 72

From the Accesit project it can be seen how climate information becomes understood and manageable because: a) it can be treated through standardised administrative and procedural mechanisms (for example, the impact chains have a map of administrative processes and decision-making processes (GA23)); and b) because alternatives to adapt are provided (the Adaptation Pathways provided by Accesit project offered a palette of adaptation measures ranked according to their cost-effectiveness applicable as measures to counteract the effects of climate variability). Selected adaptation measures emerging from Adaptation Pathways (Tecnalia 2018-C, p. 22) are sketched as an implementation time-line where co-benefits and opportunities emerge from the chronological synchronisation of measures. Functions and attributions can be clearly associated within each pathway as there is an indication regarding core objectives, budgets and time-lines, which enables the distribution of roles and tasks according to administrative competences. These observations suggest that when the two elements converge -treating climate change through existing administrative competences and proposing adaptation measures-, Coding seems to be facilitated.

Coding supports the construction of a knowledge base that can be used on specific occasions; hence, Coding seems to have a deep implication in the knowledge base that orients how people work.

- *The use of climate information in Bilbao has provided a knowledge base that we carry with us..." (BC61); "... It's something you know... A passive knowledge that is extracted according to the needs…" (BC62); "... I pay more attention than before to the issues of biodiversity and waterproofing of soils... in my day to day I try to integrate the theme of green and permeable things much more in our plans..." (BB94); "... we do not return to the data provided by Resin... it is not necessary either. These are things that you learn and you keep (in mind)..." (BC43); "... It is not that you do only specifically climate change work, but that you integrate that into everything, on a day-to-day basis… it gives you more arguments to discuss… you are associating it with other topics..." (BC68).*

Quote BC68 emphasises experiential knowledge as being central to Coding: expanding the stock of argumentative resources by recovering pieces of information at specific and strategic moments in order to connect two previously unconnected topics, so that light is shed on new aspects of urban development. Such association could not be possible if municipal officials did not carry pieces of information in their mind and applied their judgement to discern the specific situation in which best to use the information stock.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
6. Coding	Accesit Project (Tecnalia (2018-C, p. 22)	Conceiving risk in relation to urban development; Direct attention to specific areas of concern	Associating with particular administrative competences; Recovering pieces of information in specific situations; Impact chains reflect collective reasoning to connect climate risks in causal webs.	Anchoring in specific municipal competences. Ordering: directing attention towards specific areas of concern	It generates a passive-knowledge base; Collective reasoning, deliberation

Practice 7. Aligning to traditional measurement procedures

Coding is reflected in the enactment of different material representations of experiential knowledge (Shove, 2012), such as indicators. The use of indicators is a well-established method based on empirical evidence that sustains the ability to make performances comparable to previous experiences, allow the collective evaluation of performance, and make work answerable by offering a common jargon to communicate how work is being performed. Hence, Suchman (1995) underlines the fact that indicators are a method of acquiring cognitive

legitimacy, because they are dependent on socially accepted procedures that emphasise performance and provide a skilful impression of management.

Measuring performance and progress is the core to working in Bilbao (BA109): *"In the end, you are always thinking that you need to measure"* (BC65). Municipal work in Bilbao functions under what Mitchell (2011) describes as disclosure-based transparency policies (in Bierman et al., 2011). In these terms, indicators are a form to operatize the provision of transparency, which is a central feature of accountability, understood as "*the willingness to accept responsibility or to account for one's actions*" (ibid, p. 1857). Institutional performance is best evaluated by criteria such as efficiency, equity, and sustainability (Young, 2008). The need for quantifying the contribution of each area to improve the city orients working practices by promoting forms of work that prioritise the use of measurable elements:

- *"The idea is... to say that we are improving the city with the city's indicators: better economic rates, less unemployment... standard indicators of the city" (BA113*).

The indicators used in Bilbao are indicators of achievement (BB102). These indicators are weighted against a measure of success and are thus used to provide specific, observable and measurable characteristics in the progress and execution of projects or plans (normally stated as in % of progress against targets) (Southern Utah University, 2015).

- *"... here works the model of Quality management. In the end, what you do is: You plan, implement, check and improve... the opportunity to improve the city is combined with the need to measure..." (BA108).*

Hence, indicators must provide some margin of action: representing a current situation which has limited scope for improvement may be counter-productive when the goal is to represent substantial progress. Thus, while some indicators may represent important features, limited evidence of progress may hinder their use:

- *"... if we set a renewable energy indicator... we provide x; but going from x to x-plus.... is not easy, because you are not going to put solar panels on all buildings... so there are indicators that are nice, but in which you have little margin for work..." (BC36).*

Indicators are considered a core method for communicating, generating narratives and standardising processes. Hence, they are a promising method for paving the way to acting upon climate information (BA72). But evaluating performance demands practical knowledge: "*knowing in the sense of being able to evaluate a performance*" (Shove, 2012, p. 23), and knowing what to do with the results of the evaluated performance (Walsh et al., 2019). For example, operatizing Bilbao's Adaptation Plan has been carried out by selecting measures

within the Plan that could be associated to existing urban indicators already in place and which are manageable:

- "*... the way in which we frame it now is more reasonable ... it is a more operational way for us ... the indicator system includes things from the Adaptation Plan...*" *(BC51).*

Thus, constructing indicators requires knowing what information supports bringing core messages across and which information can be associated with existing measurement procedures. However, not all indicators may be suitable for this task because they can be difficult to access, data requirements may be too high and hinder their regular update, or they may not provide a clear message *(BC33; BB98; BC13; BC14;* BC17). Additionally, the capacity to associate climate information to this traditional form of assessment can be hindered by the different nature of indicators used in the municipality and climate information (BC64):

- *".... heat waves, precipitation, etc... in reality that data is not part of the daily "war"; our "daily war" is about the indicators that we have the capacity to act as a municipality..." (BC37).*

The practice of *Aligning* suggests that the likelihood of adopting climate information is higher if it works as an input that can be associated with and can support measurement systems that are already in place:

- *"... if (climate information) supports our indicators, then we can use it.... what I'm looking for is data that allows me to generate indicators. I go to the data: I already have an index of "permeability"... with my municipal projects do I improve the permeability?" (BA111); "...We use climate information as diagnostic information… to analyse risk and define methodologies… and within this methodology go looking for the appropriate indicators" (BA72).*

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
7. Aligning	Indicators	Socially accepted techniques. Indicator management must be light and not too demanding.	Knowing how to construct and manage indicators.	Limitation by standardising methods	It promotes a common evaluation standard that facilitates comprehension

3.2.2.3. Designing category

Characteristics: Climate information shapes the activities of the more advanced stages of the adaptation process; it provides more precise technical and financial information to appraise,

weigh up and prioritise adaptation options. Climate information connects resources, competences and expertise for the execution of specific operations.

3.2.2.3.1. Operational arena

Operational arenas describe two dynamics: first, the way in which the provision of specific services is synchronised with external experts; and second, the dynamics sustaining the provision of sectorial non-climate data needed for coding climate information with regard to local contexts.

Practice 8. Outsourcing

In Operational arenas, climate information shapes the activities of the more advanced stages of the adaptation process (assessment, selection and implementation of options (Cortekar et al. 2016)); or shapes actions or activities involved in processes of redesigning, re-organizing and evaluating development policies, programmes, and projects (Gupta et al., 2010). Two considerations emerge in this context. First, climate information is expected to provide precise technical and financial information to appraise, weigh up and prioritise adaptation options.

- *"... It is not only about reflecting a water stain (in a map) but also understanding what that implies... frequency (of flooding)... assets you have in those areas and how they will be affected...how to supply, communicate one part of the city with the other, cover basic things…" (BC41).*

Second, climate information must be presented in a way that offers options to policy-makers: in the context of the Zorrozaurre Regeneration Project, the City Council has authorised the opening of the Deusto Canal to help prevent flooding by decreasing the river level by one metre (Saitec, 2007). The Bilbao Bizkaia Water Consortium has invested EUR 33 million to build a 75,000 m3 capacity storm water tank which will also help prevent flooding and protect Bilbao's critical water infrastructure (Zorrozaurre Commisión de Regeneración, 2015). Flood-associated costs are expected to be reduced by up to 67% for return periods of 100 years, and by 30% for return periods of 500 years (Oses-Erazo et al. 2012). The Econoadapt Project (Sainz de Muerieta, 2017) provided a broad range of infrastructure economic appraisal to protect Zorrozaure against projected floods; thus, orienting investment decisions (ibid).

The literature review evidences that *specificity and the provision of alternatives* become central aspects demanded by policy-makers. Indeed, most studies available for Bilbao in this context pay specific attention to these two issues[24]. The high degree of specificity needed in

24 such as "Description of adaptation options and their costs and benefits: general catalogue of options for adaptation to an increasing flood-risk including cost-and-benefit analysis" (Scussolini et al. 2014); and "Adaptation to Urban Floods by Planning and Design: A set of adaptive strategies and design solutions to manage floods and storm water in Bilbao" (NTNU, 2014); "Assessment of the urban heat island effect" (Tecnalia, 2014-A) and "Design solutions for Urban Heat Island mitigation in the City of Bilbao" (Tecnalia, 2014-B)

infrastructure projects demands such information normally being outsourced in the form of specific consultancy contracts. These contracts are carried out under close scrutiny by municipal officials, especially since municipal budgets are involved. Developing these contracts demands coordinating municipal officials with a range of expertise (BD22), so that terms of reference are clear and ensure the delivery of products according to the expected standards. There is a long chain of decisions that must be synchronised. For example, in the case of an infrastructure project, a consultancy firm may provide a detailed design, but materials to be used in the construction are in the end decided upon by municipal authorities (GB8) who draft the urbanisation project (BB87) and specify materials according to parameters such as quality and maintenance costs (BB88). Hence, agreeing on the terms of contracts demands a broad understanding of the distribution of administrative competences, but also the forms of work in other departments and the forms of assessment and standards relevant to each party applicable at different stages of the project. Attributions over decision-making in an urban physical space overlap across municipal areas and between governance scales (ministry, regional authorities and municipal areas). Thus, urban planning and the use of climate information are subjected to confrontation emerging from multiple interests distributed across administrative divisions. Confrontation can emerge for instance, when additional financial costs related to maintaining new infrastructure are considered to be too high to make a project viable (BB82, BB89, BB90). Synchronisation therefore play is a core aspect in the relationship with external service providers.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
8. Outsourcing	Contracts, deliverables	Improving the implementation of administrative competences (functions and attributions); Attending specific working scales; Improving knowledge gaps.	Knowing what to demand, in which format and under what standard in order to make deliverables applicable to specific needs.	Stabilisation by methodological closure.	Improved knowledge base

Practice 9. Data storing:

Coding is about contextualisation; hence, it demands substrate, sectorial non-climate data. Practices involved in the management of sectorial non-climate data emerged as enablers of coding. Data management includes all practices involved in the circulation of data within the municipality (accessing, retrieving, sharing, cataloguing and updating data) as well as data

analytics (delivering detailed information that can interact with existing administrative competences (B22)).

Three sets of practices in the field of data management in Bilbao were identified: Storing data and information; Collecting data; and data analytics.

As a component of the urban information system, data storing mediates the circulation of data between people to a great extent: the efficiency behind the circulation of data depends significantly on the format in which data is stored and the facility to access data. Data storing in Bilbao occurs in an anarchic and rather unstructured fashion -it is not organised in information catalogues-: data is often incomplete, outdated, disaggregated, and dispersed in various locations, making access to data a challenging task (B22, BC53-55). A reason for this is attributed to the fact that the distribution of functions determined by administrative competences drives people's attention towards specific activities and objectives. Each function demands specific datasets, which provoke the fact that data categories, the volume, frequency of collection and storing format are unique to each department and even vary according to specific programmes or projects within the very same departments (BA75, BC55, BA22). Data becomes "owned" by specific people in specific departments who often end up being the only ones who know about the existence of a particular dataset (GA7). Efficiency is reduced as collected data that could be beneficial to other departments is not usable as it is not stored according to a standard procedure, limiting its access.

- *"... people focus on their daily routines and tasks and do not think that the information we gather can support or help other people" (BC60); "... they have information that they use for something else, but that data can also be informative (with regard) to climate change... people's exposure, vulnerability, etc." (GB18).*

Current efforts to overcome the challenges of storing data include establishing permanent task forces to select valuable information that can become useful for the operations of other departments *(BD37).* Once relevant information is selected, it is then organised in a catalogue indicating its source and updating period (BD36), and it is made permanently available to users. The generation of catalogues is guided by principles of improved decision-making: planners need data that provides more precision, efficacy and objectivity (BD43; BD27). Anticipating which information can potentially become more significant to others results from recursive conversations aimed at characterising the way in which people work and take decisions *(BD38).*

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
9. Data storing	Data, storing bites and software. Catalogues	Improving the implementation of administrative functions in each municipal department/area	How to support sectorial work.	Support (sectorial) work.	Limited efficiency and analytical capability

Practice 10. Collecting real-time data, requesting and sharing information:

Collecting real time data is shaped by issues of transparency. For instance, ethical and cultural considerations emerge as real-time data collection raises concerns about citizens' privacy (BD33), demanding additional efforts to ensure transparency by communicating how real-time monitoring schemes follow Data Protection Law[25]. Municipal officials implement workshops and organise information meetings with neighbours in order to explain data protection aspects and the purpose of collecting data *(BD44, 45)*; or follow accepted standards and recommendations from credited institutions, such as the Basque Data Protection Agency (BD47). Transparency is facilitated by implementing demonstration projects such as developing a geoportal where all data is presented and which follows strict transparency standards (BD12).

Given the absence of formal mechanisms that standardise data sharing and the complexity of protocols for requesting data (BB99), data circulation unfolds informally through personal interactions taking place in meetings, or through e-mail exchanges, seminars or corridor conversations. Knowing who has the data (BC15), in which format data is stored (BA73) and how to request sensitive information (BC8) are all central aspects mediating the circulation of data. Hence, normative aspects orienting social interactions become central: demanding the minimum in order *not to bother others* (BC8); and adding value to data providers, are considered essential currencies that facilitate these interactions.

- *"... I have requested data... I know the person... I (requested from him) three specific datasets -not 33-, hoping that they are not difficult to get" (BC57); "...our work cannot suppose that other people who have to provide us with information have to be too attentive to what we tell them, right? Because in this way we are harming their daily work and in the medium term it tires them out and they will not be able to contribute everything we need" (BC14);*

[25] The provision of transparency is regulated under law 19/2013 and under the EU-GDPR (2018)

- *"We have to add value (by for example) giving them feedback on what they are giving us. They can have data on pollution, we can give them diagrams or charts to see how the pollution evolves. These are tasks that they would not have planned to do and that we can do- and that in the end, it facilitates their work" (BC24).*

Comment BC24 above highlights the relevance of understanding what is potentially valuable to others and to anticipate how to deliver value to their work, which suggests that adding value rests on a deep understanding of how people work beyond departmental frontiers.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
10. Data sharing	Formal protocols, e-mails.	Respecting administrative competences, timings, adding value, collaborating.	How to request data: be specific, track data, characteristics of data owner.	Connect data	Increased awareness.

Practice 11. Data analytics: From tracking trends to creating possibilities

Bilbao is a dynamic city in permanent change (BA50); hence, it demands precise and updated data and information (BA102) in order to make trends visible and to detect emerging challenges, making the management of urban indicators a central part of working in Bilbao (BA17). This requires large volumes of quality data, increasing the need for diverse and new data sources and the capacity to selecting valuable data (BD32). The assumption that larger volumes of good-quality data improve data analysis is largely shared among Big Data advocates (Smallwood 2014, Redman, 2013, Almutiri et al. 2013).

Data analytics consist of processes to find specific patterns to explain the behaviour of datasets in order to characterise city dynamics and inform about the implementation of administrative competences[26]. Data analysis in Bilbao was evidenced as occurring within the spheres of descriptive and predictive analytics. While descriptive analytics assess historical data in order to identify trends and factors that explain the course of certain actions; predictive analytics uses the insights provided by descriptive analytics to foresee upcoming results and restructure strategies[27]. Both types of analytical processes display aspects of creative thinking, whereby data is applied to understanding existing and predictable challenges. Creative thinking is defined as the conceptual blending generated through associations and connections between dissimilar subjects (Michalko, 2011, p. xiv). Conceptual blending occurs when two or more

[26] Own definition adapted to an urban context from the core concept provided by Investopedia (https://www.investopedia.com/terms/d/data-analytics.asp) checked 11.08.2020.
[27] https://www.idashboards.com/blog/2019/09/25/understand-the-3-types-of-analytics-descriptive-predictive-and-prescriptive/

concepts are connected in the same mental space to form new ideas (ibid). Emphasising the role of conceptual blending in data analytics facilitates highlighting how problem solving and learning emerge as people become aware of urban trends.

From an operational perspective, connecting and associating datasets depends on the quality and availability of data, as well as on the possibility of connecting data sources from different municipal areas. Hence, data analytics depends on the practices of collecting data and storing data. But most crucially, conceptualised in terms of conceptual blending (association and connection), data analytics is underlined as a practice that demands competences and experiential know-how and which is oriented by normativity. This is illustrated in the following example: The association made between the three elements "*means of transport, efficiency in time/distance relation, and real-time monitoring*" -widely used in public transport schemes-, was transferred as a template to serve a public cycling scheme. Identifying, prioritising and transferring this association pattern to a new service demanded competences and sufficient experience to understand how such templates could become applicable and responsive to other needs:

- *"…There are always new variables to incorporate" (BD18); "...we have a bicycle loan service ... and we are mixing it with other information, where you can (optimise) cycling; you have a legend about which (bikes) are shared, one-way streets, etc. Then, we try to put information in real time (how many bikes are available by area)" (BD9).*

Data that had previously not been considered useful can become a resource to link previously unconnected issues, informing how to increase and to improve the scope and application of municipal functions.

- *"... the area of Mobility ... regulates parking ... (beyond) data on how many parking spaces are available; they begin to see data such as type (and) number of houses, types of families, number of people, how many have the option to park, then it is something much more transversal and they (start) seeing the problems from a vertical to a more transversal angle and they look for integrative solutions" (BD21).*

In the context of usability, coding demands blending dissimilar topics (sectorial non-climate data and climate information) in order to generate a coherent conceptual narrative that can be activated in practice. Conceptual blending is facilitated by tools such as indicators because indicators facilitate the association of specific datasets to generate new concepts and to connect them with administrative procedures and practices *(BD14).*

Conceptual blending is portrayed as a practice which is supported by material entities (software, indicators); it demands experiential know-how (analytical competences, transferring concepts

and identifying appropriate data inputs), and it is rooted in norms about how work can be improved (innovating with new municipal services, improving existing delivery and quality of municipal services, observing trends and anticipating outcomes).

The data management practices described in this section illustrate the managerial complexities (timing, rhythms, purposes and logistics) of bringing together sectorial-municipal-data and climate data. The data management system in place in Bilbao is characterised by informality and by a reliance on people's judgements, which demand competences to track down where information is located and knowing who owns information, and to pragmatically evidence how collaboration for data circulation generates win-win outcomes; thus, highlighting the role of normativity and experiential knowledge. Here, the concept of data governance becomes relevant to highlighting the absence of a system whose aim is to "*provide users with clean, accurate data"* (Smallwood, 2014, p. 110). Data governance refers to "*the capability to establish data controls.... that ensure that high data quality exists throughout the complete lifecycle of the data... ensuring that data can be used by the entire organization*"[1]. Whereas the provision of transparency is regulated by law 19/2013 and by the EU-GDPR (2018); the internal flow of information is not yet regulated in such a formal fashion. In the absence of a formal data governance structure, the set of practices illustrated in this sub-section have highlighted how data management results from practices which are not formalised, but that emerge from the day-to-day logic of working dynamics.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
11. Data analytics	Real-time data collection tools; Data, storage volume, GIS software	Transparency, accountability. Data Protection Law.	Identify coherent relationships between previously unconnected topics.	Synchronise the use of data	Reinforced coordination

3.2.3. Findings and interim conclusions of case study on Bilbao.

The case study on Bilbao features a highly official administrative structure whereby it is assumed that changes needed for integrating climate information into decision-making practice demand granting the use of climate information with an official status through legal amendments. An official status would anchor the use of climate information in administrative competences, official instruments, procedures and methods through legally binding frameworks which shape and limit practices by legal decree. In this context, the use of climate information in Bilbao is characterised as being in a "positioning mode": endorsement is being sought from decision-makers whose standing regarding the use of climate information is ambiguous and conditional on fulfilling sectorial needs, resulting in legitimacy efforts being mostly in a gaining mode.

The use of climate information was found to be mediated by the structuring role played by administrative competences. Administrative competences shape usability by: 1) restricting the administrative and policy environment within which usability unfolds (e.g. when decision-making competencies are based on institutions positioned at a higher hierarchical level and hinder decisions such as greening an area affected by a heat island); 2) by stimulating silo working that results in the selective valorisation of information (a department's functions guide attention towards specific information, resulting in barriers to sharing information); or 3) by disregarding activities that are not official and obligatory, hence posing procedural barriers for policy objects not yet made official (e.g. when the use of heat maps is questioned for not being made official within urban risk maps).

Additionally, it was observed that practices in the constellation of usability were connected with the historical, cultural role played by the urban transformation in the late 1980s, which appears to have defined a paradigm that became materialised in official mandates and financial structures and which shaped the institution of risk perception being mostly associated with floods. Thus, the urban transformation mediated the practical knowledge involved in the use of climate information by establishing risk perceptions, urban development priorities and values as to what accounts as acceptable practice. The urban transformation in this sense appears to have played a prominent role in shaping a worldview that orients Bilbao's professional vision, because worldviews "*filter human perceptions and influence every aspect of how people understand and interact with the world around them*" (Schlitz, 2010 in O'Brien 2019, p. 8).

3.2.3.1. Illustrating practices

Usability was illustrated through eleven practices grouped in three categories -Reflecting, Narrating and Designing- which are cross-cut by three policy arenas (political, strategic and operational).

1. **In a Reflecting category**, practices are mainly oriented to increasing awareness and generating sufficient endorsement from decision-makers acting in different policy fora. Practices are strategically oriented to respond to the demands of endorsing audiences by connecting climate risk vis-à-vis specific sectorial problems. Practices such as "Visibilising trends" highlight the fact that positioning climate information can emerge in response to existing and perceived legal obligations. Practices such as "Bonding" highlight the fact that external experts can support gaining endorsement since their status grants credibility to legitimation claims.
2. **In a Narrating category,** practices illustrate the premise that a minimum requirement for usability is that climate information must be associated with administrative competences and be sensitive to customary working practices. Narratives facilitate positioning the use of climate information by shedding light on how decision-making processes, the delivery of municipal services and general security are affected by climate change. In this context, important efforts are invested into linking climate information with traditional standards, methodologies (risk assessments, financial estimates, and processes of compliance with international commitments) and monitoring procedures.
3. **In a Designing category,** practices are concerned with the provision of detailed climate information demanded to appraise, weigh up and prioritise adaptation options or to design climate sensitive policies. The use of climate information is assessed on a case-to-case basis: objectives (either political, technical or operational) would demand different information sets. The provision of precise information demands interaction with external specialists who can provide specific expertise. The management of sectorial non-climate information emerges as a central aspect enabling anchoring practices such as Coding.

Emerging from these observations, usability could be explained as the result of associating climate information with working practices in a relationship mediated by the norms applied to judge the appropriateness of a practice in any given situation.

3.2.3.2. Normativity and experiential knowledge

Normative criteria indicate that practices are "*socially sustained... by normative adequacy ceaselessly discussed among practitioners*" (Gherardi, 2012, p. 70). These criteria could be evidenced through the political, strategic or operational arenas and derived in three evaluative criteria: normative-political, normative-procedural and normative-cultural criteria.

1. **Normative-political criteria:** Municipal practices occur within a highly regulated environment; and hence, practices must navigate through official obligations in synchrony with the division of functions and attributions. However, the absence of specific official decrees to orient the use of climate information means that usability must be constructed through a process of experimentation, deliberation and negotiation that often unfolds on the edges of what is considered official practice. Practices inform one that these processes occur within a normative framework that rewards technically and scientifically sound proposals that do not provoke large-scale disturbances in the implementation of administrative competences and which do not disturb the pace and rhythm of work. This suggests that the compliance with normative-political criteria emerges as an achievement in terms of weaving norms with experiential knowledge gathered through hours of work. Indeed, experienced practitioners make use of this normative structure as an opportunity to push for changes by -for instance- demonstrating the imminent emergence of new legal obligations.
2. **Normative-procedural criteria:** Appropriate practice in Bilbao is practice that conforms with established technical and procedural standards in line with administrative competences. Procedural criteria are closely associated with epistemic acceptance: "*in all communities, certain practices are considered the right way to do things because they are sustained by a value-dimension of the occupation or profession*" (Gherardi, 2012, p. 204). Normatively, technical procedures that are based on well-established methods and on socially accepted techniques are acknowledged as being appropriate practice. These observations suggest that usability benefits from methods that link climate information to official procedures. In Bilbao, the need for quantifying the contribution of municipal departments to improving the city promotes forms of work that prioritise the use of official evaluation methodologies, such as indicators, which are based on official procedures and can be made operational through the standardised, administrative and procedural mechanisms already in place. But in order to be usable, indicators had to comply with normative-procedural considerations, such as enabling action by providing some margin of improvement, or not being excessively data- and

competence-demanding. In another example, impact chains linked climate risk to a map of administrative and decision-making processes framed in time-lines, financial periods with assigned budgets, and measurable objectives distributed across competent municipal departments, enabling the distribution of roles and tasks according to administrative competences. In sum, normative-procedural criteria depend on methodological robustness and familiarity with the traditional procedures that provide order to the flow of work.

3. **Normative-cultural criteria:** The coordination of work required for using climate information is dependent on people's interactions and expectations regarding how work is to be achieved. In these terms, normative-cultural criteria are mostly evidenced as tacit rules emerging as patterns of shared expectations and assumptions. Jasanoff (2018) underlines the existence of tacit rules to explain *"how things go on... (among) fellows"* (p. 7) and which make up the foundations of the social order. Knowing how to work in Bilbao demands understanding what the norms that orient working relations are, and knowing how to follow the expected pattern of behaviour that regulates people's interactions: learning what becomes sensitive, controversial and conflicting to other parties, so that controversies are accounted for as working unfolds; how colleagues apply judgement to deal with specific situations; comprehending the rhythm, sequences and timings that mark the pace of work; and avoid disturbances by ensuring that progress occurs in view of colleagues' workloads, administrative timings and procedural complexities; and above all, how to contribute to people's work. These criteria are best illustrated by the example of data sharing practices, which by occurring within a non-regulated and informal field, rely largely on knowing how to request data: knowing who owns the data, how much data can be asked for, and showing how collaborating generates win-win situations. Hence, the knowledge dimension is inseparable from a normative dimension, which can be summarised as being the set of practical understandings and competences needed to follow the norms about how work is expected to take place in Bilbao.

3.2.3.3. Anchoring and enabling practices

Observing practices as being clustered according to political, strategic and operational arenas informs one about two types of practices involved in the use of climate information:

3.2.3.3.1. Anchoring practices, which are enacted in direct connection with climate information as a material entity. The group of anchoring practices include "Coding", "Aligning" and "Data analytics".

3.2.3.3.2. Enabling practices, in which two sub-groups can be distinguished:

a) Customary practices, that facilitate the use of climate information and emerge from customary working practices in Bilbao. This group includes "Data sharing", "Data storing", since they are concerned with the provision of sectorial data for a coding exercise; and "Bonding" and "Outsourcing", which while being traditional practices of information management used also in other sectors (mobility, energy management), they become essential to link competences needed for managing climate information.

b) Legitimacy-seeking activities: represent the set of activities purposefully applied to gaining legitimacy and endorsement. These activities emphasise intended human action that builds on judgement and experience. Following Taylor (1971) legitimacy-seeking activities are not simply understood as a set of individual or isolated actions, but *"essentially (as) modes of social relation, of mutual action"* (in Shove, 2012, p. 5), which challenge and transform habits and routines (ibid). Legitimacy-seeking activities emerge within the boundaries of customary municipal practices since these activities draw on existing resources through traditional mechanisms anchored in administrative competences, are earmarked within normative canons and build upon skills and competences that emerge from previous experience: "Visibilising trends", "Scouting" and "Testing boundaries" are common practices in the exercise of deliberation and negotiation undertaken by municipal officials in Bilbao, these practices are structured within the canons of cultural norms, and are applied in this case by municipal oficials to gain endorsement of the use of climate information.

Enabling practices are a constitutive part of the constellation of the practices of usability because anchoring practices depend on the enactment and performance of enabling practices. For example, "Coding" and "Data analytics" are largely based on the availability of sectorial-non-climate data provided by the other "data management" practices. If the latter did not perform well (data was scarce, incomplete or outdated), they would affect the performance of the former two by reducing the pool of available sectorial-non-climate data available for analysis and for contextualisation purposes. On the other hand, legitimacy-seeking activities provide the enabling environment needed for anchoring practices to flow.

3.2.3.4. Changes in the constellation of practices:

Changes in the constellation of practices where usability is enacted were evidenced through changes in material and knowledge constitution.

3.2.3.5. Material constitution:

In material terms, usability was dominated by the availability of legal documents that support officialising the use of climate information (such as DOT and IHOBE's decontamination catalogues); and by the available sectorial, non-climate information (needed for contextualisation purposes). Changes in the material constitution were evidenced from two perspectives:

a) new practices are enacted in connection with new material entities. Practices such as "Highlighting", "Coding" or "Visibilising trends" emerge in connection with different material entities (risk assessments, sectorial non-climate data and normative documents respectively).

b) climate information was granted official status and became a material representation of norms (integrated into the Urban General Plan and other Territorial Planning Instruments) and procedures (e.g., calibrating return periods according to projected changes in precipitation).

3.2.3.6. Knowledge constitution

The knowledge dimension is dominated by competences and skills that emerge out of social interactions, and experience involved in the implementation of administrative functions. Changes in knowledge composition could be evidenced through three aspects:

1) Usability as a constellation of anchoring and enabling practices demands acknowledging that the network of practitioners involved in the use of climate information is large and diverse in terms of competences and skills; but also, in terms of interests, standings and agency. In this context, the composition of knowledge is affected by the increased awareness that emerges as more people are engaged through social interaction to deal with multiple social problems.

2) It could be observed that the diversity of experiential knowledge results in actors applying their experience and skills to reflect upon decisions in a systemic fashion. For example, the practices of "Data Analytics" and "Coding" illustrate how municipal officials apply a specific reasoning and judgement to associate topics and identify relationships in order to conceptualise urban problems. However, since information selection is shaped by preferences based on collective memory that orients attention to certain topics (floods) in detriment to other topics (high temperatures), it could be evidenced that these processes are normatively charged.

3) As the practice of "testing boundaries" showed, experiential knowledge plays a critical role in municipal officials knowing how to push for changes within normative canons. This form of practical knowledge resonates with Rouse's (2007-A) ideas of "*profound human understandings*" which are also visible through practices such as "Visibilising trends" and "Bonding", which inform how practitioners identify momentums (the convergence of a policy

window, available information and assistance from scientists) to position climate information in specific policy fora.

Interim conclusions for the case study on Bilbao

The use of climate information in Bilbao is characterised by three central aspects:

First, usability unfolds as a constellation of activities that take place sporadically, opportunistically and scattered across different policy areas and within spheres of experimentation of what is allowed within the administrative competences of public officials.

Second, the use of climate information could be observed to occur most prominently as new practices being enacted in connection with climate information sets; and to a lesser degree, usability could be observed through the transformation of few traditional municipal practices which were temporarily re-oriented in order to support usability practices, such as those practices involved in the collection of territorial data and information. In these terms, the use of climate information emerged primarily as a temporary add-on to existing municipal routines. Furthermore, it could not be evidenced that the use of climate information provoked lasting changes to traditional working practices.

Third, from the point of view of legitimacy, it could be observed that purposeful action takes place in order to gain endorsement and to legitimise the use of climate information. Varying efforts are being undertaken in order to persuade key actors to endorse and grant usability an official status. An official status is assumed to anchor the use of climate information in legally binding frameworks, enabling its integration in administrative competences, official instruments, procedures, methodologies and planning tools. From this perspective, the use of climate information in Bilbao is in a "positioning mode", which implies that endorsement is being sought from decision-makers whose standing regarding the use of climate information is ambiguous and conditional on fulfilling sectorial needs, rather than in response to an overarching climate adaptation agenda. Usability being in a "positioning mode" reflects that Bilbao is in initial stages of usability, where a certain degree of institutionalisation must be built. In this context, initiatives such as Lurr-Adapt present a promising scenario for the use of climate information in the foreseeable future.

3.3. Case study Donostia/San Sebastian

The use of climate information in Donostia is illustrated through the implementation of the Klima2050 strategy, an official plan that aims to ensure the implementation of 31 adaptation actions by the year 2050. Since the successful implementation of Klima2050 depends on transversal coordination and a long-term commitment, Klima2050 mandates the generation of a community of practice (CoP) whose mission is to guarantee that all climate-related activities are implemented. The use of climate information in Donostia is characterised as being in an "aligning mode": climate-oriented decisions are recognised in official frameworks and the use of climate projections is supported by legal decrees. However, a number of policy contradictions must be resolved in order to fully deploy Klima2050, which demands aligning a constellation of urban plans and decrees, and ensuring that transversal action is not jeopardised by sectorial functions or overlapping attributions.

Against this context, the case study centres around understanding how the community of practice is shaped as community members interact with climate information. The use of climate information is illustrated through eight practice-constellations positioned in two categories:

-The "Articulating" category describes the collective work involved in articulating the CoP. This category illustrates how climate information is positioned as a knowledge object that orients the actions of the CoP.

-A "Designing" category explains the process involved in anchoring climate information in administrative procedures, methodologies, standards and policies.

Changes to practices could be observed through changes in the distribution of tasks and responsibilities and through the reconfiguration of actors involved in managing climate-related activities.

3.3.1. The city vigilant of the sea

Donostia/San Sebastian, the capital of the Province of Gipuzkoa, is a medium- size city situated only 20 miles from the French border on the coast of the Cantabric Sea, with an area of 60,89 km2 and a population of 186.000 (436.500 in the metropolitan area) (IHOBE, 2020). Its climatic regime is characterised as Oceanic with an average precipitation of 1500mm/year and 15°C average annual T°[28]. The Urumea River which emerges in Navarra flows through the city. Donostia emerged from the San Sebastian Monastery (XI century) and became a municipality in 1180 (Arrieta, 2011). From this year onwards and up to 1885, the history of the city is characterised by a sad series of war defeats and destruction. In 1885 the city changed its position

[28] Spanish National Institute for Statistics https://www.ine.es/dyngs/IOE/es/operacion.htm?id=1259945998275. Checked: 27.08.2020

as a military fortress and it became the provincial capital of Gipuzkoa. In that very same year, the widowed Queen of Spain transferred the entire court to a summer residence in Donostia, marking the beginning of the city as a bourgeois tourist destination in Europe, boosting the elegant urban development influenced by French architects that characterises Donostia up to today (ibid).

Donostia positions itself in the XXI century as a city concerned with delivering high living standards to its citizens through innovation, industrialisation and tourism (ibid). The city's economy is based on a diverse constellation of small enterprises and trading activities prominently oriented to the provision of services for tourism. Donostia is characterised as being a pioneering city in the use of smart technologies in areas ranging from energy, public lighting, recycling, public space, smart design and ICT[29]-[30]. Donostia's Innovation Strategy poses as a central objective the retention and attraction of international, talented entrepreneurs[31]. The city integrates a programme to support companies from emerging technological sectors through the implementation and deployment of innovation networks (initiatives such as Talent House and Innovation Campus are highlighted as being emblematic initiatives). Donostia is a cultural hub in the north of Europe (selected as European Cultural Capital in 2016).

3.3.2. Gipuzkoan Regional Administration and Climate change

The Provincial Gipuzkoan Council[32] provides relevant input and strategic support to climate change activities in Donostia. Gipuzkoa has generated a Provincial climate strategy following the standard of the Basque Country's Klima2050, called Gipuzkoa Klima2050 (Diputación Foral de Gipuzkoa, 2018). Within the strategic objectives, territorial resilience is strategically formulated through methodologies to support urban and territorial planning (Diputación Foral de Gipuzkoa, 2019) and through recommendations to the Partial Territorial Plan (which is currently in place until 2032) (ibid). The Gipuzkoan Administration publishes the vulnerability Assessment of the Province of Gipuzkoa, which emerges from the project "Climate Scenarios for the Provincial level" -high-resolution climate projections (1km x 1km) for RCP 4.5 and 8.5 based on Euro-CORDEX simulations (Escenarios Climaticos Gipuzkoa 2020; Naturklima, 2020; IHOBE, 2019-B)[33].

[29] Smart-city Project. Available at https://smr-project.eu/donostia/ (checked 07.09.2020)
[30] Available at http://www.fomentosansebastian.eus/en/donostia-smart/proyectos-de-ciudad-donostia-smart/1815-smartkalea (checked 20.08.2020)
[31] Further details available at http://www.donostiainn.eus/es/donostia-es-innovacion (checked 20.08.2020)
[32] In Spanish administrative terminology, Gipuzkua is defined as a "Diputacion Foral".
[33] As previously explained, the Klimatek 2016 and Klimatek 2017-2018 projects have developed a climate atlas (period 1971-2015) and regional scenarios of climate change for the 21st century (2011- 2040, 2041-2070, 2071-2100) with high resolution (1km x 1 km) for different basic variables (mean temperature, maximum and minimum, precipitation, evapotranspiration), based on simulations of the EUROCORDEX project (http://escenariosklima.ihobe.eus).

Table 16: Identified vulnerabilities for the Gipuzkoan Province.

Drought	Sea-Level rise	Urban risks	Tourism
-RCP 8.5 2100: river flow reduction of 11-15%.	-Average sea-level rise of 0.5 supposes 25-40% beaches will disappear -Contamination by saline intrusion	All municipalities impacted by 3- 4 extreme events	Infrastructures affected/modification of tourist demand.

Source: Naturklima, 2020

3.3.3. Climate change in Donostia

In the context of climate change actions, Donostia is regarded as one of the most active cities in Europe[34]. In 2008, the city was praised by the Spanish Federation of Municipalities for being the most sustainable city of Spain (Premios a la Sostenibilidad de la FEMP, 2008). In 2008 it officially approved a mixed mitigation-adaptation strategy; in 2010, the city adhered to the Covenant of Mayors and developed a CO2 inventory and an energy plan (PAES). In 2017, it ratified the Global Covenant of Mayors for Climate and Energy[35]-. Donostia has integrated climate considerations into its Partial Territorial Plan (PTP), which specifies an extension of the flood-prone areas to limit urban sprawl according to URA's indications (return periods of 500 years[36]).

As a coastal city, Donostia has a close relationship with the sea, and activities such as surfing and sailing are a prominent aspect of the local culture and an attraction for people worldwide. Climate risk in Donostia is considered mostly in association with water. The risk of river floods from the Urumea River and the impact of sea-level rise and severe storms "Galernas" (stormy northwest winds in the North of Spain)[37] on the beaches are central concerns (Plan de Klima Accion 2050 Donostia).

- *"... we have a lot of relationship with the sea, the waves... citizens watch the waves during periods of extreme waves on the coast... then, 2014 was very significant because... it became very destructive" (DE63); "2014 ... is a turning point..." (DE90).*

The year 2014 marks a turning point also since the city must develop an adaptation plan in the framework of the Covenant of Mayors (DE91-92). Past climate trends are used as input to support an increase in awareness regarding potential future risks posed by climate change (Donostiako Udala, 2017-B)[38]. In 2017 Donostia approves its Climate Change Adaptation Plan

[34] Donostia is one of the few Basque municipalities that have been recognized by ICLEI for fully complying with the Compact of Mayors initiative, led by the global networks of cities C40, ICLEI and UCLG.
[35] Covenant of Mayors: http://www.pactodelosalcaldes.eu/es/
[36] This is in line with the Reglamento del Dominio Publico Hidraulico RD638/2016) which is drafted in consonance with European Directive of risk management 2007/60/CE (23.10.2007). The legislation considers high-risk areas where exists a 1% annual probability of a flood event causing a 1mt high water level or water flow speed superior to 1m/s. exists (RDPH art.9)
37Source: Smart-Mature-resilience Project. Available at: http://smr-project-test.appspot.com/RPDonostia.page Checked: 07.09.2020.
38 1995-2014 is among the nineteen warmest years on the records; Average annual temperature in recent years is 0.8 ºC higher than average the temperature; Annual average recorded in the pre-industrial era (period 1961-1990).

and Vulnerability Assessment. One of the core objectives of the Plan is the consolidation of an internal transversal structure to support the implementation of the Plan (Donostia, 2017-A).

3.3.3.1. Klima2050

The coordination of all climate related activities -including adaptation and mitigation- are integrated within Donostia's Klima2050 Strategy (Donostia, 2018). The Strategy plays an articulation role for all existing and also new public policies (ibid). The distribution and responsibilities laid down in the Strategy reach out to all municipal units and departments and it overlaps with the responsibilities taken as a result of other existing plans (currently, 19 transversal and inter-sectorial plans interplay in the municipal administration) (Donostia, 2018)

- *"...there is a proliferation of plans, which are all very important, but when it comes to following up, it complicates things a lot, so we are trying to integrate them: agenda 21, Klima2050, adaptation plan, waste plan, sustainable energy plan linked to the Compact of Mayors... to manage it all, we must make a macro-assembly.... the level of details of the actions is very different depending on the origin of the plan..." (DE55).*

Some of the challenges that lie ahead in the implementation of the Klima2050 Strategy are the alignment of city plans.

Table 17: City Plans to be aligned in the context of Klima2050.

2008. Sustainable- Safe Mobility Plan 2008-2024 2010. General Urban Plan 2011. Action Plan for Sustainable Energy 2012. Master Plan for Sustainable Human Development 2012-2015 2015. Plan Smart Donostia 2016-2020 2015. 2030 Environmental Strategy 2015. Environmental Plan / Agenda 21 2015-2022	2016. Partial Territorial Plan for Donostia (Donostialdea-Bajo Bidasoa) 2017. Plan for Adaptation to Climate Change 2017. Updating of the city's Strategic Plan. E2020DSS Strategy 2017. Donostia Tourism Master Plan 2017-2021 2017. Document Director of Waste from Donostia / 2018. Municipal Housing Plan

Source: Donostia, 2018, p. 34

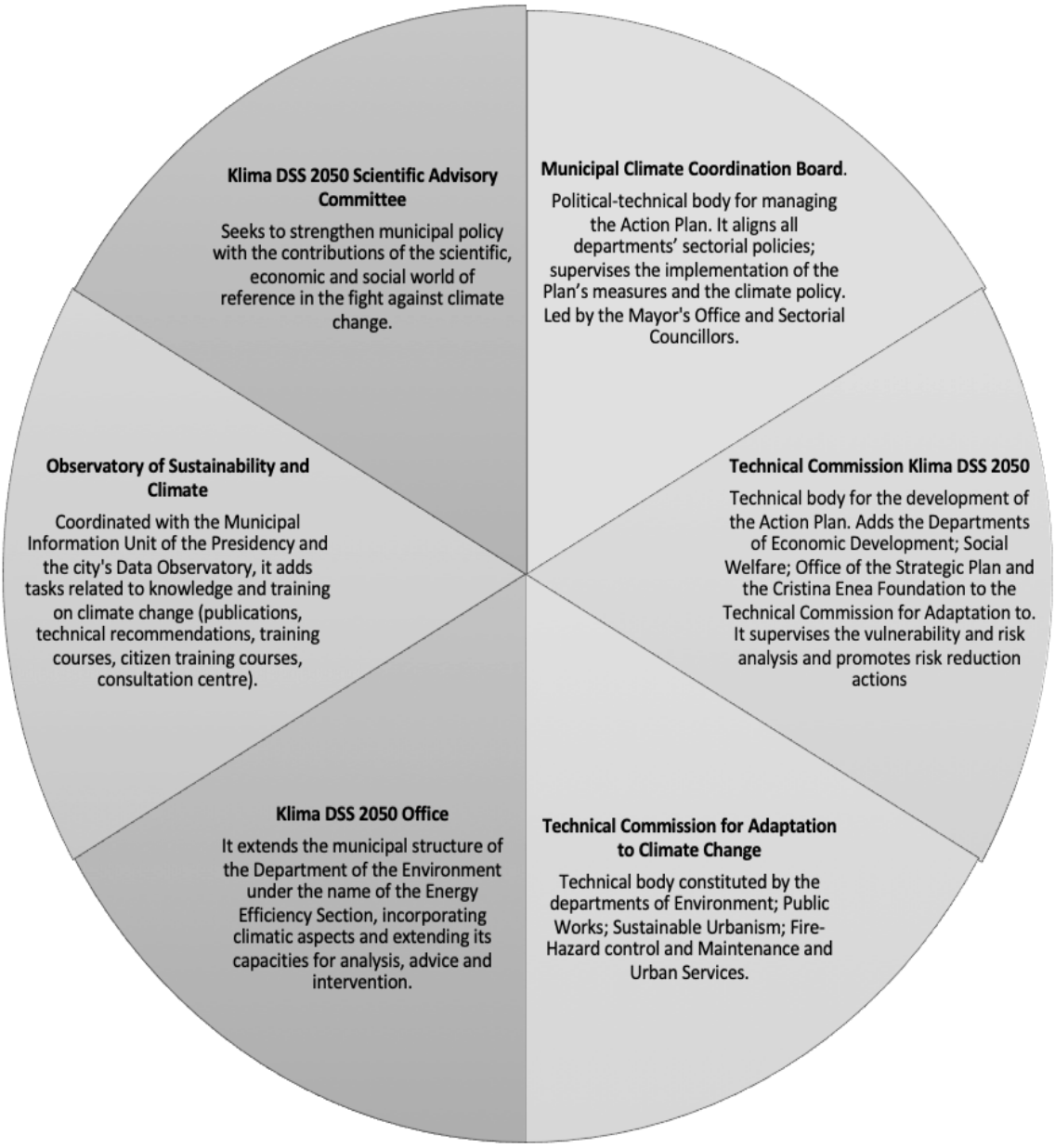
Additionally, other foreseeable challenges to implement Klima2050 include: a) adapting official mandates according to differing protocols, times and the administrative competences distributed among different areas and supra-municipal structures; b) adopting financial mechanisms to support the implementation of the adaptation plan; c) as well as changing working cultures, increasing horizontal and transversal approaches to working.

Klima2050 represents the continuation of a long-standing planning process whereby it was considered necessary to establish a temporal horizon to implement actions stated in the adaptation and mitigation plans -up to the year 2050- (Donostia, 2018). As in all long-term

Minimum temperatures in recent years are 0.9 ºC higher than those registered in the pre-industrial era (period 1961-1990).

strategic plans, the extended 2050 temporal horizon brings about the challenge of coordinating several administrations on a long-term commitment; therefore, Klima2050 demands a broader social, political and economic consensus for its implementation (ibid).

Figure 6: Community of Practice to implement Klima2050



Source: Adapted from Donostia, 2018

3.3.4. The site of Donostia

As this research unfolded, Donostia was in the process of structuring the institutional coordination mechanisms demanded to implement the KLIMA2050 Strategy. Klima2050 works as an official mandate which obliges municipal departments to take on specific roles and responsibilities. Klima2050 mandates the formation of a *community of practice (CoP from here*

on) to articulate and ensure that by the year 2050, each of the 31 adaptation measures convened in the Strategy will be executed. This brings two aspects into consideration for the course of this research:

- First, setting up the institutional architecture needed to deploy the Klima2050 strategy presented a momentum characterised by a steep learning curve resulting from new forms of interactions among municipal officials. These interactions were informative about the agreements and tactics devised for executing the strategy; for instance, how negotiations took place, solutions to problems were devised, and alternative plans were co-designed.
- Second, the temporal goal set for 2050 provided a setting that was revealing about the role of legitimation in ensuring that Klima2050 would continue to being implemented against the risk of changing political agendas over the next 30 years.

The site of Donostia is featured as the articulation of the work necessary to coordinate the set of actors, skills, knowledge, material resources and institutional arrangements to implement the Klima2050 Strategy. In this context, climate information within the Klima2050 CoP is positioned as a material entity which becomes involved in the negotiations to establish priorities, expectations and responsibilities that orient the CoP. Exploring the use of climate information in practice in the case of Donostia aims to shed light on: 1) identifying the role of climate information in sustaining the CoP's common orientation, evidencing how the CoP is a result of the practical interaction with climate information; 2) and evidencing what skills become prominent as the CoP becomes a device for the reproduction of such practices.

3.3.4.1. A conceptual approach to Communities of Practice (CoP)

A perspective on Klima2050 as an official management mandate exposes the research to one of the central inquiries presented by Practice Theory in working contexts: evidencing the discrepancy between prescribed work (which is mandated by the Klima2050 strategy) versus work that occurs in practice (Gherardi, 2012). In this context, Wenger (2000) highlights the fact that "*management cannot establish a community of practice but only facilitate its spontaneous emergence*" (Wenger, 2000 in Gherardi, 2009, p. 517).

Within Practice theories, the concept of communities of practice refers to the relations between practices and the community (Nicolini, 2012), and the focus of attention is on "*the creation, dissemination and conservation of knowledge that occur in working practices, as well as the community that arises around the practice*" (Gherardi, 2012, p. 19). Central to the concept of communities of practice in Practice Theory is, the emphasis is on the practice rather than on the community: *"it is the activities themselves that create communities because it is activities that*

hold together a configuration of people, artefacts, and social relations... (where) knowledge, activity, and social relations are closely intertwined... The common activity provides the medium and the resource... (for) generating a 'sense of community', and the inevitable conflicts and power struggles between those who know and those who don't" (Gherardi, 2009, p. 522).

In highlighting practice over the community, knowledge is recognised as an activity "*contextually employed during performance of a practice*" (ibid); and it becomes "*a central element for the growth and transformation of the identity of a community of practice*" (Nicolini, 2012, p. 87). The concept of *situated learning* (developed by Lave and Wenger, 1991) suggests that learning occurs as "*a process of participating in practices in which... identity and social membership are formed*" (in Alkemeyer et al. 2017 in Hui et al., 2017 p. 12). Learning becomes a precondition and an evolving form of membership of the community and a central aspect in defining the identity of its members (ibid).

The community, on the other hand, can be diverse in its backgrounds or interests (Nicolini, 2012). Personal situatedness[39] means that people are "*confronted with expectations, limitations and possibilities*" which are unique (Alkemeyer et al. 2017 in Hui et al. 2017, p. 14); and which are brought forward as negotiation elements; because in the end, "*working on a shared object by no means inevitably produces consensus*" (ibid). However, given that it is practices that provide the "*commonality that allows people to connect with the history of learning, to understand each other, and to act in a coordinated manner*" (Nicolini, 2012, p. 93), the community becomes the effect of the connection between practices, while simultaneously acts as "*the device for the reproduction of practices*" (Gherardi, 2009, p. 528). In Gherardi's words, "*the practice performs a community*" (Gherardi, 2013, p. i). Nicolini sheds further light on the normative component within communities of practice by stressing that norms "*dictate the rules that frame what constitutes accepted knowledge... bonding their members through legitimised criteria*" (Nicolini, 2012, p. 89).

3.3.4.2. Administrative competences

Mandating the generation of a coordinating structure to implement the Klima2050 Strategy posed the challenge to accommodate the Klima2050 within the department's administrative competences. As previously explained in the case study concerning Bilbao, administrative competences determine to a large extent how priorities are established: what accounts as important and relevant and where attention is directed to, is in the end contingent on sector,

[39] A "situation" is defined as "*a momentary configuration of participants in the course of a practice, where two or more participants can never occupy the same socio-material position. Therefore, each of them has his or her unique perspective on the shared practice related tot he position they occupy in the situation*" (Alkemeyer, 2017 in Hui et al., 2017, p. 14).

functions and attributions. Administrative competences in Donostia were found to mediate the use of climate information through four mechanisms:

1) Administrative competences specify the skills and resources needed to carry out the specific functions required by the Klima2050 strategy. Hence, administrative competences determine forms of participation in the CoP by specifying whose expertise counts and who has the jurisdictional control to fulfil specific demands, which at the same time shape the degree and form of participation.

- *"…. for example, in water issues, coasts, it is more the responsibility of the Department of Urban Services and Maintenance. We can give our opinion (about the development of programmes, etc.) but the execution is not ours…" (DA6)*
- *"In the adaptation commission, we were invited because we handle the basic information of the city, so... we provided a series of data, different layers to be able to make the plan" (DD28).*

2) Functions established by administrative competences determine investment priorities and planning periods, which may not be conducive to the use of climate information. For example, correcting return periods to integrate the risk of floods in urban design may be a reasonable thing to do from a climate perspective, but it is unviable due to investment priorities.

- *"...Climate projections do not influence investments… upgrading T10 and T25 years... does not happen, because the investments are made in large things such as changing damaged water collectors... the useful life of a collector is 100 years more or less… a parameter of 100 years is used so every 100 years we make it all new" (DC22-23).*

3) Administrative functions determine different investment assessment methods. For instance, for the Emergency Water and Sanitation Service, time indication for renovating infrastructure depends on the material status, while other forms of assessment are excluded:

- *"… regarding sanitation, we request investments when we see that the collectors are reaching their expected lifetime, and other criteria are not considered -multicriteria, cost-benefit- … those collectors must be changed … the collapse of the infrastructure means (costs are) 5 times higher than (anticipated)" (DC18); "…If it is already difficult for us to plan investments for what is being broken, it is much more complicated to propose sanitation improvements … for the future" (DC21).*

4) Administrative competences intervene in the politics of negotiating investment needs. As the Emergency Water and Sanitation Service operates in an area considered essential for the normal functioning of the city, investments are allocated in order to ensure service continuation rather than service upgrade.

- *"…. these services are not politically saleable. These are services assumed by everyone and it seems that they have not associated costs, that they are self-maintained, so it is difficult to sell investments politically speaking..." (DC20).*

3.3.4.3. Social orders: articulating a community of practice

Social orders are informed by Wenger's (1998 and 2000) framework whereby attention is directed towards the "*common sense constituted within a community of practice.*" (Alkemeyer et al. 2017, in Hui et al. 2017, p. 14). Wenger's framework is based on a conception of community of practice as a mechanism through which learning is mediated and knowledge is held, transferred and created, and which emphasises that modes of belonging to a community contribute to the evolution of the community (Wenger, 1998 in Nicolini, 2012, p. 90; Wenger, 2000 in Gherardi, 2009, p. 517).

Table 18: Summary of Wenger's Framework

Modes of belonging	Influence on the learning process
Mutual engagement	Doing things together, talking, producing artefacts; Knowing what others know, what they can do, and how they can contribute to an enterprise; A shared discourse reflecting a certain perspective on the world; Specific tools, representations, and other artefacts (Goodwin, 1994 in Gherardi, 2013)
Alignment	Making sure that local activities are sufficiently aligned with other processes
Joint enterprise	How joint enterprise is negotiated within the community;
Shared histories of learning	Learning in practice involves the evolving forms of mutual engagement, understanding and tuning the enterprise
Shared repertoire	Source of coherence-, which reflects a history of mutual engagement; Absence of introductory preambles, as if conversations and interactions were merely the continuation of an ongoing process; Very quick setup of a problem to be discussed; The ability to assess the appropriateness of actions and products; Jargon and shortcuts to communication as well as the ease of producing new ones.
Practices	Reflect a history of learning and define boundaries of communities of practice

Wenger explains that the roles played by the members of a community and the relationships they share in the group's activity define their identities in the community (Wenger, 1998 in Li et al., 2009). In this context, Gherardi (2013) explains that participation in a community of practice can be seen through "acts of presence". Acts of presence refer to forms of dealing with problems in a shared workspace and display how knowledge is deployed in the community (ibid).

Different forms of participation can be contrasted between those engaged in specific tasks versus those contributing to group work (ibid). Stemming from these differences, Joseph (1994 in Gherardi, 2013) identifies four acts of presence: being informed, putting oneself forward, standing aside and/or regaining control of the situation. Acts of presence in the context of Klima2050 were evidenced to vary according to the distribution of three roles: community articulation, project coordination and the provision/demand of accountability:

3.3.4.3.1 Articulation role*:* In the articulation of the CoP, the Environmental Department took a more prominent role compared to other departments, hence resembling the act of "putting oneself forward" ("*someone comes forward to take charge of the situation... assuming responsibility and speaking on behalf of the group – although to do so s/he requires the cooperation of everybody and is not a solitary hero*" (Gherardi, 2013, p. 12)). The articulation role taken up by the Environmental Department resulted almost as a natural continuation of the previous coordination role taken up to draft the vulnerability assessment and the adaptation plan. In its current role as Klima2050 community coordinator, the Environmental Department must ensure that the community maintains a common orientation while activities are coordinated under a joint enterprise. The Environmental Department would receive special funding for running these activities (DE99); they would organise coordination meetings (DA9); would act as a go-between the municipality and external consultants (DA9); would attract external funding to support project implementation or capacity building schemes (DE103); would coordinate participation in regional projects (H2020) (DE104); would coordinate the priorities of different departments into Klima2050 (*DE54, DE96, DE98);* and activate engagement with companies and citizens in the framework of the Strategy (DE10).

Taking articulation as a prism to characterise actors, other departments mostly took on the role of information providers (as in DA8 above), mirroring the mode of "standing aside".

- *"... the Environmental Department leads the coordination for the execution of actions... so, there is collaboration directly with the Environmental Department..." (DA6); "...we give a more sporadic collaboration, we participate in everything that is asked of us, but the planning and follow-up is done by the Environmental (Department)..." (DA8).*

In this case, Joseph (1994 in Gherardi, 2013) explains that standing aside "*is not to withdraw; rather, it is ... to make one's presence felt and be willing to collaborate, but without necessarily taking an active part"* (p. 13).

- *"... the plan has been drawn up by the Environmental Department .... and they asked us for information... on the issue of vulnerability of water and sanitation, water supply due to changes in rainfall or ... rainfall of greater intensity, storm surges .... and (effects on)*

water and sanitation structures…" (DC2); "... for the Adaptation Commission... I have given ... information for the heat wave..." (DD40).

3.3.4.3.2. Project implementation: Looking at the implementation of projects (31 actions assembled within the Adaptation Plan), since Klima2050 laid responsibility for project implementation and for the provision of accountability on departments according to sectorial functions and attributions (Donostia, 2017-A, 2017-B), each of these departments takes the stance of putting itself forward. The transversal nature of Klima2050, where the responsibility for the Strategy's activities is distributed sectorially, implies that collaboration is a demand for the functioning of the community. Klima2050 Strategy distributes tasks according to the departments' expertise and administrative competences, and municipal departments must become accountable regarding progress in the implementation of projects (DD28; DD29; DA5). While the Klima2050Strategy does not outline specific indicators for measuring progress, the strategy specifies adaptation activities in detail, ranked according to priority and their implementation period, with a specific budget and a responsible party (Donostia 2017-A, p. 8). Collaboration across departments displays how bonds of trust are granted to other parties in recognition that the attainment of goals cannot be reached by single parties. As emphasised in Wenger (2000) a characteristic of strong learning communities is that interactions and relationships are fostered based on mutual respect and trust (Wenger, 2000 in Li et al., 2009). In this sense, accountability emerges as a central requirement for mutual engagement since "*accountability emphasises that social conduct and practice is experienced normatively...conforming to the normal way of conducting actions is both morally required and morally expected from all participants*" (Nicolini, 2012, p. 136).

3.3.4.3.3. Transparency and accountability*:* Other actors, such as citizens and companies act in the realm of accountability by being entitled to demand information to scrutinize the implementation of Klima2050 strategy -hence, acting in a mode of *keeping oneself informed*-. The overarching accountability structure is dependent on the Municipal Coordination Table -led by the Mayor's Office- which must supervise, evaluate and promote the implementation of the measures of the Action Plan. Accountability is structured according to Law 19/2013 "*Transparency, access to information and good governance"* (Donostia, 2018-B). Accountability in the Klima2050 Strategy is organised procedurally through an online tool "Gestion Klima2050" which helps following up on the development and achievements of goals. The tool is compatible with the indicator system of the Gipuzkoan Provincial Administration (Diputación Foral de Gipuzkoa 2019-B), and also with the monitoring system established by Udalsarea21, which evaluates the results and effectiveness of sustainability policies and

progress in implementing Local Agendas 21 according to environmental, social, economic and governance indicators (Udalsarea, 2017).

In Donostia, the principle of collaborative transparency is prioritised over passive or active transparency models (Donostia, 2018-B). Collaborative transparency emphasises the role of social auditing as a way to link transparency with the legitimacy of municipal activities. Specific official mandates oblige the provision of accountability. The provision of accountability is structured through: A) an ordinance on citizen participation as part of the commitments acquired in the Charter of Aalborg in 2001 (DE5) which determined the structuration of Citizen Participation Councils[40] which work as permanent[41] sectoral advisory councils on specific thematic areas; B) the System of Local Sustainability Indicators of Udalsarea 21 which provides information to monitor Local Agenda21 (Udalsarea, 2017, p. 5); C) the private sector participated in drafting the strategic components of Klima2050 (DA9-DA13).

While an accountability structure appears to be well-established in Donostia; nevertheless, important challenges lie ahead. Bierman (et al., 2011) explains that accountability has 1) a normative component (standard of behaviour defined in detail); 2) a relational element (linking those who are held accountable to those who have the right to hold to account; 3) a decision element (judging whether the expected standard of behaviour has been met); and 4) a behavioural element (that allows the governing actor to sanction deviant behaviour) (Bierman et al. 2011, p. 1857). Bierman explains that "*all elements need to be present in sufficient degree to make any accountability relationship meaningful*" (p. 1857). Against these elements, despite accountability mechanisms being in place, an interviewee's observation suggests that accountability is only partially implemented:

- *"There is still not much pressure to provide accountability... there is not a "what have you done to achieve this, why is there no result?" because adaptation actions are not as measurable as emissions: an emissions inventory at least gives you a number" (DE21).*

Comment DE21 suggests that the lack of measures to assess progress in adaptation may hinder demanding accountability[42]. Applying Bierman's framework, it can be seen that component 1 and 2 are officially established; but component 3 limits assessment possibilities of whether

[40] https://www.donostia.eus/info/ciudadano/part_ciudadana.nsf/vowebContenidosId/NT0000096E?OpenDocument&idioma=cas&id=A608306616960&cat=Consejos%20asesores&subcat=Consejos%20Sectoriales&doc=D

[41] http://www.udalsarea21.net/paginas/ficha.aspx?IdMenu=4618A09F-E97E-4F18-908B-CAB6B7A6CA95&Idioma=es-ES checked 17.08.2020

[42] In the adaptation literature, this problem is well establshed (Gagnon-Lebrun et al. 2006; Sanz et al. 2019; De Paula-Domingos et al., 2015).

actions are either implemented or not; while no evidence of sanctioning is identified. What emerges as a central consideration is the observation that accountability in the context of implementing Klima2050 is in progress and not fully realised.

Table 19: Social Orders in Donostia

	Environmental Department	Other Municipal departments within CoP	Citizens and private sector
Standings (actor's perception of their capacity to control and influence these processes)	Its power to articulate the CoP is based on an official mandate which provides specific funding for coordinating activities.	Provide information for contextualising climate information and for facilitating the provision of accountability. Actors influence the success of the Klima2050 strategy by taking full control over the development of projects allocated under their competences.	Diversity of interests: changing legislation, urban development: -Companies concerned about potential legal changes to means of production (DE10); -Citizens are concerned about urban development in general (DB13)
Strategies (arrangements to work things out)	1) Articulator of the CoP and the Klima2050 Strategy 2) Attracting external funding that supported project implementation or capacity building schemes or bringing additional expertise and international networks. 3) Engagement with companies and citizens through opening revision periods to strategies supported by different means.	1) Information providers (as per demand by the Environmental Department) 2) Provision of as much information as possible together with technical explanations why sometimes it would not be possible to follow the CoP's expectations. 3) Understanding citizens' concerns through surveys and through organising technical presentations to broad audiences.	1) Demand accountability based on official mandates) through instruments provided by Local Agenda 21 2) Propose criteria to prioritise the order of project implementation and monitor municipal activity.
Arrangements (people in the same party to perform work)	It designs methods to articulate the CoP and ensure project implementation can be flexible according to other departments' competences and needs (DE54,96,98,17).	Selecting a focal point which participates in the Klima2050 meetings; contract specific studies; create specific commissions to develop strategies to attend particular topics.	Monthly Conferences of the Agora Cycle Klima2050 facilitate instance for debating goals and implementation process of Klima2050 strategy.

Relational ties which are relevant for coordinating the Klima2050 CoP include:

1. Relations of **causality** (one entity's actions or intention led to another entity performing an action (Pohlmann, 2018, p. 73) could be established between

Table 20: Relations of causality

Actor 1 (Leads)	Actor 2 (Reacts)	Relation
Environmental Department	Other Departments within CoP	Demands information to support decision-making processes
Other Departments within CoP	Environmental Department	Implementation of Klima2050 must be divided up according to Department's expertise
Council (citizens, companies)	CoP (all municipal departments)	Demand provision of accountability

2. Relations of **spatiality** (connections through activities among entities (ibid)) could be established between:

Table 21: Relations of spatiality

Actor 1 (Leads)	Actor 2 (Reacts)	Relation
Env. Department	Other Departments within CoP	Articulation and distribution of new roles

3. Relations of **prefiguration** (entities may facilitate, restrict, or enable actions of other elements (ibid)) could be established between

Table 22: relations of prefiguration

Actor 1 (Leads)	Actor 2 (Reacts)	Relation
Env. Department	Rest of the CoP	Facilitate implementation by providing funding (through fundraising activities) or extend departments' networks through participation in regional projects.

3.3.5. The use of climate information in practice

Eight practices were identified and integrated into two categories: "Articulating" and "Designing". Practices are accommodated according to their role in responding to issues of common concern that emerge in the three conceptualised arenas.

Table 23: Practices in the use of climate information in Donostia

Arena/issue	Category 1: Articulating	Category 2: Designing
Political arenas: The use of climate information is weighted against the trade-offs between what is politically desired/acceptable.	1) Establishing sources of coherence 2) Aligning CoP2050 with administrative processes	5) Highlighting
From a strategic arena, the use of climate information is assessed in terms of its contribution to facilitate rating the order of priorities of actions and the use of resources for achieving goals and designing plans and strategies in the context of climate projections.	3) Coordinating tasks	6) Coding
From an operational arena, the use of climate information is weighted against the trade-offs between what is technically needed and feasible to do. Refers to how climate information connects resources, competences and expertise for the execution of specific operations.	4) Prioritising goals	7) Storing data 8) Requesting and sharing information

3.3.5.1. Category Articulating

3.3.5.1.1. Political arena

Articulating the community mandated to implement the Klima2050 Strategy represents a coordination challenge. Official status has already been granted to planning in the context of

climate change. While Klima2050 is an official mandate, it does not bring about a sense of community by default. The discrepancy between prescriptive work and work in practice (Gherardi, 2012) offers a departing conceptual approach to explore how written indications mediate the generation of meaning and sense in a community that emerges, strives and changes through the practical experience of articulating resources, strategies and policies. From a political arena, articulation demanded attending three core challenges: establishing a common orientation, accommodating Klima2050 strategy together with other official mandates, and providing accountability.

Practice 1. Establishing sources of coherence:

A community's common orientation is sustained by social interactions that are based on the collective ability to assess the appropriateness of actions and products produced by the community (Wenger, 1998 in Li et al., 2009). For Wenger, this ability is sustained by beliefs and behaviours and it results from shared sources of coherence (ibid). Sources of coherence represent "*the canons with which the community appraises and judges the object of the practice*" (Gherardi, 2013, p. 13). Community members make use of sources of coherence as resources "*to negotiate meaning and facilitate learning within the group*" (p. 4). In the Klima2050 CoP, examples of leading cities carrying out climate action emerged as sources of coherence: they allowed comparisons and offered a pragmatic display of how things should be done. Hence, these cities acted as cultural models (Suchman, 1995) because they facilitated comprehensibility and reflected consensus about the qualities that structure an imagined ideal of urban development vis-à-vis climate change:

- *"... Copenhagen, Toronto, Vancouver... Copenhagen has solved many problems, they have a very interesting plan... they are the benchmark... Vancouver and Toronto have the whole theme of green roofs, they have an ordinance... Vancouver works a lot on the issue of public awareness... they do it very well..." (DE60).*

These benchmarks portray the desired condition to be attained by Klima2050: appropriate planning, sound technical solutions, innovation and public engagement, all of which are portrayed in the Klima2050 official document[43]. Yet, these cities are also informative as a reality check: they act as a reference point against which Donostia's municipal competences and resources are appraised.

[43] Goals stated in Klima2050: Implementing new technologies, regulation, development of administrative tools, increased research capacity, knowledge dissemination (Donostia, 2018, p. 36).

- *"... Copenhagen has an outstanding economic approach; here it would be more difficult to promote it.... I think there are cultural differences, cultural differences are very important ... we are not at that point..." (DE61).*

These cities provide an immediate impression of current resources and expertise, and allude to the direction of future actions by becoming part of normative criteria applied to the design of activities and to the assessment of practices. The use of examples of cities as benchmarks links normativity about the qualities of an imagined ideal of urban development vis-à-vis climate change in order to explain the direction of actions (DE60). These attributes are reinforced by Donostia acquiring a membership within established institutionalized environments such as Covenant of Mayors, Agenda 21, Chart of Aalborg and participation in H2020 projects, which are limited to privileged institutions and demonstrate conforming to legitimised values.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
1. Establishing sources of coherence	City reports, material representations of memberships	Appropriate planning, sound technical solutions, innovation and public engagement.	Appraising competences and resources against standards	Stabilisation by rhetorical closure	Attained a common orientation

Practice 2. <u>Aligning Klima2050 with administrative processes:</u>

As previously explained in the case study about Bilbao, administrative processes within municipalities demand minimum degrees of officialization endorsed by an appropriate agent. Klima2050 is a concrete example of a strategy that enjoys official endorsement for its application. However, officialization does not entail automatic fit within the administrative processes, attributions, functions, roles and responsibilities of each department. In this particular case, Klima2050 was issued after updating Donostia's General Plan. This is important since the General Plan in place –approved in 2010- establishes the Urban Norms that determine land-use planning in Donostia, and these norms are not fully compatible with the prescription stated in Klima2050:

- *"when it was decided that we were going to subscribe to Mayors Adapt... we agreed that it was best... to have an independent adaptation plan: coordinated but separate, because the General Plan had just been approved" (DE32); "Klima2050 specifies that no more land is to be made artificial ... but it is based on the previous General Plan which has already approved a series of (urban) developments that have not yet taken place, so the idea is that with the New General Plan, no further developments will take place..." (DE41); "... in that modification of the General Plan, a vision will have to be created from the adaptation perspective ...." (DE32).*

Aligning Klima2050 to be fully operational from the beginning would have meant serious changes to the General Plan (DE77), which would have resulted in serious legal issues that the Urban Department could not have assumed:

- *"... in the General Plan .... there are already commitments that have been acquired and then you would have to back down... changing land-uses brings a series of compensations and legal issues..." (DE74).*

Changes to the General Plan are compulsory for the provision of legal tools that allow full implementation of the Klima2050 Strategy, and the period for including such changes is unfolding as this dissertation is being written. Additional components that should be contemplated in the Plan's amendments include considerations of extreme temperatures and the revision of return periods applicable to different precipitation events (DE65); as well as the design and integration of sectorial climate adaptation criteria in urban planning (DE69-70).

Accommodating Klima2050 to the governing administrative structure of Donostia provided an opportunity for community members to understand other departments' constraints, and how these constraints are to be considered within the strategic implementation of Klima2050. For instance, while the Urban Department could not provide flexibility in applying changes to the current General Plan, their inclusion within the community has conducted to the design of amendments which will be implemented in the next updating process (DE74). Hence, in spite of such limitations, the CoP designs ways to overcome barriers and to conform to the requirements of Klima2050.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
2. Aligning CoP2050 with administrative processes	Amendments, General Plan.	Synchrony with existing administrative processes	How to synchronise Klima2050 to existing administrative processes	To shed light on implementation demands of Klima2050	Establishing the trajectory of a common enterprise

3.3.5.1.2. Strategic arenas

A strategic arena focuses on how expertise in the community is managed through the distribution of tasks and roles so that collaboration and coordination are achieved.

Practice 3. <u>Coordinating tasks:</u>

Knowing how other people work and how they can contribute to the community's joint enterprise is a central demand to articulate work in the community (Wenger, 1998). Gherardi explains that people's expertise is not sufficient to ensure successful outcomes: "*Skills and knowledge interdependencies must be effectively managed through expertise coordination*"

(Gherardi, 2009, p. 519). Klima2050's joint enterprise is coordinated through the allocation of tasks and responsibilities to different departments. The initial distribution of roles and functions in the community was determined through a series of strategic assessments where the department's administrative competences and expertise were appraised (DE15).

- *"... this depended a lot on the pertinent administrations of each department, so we analysed the organization chart and (evaluated) which departments could be involved..." (DE15).*

The results revealed that some of the technical expertise, resources and administrative requirements needed for the accomplishment of Klima2050 were already part of the customary work undertaken by different departments. In cases where additional requirements were needed -such as undertaking new studies and assessments- additional budgets were provided in order to outsource them (DE17).

- *"... We try to make (the actions) to be shared responsibilities... in the issue of heat waves we work a lot with (the Department of) Social Welfare, they have social workers, etc..." (DE29); "Some (departments) have... 6 actions and collaborate with the Environmental Department to execute and follow up..." (DA6);*

Knowing what others can do in terms of administrative competences, but also in terms of expertise and resources is a central managerial component for distributing responsibilities within the community. Collaboration is constructed on previous plans that took place in the context of sustainability issues, such as Agenda21 (DE7), which had already laid down the conditions that facilitated collaboration for Klima2050 -mutual understanding, comprehension regarding the distribution and application of administrative competences, as well as social and cultural working codes-.

- *"... for example, the water agenda, comes from Agenda 21, and we already meet once a year to discuss (with) the Diputacion, the Basque Government Water Agency... we have other shared projects... then that collaboration is already taking place..." (DE11); "... with Social Welfare we did not work much because the municipality's agenda 21 is totally environmental and it did not work with the social and economic part... but then with the adaptation plan we could involve them..." (DE15).*

Previous experience in mutual collaboration among municipal officials in Donostia facilitated generating mutual understanding about how work unfolds in different departments through previous situated actions, where the interests of the actors have already met and were "*reciprocally defined*" (Gherardi, 2012, p. 18). An important distinction in this form of mutual understanding is that the new form of collaboration is subjected to new contexts and will unfold

through new situated actions. Hence, while previous mutual understanding can make clear the social rules that structure specific social and working relations, practical knowledge will continue to unfold.

In the distribution of roles and responsibilities, knowing how other people work becomes crucial. Knowing how other people work is about perceiving working rhythms, timings, understanding hierarchies, normativity, etc. Two normative elements are highlighted through the interviews:

1) respecting work-loads and timings:

- *"... we try not to hold more than 2 meetings a year, so we have to reach a balance that is active and demanding but (we cannot) have many meetings because people get burned and do not participate ..." (DE15);*

2) progress is to be achieved gradually and slowly:

- *"... in some places, we have lowered the return periods ... a study has been made to assess the operation of the sanitation network with a T100; corrections have been established taking advantage of the fact that works were going to be carried out on the sanitation lines... but it has been something concrete -it has not been said that from now on we are going to work with that... it was only a small step..." (DE39).*

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
3. Coordinating tasks	Organisation charts; previous existing plans	Working rhythms timings, understanding hierarchies.	Knowing how other people work	Anchoring practice in administrative functions and attributions	Achieving collaboration

3.3.5.1.3. Operational arena

Practice 4. <u>Prioritising goals:</u>

The transversal nature of tasks and goals specified in Klima2050 demands cooperation and common orientation to be maintained. Ensuring what Wenger calls "a joint enterprise" is being attempted in Klima2050 by calibrating and establishing common priorities among community members. The establishment of priorities could be achieved by striking a balance between pragmatism and flexibility. On the one hand, *flexibility* was enabled through instances of revision, assessments and negotiations. Klima2050 had to comply with everyone's priorities, and that was agreed as a core element to sustain the articulation strategy:

- *"The plan was discussed very openly ... so, the result is mixed ... it is a set of (collective visions) of several departments and people. Then, urgent actions .... are prioritized...*

concrete planning, with times and budgets ... requires prioritization. Then, the plans are there to be changed; hence, it is reviewed (and) modified .... It is a plan that had to respond to a series of requirements from many areas... departments... the city, urban infrastructure...climate change...the Covenant of Mayors... internal and external needs ... then in the prioritization you can project what you achieve (or)... change" (DA8).

Pragmatism on the other hand, resulted through the provision of concrete mechanisms such as time-lines and budgets for activity development. Pragmatism was displayed in various ways; for example, by sub-diving strategies into shorter time-frames with partial goals.

- *"... the Project by Project (approach) is super important, because the general view allows you to raise awareness, to be able to focus on different topics and areas, but then when it comes to seeing results, you have to specify projects ... because we all need ... concrete actions ..." (DE54); "... The risk study considers the year 2100, but designing a plan with that time horizon is difficult -2050 was already difficult-; what was done then was to make an action plan for 2023..." (DE96); "... It is difficult to quantify the costs of the projects until you have them fully designed, so it was difficult to quantify the measures of the plan. So, what we did was to integrate budget ranges, so the actions range from actions with no cost to actions that have a significant cost..." (DE98).*

Through these examples it could be evidenced how municipal management systems are reorganized to enable the implementation of concrete adaptation projects. Management systems are adapted to fit the requirements of specific project initiatives which demand cross-departmental coordination.

- *"A key project has been "Donostia se Adapta" ... (which) has enabled us to carry out 4 adaptation actions. The novelty of this project is that it has allowed multi-departmental work, including sanitation, civil protection and environmental actions ... in this same project an app is created to inform citizens to report on extreme events, including modelling of sanitation networks if they could cope with the coming of waves..." (DE102).*

Aligning departments within a common orientation is not free of conflict, since action in this regard can be taken as interference into the business of other departments.

- *"...there are always other departments that are more difficult to work with .... they see that our collaboration (implies) more work to them and see that the work is more of supervision than of co-creation and they don't like that..." (DE29).*

In order to counterbalance this situation and encourage participation, efforts to explain the additional benefit arising from participation become central coordination tasks.

- *"... when it comes to convincing people to participate .... there has to be a win-win; that is, this has to also help them with the work they do in their department, and that their leading role is very important .... this is important to explain .... why we do this, where it is framed ... and how it fits with the work they do..." (DE52).*

Representing the additional value of participating in the CoP emerged as a core aspect in the articulation effort. This was done by facilitating additional funding to support ongoing projects, or to find projects that can be of interest to a particular department or by providing instances for participating in capacity building schemes *(DE17, DE52).*

- *"When other departments participate they have to see why it is good for them.... for that, we try to find different... ways of financing projects that can benefit them or that are directly related to parts of the plan they manage" (DE17); "we are trying to attract European funding... we have participated without funding but as beneficiaries... (thus) we get a lot of information that otherwise would have been expensive ..." (DE103-104).*

In this context, the support granted by research centres and consultancy firms unfolds as the result of three reasons: first, external actors are interested in developing their project portfolios and get close to beneficiaries, as they can become part of their list of project partners in international project calls; second, because external actors can become involved in the direct implementation of projects in the city; and third, because external support is considered to be a key in order to communicate science to a broader community of policy makers and citizens:

- *"... (the experts) with whom we work ... find means of financing studies for us by piloting projects in which we are beneficiaries ... then on the one hand there are direct financing lines for specific studies... then it is a kind of symbiosis... "(DE23); "...the challenge is how to transmit that information to the citizenry ... the best way is that the experts come directly to make the presentations ... it is very important to take into account the level of language, because the participants, while they are technicians, are technicians in different fields and those who do the studies are technical experts in a specific area, so it is necessary to be able to communicate this in a transversal way ... "(DE24).*

This practice constellation shows how specific forms of practical and experiential knowledge become relevant for the articulation of the CoP and the use of climate information. Emphasis is given to the mechanisms whereby climate information is associated with concrete working methods used by municipal officials to coordinate all parties under a joint enterprise.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
4. Prioritising goals	Quantitative methods to prioritise actions	Mutual benefit emerges from collaboration	Knowing how to balance pragmatism and flexibility	Anchor practice in administrative procedures	Cross-articulate priorities

3.3.5.2. Category Designing

3.3.5.2.1. Political arena:

Practice 5. Highlighting:

The practice of highlighting refers to activities that emerge as facts about climate change exposure are learnt by the members of a community. As municipal officials became aware about specific facts regarding exposure to climate change, they identified new ways to contribute to the goals of the community. The following quotations highlight two aspects that evidenced awareness:

1) Through social interaction (strategic meetings, task forces, workshops) municipal officials could better understand how the process of contextualising climate information to municipal activities occurs; then, they evidenced trends in data demands and anticipated future data needs, appraised the effort required to furnish information and identified specific datasets that are most appropriate for a particular matter.

- *"... Our role is to see what information needs are going to be required, what they have (today) and to be able to provide them ... indicators will come out of the commission ... we will have to maintain the indicators, then we must complement that information with what is needed to adapt to climate change: "Look, we will need the surface that has been waterproofed year by year", then, I put the notice and we take that information into account, I am writing it down ... keep thinking about that key ... you hear it and see that the impact of the heat wave according to the model will continue to be measured every year ... well, we have to prepare (the information)...hearing that they might need information on electric cars, well, I make a note... "(DD34).*

Gherardi (2012) explains that hearing represents a form of sensible knowledge as people can apply judgement to the performance of words (p. 55). Comment DD34 highlights how a special reasoning is applied by the narrator by exploring what becomes important within the words expressed and to providing an account about them: comment DD34 expresses priorities, future challenges, open questions to be resolved; and as a response, the interviewee associates these words with concepts connected to her own work (people-risk-data models) and supportive activities are projected.

2) Municipal officials applied their experiential and sectorial lens to connect exposure with a narrative associated with their own sector or function. As implications of exposure are better understood, the demand for more detailed information emerges as a continuation of the learning process.

- *"We saw that it was necessary to have the (thermal) map, because we had information on temperatures, but we needed something more detailed for neighbourhoods... (the map) shows us the level of exposure... it serves to put things in relevance" (DE67);*
- *"We have contracted a study to know the evolution of the beaches according to different climate change scenarios and we try that the experts who have carried out these studies are at the meeting and explain and present, and then contributions are collected..." (DE18)*[44].

By increasing awareness, participating parties understand how their ordinary work becomes a contribution that supports the joint enterprise, endowing routine tasks with a new importance. Hence, highlighting reflects understanding of how people's own work can best deliver a contribution to work that unfolds collectively.

- *"the agents identify themselves with that model and facilitate the processes, then they themselves in their areas think about how to work, because there is a collective end… conviction helps... (they are) transformed into active agents... they all have different influences, some political, others economic, some are more reticent..." (DB19).*

The traditional form in which these studies take place is through outsourcing. Outsourcing follows the traditional procedure of establishing contracts with external providers who have the capacity to deliver specific technical input. Preparing specific studies often demands technical expertise that may not be available within the municipality. Appraising internal competences is hence important -knowing what competence gaps exist within the municipality. The capacity to define problems with clarity is hence important, as it is expected that information inputs provided by external experts will contribute directly to solving concrete problems.

- *"we made a contract with the Agency for the sustainability of Barcelona... there are personnel limitations, we don't have great means some things are outsourced" (DD27).*

Once information is available, the department in charge will generate a report which is lately disseminated to ensure that information is communicated to other parties in case new information inputs can fill in information gaps and support other municipal departments (DD26).

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
5. Highlighting	Information sets (exposure, sectorial non-climate data)	Collective contribution to joint enterprise	Understanding how to provide a contribution	Stabilise the use of climate information by anchoring in sectorial knowledge	Distributed reasoning and understanding

[44] Quotation DE18 refers to the study "Estimation of the impacts of climate change on beaches" which project that under a RCP 8.5 scenario up to 20mts. of coastal line will be lost by the year 2100. Available at https://www.donostia.eus/ataria/documents/8023875/8050879/RESUMEN_EJECUTIVO_playas.pdf/33b93521-8588-41f0-a818-60458aebde47

3.3.5.2.2. Strategic arena:

Practice 6. Coding:

In consonance with Rowley (2006), the addition of meaning is considered as the dividing line between climate data and climate information. Communities of practice share "*socially organized methods of seeing and understanding events*" (Gherardi, 2013, p. 10). These methods shape knowledge objects which are harmonised and connected concepts (ibid). From this definition, the transition from climate data to information relies on meaning that is added and it enables the construction of a consensus to framing climate change as a knowledge object whose implications are collectively understood and shared. As previously explained through the practice of Coding in the case study about Bilbao, the addition of meaning is discussed through the concepts of standardisation and recontextualization (Shove, 2012, p. 49-53).

-Standardizing climate concepts: Donostia's vulnerability assessment (Donostia 2017-A) covers climate risk issues in five sectors: water provision and demand, energy, tourism, urban infrastructure, and public health. Based on the methodology applied in the IPCC 5th report to measure vulnerability and risk, four impact chains were developed: the impact of sea-level rise, storm surges and river flood on infrastructure; extreme precipitation on the water distribution network, on transport and urban infrastructure; as well as heat waves on human health and high temperatures on biodiversity (Donostia 2017-A).

Standardisation -as explained in Donostia's Vulnerability Assessment (Donostia, 2017-A, p. 33)- results from the process of preparation and collection of sectorial non-climate data (demographics, socio-economic indicators, sanitation system's carrying capacity, etc.), and its association with climate data through statistical methods. In Donostia's Vulnerability Assessment (ibid) the process is described as a sophisticated set of statistical analyses undertaken by external consultants, while the contribution of municipal officials is underlined as the provision of data and the later validation of the results (p. 33).

-Recontextualization: A process of recontextualization can be identified in Donostia's Vulnerability Assessment by observing how categories are created as climate data is associated with sectorial, non-climate information in each of the impact chains. Heat waves are categorised as threats not because the temperature rises sharply during a few days, but because high temperatures are associated with negative impacts on the health status of elderly people which had previously gone unnoticed:

- *"For us heat waves are important because Donostia is not a city prepared for the heat..." (DE94); "... for Donostia it is very important because we have a ... larger*

population..." (DE27); "... more than 6 thousand people over the age of 85 who live alone..." (DD39).

But heat waves in Donostia are also associated with impacts on local biodiversity. Hence, applying Shove's (2012) conceptual proposition, it can be observed that meaning associated with heat waves is extended in association with losing ecosystems. In this context, climate information has made the generating of new categories and rankings possible: categories such as "elderly" or "living alone" bring different connotations and influence the lens with which climate risk is to be appraised. Climate change is recontextualised as the concept of urban risk is populated with ideas such as the elderly being more exposed to high temperatures or a disappearing coastline affecting tourism. Categories in this case, are composed of assumptions about how climate risk jeopardises an ideal of urban development. These assumptions shape and grant meaning to climate risk as a specific social problem. New categories help to prioritise action and to divide up the expert tasks needed to serve specific functions (Blue, 2017) for reducing exposure and vulnerability, including demanding new studies to further scrutinise the impacts of climate change on lesser understood processes or situations (DE37, DE71).

What emerges from this recontextualization exercise is that municipal officials apply their experience and expertise to better understand and prioritise climate risk: they apply a point of view that reflects social meaning according to their work to generate these categories. Shove (2012) observes that the addition of meaning is contingent on people's "*prior, first-hand, practice-based experience..."* (p. 53) because concepts that had already existed and had a recognisable quality can be associated with concepts that are important (in this case) for urban development: resilience, safety, liveability, etc. Hence, the addition of meaning brings to the forefront normativity and experiential knowledge as central elements.

Pearlson and Saunders (2004 in Rowley, 2006) explain that *"the processing of data requires a decision about the type of analysis, and this, in turn, requires an interpretation of the content of the data. To be relevant and have a purpose, information must be considered within the context where it is received and used*" (in Rowley 2006, p. 171). The addition of meaning in the use of climate information in Donostia could be evidenced by highlighting how normativity and experiential knowledge were manifested within the methodological development of Donostia's Vulnerability Assessment. The methodological process follows in general terms the classic process associated with converting data into information (Curtis and Cobham, 2005 in Rowley 2006) which include *"classification, rearranging/sorting, aggregating, performing calculations, and selection"* (p.171). In order to identify when and how meaning emerges within this process, each step of the methodological sequence was cross-checked against the

interviews, with the aim of searching for instances where the methodological process overlapped with experiential knowledge and normativity, as presented in table 24.

Table 24: The addition of meaning: transitioning from data to information

Methodological sequence for developing impact chains (Translated from IHOBE, 2017-A, p. 33)	**Description of participation between external consultants and municipal officials** Source: IHOBE, 2017-A, p. 33	**Evidence of experiential knowing and normativity (Information emerging from the interviews)**
1. Development of problem trees and identification of impact chains Identifying cause-effect relations (climate threats and municipal aspects)	**Step 1.** Impact chains were selected together with municipal officials (p. 33)	**Step 1. Strategic appraisal is collective and normative:** Impact chains respond to key urban challenges: demographic ageing (core indicator to heat waves), dependence on tourism (shrinking coastline and areas of natural interest).
2. Deifining data modelling method Search for indicators -literature and existing data-bases	**Step 2.** Identification of indicators to describe the social, economic and environmental reality of the municipality, characterizing the degree of fragility (sensitivity) and the adaptive capacity of the population, buildings, infrastructures, economic activities and conservation areas in the face of climate change (ibid)	**Step 2. Interpretation (experiential knowing):** determining sensitivity indicators responds to aspects of age, poverty, social exclusion. Indicators must be manageable and hence, selection rests on work experience.
3. Collecting and generating data Spatial analysis	**Step 3.** Data was provided by City Council Departments (Environment, Urbanism, Tourism, Development, Sanitation), and it was supplemented with data from the Basque Government, URA, Insurance Compensation Consortium, Aranzadi Science Society, etc. (ibid).	**Step 3.** Data management systems are central practical aspects that enable the provision of updated, relevant and salient sectorial non-climate data. Practices involved in the provision of data highlight aspects of practical knowledge and normativity, as explained later in this section.
4. Statistical analysis transformation, standardisation, consistency 5. Weighting indicators and generating indexes through statistical analysis	**Steps 4 & 5.** The vulnerability assessment considers the neighbourhood as a unit of spatial analysis according to urban criteria. The statistical treatment of the indicators (R data analysis), involves normalization, standardization; internal consistency analysis; and assignment of weights -also by statistical methods- (ibid).	**Steps 4 & 5.** Strategic appraisal: allocating a neighbourhood as a unit of analysis responds to an understanding of how urban dynamics, problems, etc. can be best portrayed. Assigning weights to indicators and validation of interpretations developed by external experts occur through deliberative processes in formal meetings (DE18).
6. Generating cartography Cartography for each impact chain	**Step 6.** Provided by interview: *"...I... provided demographic information... we were at a table with the (consultants) and they asked "well, where do you think the population that could be most affected lives?" ... and I would give a list of what came into my mind and what we already had available and georeferenced..."* (DD6).	**Step 6.** Quote DD6 highlights the selective mechanism applied by a municipal official in prioritising specific datasets to be used by the consultant; hence, underlining aspects of experiential knowledge to discern what becomes important for a specific assessment.

From table 24 it can be inferred that the addition of meaning occurs throughout the entire methodological development of Donostia's Vulnerability Assessment. Differentiating how meaning is added as distributed along the series of different steps sheds light on the significant role played by municipal officials in the entire process: points of view, previous experiences and norms are active components of this interaction and are decisive for granting significance and meaning to the contextualisation process that turns data into information.

From the climate information documents available for the case study about Donostia, it can be observed that in the addition of meaning in the data-to-information process two aspects are required:

1) Identifying how climate information can be operatized through standardised measurement systems and methodologies:

a) The information provided in Donostia's Vulnerability Assessment specifies a set of indicators[45] for impact chains (Donostia, 2017-A) studied in 108 sub-territorial units to identify human and physical elements exposed to climate change. Risk values in heat waves are context-dependent according to vulnerability values (cases where population density is high) or to a higher sensitivity (percentage of elderly residents aged 70 and over with respect to the total population within each unit).

b) The project *"OSATU: Impact assessment from extreme temperatures about health in the Basque Country under conditions of climate change"* (IHOBE, 2017-E), links the potential impacts of extreme temperature to people's health status, and provides an economic estimate of the impacts of heat waves in terms of mortality explained through cost-benefit analysis[46].

c) The study "Natural solutions for Donostia" (IHOBE, 2017-A) provides a methodological sequence to identify the natural capital of the municipality and its adaptation assets; as well as the urban spaces available to host natural solutions, highlighting spaces with an overlap of vulnerability and available space for implementation; identifying new urban development and/or regeneration areas that

[45] **Indicator: Number of heat waves (HWN):** With respect to the future, the projections estimate an increase in the number of events. It is expected that there will be between 2 and 4 more heat waves per year by the end of the century, considering the RCP 4.5 and RCP 8.5 scenarios respectively.
Indicators of intense rainfall: Number of days with rainfall above the 95th percentile (R95p): High uncertainty regarding the total annual precipitation corresponding to extreme rainfall (R95p). However, taking the RCP 8.5 scenario as a reference, it seems that there may be an increase of 5% by the middle of the century and 1% by the end of the century.

[46] The mortality risk attributable to heat waves (the proportion of daily mortality from natural causes that can be attributed to exposure to heat) represents the additional risk for each degree centigrade that exceeds the impact temperature. For Donostia, in the period 2020-2100 under a RCP 4.5 scenario, a total of 800-850 deaths-year is estimated; while under a RCP 8.5 it rises to 1300 (P. 21).

could host natural solutions; and creating synergies between adaptation and mitigation measures and actions.

2) Dealing with uncertainty: The results of the vulnerability assessment applied to sea-level rise and storm surge indicate a large difference in the estimates[47]. Given the difference, an updated definition of risk-prone areas considers now a 64cm sea-level rise, being the maximum estimated under an RCP 8.5. Following the results of additional studies (IHOBE, 2019-E), the distribution of the probability of flooded areas has been expressed in terms of return periods (in this case of 50 years) (ibid. p. 26). In terms of river floods, while exposed sub-territorial units have been identified, the incidence provoked by floods in other smaller water courses (which would increase the area flooded) has not yet been identified. Additionally, current climate models provide information on rainfall intensity within a wide range and with contrasting results compared to other studies[48]. Hence, a precautionary principle is used in the vulnerability assessment and a 20% increase coefficient is applied, meaning that original areas affected by events of 500 yeas return periods are now considered as 100 years return periods.

One of the core conclusions that emerged from Donostia's vulnerability assessment was the need to run additional studies that could provide further input regarding the effects of climate change according to each impact chain. The following studies emerge in response to this:

a) "Analysis of the impact of climate change on the municipality's critical services and infrastructures" *(Donostia, 2019)* (energy, gas, telecommunications and water sanitation) to see how a correct service could be guaranteed in the face of extreme episodes associated with climate change. The study portrays interdependencies between each critical municipal service and its cascading effects in case the service is interrupted due to extreme climate events.

b) "Hydraulic and hydrological study of the river flows of Polygon 27"[49] models the carrying capacity of the sanitation network in the Polygon 27-area. Rivers flowing through this area have large flows and, therefore, their impact on the sanitation network in the event of flooding may be greater than in other areas. The study shows that events with return periods (R) R10 can be tolerated, while R25 can be partially tolerated with regard to the sanitation system; while for R100, the system's carrying capacity will be

[47] A rise in sea level is expected by the end of the century (2081-2100) of 47 ± 16 cm under the RPC 4.5 scenario and 64 ± 22 cm under the RCP 8.5 scenario for the Bay of Biscay (Donostiako Udala, 2017-A)

[48] Brunet et al., 2008 suggest a decrease in precipitation of 15-20% by the year 2100; while the Basque Water Agency (Gobierno de España, 2018) concludes zero changes in water flows for low return periods -10 years- and increases of up to 25% for higher return periods (100 and 500 years) by the end of the century.

[49] Available at https://www.donostia.eus/ataria/documents/8023875/8050879/RESUMEN_EJECUTIVO_RegatasPOL27.pdf/728156d2-bbc9-47bf-8e98-d43e15b282bd

pushed to the limit and some collectors will collapse. For events with return periods of 500 years, the flooding of urban areas become more evident.

C) "*How to improve resilience to climate change in the municipalities of the Basque Country: the case of Donostia / San Sebastián and Tolosa*" (Donostia, 2019-B) offers a resilience assessment model concerning four areas: Municipal preparation to deal with disasters; leadership; cooperation and technical aspects. The model proposes the assessment of an implementation level of 15 policies against five stages: incipient, moderate, advanced, consolidated and proactive (ibid. p. 55).

The practice of Coding highlights how climate information provides a scientifically robust base that orients specific actions by highlighting the most pressing development aspects that could be affected by climate change through specific quantitative and qualitative parameters which are commonly used in municipal working routines, including estimations of financial loss, mortality rates, service interruption; all of which help to establish thresholds and priority areas and orient the distribution of roles according to expertise, resources and administrative competences. Coding in this sense supports both, garnering moral and procedural legitimacy by embracing socially accepted techniques and science-based approaches (Suchman, 1995) (DE68, DE102).

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
6. Coding	Climate data, sectorial, non-climate information	Respond to key urban challenges	Knowing what key challenges are; how to link key challenges to climate data.	Stabilise the use of climate information by embracing socially accepted techniques and science-based approaches. Stabilising usability by linking to traditional administrative competences.	Consensus regarding the role of climate information in key aspects of urban planning

3.3.5.2.3. Operational arenas

Coding highlights the importance of sectorial, non-climate information as a substrate for adding meaning to climate data. An operational arena describes practices sustaining the collection, storing, sharing and analysis of sectorial, non-climate data.

Practice 7. Storing data:

The format in which data is stored mediates to a large extent the facility with which data is shared and used. The degree of data aggregation may hinder the possibility of rapidly identifying core aspects of data; data may be grouped within larger datasets indexed in a way that does not reflect the type of data that is included, etc. (DD18). Hence, the challenges presented by data storing practices to the entire information management system are not minor:

- *"... Each department has its databases in different applications and programs ... to fulfil specific services ... each one generated their own fields, so then it is not easy to share (data) ... you have to remove certain data ... consider data security and encrypting... it is an expensive process…" (DD10).*

The evolution of data and information management systems is perhaps one of the areas within organisational management that has experienced the fastest development and change during the past decades (Gray, 1996). Today, a better understanding about the integration of urban processes has made old information management systems obsolete. While in the past, information was collected and stored to serve specific administrative tasks, today's analytical needs demand integration of distributed data (ibid). The transition to new information management systems means that efforts to disaggregate, index, update and store data are greater than ever before:

- *"... Before, the use of databases was simply the management of the department, minor databases ... license, number, address, date ... it followed the chain of an administrative process -normal and known- ... you didn't have to fill in certain fields that are now very interesting ... you didn't see them, you didn't need them and then you didn't have them ... so now it is not easy to exploit the information even if the databases exist ... because the database is not prepared for that…" (DD12).*

Following the new data management paradigm, Donostia's administration intends to ensure that data supports analytical and decision-making processes and that data is accessible by everyone, including citizens and companies (DD12). Currently, an extensive automatization process is being undertaken in Donostia in order to facilitate storing data. The process consists of a series of procedures that articulate data generation, standardise storage under specific indexing protocols, and facilitate sharing through on-line platforms. The magnitude of such an endeavour has demanded exploring large datasets from different departments, filtering and selecting what is important from what is negligible (DA20).

- *"... we began to see each of the 25 departments and each of their databases, we began with the most transversal and generic things that we thought would be of interest to each one... We began with the register that collects information about people: how many are they, where they live, ages, characteristics, etc. and we have turned it into a software that allows you to work with that data... to optimize services to the population" (DD13).*

Storing data became an exercise not so much of collecting large volumes of data, but rather about paying attention to what could become important as input to supporting analysis and decision-making processes carried out by different departments. This could only be made

possible by personal interactions where specific input was requested from datasets and which gave tips about the sorts of information that could provide additional value to people's work. Filtering the data was hence only possible through interactions where a mutual understanding about priorities and forms of working could be made clear *(DD15).*

However, the process was not free from barriers:

- *"... we reached 4 (Departments)… it was very difficult for several reasons: going from one department's database to an entire informatics system ... it was very long... all the cartography part had to be assembled, there was data encryption, most of the data came with a lot of information and that information had to be passed through many filters that took a large part of the funds ... there were many phases and we did not know them, nobody had done... (this) before ... at first you think: how easy! You ask for a piece of information and now... the problem is not so much a format, it was more the computing part, the processes that had to be run" (DD54).*

Improving data-storing techniques can be a costly and complex business. Comment DD54 shows how changing data management systems cannot occur independently from changes in the use of technology. As the use of technology is central for optimising storing processes, it is also central for facilitating the access to and the distribution of data. In the next example, it is shown how as data is being posted on an online platform so that the users' access is facilitated, further challenges emerge as the use of the technology is mediated by cultural working aspects:

- *"... I don't know if it has been too successful because several people have requested the license (to access the platform) ... (but) many people continue to request information by phone, and if you don't use it every day, the passwords are lost…" (DD25).*

Orlikowski (2007) has extensively explained how people apply social rules to the use of technologies. When processes of technology adoption and dissemination are considered as two different phenomena, the use of technologies is subjected to barriers that emerge as social rules remain associated with an old system of data exchange (in this case, requested by phone) (ibid). Against this perspective, the use of the platform is being supported by pedagogy where users learn which is to be found in the platform and how it can be accessed:

- *"...the idea is that when the new data comes ... (we) upload it (and) update it. (Then) a press conference is given by the mayor ... we make presentations by departments... we then show the information that is there (we explain): you can access this, this is the way to register and use the database, so that they can use data instead of asking for it, they can extract it, analyse it as they see fit ..." (DD25).*

In this educational project accessing information is portrayed as a way of adding value to how people work by extending the possibilities of running analysis and reducing energy and time in requesting information.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
7. Storing data	Data, portals	Improving working practices, existing social rules	Selecting important data	Anchor practices in new material entities and methods	Effects not fully measured yet, but expected to facilitate dissemination of data through the application of standards

Practice 8. Requesting and sharing information:

Requesting and sharing information refers to the practical interaction between people throughout municipal departments and which is aimed at gathering specific datasets required for diverse purposes. Information may be stored in a format that is not ready for it to be shared -it may be aggregated or stored in a particular format that makes sense to the person who stores the data. Hence, people may have to engage in dialogue to express what they need, while the sender may need to reflect about what sort of data is closest to what it has been required. Hence, requesting information is about mutual understanding (DD22): requesting information may entail an additional workload for the sender (DD42); therefore, appraising the effort needed by the sender, understanding when is the correct timing to ask for data, or potentially displaying how the extra effort also brings benefits to the sender, all emerge as relevant norms in these interactions. Understanding how other people organise time schedules, distribute workloads, or react to contingencies according to their work, are important issues to consider regarding the circulation of data and information.

- *"... We ask for information depending on the department: with some people we get along well, with others less ... some do not see the value of sharing information ... sometimes they do not share information; It depends on the people or if they think that we will give them more work ... sometimes it is simply that there are people who are more suspicious: this information is mine and I do not want to share it ... they do not see that the information belongs to the municipality, to citizens ... sometimes also because the information can be sensitive, due to data protection issues and many guarantees are required ... "(DD23).*

Two aspects stand out in comment DD23: first, the transparency model of Donostia stipulates that data and information are to be shared internally and made available to external sources directly through the internet, so that interaction with data and information are not only possible,

but actively encouraged (Donostia (2018-B, p. 65). However, people can behave as the owners of information; and despite information management being legally regulated by standards (*Transparency, access to information and good governance* Law 19/2013, in Donostia (2018-B)), reticence to share seems to be a feature which is encountered. Second, transparency mechanisms mean that while data should be made accessible, not all data can be treated in the same fashion because some datasets are sensitive:

- *"... We work with personal data ... so there are ... many requirements, and there was a lot of friction ... complying with security and data protection measures ... behind there is a very complex issue ... they were taking data only what was needed ... (DD54).*

However, in cases where information is sensitive, specific procedures must apply in order to allow sharing information. Information considered sensitive is defined in the Transparency Model (article 105, Law 19/2013) as information that can potentially affect either the security of the state or people's intimacy; and in these cases, information disclosure will be subjected to a specific evaluation where the presumed harm to either people or the state will be assessed in terms of whether it provides objective input to a specific scrutiny process (article 62 Law 19/2013) (p. 16). Additionally, other instances exist which avoid enforcing the law, such as simply assessing the need for disclosing data and information in formal evaluation meetings (DD22). However, normally it is expected that information will be requested simply by email, by phone, or in corridor conversations.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
8. Requesting & sharing information	Sectorial-non-climate data, emails, etc.	Guiding normativism in working practices.	Knowing how to request data (including sensitive data).	Facilitate coding	Increased social interaction

3.3.6. Findings and interim conclusions for the case study about Donostia

The use of climate information in Donostia is characterised as being in an "aligning mode": climate-oriented decisions are recognised in official frameworks and the use of climate projections are based on legal decrees. However, a number of policy contradictions must be resolved in order to fully deploy Klima2050, which demands aligning a constellation of urban plans and decrees, and ensuring that transversal action is not jeopardised by sectorial functions or overlapping attributions.

The use of climate information was found to be mediated by the structuring role played by administrative competences. Articulating the Klima2050 strategy demands an official relational space that allows the distribution of roles and responsibilities in line with the functions and attributions framed in administrative competences. Thus, administrative competences determine the degree and form of participation in the CoP by regulating the resources, jurisdictions, priorities and methodologies that give shape to the activities undertaken by CoP members.

The link between the use of climate information and history was attributed to the influence of history on the perception of risk being associated to river floods and the impact of sea-level rise and severe storms which affect beach tourism (a central economic activity). Precipitation and high temperatures are mostly discussed in economic terms (effects on tourism) and demographic terms (sensitivity towards the elderly). More recently, heat waves have become evidenced as important threats against Donostia's large aging population.

3.3.6.1. Practices and categories

The use of climate information in Donostia is illustrated through 8 practices, which were grouped in two categories, "Articulating" and "Designing" and which were distributed according to whether they responded to issues of common concern embodied in political, strategic and/or operational arenas.

The categories highlight the role of climate information in two terms: "Articulating" is based on climate change being a knowledge object that orients the activities of the CoP; while "Designing" depicts how climate information is managed in order to position climate change as a knowledge object.

3.3.6.1.1. Category Articulating*:* Practices in this category underline the challenge of building a consensus in a community that is diverse in its backgrounds and interests and whose roles are framed within the distribution of administrative competences. Articulating Klima2050 is illustrated as a process of learning through social interactions, where deliberation, persuasion and negotiation occur vis-à-vis myriad forms of work. The role of climate information becomes

central to this process by providing an acknowledged scientific basis upon which climate change becomes a knowledge object: a collectively understood and shared problem that sustains the CoP's common orientation and activities within a joint enterprise; and which facilitates distributing roles within the community according to expertise, resources and administrative competences.

In this context, the use of climate information is linked to experiential knowledge through:

- **Knowing how to establish a common orientation by finding sources of coherence:** The community's common orientation centres on the identification of sources of coherence that act as the canons to judge practice (Gherardi, 2013). Examples of cities at the forefront of climate action provided a sense of coherence by providing a normative orientation that reflected shared social values regarding urban development vis-à-vis climate change: appropriate planning, sound technical solutions, innovation and public engagement. This form of practical knowledge highlights the role of sources of coherence in facilitating understanding and in sustaining the use of climate information by rhetorical closure, implying a general agreement on the contribution of climate information to attaining an ideal of urban development.
- **Knowing how to stimulate membership:** Trust is recognised as "*an essential component of all enduring social relationships*" (Seligman, 1997, in Sztompka, 1999, p. ix), and it was considered a central element to stimulate membership of the CoP. Trust was demonstrated by granting autonomy to departments regarding the implementation of projects, recognising that departments' expertise and experience will deliver the best possible outcome. Additionally, demonstrating how membership of the CoP brought benefits to people's own work was part of the strategy: by facilitating additional funding to support ongoing projects, by distributing the implementation of projects according to the particular interest of a department, or by providing opportunities for capacity building.
- **Knowing how to adapt the management system to accommodate the use of climate information:** Establishing a management system that could accommodate the implementation of Klima2050 was a process of learning. Lessons learnt indicated that ensuring flexibility and pragmatism were crucial aspects of the management system. If pragmatism was delivered by fitting actions into concrete planning methods –distributing times and budgets, using customary measurement methods-; flexibility was delivered by splitting up the implementation of concrete projects, or by subdividing strategies into shorter time frames with partial goals and flexible budgets.

- **Learning how other people work from previous experience:** The distribution of roles, functions and responsibilities within the community derived from a process of appraising a department's administrative competences and expertise; but most importantly, by comprehending how people across departments interacted with one another. Previous experience from coordinating transversal plans such as Agenda 21 facilitated the understanding of how social and cultural working norm structure inter-department interactions, while it provided information regarding how objectives are settled and reached, rhythms and timings flow, hierarchies are managed, and workloads contemplated within the distribution of tasks.
- **Working things out:** Accommodating Klima2050 often had to navigate through policy contradictions. In cases in which legal amendments could not support implementing Klima2050, collaboration still could unfold by preparing the ground for future changes (e.g. policy-makers being active in the design of amendments to be integrated in the next update of the Urban General Plan). Hence, the work of the CoP did not stagnate; but it was instead gathering momentum to enable future action.

3.3.6.1.2. Category Designing*: 5) Highlighting, 6) Coding; 7) Storing data; and 8) Requesting and sharing information.* The category "Designing" underlines the process whereby climate information is contextualised as a knowledge object. Practices in the Designing category illustrate how sectorial lenses and experiences are applied to locating climate information in the context of working practices, by 1) using methods which are customary to municipal work in Donostia, and which 2) help to evidence how climate change could disturb municipal work (service delivery, human security, urban development and cascading effects).

In the process of contextualising climate information, the practical involvement of municipal officials in the addition of meaning is highlighted through different expressions of know-how:

- **Knowing how to generate categories:** Categories resulted from a process of re-contextualisation, whereby municipal officials connect climate information to their working contexts by –as explained in Shove (2012)-applying a point of view that reflects the social meaning embedded in their work. Social meaning embodied in these categories can be observed as climate risk is understood, managed and framed based on a professional perspective, underpinned by: a) the collective selection and design of methodologies to appraise risk based on traditional municipal methodologies (indicators of age, health status, mortality rates, poverty, social exclusion); and b) by managing climate information through customary working procedures (e.g. allocating a neighbourhood unit to parameterise vulnerability). For example, heat waves are categorised as being a threat since they can be

associated with negative impacts on the health status of the elderly. Climate change is re-contextualised as the concept of urban risk being populated with ideas such as the elderly being more exposed to high temperatures. In this context, climate information has supported the generation of new categories and rankings: categories such as "elderly" or "living alone" bring different connotations to "exposure to high temperatures" and influences the lens with which climate risk is appraised. From this point of view, it is suggested that generating categories helps to stabilise the use of climate information by anchoring it in sectorial knowledge and by embracing socially accepted techniques and science-based approaches.

- **Knowing how to deliver value through data management:** Delivering value through data was understood as collecting "the correct data". Learning becomes visible by observing how data management systems are transitioning in order to respond to new problems that are collectively defined as data is being integrated and enable new analysis to take place, also providing a better orientation regarding the modernisation of key services.

3.3.6.2. Anchoring and enabling practices

Practices distributed in these two categories were found to be playing either an anchoring or an enabling role. The practices "Highlighting" and "Coding" are characterised as anchoring practices since they emerge from the direct connection with climate information. The other six practices are typified as enabling practices since they sustain usability in three different ways:

1) Enabling practices such as "Establishing sources of coherence" and "Prioritising goals" support usability by providing normative orientation to activities undertaken by the CoP, building consensus around the use of climate information.
2) Anchoring the use of climate information in procedural methods and standards, including practices such as "Aligning CoP2050 with administrative processes"; as well as the practice of "Coordinating tasks", which highlight the relevance of adapting management systems to enable the application of climate information in different operations.
3) Providing substrate, sectorial, non-climate data and information needed for contextualising climate information within local settings, as in the case of all data management practices.

3.3.6.3. Normative criteria

The forms of practical knowledge previously described underline that practical knowledge and normative criteria come together in interplay as people interact to articulate the CoP supported by climate information. Normative adequacy in the case study about Donostia could be detected

as practices exhibited normative regularity (Rouse, 2007) as observed through the application of three evaluative criteria:

- **Normative-political criteria and normative-procedural criteria**: The use of climate information has already gained political support from political authorities; therefore, the establishment of agreements regarding the use of climate information occurs on a technical level where directors of each municipal department can decide which decisions will be informed by climate information. Since decisions as to how to plan for climate adaptation are fully granted to each municipal department, the overlap of these criteria is better appreciated by being observed in association.

  Ongoing negotiation and persuasion were central features of the challenge to articulate the CoP. The construction-on-the-go mode in which the CoP operates permanently demands reaching agreements, which -as highlighted by Gherardi (2012)-, once established do not last forever and are often interrupted. While there is a consensus in the sense that the contribution of municipal departments to the CoP's mission is of utmost importance (and indeed, officially demanded), the way in which departments contribute to achieving Klima2050 is not fixed. Since the CoP bestows departments with the full ownership and responsibility over project implementation, the principle of "managing with flexibility and pragmatism" becomes prominent to highlighting respect for the attributions, functions, experience and expertise of other departments. Normative criteria are built around the trust that responds to the perceived procedural and technical saliency displayed by the departments' expertise and which is acknowledged as the best way possible of doing things. Hence, in a system where responsibility is distributed across actors whose expertise is acknowledged as the best possible available, imposing a view on how to do things is not adequate. Rather, it seems to be more sensible to grant trust and to keep on negotiating the frontiers of goals.
- **Normative-cultural criteria:** Since people's interactions lie as the heart of coordinating the CoP, learning how people work became a central requirement for articulating the CoP. Learning about other people's activities evidenced the importance of understanding rhythms and timings, and hierarchies and workloads in order to distribute tasks in the CoP. For example, renovations in the sanitation network enabled the use of corrected return periods; an action that was accepted since it represented a single improvement and not an intervention to the whole sanitation system. The decision was accepted since it responded to normative criteria that indicate that changes are

acceptable, provided they occur slowly, gradually and without disrupting the rhythms of decision-making. These criteria emerge as central aspects in the field of persuasion. Normative-cultural criteria are also evidenced as membership to the CoP is stimulated by adding value to people's work; which is done by pragmatically displaying the benefits that emerge from participating in the CoP (funding, competence development, etc.).

3.3.6.4. Changes in practices

Practice change can be observed through engagement, interaction and participation in Klima2050. Blue and Spurling, 2017 (in Hui et al., 2017) suggest that some of the core indications of practice changes are to be seen through:

3.3.6.4.1. Changing jurisdictions*:* Klima2050 has distributed activities across municipal departments according to expertise, previous experience, functions and attributions. Implementing tasks in the context of Klima2050 demand a new configuration of actors working together, extending the jurisdictions of some actors (the environmental department is a prominent example of this) and reducing exclusivity of the attributions of departments over other issues (plans attending urban risk grant decision-making power over the physical environment to multiple municipal departments).

3.3.6.4.2. Through advances in the use of science*:* Changes in the knowledge constitution show how climate information contributes to increasing people's awareness and facilitates linking climate change to people's own work, orienting the form of contribution towards the CoP and facilitating the identification of new spaces for collaboration. For example, informed by climate projections, technicians became concerned regarding the carrying capacity of the drainage system and indicated the need to consider sustainable drainage as an alternative to the traditional drainage system (DE72); or municipal officials becoming attentive to specific data that could support "Coding" (DD33).

3.3.6.4.3. The extended configuration of municipal actors that participate in climate adaptation-linked practices*:* Since implementing Klima2050 demands distributing roles and responsibilities across all municipal departments, the configuration of participants in practices linked to climate adaptation and the use of climate information has increased.

As these three observations suggest, ways of doing things change and new practices emerge which could be observed through changes in the knowledge and material composition of practices.

3.3.6.4.4. Changes in the knowledge composition, are evidenced in three examples.

-First, in relation to the constitution and extension of meaning which occur in practice through the formulation of categories that framed climate risk as a specific social problem. The constitution of meaning is visible as an increasing number of concepts become connected with a particular factor. The practice of "Coding" underlines how meaning is constituted as heat waves were populated with ideas about the frailty of the elderly (a concept charged with a negative connotation) and are also extended by being populated with ideas regarding the exposure of natural areas. Categories were created which helped to prioritise action and to divide expert tasks: the constitution and extension of meaning allowed one to define problems and to shape activities around the devise of solutions.

-Second, changes to the composition of knowledge could be observed as interaction with climate information endowed customary working practices with new importance, as shown in the practice of "Highlighting", where people would find new mechanisms to organise and prioritise data in order to contribute to the CoP.

-Third, it can be seen that changes to the composition of knowledge emerge as practitioners found ways through to deal with uncertainties; for instance, by applying a precautionary principle to new infrastructure developments.

Resulting from these observations, the knowledge composition seems to be dominated by skills needed to conceptualise problems and to generate categories, as well as by the experience necessary to devise solutions oriented by working practices.

3.3.6.4.5. Changes in the material composition can be observed from three angles, which point out that changes in practices are dominated by availability, absence or status of material entities.

-Availability -material entities structure practices-: the drafting and extensive use of Donostia's Vulnerability Assessment (Donostia, 2017-A, p. 33) englobes activities included in the preparation and collection of sectorial, non-climate data and its association with climate-data through statistical methods. At the same time, the same material entity becomes a common node connecting various practices.

-Absence of material entities trigger the enactment of other practices: The lack of detailed studies regarding the impact of high temperatures on biodiversity made it impossible to inform about the distribution of risk in detail. Proxy indicators (rural-natural density/biodiversity indexes) were designed, agreed upon and used to compensate for the lack of information; and from these, methodological sequences developed (e.g. identification of the natural capital of the municipality and its adaptation assets).

-Changes in the material status of infrastructure open a window of opportunity for specific actions to take place: For example, the Emergency, Water and Sanitation Service must improve

the sanitation infrastructure as its material condition worsens off.

Interim conclusion of the case study about Donostia

Since Klima2050 has already been endorsed by legal decrees, characterising the use of climate information in Donostia in an "aligning mode" means that legitimacy in this case is not about reaching a consensus on whether or not climate information should orient policy and practice; but rather, as to how policy-making across all municipal departments will be aligned to dealing with climate risk. Hence, an "aligning mode" is about reaching a congruence of behaviour (Suchman, 1995) so that the activities and the decisions of departments are oriented towards a joint enterprise. Reaching a congruence of behaviour represented a challenge: since CoP members are diverse and the Klima2050 projects are distributed within different departments, the intricacies of technical, legal and socio-cultural aspects reflect how a legal mandate cannot enforce the emergence of consensus by default. For example, climate projections may make evident the need for increasing the carrying capacity of rain-water collectors; but physical improvements are financially unviable, while legislation and decision-making procedures do not support a policy environment to integrate such amendments. Or projected increases in the frequency and magnitude of heat waves may make evident the need to expand the green factor in the city; but the General Urban Plan has already granted permission for the construction of new hard surfaces, making it for the moment impossible to limit the urban grey factor.

While Klima2050 should correct these incongruences during the course of the next decades, in spite of these barriers, municipal officials are finding ways to contribute to Klima2050's collective goals through alternative ways: flood-return periods are being adjusted in order to reflect projected extreme precipitation events and orient future infrastructure upgrades; also, legislators are preparing legal amendments to ensure the Urban Plan makes explicit the need to consider climate adaptation in the next update. In summary, legitimation in an "aligning mode" can be accommodated conceptually within the characteristics observed in gaining moral-consequential legitimacy: while climate-oriented planning enjoys a degree of institutionalisation, new operations are still technically problematic and there is a need to provide a sense that the new endeavours define a sector (based on Suchman, 1995).

In conclusion, the case study about Donostia highlights the mutually constitutive relationship between working and using climate information by informing how the articulation of work is both, a result and an enabler of the use of climate information.

3.4. Case study Copenhagen

The use of climate information in Copenhagen transpires through the design and implementation of Copenhagen's Cloudburst Management Plan (CBMP), and the use of climate information is featured through the articulation of work sustaining this initiative. The CBMP is a €2.6 billion project which encompasses more than 300 urban infrastructure initiatives to be implemented over the next 20 years. The CBMP is designed as a network of surface catchment areas working as small-scale-on-site treatment plants to control water pollution and reduce the risk of flooding. The CBMP provides an alternative to traditional water management systems by combining a green- and blue-infrastructure approach to manage water on the surface; an approach which is considered to add value to the city.

The use of climate information is illustrated through five practice constellations which are distributed in two categories: "Narrating" and "Articulating". A "Narrating" category underlines how climate information sustained the construction of a rhetoric of urban safety and prosperity which secured the endorsement of the CBMP. An "Articulating" category stresses how the use of climate information results from the coordinating framework based on the CBMP. The use of climate information in Copenhagen is in a "maintenance" mode which recognises that while legitimacy over the use of climate information has been gained, it still has to be "maintained" in the face of future changes in climate conditions, changes in urban patterns and potential changes in political agendas.

3.4.1. Introduction

In early 1990, an ambitious plan was proposed aiming to make the harbour in Copenhagen suitable for swimming. The European Water Framework Directive[50] (article 16) indicated that water quality in any natural water body -including the harbour in Copenhagen- should allow recreational activities such as swimming to take place for at least 95% of the year *(CB2)*, which meant that water reaching natural recipients had to be sufficiently clean. Such a goal demanded large infrastructural changes in order to turn the existing combined sewage-rain water treatment into a system where waters could be treated separately. An additional challenge emerged in 2008 as IPCC scenarios (SRES A2) suggested that Copenhagen was going to experience increased precipitation, bringing additional pressure to the combined system *(CB4)*. Climate

[50] **European Law** Water Framework Directive https://ec.europa.eu/environment/water/water-dangersub/index.htm : The first component constitutes the major part of the Union's strategy against the chemical pollution of surface waters. It is set out in Article 16 of the Water Framework Directive 2000/60/EC. This requires the establishment of a list of priority substances, these to be selected from amongst those presenting a significant risk to or via the aquatic environment at EU level. It also requires the designation of a subset of priority hazardous substances, and proposals for controls to reduce the emissions, discharges and losses of all the substances and to phase out the emissions, discharges and losses of the subset of priority hazardous substances.

change projections estimated flood-risk would result in damage costs of up to DKK 16 billion[51] over the next 100 years (Copenhagen, 2015-A). However, as early as the year 2011 Copenhagen was hit by a cloudburst event which caused damage totalling more than DKK 6bn[52]. The proposed solution to this compounded environmental, technical and urban challenge was the design of a system in which rainwater can be treated through small-scale treatment plants dealing with rainfall on a local scale through a network of surface catchment areas (CE11), the so-called "Cloudburst management Plan".

Since the use of climate information in Copenhagen transpires through the design and implementation of the Cloudburst management plan, the use of climate information is explored in terms of the articulation of work needed to implement this ambitious long-term plan.

3.4.1.1. National institutional framework for climate change

Climate change adaptation in Denmark is earmarked in several laws and decrees. While legal frameworks forbid new developments in risk-prone areas -such as river valleys, along coastlines and forests[53]; Denmark's National Adaptation Strategy (2008) and the National Adaptation Plan (2012) support adaptation initiatives in key sectors, including coastal management, buildings and construction, water, energy, agriculture, forest, fisheries, planning, health, preparedness, nature, insurance and transport[54].

Denmark does not have an explicit national urban policy framework, but national and European policies guide urban development. Since 2012 drafting municipal adaptation plans in line with the National Adaptation Plan (NAP) has been made compulsory. A diverse institutional network emerged to advise, guide, support, and help coordinate municipalities in implementing adaptation solutions and planning, including a Task Force on Climate Change Adaptation and a municipal climate adaptation network focused on climate adaptation technologies in the context of water management[55].

Municipal planning falls within the competence of the municipal council. Cities have an extended control in terms of how urban planning takes place, ranging from allocating housing priorities, stating house and building dimensions, parking areas, to zoning an area for green roofs (CC45). The **Danish Planning Act** sets the framework for spatial planning and contributes to the implementation of urban policy[56]. T**he Danish Act on Urban Renewal and Urban Development** serves as a tool for Danish municipalities to make targeted efforts in

[51] € 2.151.128.000.- (equivalent, as of the 15.02.2021, www.currencyconverter.com)
[52] € 806.673.000.- (equivalent, as of the 15.02.2021, www.currencyconverter.com)
[53] Water Sector Law, Act on Watercourses, Flood Protection Act, Coastal Protection Act, Nature Protection Act, Environmental Goals Act, Act on payment rules for wastewater supply companies, Roads Act, Emergency Management Act, Planning Act
[54] Source: https://climate-adapt.eea.europa.eu/countries-regions/countries/denmark **visited 09.09.20**
[55] Source https://climate-adapt.eea.europa.eu/countries-regions/countries/denmark
[56] Source: *https://en.klimatilpasning.dk/sectors/plan/climate-change-impact-on-plan/*

urban and housing policy, particularly related to the provision and renewal of housing (OECD, 2017). **The Danish Directive of water management**[57] indicates that maintaining and upgrading underground water infrastructure is within the mandates of the utility company; while water management occurring at the surface is the responsibility of the municipality. Finally, the **Danish Emergency Management Act** indicates that Municipalities are to plan the retention and continuation of vital societal functions and develop preparedness plans[58].

3.4.1.2. Actor constellation in climate information management

The constellation of institutions that play a role in the management of climate information in Copenhagen is vast and actors have a diversity of roles (see annex 9).

Figure 7: Role of different actors in the management of climate information in Denmark

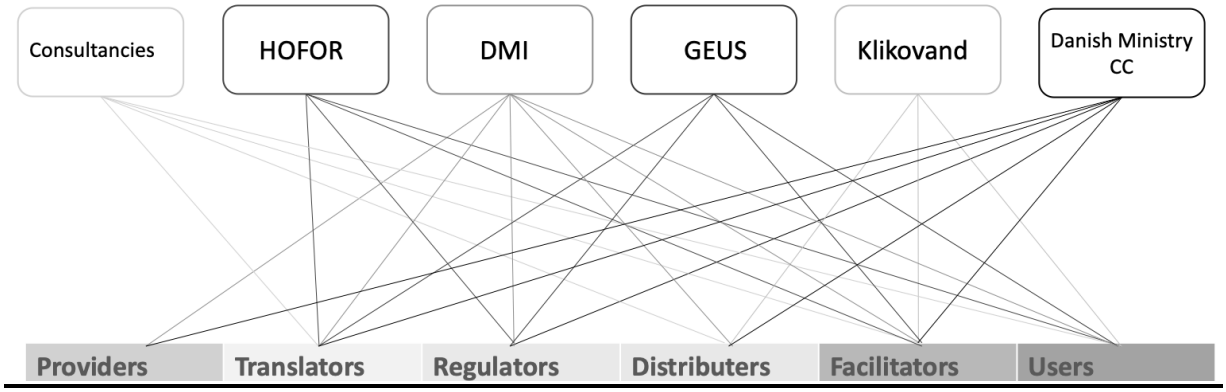


Table 25: Specifying the role of actors in the use and management of climate information in Denmark.

	Consultancies	Hofor	DMI	GEUS	Klikovand	Ministry
Provision			Adjusted Cordex data (HCLIM)			Supply data on climate
Translation	Tailor information according to project and financial estimates	Provides estimates for surface projects	Provide climate projection on a municipal scale	Hydrological effects of climate change on water resources	Draft specific reports for municipal use	Generates narratives
Regulation		Regulates the estimations to be applied in the CBMP to consider infiltration capacity according to	Establishes the standards for managing climate data	responsible for the national database on geology and water resources; Provides the National Water		Establish the framework of Denmark's climate initiatives

[57] The water sector in Denmark consists of about 2300 public drinking water supply companies structured as consumer owned waterworks. About 300 of the largest companies are subject to financial regulation ensuring reasonable prices.
[58] Source: https://climate-adapt.eea.europa.eu/countries-regions/countries/denmark

		future PP estimates		Resource Model		
Distribution	Through workshops with different municipalities		Public access to data		Workshops with municipalities	Demand adaptation plans
Facilitation	Workshops with Copenhagen	Ongoing meetings with Copenhagen	Climate Atlas	Advisory role to the ministries, local authorities and the water industry		Funds DMI to release downscaled projections
Use	Hydrological modelling Fulfil project demands	Merging hydrological and climate models; Estimate impacts of CC on future PP	Modelling, awareness raising	Use of climate scenario data in hydrological modelling, quantification of the effects of climate change and quantification of the effects of climate adaptation measures	Capacity building, project tendering	

In the context of climate information, actors play a variety of roles (providers, connectors, facilitators). What figure 7 and table 25 make evident is that actors play more than one role and actors overlap their roles, thus often complementing each other. Interaction between these actors is active and emerges as a large community of practice where learning occurs across organisations. While these actors are not bound by legal obligations, strong cross-collaboration and common standards facilitate climate information being available for decision-making. For example, the climate change community (represented mostly by DMI) and hydrologists have a long-standing tradition of collaborating to integrate climate models into hydrological models by making value calculations of projected precipitation to correspond with average and extremes using similar return periods for precipitation as those used in the community of hydrologists (T10, T50, T100) (CF7). Scientific standards regarding how information is to be treated are established by the Ministry of Climate and Energy (which scenarios are to be used, which models are to be used for coupling climatic and hydrological models, and what levels of risk tolerance are to be accepted). Supplementary procedures to estimate the risk of climate change include a National Analytical Framework, which integrates the impacts of floods against different levels of severity (different return periods) (Kaspersen, et. Al. 2012). Informing about infrastructure design, Mikkelsen (et al., 1997 in Arnbjerg-Nielsen, 2015) introduced the concept of Safety Factors, which result from a relationship between a climate factor, a densification

factor and model flaws[59]. Also, a Water Resource Model (Nationale Vandressource Model)[60] - set up in MIKE SHE[61]- offers a nationwide overview of the exploitable drinking water resource (which in Denmark is almost 100% groundwater based) (Sprocati et al., 2019).

Table 26: Time-line of climate information management in Denmark. [62]

2012	2014	2016	2018	2019	2020
Task Force on Climate Change Adaptation; Sectoral and cross-sectoral analysis of climate risks/vulnerability.	DMI prepares an assessment on future climate change by coupling hydrological models (HIRHAM, MIKE-SHE) and following IPCC 5th AR.	Danish Coastal Authority prepares a risk assessment on erosion and flooding under climate change (IPCC5 AR).	DMI launched a guidance on the use of the RCP emission scenarios based on HCLIM (Beluši,2019).	Every fourth year the Danish EPA publishes a report on the climate change status in Denmark	DMI currently prepares datasets and indicators based on IPCC's 5th AR

3.4.2. Rain and Copenhagen

Floods are acknowledged as being one of the costliest natural hazards (Hemmati et al., 2020). In Copenhagen, convective rainfall is the key hazard for the city and it will become more frequent and more severe (Arnbjerg-Nielsen, 2020). Convective rainfall storms are associated with short duration extreme rainfall expected to occur in hourly and sub-hourly resolutions *"that vary in space, potentially leading to quite different registrations of rainfall intensity even at neighbouring sites*" (Gregersen, 2015, p. 9). In Copenhagen, if under a 4°C scenario an increase of 20- 40% in extreme precipitations is projected, under a 6°C scenario *"business-as-usual is not an option, since even in the absence of policy-driven adaptation, large-scale autonomous adaptation will occur. Essentially, the most vulnerable urban areas could be abandoned under such a scenario because of damage to assets in these areas that is too frequent and too extensive"* (Arnbjerg-Nielsen, 2020, p. 83). While from a policy perspective it is assumed that exposure to flood events will be constant (current law forbids building in risk-prone areas, hence the number of assets exposed remains constant over time (Zhou et al., 2012 in Arnbjerg-Nielsen, 2020)), flood hazards *"will increase at least linearly, perhaps even exponentially...unless structural changes in urban water management are implemented*" (ibid. p. 9).

[59] ***Safety factor = Climate factor x densification factor x model flaws:*** The Climate Factor represents the ratio between the future design intensity and the present design intensity and it varies depending on the return period for an expected plan (Arnbjerg-Nielsen, 2015): for a 2-year return period applies a 1,2 factor, meaning an expectation of 20 % more rain within the next 100 years (CD3-Informant); a Densification factor considers a probable increase in the degree of hard surfaces, which for cities –(assuming more areas become impermeable at around 10% over the next 100 years (CD3 informant); and model flaws set to be around 1,1 – 1,3. Taking into account that the models are not 100% correct" (CD3 informant).

[60] Source: www.vandmodel.dk

[61] Integrated catchment modelling that delivers integrated modelling of groundwater, surface water, recharge and evapotranspiration, partition rainfall into runoff, evapotranspiration and groundwater recharge

[62] Source: https://climate-adapt.eea.europa.eu/countries-regions/countries/denmark

Water management represents a technical challenge to Copenhagen. The city is currently upgrading the traditional sewage system which combined the retention of rain water and contaminated water. In combined sewer systems, storm-water "*with a low content of nutrients and pathogens and a high content of some heavy metals and organic micro-pollutants (is) mixed with sewage with a very high content of pathogens*" (Eriksson et al. 2007, p. 41). Human exposure to this mixture poses an immediate health risk (Lund et al. 2019).

In response, Copenhagen implemented the paradigm of Storm Water Management (SWM), which follows an integrated urban water approach "*in recognition of the growing interplay between the drainage infrastructure and other services in the city driven by e.g. requirements of multi- functionality of urban space needed for drainage management and difficulties in cost recovery of traditional sewer management*" (Arnbjerg-Nielsen, 2020, p. 9). In principle, the SWM prevents uncontrolled flooding and pollution through the implementation, operation and decommissioning of storm water infrastructure; and by controlling pollution on-site from discharges of polluted storm water into the environment (Brudler, et al. 2019). Under a SWM, financial estimates consider an overall "*socio-economic surplus of DKK 5bn*[63] *over 100 years... compared to a traditional piping solution* (Copenhagen, 2014, p. 6).

3.4.2.1. Copenhagen's Cloud Burst Management Plan (CBMP)

The paradigm of combined solutions to control excess rain and waste-waters is called Copenhagen's Cloud Burst Management Plan (CBMP from here on): "*Instead of sending the water from torrential downpours and everyday rainfall down into the sewers, combined pipe and surface solutions –considered more flexible than pure pipe solutions, are to be established for storm water management"* (Copenhagen, 2015-A, p. 32). The CBMP emerged through coordinated efforts led by the City Administration of Copenhagen and the utility company Hofor.

Climate information used in the context of CBMP included climate projections coupled with hydrological models[64]-[65] and sectorial-non-climate data (CG90). The utility company Hofor provided integrated climate and hydraulic models to inform about the plan, while the municipality established the level of protection that the CBMP had to deliver. The CBMP states

[63] €672.227.500.- (equivalent, as of the 15.02.2021, www.currencyconverter.com)

[64] Current planning used by the Copenhagen Municipality is based on Arnbjerg-Nielsen (2012), RCP8.5 according to Sørup et al. (2015) and the estimated climate factors for the 6°C scenario. Source: Arnbjerg-Nielsen, 2015, p. 75).

[65] Coupling climate and hydraulic models is a complex task due to unresolved temporal and spatial scales: *"complex 3D hydrological models are typically adjusted to perform well at the catchment scale, but not for any arbitrarily large domain as typically specified for a Regional Climate Models. The standard parameter adjustments obtained by matching (calibrating) the hydrological model to observations are lost when coupling to a climate model. The hydrological model is simply assigned to input from the atmospheric model to which it is not calibrated*" (Larsen, 2017, p. i). However, realistic representations of local precipitation have been undertaken in different catchments in Denmark where hydrostatic RCM HIRHAM version 5 have been coupled to MIKE SHE hydrology model, which allowed integrating "*water and energy fluxes between the subsurface, land surface, plant cover and the atmosphere*" (ibid).

that the city is to be protected to *"a level at which damaging floods -water to a depth of more than 10 cm on the ground- do not occur in a 100-year rainfall event"* (Copenhagen, 2014, p. 6). Certainly, allowing 10 cm of water "*to flow on most streets without causing damage*" is challenging (Arnbjerg-Nielsen et al., 2007, p. 83).

At the time of developing the CBMP, projections of climate change impacts for extreme precipitation were in accordance with national guidelines. Further assessments were undertaken in order to compare the impacts provoked by a A1B scenario over a 100-year horizon from 2010 to 2100 against a 6°C scenario in 2100 and a high radiative forcing RCP8.5 scenario (van der Linden & Mitchell 2009; Christensen et al. 2015; Mayer et al. 2015 in Arnbjerg- Nielsen, 2015). The calibration assessment included the use of a multi-model ensemble of regional climate projections in Europe from the ENSEMBLES project (van der Linden & Mitchell, 2009). Against these simulations, the CBMP was expected to deliver a reduction in flood risk of 0.2−0.3 times the current expected annual damage (EAD) in 2100 for the A1B scenario and a reduction of 0.6−1.0 and 1.2−2.1 times the current EAD for the RCP8.5 and 6°C scenario, respectively (ibid).

The city and the utility company agreed on a DKK 20 billion[66] investment for the Cloudburst Management Plan with a 20-year time framework to implement 300 projects of varying size and complexity (Hofor, 2016). Central to the CBMP was an approach to implement blue and green spaces as surface solutions ("*storm water detention roads and detention areas that transport or detain the water*" (Copenhagen, 2014, p. 14)) thus forming a combined alternative solution that simultaneously integrates water in the urban space and it creates green corridors that increase biodiversity and also combat the urban heat island effects (Hofor, 2016).

Since the CBMP is expected to reach its goals in the long-term (20 years) against a 2.6-billion-euro investment, the implementation of the CBMP has to guarantee flexibility and robustness. The decision to implement a surface-water management strategy is considered as being a more flexible solution as it is easier to expand a surface water project than expand underground pipes; in other words, "*a combination of green-blue-grey solutions is more cost-effective"* (Copenhagen, 2014, p. 15). This combination would also provide the opportunity to demonstrate immediate action, because by focussing on surface-water management, the city could create a reservoir in a park without waiting for 20 or 30 more years, thus avoiding further costs in the future and including protection in the new development of the city (CB9).

However, this transformation is complex administratively, technically and technologically. In Copenhagen, the underground space is already being used up almost to its limit; therefore, any intervention such as installing a new water collection tank or expanding the existing piping

[66] €2.688.910.000.- (equivalent, as of the 15.02.2021, www.currencyconverter.com)

system represents a considerable technical challenge. As reported by Lund and colleagues (2019) "*the cost and logistics of changing the existing combined sewer systems into two-string systems that separate storm water and wastewater are often prohibitive*" (p. 1004). The engineering design of water infrastructure is affected by the intrinsic difficulties of urban water management and the complexities of urban hydrology. Urban management demands a high focus on measuring precipitation with a suitably high resolution *"often formulated as a requirement of several decades of measurements with a spatial resolution of 1 km2 and a temporal resolution of 1 minute"* (Arnbjerg-Nielsen, 2020, p. 22). In the case of convective rains, point scale and hourly resolutions make large differences. This is illustrated by the ex-post assessment of the July 2011 event: **"***Local measurements indicated that the severity corresponded to a return period of 2000 years at some locations. However, if aggregated to daily resolution and 25*25 km the event would still be severe, but actual damage to the city would be negligible*" (p. 22). Hence, implementing the CBMP demanded complex information management and a diversity of expertise.

3.4.3. The site of Copenhagen

The use of climate information in Copenhagen transpires through the implementation of the Cloudburst Management plan. Therefore, the Site of Copenhagen is conceptualised as the articulation of work being in place to implement the Cloud Burst Management Plan. Climate information informed about the design and implementation of the CBMP in different stages. Climate information was used for calculating the level of safety that the CBMP should deliver; climate information coupled with hydrological models allowed calculations of financial risks and the expected annual damage (EAD) projected to the year 2100; and risk maps allowed the identification of zones exposed to particular risks -flood or heat-. Several activities unfolded previously, during and after the use of different climate information sets.

One of the central challenges that poses the implementation of the CBMP is its novelty: there was no previous experience in applying such a broad and ambitious plan for managing floods in the city. Therefore, municipal officials are in a constant state of learning by experience, attentive to the emergence of potential problems and in a "solutions oriented" state of mind. In these terms, the implementation of the CBMP is dependent on a common understanding that collaboration is central to achieving the proposed goals. Collaboration is described as a cultural value strongly defended in the working culture because it facilitates actions taking place, it makes the unfolding of people's tasks to be more efficient and it fosters positive human interactions (CC44).

- *"... to be on top of all those requirements and departments... it requires working with the silos... that's why we keep on talking and meeting, because it is needed...so it is not about stealing ideas, it is about "one plus one making three", that extra benefit...." (CA53).*

Collaboration is acknowledged as a requirement for coordinating resources more efficiently:

- *"When you go and see that funding is limited, we have to mainstream the investment and see the window of opportunity... (if) one month you dig it all up to put in new pipes and then three months later install electric installations and then 2 years later we take it all up again because we need to do something else... so we need to coordinate". (CE53)*

Collaboration in this sense is central for three reasons:

1) To ensure an efficient use of resources in the implementation of the CBMP. As reported by the city, "*Coordination can reduce construction expenditure if implementation of cloudburst and storm-water management is integrated with other construction projects in the city, (thus) saving up to DKK 1bn... over the period of implementation*" (Copenhagen, 2014, p. 22).

2) To solve institutional and legal barriers:

- *"...the EU (flood directive) says you are not allowed to intervene in protected areas, but (our) national law says that you have to protect people. So, if you (want to set up) a dike, you cannot just do it here or there, even though if people are under risk... so that's why we keep on meeting up... the city, the utilities, you start learning things all the time" (CE56).*

3) To resolve unexpected problems linked to specific contexts:

- *"Take-home message? ...well, it takes time to realise why and why not to do things in one way...we may want to create a water ditch on the side of the road, but then the police say that it may be risky because people can drive into it, so we then say that we can cover it with protection measures, but then they come and say that drugs can be hidden there... and having water underneath means having more mosquitoes...so when we meet up with the community and the city, all these things come up and there is a multi-criteria element behind the decisions that make them be the way they are... the only way you can know about these things, is to meet up and discuss these things... So, the (CBMP) plan is a common driver so that we can also start working together... so when new roads have to be constructed or new parks have to be created, we all know that we can coordinate things..." (CE57).*

What emerges from these observations suggests that implementing the CBMP is based on collaborations that are planned but that also develop as implementation unfolds. Consequently,

trial and error, resolving differences, coming up with solutions to encounter problems and designing new processes are all core features of the implementation of the CBMP.

The interests, standings and the use of resources that unfold within these situated social interactions are illustrated in the following subsection, Social orders.

3.4.3.1. Social orders: articulation of work within the municipality

An overall picture of the social orders structure highlights how the implementation of the CBMP has been a long process where the interests of key stakeholders had to converge. The Adaptation Department is the municipal unit in charge of overseeing the implementation of the CBMP, and they have to ensure coordination is attained vis-à-vis multiple aspects. For example, each project implemented within the framework of the CBMP demands environmental permits that confirm compliance with environmental standards. Hence, gaining environmental permits become a central legal obligation for the implementation of the whole plan.

- *"... handling of rain water cannot conflict with our environmental goals..." (CE8); "if you want to use parks in the city which are protected by law for preservation... you find conflicts against adaptation projects..." (CE12); "you cannot just... lower the terrain to retain water... that is a problem... we need to deal with that by applying dispensation -in spite of the law on some occasions you may get a permit or allowance for use..." (CE13).*

Table 27: Social orders in Copenhagen

	Environmental Department	Adaptation Department	Hofor (utility company)	Politicians	Neighbours
Position regarding the implementation of the CBMP	Interested in CBMP in order to secure non-contaminated waters reach natural water recipients; positive standing regarding CBMP since it increases green areas. Concerned about water handling on the surface occurs according to environmental standards (CE20).	It must ensure city protection against floods provide additional tangible and intangible value to the city and its dwellers. Interested in implementing the CBMP as fast as possible.	Interested in decreasing the pressure on the underground water piping system; it must secure sewage system works smoothly and without risks of overflows or contaminated water. Treating the water on the surface is cheaper than increasing the already overcrowded piping system.	Implementing the CBMP was considered as a wiser investment than expanding underground infrastructure for water catchment. CBMP provides business opportunities, portraying Copenhagen as a front runner city world-wide: "*scientific work is important to convince, do nothing is a possibility but you have to pay the price sometimes" (CB46).*	Must participate in co-funding some projects, administer implemented projects or allow infrastructure changes in their properties (CB35; CG21) Citizens *"are obliged to invest in climate adaptation. They generally have to safeguard their own homes and basements against penetrating water... and... against sewage"* (Copenhagen 2015-A, p. 25).
Arrangements to work things out across parties	Provides environmental permits to CBMP projects-; inspects the appropriate application of environmental standards; Conducts tests and analyses on new technologies; locates new sites for potential projects, identifies contaminated areas, tracks progress on urban projects.	All new infrastructure projects in the city must support the CBMP. Vulnerability, exposure, financial risk assessments based on climate projections are used to guide discussions regarding the relevance of implementing the CBMP.	Provide hydrological and climate models; technologies for monitoring, technical know-how in water management. *"HOFOR finances the project over 25 years by refunding the municipality's instalments"* (Copenhagen, 2015-A, p. 24)	Political –decisive- power to approve new projects and budgets; redesign administrative competences *"Ensuring neighbours' participation is important because it is not politically acceptable to reject too many projects presented by the community"* (CG17).	Delivering transparency was an exercise of inclusion. Neighbours need to know about restrictions and technical challenges associated with the surface solutions that are to be implemented in their roads, schools or nearby parks.
Arrangements for work to be performed	Coordinates water discharge standards, provision of environmental permits (including the power to veto projects if environmental standards are not met)	Interaction with external parties (scientists, consultancies, neighbours). To ensure a scientific-technical and democratically sound process.	Variety of coordination schemes to ensure the provision of clean water and wastewater systems.	Interaction with technical departments and scientists in order to inform about decisions.	The municipality invested in providing as much information as available for each site so that neighbours could discuss, based on reality criteria.

The following relational bonds could be identified among these actors which are relevant for coordinating the implementation of the CBMP:

1. Relations of **causality** (one entity's actions or intention leads to another entity performing an action (Pohlmann, 2018, p. 73)) could be established between

Table 28: Relations of Causality

Actor 1 (Leads)	Actor 2 (Reacts)	Relation
Adaptation department	Politicians	Provision of salient-scientific climate information and assessments needed for political buy-in to implement CBMP
Politicians	Adaptation Department	Performs the implementation of CBMP through endorsement granted by politicians. Security levels must be met; technical aspects must be robust to meet such standards.
Environmental Department	Adaptation Department	Meeting environmental standards in project proposals enforced by the Environmental Department provokes Adaptation Department into adapting projects' technical aspects to meet such requirements.

2. Relations of **spatiality** (connections through activities among entities (ibid)) could be established between

Table 29: Relations of Spatiality

Actor 1 (Leads)	Actor 2 (Reacts)	Relation
Adaptation Department	Neighbours	Providing technical expertise and facilitating technologies to neighbours to facilitate their engagement in project design.

3. Relations of **prefiguration** (entities may facilitate, restrict, or enable actions of other elements (ibid)) could be established between

Table 30: Relations of Prefiguration

Actor 1 (Leads)	Actor 2 (Reacts)	Relation
Politicians	Adaptation Department	Politicians have enabled the implementation of the CBMP by legal decrees (CBMP overruling other plans), positioning the Adaptation Department as the leading unit.
Neighbours	Adaptation department	Facilitate or restrict project implementation by granting or hindering endorsement to CBMP projects.
Adaptation Department	Neighbours	Geo-data software enables participation in project proposals and implementation.
Environmental Department	Adaptation Department	Restricts water management strategies by granting environmental permits.

3.4.4. The use of climate information in practice

The use of climate information in Copenhagen is featured in 5 practices distributed in two categories varying according to three arenas, as shown in Table 29 below:

Table 31: The use of climate information in Copenhagen

Arena/issue	Category 1: Narrating	Category 2: Articulating
Political arenas: The use of climate information is weighted against the trade-offs between what is politically desired/acceptable.	1) Framing risk as value	3) Formalising
From a strategic arena, the use of climate information is assessed in terms of its contribution to facilitate rating the order of priorities of actions and the use of resources for achieving goals and designing plans and strategies in the context of climate projections.		4) Coordinating
From an operational arena, the use of climate information is weighted against the trade-offs between what is technically needed and feasible to do. Refers to how climate information connects resources, competences and expertise for the execution of specific operations.	2) Outsourcing	5) Data management

3.4.4.1. Category Narrating

In a narrating category, climate information is used as input to appraise the physical and financial risks posed by the projected increase in the frequency and magnitude of convective rainfall. Climate information provides an overall orienting framework to guide decisions since it helps to establish thresholds and boundaries regarding acceptable risks and damage. Climate information is considered as being one more input within the pool of inputs needed for decision-making:

- *"Climate information is important for the plan as a round level, the basic level of understanding how rainfall would influence the city" (CA46); "It makes sense to use climate information as (a) guidance, but not as the only thing. There are more things that we have to take into consideration... we need the here and now data... data on warnings, data on rainfall" (CA40); "You settle dimensions and when you get to the project level, we do not make specific calculations in each project cose we do it for the entire (CBMP) plan... We have to stick to that because our projects are connected, they are not stand-alone projects." (CA46).*

3.4.4.1.1. Political & strategic arenas:

Practice 1. <u>Framing risk as value</u>

The origins of the CBMP can be connected to two historical accounts: first, a large increase in the number of extreme precipitation events in the last ten years played a decisive role in positioning flood risk on the political agenda (CC4). The flood event which occurred in 2011 became a 2000-year return period in some parts of the city, causing damage to more than 30%

of the buildings and bringing about estimated financial losses of more than 800 million euros (Arnbjerg-Nielsen, 2015). Second, flood control was reinforced as a political priority since projected increases in the frequency of convective rain was evidenced as a threat to ensuring the delivery of clean water to natural recipients. Traditionally, rain water was considered to be clean and it used to be discharged directly into lakes, streams and the sea. But further analyses showed how rainwater picked up pollutants as it flowed: atmospheric deposits, emissions from materials, Copper from rooftop surfaces, Carbon composites, Zinc, Lead, (Lead has been banned in Denmark as a construction material for 20 years); and ensuring that a high concentration of pollutants did not reach natural recipients was mandated by national and European law (CE9). A policy window emerged as a biological problem (ensuring that discharged rainwater met the minimum quality standards) and a security problem (floods) converged. The solution to both problems was framed as an urban restoration project (CA5) which could deliver new opportunities.

- *"...how to make it attractive for people... it was a double vision... we don't only do a thing to solve a problem, we try to find the benefit in other aspects" (CA5).*

Urban development in Copenhagen is strongly influenced by ideas of value addition, and value addition was a central element to the design of the CBMP. The CBMP was to be positioned not only as a project to protect the city, but also as a project that delivered additional value to the city.

- *"In 2010... when we prepared the (adaptation) plan, we started to have a political discussion about (the CBMP) ... exactly the same year when afterwards we got affected by the cloudburst event. Then, it was clear, the need to continue discussing: What is the most cost-effective solution for the city? what could be the benefit for the city? what is the effect of doing nothing? and what kind of protection should we achieve in the city?... that was the basis to develop (sic) the CBMP, and (then) we explored the cost and the benefit of interventions..."* (CB7); *"...(it) is a driver for so much more..." (CE33); "...it was not just about fixing the problem... People who work in development have that as a norm... it permeated all our workers in the adaptation plan" (CA6); "Of course the hydrological solution has to be there, it has to work and that's why we are doing (sic) the intervention, but how much can you put onto that that can benefit?... You get two for the price of one" (CA19); "... we fix more than one problem with our projects" (CA16).*

The dual-concept where risk is framed as an opportunity became the central rhetoric orienting the CBMP. In this context, three elements became central:

1) Adding value was presented in the CBMP under the principle of "*no-regret solutions*": the flexibility of surface solutions was going to provide a basis for no-regret because "*...even without climate change, who would be against having a green park?" (CA9).* The CBMP was framed as an opportunity for greening the city and improving public spaces; providing flexibility for future interventions and generating synergies between infrastructure upgrade in combination with implementing 300 projects.

- *"... (in) areas that need to do upgrade (sic)... you can bring green into the city, so you can use climate change as the driver to make a more liveable city, and instead of just planting a tree, you plant it because it gives shade, is nice, is cool... that has been done for ever, but now you put a name on it, and people are willing to put (sic) money on it" (CE31).*

Ensuring flexibility was central to developing the strategic proposal of the CBMP. There are inherent uncertainties in long-term urban development projects such as in the case of the CBMP. While exposure to hazards "*is rather easy to model for present climate, making projections are deeply uncertain because the future exposure is determined by poorly understood mechanisms that drive city development and their interactions*" (Arnbjerg-Nielsen, 2020, p. 93).

- *"... when you talk about the city in 100 years from now, you look at the city 100 years ago, and you see that today's city is very different, so it is difficult to depict what the city will look like, in terms of the technology, human needs... and the pipes we are digging (sic) now, they have a life expectancy of at least 100 years... so we have to be quite sure that what we do is a good idea..." (CB48).*

The implementation of the CBMP is a challenge without precedents for the city of Copenhagen. Financial returns, political interests and citizens' expectations are at stake in a fragile balance where the reduction of risk must come together with the provision of opportunities for today and for the future. While the CBMP may have successfully secured endorsement for its implementation, challenges still lie ahead, particularly concerning two scenarios. In the first one, it was already proven that initial 16 billion DKK financial estimates of loss and damage up to the year 2100 was an underestimation, since up to the year 2014, three rainfall events accumulated damage estimated at nearly 12 billion DKK (Copenhagen, 2014). In the contrasting scenario (without extreme events), Arnbjerg-Nielsen (et al*., 2015)* suggests that *"it will take several decades to implement the plan even under the most optimistic circumstances, and it remains to be seen as to whether the political awareness will remain high if the frequency of extreme precipitation becomes relatively low at some future point in time" (p. 83).*

It becomes clear that after having gained legitimacy to secure the implementation of the CBMP, efforts will be necessary to maintain legitimacy. Suchman explains that legitimacy has to be maintained against threats such as *"Anomalies, failures and external shocks" (1995, p. 594)*. The additional pressure of climate adaptation as a "super-wicked problem of policy making" (Lonsdale, 2010) adds some elements of complexity to maintaining legitimacy since it brings question marks to the number of resources that the city will have to incur in order to absorb projected climate impacts (Lonsdale, 2010) -or to justify overspending during longer periods without extreme events-. Estimating costs accurately seems to be an impossible task at the present time, either due to the difficulty to estimate the trajectory of urban development and technological innovations on the long-term, or due to significant differences in the factors used for constructing scenarios for the optimal level of protection against flood risk (Arnbjerg-Nielsen, 2020): "*Case studies in Denmark are still emerging and optimum levels of flood risk protection vary between return periods from 10 to 250 years, even in today's climate (!)*" (p. 102). Indeed, projected changes in rain patterns for the area of Copenhagen only strongly emerge in later periods (2060 onwards) (CA39).

However, uncertainty became an issue, not so much due to projected changes in rainfall, but rather because imagining a future city proved to be a difficult task:

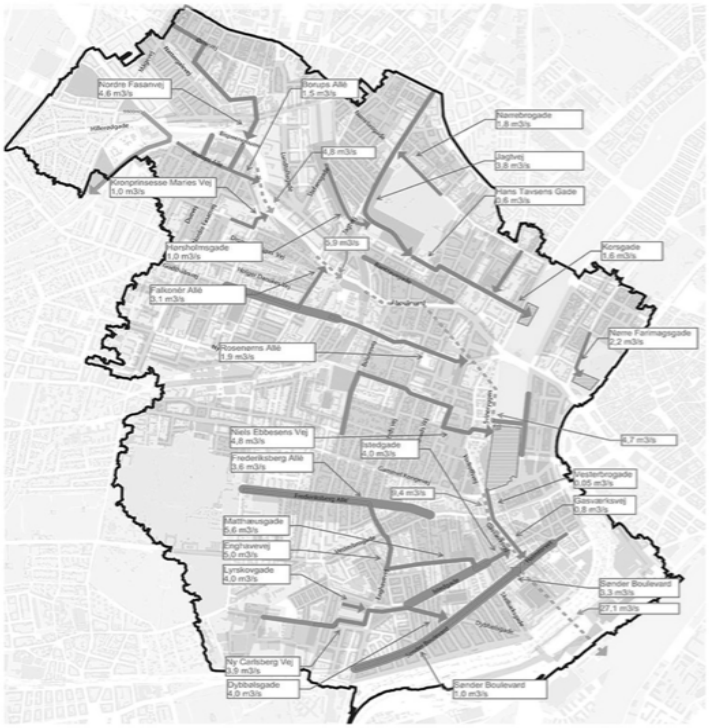
- *"...it is only after 50 years that the models show different directions... so, when you work on this (on planning for the future), you have to allow yourself some or a lot of flexibility, and these insecurities... we don't have the answer yet, and that's why the surface solution is a better approach and is more flexible than underground reservoirs..." (CA39).*

The future is to a degree, uncertain and "*not all uncertainties about the future can be eliminated*" (Walker et al., 2013, p. 957). Strategies to deal with such a level of uncertainty normally fall into two categories: robust strategies, which perform well in different futures; and adaptive strategies, which can be shaped or transformed with regard to unforeseen conditions, thus leaving space for corrective action (ibid). Robustness and adaptability became materialised in the branch approach used in the design of the CBMP. Under this scheme, the city was divided into seven catchment areas (CA22) to allow structuring water management like a puzzle, in which each part in the system fulfils a function (CA47). In the design, the 300 projects are linked as a network that provides functionality to the CBMP as an inter-connected system (CA47). If irregularities emerge, this approach allows changes in parts of the system without having to change the entire system and delivering redundancy to the functionality of the system.

Flexibility was also a central part of the logistical implementation of the CBMP. In this sense, the CBMP was divided into short-term implementation stages that progressed into the future, where short-term benefits could be displayed more easily:

"... the mix of the long-term benefit from adaptation -which can be quite intangible for the present time- has to be combined with the short-term benefits such as improving urban design, improving city life" (CA4). "...We saw that climate change was a bit further away, so we needed to ... have short term benefit... it was not the here and now..." (CA8).

Map 3: Overview of adaptation measures planned for 1 urban catchment in Copenhagen.



"*Local retention measures are implemented in all areas marked in light colour, all roads marked with dark colour indicate that the service level of 10 cm of water must be managed by local measures (e.g., channels), and mid-blue areas show locations where water will be stored temporarily during major storms. Dark roads indicate where traffic will be affected because of retention measures implemented on the road itself. Hatched areas indicate where water levels will be lowered permanently to allow storage of storm water during heavy storms. A tunnel (dashed line) with a downstream capacity of 27.1 m3 s−1 must still be constructed to ensure that the design criterion is achieved*". Source: Arnbjerg-Nielsen, 2015, p. 78.

2) A central aspect of the value addition rhetoric was to generate a business case for implementing the CBMP -in this case- through the generation of new jobs, tax revenue and reduced insurance costs. As explained in Copenhagen (2015-A), *"The construction works relating to cloudburst and storm water management for Copenhagen will result in jobs and tax revenue being created in the construction phase. Combined employment of more than 13,000 full-time equivalents and DKK 1.6 billion in tax revenue are created in the construction period"* (p. 44). Financial estimates were also central to making the case for funding the CBMP against insurance costs. The calculations demonstrated that while damage provoked by extreme rainfall has increased the insurance costs of properties, it is expected that the protection effect of the CBMP should buffer damage and therefore also the costs of insurance: "*Insurance terms for municipal properties in the City of Copenhagen worsened substantially after the torrential rain on 2 July 2011. Since the areas concerned have been the subject of cloudburst management*

measures, it has been possible to bring premiums back to their original level. Implementation of the measures in the climate change adaptation plan dramatically reduces the risk of damage to buildings etc. during heavy rain. As a result, the insurance industry also achieves a corresponding reduction in risk of claim pay outs in connection with extreme rainfall events" (Copenhagen, 2015-A, p. 44).

Collaborating with the insurance sector has been central to generating a business case for the CBMP. Insurance companies provided financial data that emerged from insurance claims and costs paid after the 2011 flood event, which facilitated the modelling of financial costs associated with cloudburst events. When the city developed a blue-spot map based on COWI (2010) (Sprocati et al. 2019), overlapping costs paid by insurance companies with identified flood zones (blue-spots on the map) allowed one to have a good approximation to confirm the accuracy of the map and also to project damage costs (CA35-36; CB31, CE18). Combining insurance models within city protection estimates facilitates the coordination with the insurance sector, because by applying a similar approach to calculating damage (economic modelling for the insured infrastructure), then policies can better integrate strategies to reduce costs:

- *"A return period of 100 years in 100 years is a very high level of protection against damage, so even if we had another T1000 event, considering the level of protection that we now have, the level of damage would be much smaller, and the (insurance companies) are interested in this, because they work with the same approach as we do, they also run economic modelling for the insured infrastructure..." (CB31).*

3) Establishing the level of protection of the CBMP: The CBMP follows a "*never-ever approach"* (CE26), which in principle sustains the fact that the impacts provoked by the extreme rainfall in 2010 and 2011 went beyond the tolerable threshold and had to be avoided in future. Copenhagen's vulnerability assessment was guided by a financial approach where vulnerability was conveyed in monetary terms expressed as repair unit costs of potentially affected assets (flooded houses, businesses, infrastructure, disruption of traffic and electricity) against different return periods (Arnbjerg-Nielsen, 2015). The safety level of the CBMP was defined by the municipality and it was integrated into a hydraulic model developed by the water utility company Hofor which is applicable to the design of projects (CB26).

- *"... For the plan, the information used is very dominant from the hazards approach, so, it includes hydro-dynamic modelling... (and) it is driven by historic events" (CE25 & CE28).*

The expected level of protection delivered by the CBMP would thus respond to questions such as *how frequently is flooding acceptable? What would be an acceptable water level during a*

flood? And this resulted in two indications: "*sewer discharge will be allowed to reach ground level once every 10 years, and average water levels will be allowed to exceed ground level by 10 cm once every 100 years, excepting areas specifically designated for flood control storage*" (Copenhagen, 2012, p. 12). Investments in the CBMP have to ensure a level of protection against flood events under return periods of up to 100 years, while losses arising from a larger return period would have to be covered by private and public property insurance.

While financial estimates were central to determining the magnitude of projected losses emerging from extreme precipitation, quantitative impact assessments are assumed to be limited since many vulnerabilities are difficult to express in monetary terms (Adger 2006). In this context, decisions about the course of projects within the CBMP were discussed from a multi-criteria approach, and cost-benefit analyses were only part of the preliminary assessment required for decision-making. Classic risk analysis allocates money in different terms, where benefit emerges from damage avoided and loss. However, other indirect effects –such as health issues- may also be relevant for decision-makers. A strong element that has a significant influence on decision-making in Copenhagen is the politics of *"caring for everyone";* which means displaying the value of equity as much as possible through political decisions. In this context, striking a balance between equity and financial equilibrium appeared to be a compulsory exercise:

- *"... (in) cost-benefit analysis... we use a matrix to prioritize... you have 3 cases, we would go with the one with the best cost-benefit analysis... but then you look at the people living there; they are exposed on a similar level, but because there are not that many people or the houses are not as expensive as others or critical infrastructure, then from a pure cost-benefit analysis, it comes down the list... so these analyses are conservative and have no human factor in them..." (CE32); "... and we discussed where in the city there was not a good business case to do things... some areas we saw that the benefit was limited... but (politicians) decided that politically, they wanted to implement the plan for the entire city.... "we want that all citizens feel that we are concerned about them to ensure their safety" (sic) (CA53); "...the municipality decided to stay with the higher level (of protection), even though that would be over-investing... that was a political signal...*" (*CE30); "...Cost benefit analysis is important, you still have to make the business case..."(CA10); "...because you don't want to show that you are wasting resources (either)..." (CE34); "...But what really makes it acceptable, is that you show that you would be able to get other things... the local improvements and people involved in the process and so on..." (CA10).*

Delivering a 1.6-billion-euro plan for protecting Copenhagen was an event without precedent. The scale of commitment demanded politicians became well-informed about the risks of future extreme rainfall events, about the costs of non-action, the barriers for implementing the CBMP, uncertainties about and the limits of its expected protection level. Preparing background information needed for convincing politicians to support the implementation of the CBMP was not a trivial activity. When talking to politicians, being convincing seemed to be an achievement that was learnt through experiential knowledge that emerged as discussions around the CBMP unfolded: after every meeting, the Adaptation Department would meet up, discuss the feedback given by politicians, assess how questions could be better answered, understand what seemed to be important for decision-makers; test, explore the way they think and assess what is important to them. Through this process, the most important norms orienting political decisions could be evidenced. Two normative criteria emerged as central to politicians evaluating the proposal of the CBMP: transparency and accountability.

- *"... we spent a lot of time with politicians, two day-long seminars... they asked questions, we answered... so they could get as much information as we could offer... we prepared 1200 pages with maps, figures, so they felt confident...we put in financial assessments, we spent a lot of time for that convincing... we were transparent whenever they asked questions that we could not answer... We presented all the info and we explained when we were not certain, so it was a very open and transparent conversation and it ended up as a consensus to get money for the plan (1.6 billion euros)" (CA49); "... We ran assessments to learn what was important to them. We did that with our general manager, what were the main messages that came out of that..." (CA56).*

Either in a seminar, workshop or lecture format, many activities were included in selling the CBMP politically. Learning how politicians think and reason was a decisive step in the selling strategy.

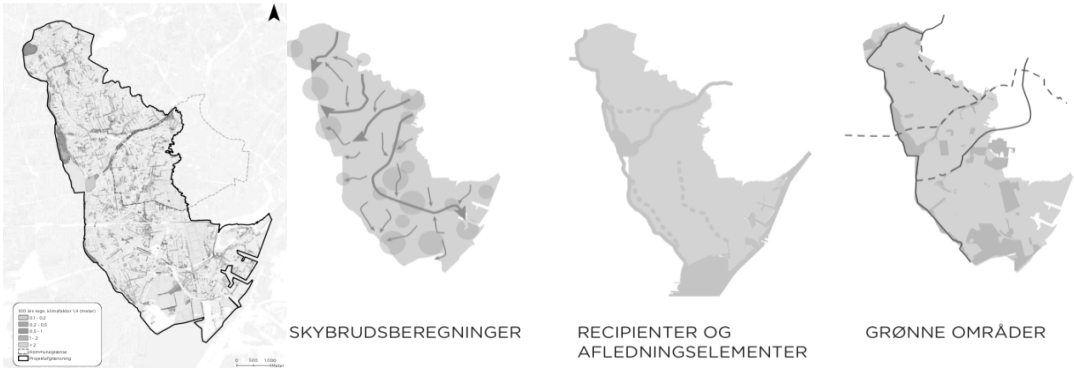
- *"Well, off course we had political suggestions, but it was them (politicians) who made the political assessment... we had this seminar where the aim was not to have a political discussion, but for us to present the work we are doing and for them to ask questions, we also wanted to understand their way of thinking so we could learn how to present the information. So, we didn't have that "yes or no" conversation, but it was a lot more open and we had that process of discussion about the politics..." (CA55); "... and the next day -after the plan had be accepted by the committee-, the mayor visited our team and said to us: "the reason why it didn't require any questions from the council and it*

goes on, is because people have confidence in what you have done"; so, it was a lot about learning how to teach the politicians how this plan would unfold..." (CA58).

The persuasion strategy was supported (beyond financial and risk assessments) by visual representations that facilitated communicating the relevance of the plan.

- *"... so not only handling (sic) water in a concrete basin, but also doing it on the surface and showing that we added value to greening the city... and the citizens could see it and it generated great enthusiasm...so this approach, demonstrating and showcasing, was important for us..." (CB20).*

Map 4: Strategic approach to control excess rainfall by using green and blue solutions



The map on the left shows in blue colour the areas to be affected by a 100-year flood event. The three pictures on the right display the flow of water and the natural recipients that could absorb excess rainfall. Source: købenHaVn Vest & frederiksberg Vest, p. 6[67].

Figure 8: Display of projected solution

Adding value while protecting the city[68].

More than a project, the CBMP has been framed as an urban development model in which value emerges not only by addressing specific risks; but also, by tackling the vicious systems that construct risks in the present day and which affect future development:

[67] Available at https://blivhoert.kk.dk/hoering/skybrudskonkretisering-koebenhavn-vest-og-frederiksberg-vest
[68] Source: købenHaVn Vest & frederiksberg Vest, p. 12. Available at https://blivhoert.kk.dk/hoering/skybrudskonkretisering-koebenhavn-vest-og-frederiksberg-vest

- *"... I think the politicians here have been clever and see the benefit of doing (sic) the plan now and avoiding further costs in the future, and see that doing it this way is much cheaper... and include protection in the new development of the city..." (CB27).*

As a result, added value has been strongly branded as part of Copenhagen's image: Copenhagen exploits its image and brands itself as a front runner in urban innovation, quality of life and economic development.

- *"The Copenhagen brand is much about how we have been working... so it was a double vision of making things attractive... And that is the brand: we don't only solve the problem; we also find the opportunity at the same time. (What) it is called the added benefit" (CA5).*

In political and strategic arenas, climate information sustains the scientific-technical basis that structures the rhetoric used for gathering endorsement of the ambitious CBMP based on the addition of value.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
1. Framing risk as value	Rainwater pollution analysis, precipitation projections, ex-post financial impact assessments; visual representations of future risk and opportunities.	Problem solving with additional value: No-regret, business case, never-ever approach, caring for everyone; transparency and accountability	How to reframe problems/challenges as opportunities for bringing extra benefits; learning from endorsing audiences	Stabilisation by rhetorical closure.	Reduced flood-risk as an opportunity.

3.4.4.1.2. Operational arenas

Practice 2. <u>Outsourcing</u>

The information sets needed for making the case to implement the CBMP were mostly outsourced to external consultants. Information needs are normally specific, demand analyses that require technological devices that are expensive, while some analyses call for a diversity of disciplines and information sources (*CE28).* Hence, outsourcing is comparatively less costly than generating the required competences for running such analyses internally within the municipality. As reported by an informant from a consultancy firm, given the complex and transversal nature of adaptation projects, bids normally include a range of different services and professional expertise:

- *"The services we offer are the classic: stretching out from screening, what is exposure and vulnerability in an area, combined risk in an area, identify potential*

solutions to mitigate risk and explore adaptation opportunities, and then we look into benefits, co-benefits to resolve classic problem of too much or too little water, and move into the engineering design and implementation and follow up, so it is the whole project cycle..." (CE3).

The process whereby outsourcing unfolds is fairly traditional: the local government would identify the information need; through a standardized administrative process set the terms of reference for the consultancy, calls for tenders are published, proposals assessed, contracts are agreed upon and implementation kicks off: *"... but in a process like that we had many dialogues and ideas..." (CE5).* Learning processes could be identified through the practice of outsourcing: methods used in the consultancy work are explained to municipal officials; preliminary observations and results would be discussed and validated through workshops or meetings. Establishing concrete terms of reference of what it is expected from a consultancy implies that municipal officials have to be well-aware of how information could provide meaningful input to serve a specific purpose. Progressing from more general terms of reference to demanding more specific information supposes that a background understanding of the relationship between city functionality and climate change builds up.

- *"When we started, we had a lot of climate projections.... that was downscaled from the meteorological Danish institute... we paid for it... but then, there was the whole hydrologic model that (had) the utility company... then we hired consultants who developed this model further and then all the data was handed back to the utility company so they could update their model" (CA21).*

Consultants competing for a contract intend to make their bids as attractive as possible, offering experience and specialized services; sometimes, going beyond what is demanded in the terms of reference, providing new opportunities or additional products (*CD60).* Through ongoing dialogue between municipal officials with consultants, bonds of trust are developed, sometimes friendships emerge; but most importantly, longstanding professional relations provide synergies, even when there is no contractual obligation between both parties (CE7):

- *"...for all of us, partnerships are the way forward because that is the way to spike new ideas and to accelerate things, and it is a lot more motivating to work that way..." (CE52); "... in many projects people would love to see the project graphically and you as a company want to make the most of that opportunity to brand it, and that means of course we would be available for presentations..." (CE50);*

In this relationship, even when there are no contractual obligations, a municipal official would just make a phone call and present a specific question to the consultancy firm. The question, at

the same time can involve the opportunity for further engagement; it can inform the consultancy firm about the direction that previously delivered reports are embarking on, or suggest possible new products to offer (workshops, seminars, new specialised services). It becomes a synergistic relationship:

- *"... we want to have a relationship with our clients even when there is no special project collaboration ongoing, so we are eager to do seminars, workshops because we want to find ways to tackling problems or allowing us consultants to demonstrate to the municipality where we can also help with other services, so there is certainly interest for us, and for the city I presume they are also interested because they also get a sort of free consultancy,... but we motivate each other to see what else should be on the agenda, and the city has the responsibility to keep on pushing and prioritising the funds, so I believe that it is not that we would push for them to settle priorities, but to keep them on their toes to show them what is also possible (to be done)..." (CE51).*

Learning as seen in the practice of Outsourcing occurs as a mutually-constitutive knowledge element where new challenges demand new solutions which need expertise from consultants as much as it does from municipal officials. Opportunities emerge for both parties as a common objective is anchored in mutual interest -improving the information base needed to implement the CBMP on the one hand, and a business opportunity on the other hand-.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
2. Outsourcing	Terms of reference, contracts, information produced by the consultancy.	Attending specific requirements; trust.	Constructing solutions; validating consultancy results	Grant credibility by providing scientific and technically salient process	Increased network, increase learning opportunities.

3.4.4.2. Category Articulating

3.4.4.2.1. Political arena

Practice 3. <u>Formalising</u>

The original city administration consisted of 4 departments: Permits, Development, Construction and Maintenance. When the plan was initially drafted, the CBMP was located within the Development Department and it would have later been transferred to the Construction Department for implementation. However, the original administrative structure was not designed to accommodate a transversal institutional design for managing water, nor for coordinating nearly 300 projects.

- *"... (CBMP) is an ongoing development project; all the techniques and projects to handle (sic) the water, the cooperation to do so this is new for us all..." (CB25).*

Since the CBMP was devised in a way that it broke existing institutional rules, it demanded a re-design of the institutional architecture of the city administration. The only conceivable way in which the CBMP could be implemented would be by it becoming *"a backbone of development"* (CB18). As a formalisation strategy, the creation of a dedicated department to coordinate the implementation of the CBMP played a pivotal role. In these terms, one department would take control of the entire project, the areas of development and implementation faces (CB15) and every new infrastructural project (either regeneration, upgrade or new development) would be designed in consultation with the CBMP project-portfolio (CB18).

- *"This is a new way of managing water, because it goes in line with other existing challenges... would it pollute the water of the harbour? is it legal to use the road for moving the water out of the city? So, we had to look for changes in the legislation, regulations... they are not made for these plans" (CB23).*

This new framework implied that all new city developments must be consistent with the Plan, facilitating implementation and improving project and budget synchronization. This logic therefore, results from a financial efficiency principle: as projects are approved and budgets are allocated, it is expected that budgets from two projects can be merged and increase the impact, the scope or redundancy of urban interventions.

- *"... In the field, sometimes it makes sense to execute two projects together and then you get two main sources of funding feeding into one project (discharge water where there is another adaptation project, for example) ..." (CG10).*

Formalisation resulted in this form of water management being stabilised by means of three mechanisms. First, the new distribution of attributions and functions demanded for implementing the CBMP, imposed legal restrictions and affected the entire jurisdiction that regulate the mechanisms of how water is managed. Second, through new competences linked to water being managed at the surface; and third, stabilisation by rhetorical closure, where alternatives to managing excess rainwater become unthinkable outside the scope of the CBMP. Gherardi (2012) explains that in rhetorical closure, organisations *"redefine the categories of their practices"* (p. 171). This is achieved by proposing specific distinctions based on science or on legitimised concepts (such as water being managed at the surface through a mix of green-grey solutions); and on scientific (climate change) and technical grounds (regarding the carrying capacity of infiltration systems).

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
3. Formalising	Legal decrees	Legal rules defining normativity	New forms of articulating work	Provide stability to implement the CBMP	Stabilisation of water management.

3.4.4.2.2. Strategic arenas

Practice 4. Collaborating

A number of challenges involved in implementing the CBMP have been identified: Projects will need to be carried out on 132 km of private roads; the Plan may impact on conservation goals; large-scale projects will require cooperation between municipalities; while storm water will need to be treated before reaching natural recipients (Copenhagen 2015-A, p. 16). However, of central importance for this research is the challenge behind articulating work to overcome these barriers:

- *"... in order to work downstream, we also had to work with challenges upstream and then manage the water that would be poured out of the system... water had to travel the city... so we had to identify opportunities where other departments were going to implement projects and find ways of how to include those projects as part of the CBMP" (CB16).*

Collaboration became the only imaginable way to overcome spatial and administrative problems that could not be resolved by single parties.

-**Spatial challenges**: Since solutions are context specific, each one of the 300 projects require being designed in relation to local circumstances, accounting for the complexity of hydraulics, technical aspects, and local circumstances, demanding multiple expertise to be aligned:

- *"... we try to make the city easier for wheelchairs, but then we raise the footpath 10 cm in order to contain water... then how are people who cannot walk cross the street? ... there are tons of clashes between technical solutions and how you want to serve people... and instead of seeing them as impossible, we have to see how much (it) is possible to do there..." (CE56).*

-Administrative challenges: Since it is not possible to roll out the entire plan at once, prioritising areas (based on risk assessment, effects of implementation and synergy with other plans) and coordinating the timing for each project became compulsory (Copenhagen, 2012, p. 14 & 23). The joint municipal water-utility funding scheme and a legal division, where underground infrastructure is managed by utility companies and surface infrastructure by the municipality, demand both parties to coordinate implementation.

- *"... in co-financed projects to promote blue-and green... you cannot have a CBMP without having both, the city and the utility company there..." (CE8); "...but sometimes Hofor may say that they don't have the money to implement the project, or it is not in their priority list, so a core element is that the priority in the project is similar to the two institutions..." (CE9).*

In order to address these challenges, collaboration needed to be established with different actors:

-First, collaborating with other local governments: the spatial need to circulate water to natural recipients demanded collaborating with the neighbouring municipality of Frederiksberg *(CA24).*

-Second, collaborating with citizens and the utility company: local actors become central to the ongoing development of the CBMP. Since sewer companies are not required to protect basements against flooding (Copenhagen, 2012), disconnecting basements from the public sewer system (Arnbjerg-Nielsen, 2015) and other improvements are expected to be funded by private individuals (Copenhagen, 2012, p. 38). Landowners become project owners, and they finance (through loans) the development, construction and subsequent management of the project, in return for 100% reimbursement by HOFOR (Copenhagen, 2015-A, p. 23)[69]. Citizens' Local Committees form partnerships with the Municipality through different mechanisms in order to participate in the preparation of project proposals, which is considered to provide a more democratic approach to planning (Engberg, 2018). Interaction is facilitated with support of different tools, including for example, the initiative "Collaboratorium for Climate Adaptation" [70] which is a website for local communities that provides an overview of all the stages of project development in their communities.

-Third, collaborating with colleagues: perhaps one of the clearest illustrations of the norms that underlie collaboration in Copenhagen comes from examples when sharing data and information:

- *"Sharing data is not a problem in the working culture... we are very open to sharing data in Denmark... in cities like New York data is an asset, something that gives you power and so on... but here data is not an asset... we don't use it to bargain... we share it... that is how we do it. Data sharing is extremely important" (CA23).*

Sharing information is a common practice that appears to be regulated by values of openness and transparency which result in sharing information to be clear and straightforward.

[69] The City Administration can become a landowner in situations when it must take over private roads in order to ensure implementation, operation and maintenance of projects on surface areas (Copenhagen, 2015).
[70] The platform can be visited at https://www.callcopenhagen.dk/en/collaboratorium/

- *"... There is not a big plan how to share the data we gather... of course we know people, we know who we work with, so when we have some data and news, we share that with our network..." (CE26); "...Getting info is pretty straightforward... some info may demand more bureaucracy because it is more controversial, but in general it is just asking for the data" (CA28).*

Data delivers collective value as it allows people to run multiple analyses and to make informed decisions. The way in which data and information are stored plays a central role in enabling third parties to access and use common archives. Different sorts of classification codes exist and must be known by municipal officials in order to understand how data is organised. This large diversity demands in most cases that people must receive some form of mentoring in order to understand the data or in order to have the whole picture of what data is available.

- *"... I have tried to create a worksheet in excel where I can tell people what information to look at, to be able to screen an area to assess if it would be possible to infiltrate ground water... so people ask me for information, but I get information from many different places, then I summarize it in my own spread sheet... (CC21).*

The implementation of the CBMP demands new forms of collaboration where multiple parties are involved in the resolution of diverse emerging challenges: *"...the principles for the treatment of everyday rain have been established, but the final treatment solutions are not yet known."* (Copenhagen 2015-A, p. 10). Knowing how to collaborate in practice thus becomes as a competence, where norms (transparency, openness or good will) become central to orient collaboration efforts.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
4. Collaborating	Funds, physical complexities, software for increasing participation	Adding value, promoting democratic decision-making	Identify opportunities to coordinate project implementation; diverse forms of collaborative work.	Increasing connectivity in the network of practitioners linked to implementing the CBMP	Improved synchronisation among stakeholders

3.4.4.2.3. Operational arenas:

Practice 5. Data management

Dimensioning the CBMP as an ongoing project and a development paradigm, it becomes evident that large volumes of data are needed -and data requirements are not static-. Quite the opposite, ongoing management, evaluation and design of new projects within Cloudburst

branches require a real-time monitoring capacity and trend identification. Arnbjerg-Nielsen (2020) reports that data and information management become central to "*establishing sensible ways of projecting future changes of both drivers and decision criteria and trajectories of adaptation; (for) recognizing the interplay between urban water management and other critical services in society, including mobility and energy; (and also for) exploring the uncertainties of both technical, hydrological, and social processes involved in the design and analysis of urban drainage systems with the intent of enabling good urban water management decisions*" (p. 25). Data management has changed dramatically throughout the implementation process of the CBMP. For example, in the planning stage, information needed included type of water management solution according to segment (basin or retention road, etc.), expected costs, estimates for maintenance per year, etc. (CG5). As implementation progressed, data needs increased and changed and new protocols applied:

- *"... Now we are in the execution of projects, now we need to add more data to this... when the project would officially start... limitations for funding ... not to exceed the maximum budget allowed per administration per year..."* (CG8).

As a project begins, information about the project is fed from a master plan data base and connected with a management dataset that informs about things such as when the project is expected to start, when it is expected to end, who is going to finance it, how it is going to be financed, how much water can be treated by the project, etc. (CG10, CG11). Projects are connected through automated systems. Synergies can be created between projects that are to be constructed, thus saving capital and increasing the scope and impact of the planned infrastructure project (Copenhagen, 2015-A).

- *"... sometimes it makes sense to execute two projects together and then you get two main funding sources feeding into one project" (CG10); "...a dataset tracks all ongoing construction sites...-for example a schoolyard- ... just got new funding to update their football pitch, then we can establish collaboration and redesign the schoolyard and simultaneously do a climate adaptation project" (CG12); "... other branches can see that there are urgent things that have to take place ... then you would have to upgrade with the adaptation plan..." (CG14). "...As soon as you get funding, the project gets into... (a) data base; then this will ring a bell to the Unit on Climate Change and then there is a need to talk and see how to bring together projects. This is compulsory..." (CG13);*

Data management is facilitated by material entities that support real-time monitoring and dynamic data sharing platforms. Copenhagen has a robust digital structure in place[71] (data hubs for data sharing -mobile phones, and standards for data security and privacy)[72]. Real-time data can be collected from different sources: from monitoring the runoff from roofs and roads in order to know about the content of pollutants in the rain water (CE19); or from flood events in the past:

- *"...our utility company collected a lot of data from YouTube after the 2011 event... people took small pictures from their windows...waterfall running down the steps, etc. it helps us identify the issues we have in specific spaces ..." (CA37).*

Monitoring technologies are considered central to reducing routine monitoring to detect inefficiencies in the water systems that would otherwise have to be undertaken by people on site: "The *increased combined use of Internet of Things[73]-driven, system-wide monitoring and real-time modelling... allow simulating the performance of the underground pipe networks; detecting leaks in distribution networks...aimed at optimising the storage capacity to minimise combined sewer overflows during rain" (Denmark, 2020, p. 14-15).* Data integration and sharing is facilitated by centralizing data repositories in large portals accessible by all municipal departments, allowing new analyses to be run or old datasets to be updated. Datasets are connected by specific project management software. For example,

- *"...the KK-kort is a digital map and database that provides a huge amount of information that has been collected and organized etc... so, there is a fabulous amount of information available at my fingertips. I can see the ground water level..." (CC30); "(or)... different lots that have been identified as contaminated..." (CC17); "...(there) it is maybe possible to infiltrate water, then I would go to other... geological data bases*

[71] Copenhagen has been awarded the World Smart Cities Award 2019 for its "Copenhagen Connecting" plan –considered the best plan in the world for collecting and using data to create a greener city- https://en.digst.dk/media/14143/ds_singlepage_uk_web.pdf. There is a nationwide approach to smart data management in Denmark: The Digital Strategy (https://en.digst.dk/policy-and-strategy/digital-strategy/) allows joint municipal and regional digital strategies; The partnership City Pack supports smart city development at a national level; 'Open Data DK' fosters transparency in public administration, stimulating data-driven growth through free and available data ((SMART CITIES: Creating liveable, sustainable and prosperous societies) Version 2.0 Januar 2020 https://stateofgreen.com/en/uploads/2018/05/SoG_WhitePaper_SmartCity_WEB.pdf?time=1582113736); **"Open Government Partnership"** allows public authorities to register core information about individuals, businesses, real property, buildings, etc. These initiatives respond to a national approach that sustains that data "holds a large commercial productivity and growth potential" (Data strategy p. 38); thus, adding value to collected data by facilitating access, management and analysis. This level of success seems to respond to people's "trust and confidence in each other and in the public sector"; in people generally having a high level of education, good digital competences and having experience with digital technologies" (https://en.digst.dk/media/14143/ds_singlepage_uk_web.pdf)

72 https://stateofgreen.com/en/partners/city-of-copenhagen/solutions/copenhagen-connecting-driving-data-to-quality-service-to-the-benefit-of-citizens-and-businesses/

[73] The Internet of things (IoT) is a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Source: Wikipedia, https://en.wikipedia.org/wiki/Internet_of_things checked on the 3rd April 2020

and get information and start assessing whether in this area, there is potential to infiltrate water..." (CC31).

Advanced technologies enable fast and easy ways to collect, catalogue, withdraw, integrate and share data, thus supporting data management practices. Data management practices in Copenhagen simplify the coordination of daily tasks and the implementation of essential functions; for example, real-time monitoring techniques offer possibilities of assessing changes in the use of space, or to detect opportunities immediately -including recognising sites for new infiltration projects-. Trend identification has been highlighted as a core aspect of "*projecting future changes of both drivers and decision criteria and trajectories of adaptation"* (Arnbjerg-Nielsen, 2020, p. 25). Data management is a central aspect for continuously detecting trends that show how the local development process interplays with the dynamics that determine climate risk generation or reduction.

The CBMP is to be revised every four years in order to assess whether the initial CBMP design is on track to deliver its level of protection, which demands visualising changes in socio-economic trends with regard to progress in the development of climate scenarios –underlying the constant search for reducing any uncertainties that were not clear when the CBMP was designed- (CB8). In this context, Data management practices play a central role in linking the use of climate information and the development process by supporting –for instance- identifying socio-economic trends, land-use dynamics or damaged water infrastructure, all of which provide a proxy indication of social vulnerability, exposure and adaptive capacity.

Practice Name	Material entity	Normative dimension	Know-how expressed by the practice	Role of the practice	Effect of the practice
5. Data management	Software: Automated systems for project connectivity, real-time monitoring technologies; dynamic data sharing platforms.	Adding value by reducing implementation costs; data protection law; enabling third parties to identify and withdraw valuable data	Adapting to information and administrative needs emerging from changes in project implementation	Increase coordination; anticipating challenges, visualising trends and uncertainties.	Integrated collaborative work; projecting changes in drivers affecting urban water management and other critical services.

3.4.5. Findings and interim conclusions case study Copenhagen

Climate information has played a pivotal role in the development of the CBMP in two contexts: first, helping to build a consensus for its approval; and second, as input orienting its design principle. In each context, two legitimacy challenges were identified:

a) Building a consensus for approving the CBMP: Legitimacy efforts could be observed to be in line with the characteristics of gaining moral legitimacy (Suchman, 1995), since a substantial amount of energy has been devoted towards creating objectivity regarding the risks of extreme precipitation on the local development process and a sense that a new endeavour –the CBMP- can define a new water management paradigm. Endorsement rests on the judgements of legitimators regarding whether the CBMP is *the* right thing to do in terms of effectively promoting societal welfare and adding value to the city. In this context, climate information has been used to establish three parameters that support building a consensus for approving the CBMP:

-Establishing parameters of risk acceptability: climate projections showing an increase in the frequency and magnitude of floods become central inputs to decisions regarding the thresholds of risk acceptability– *how frequently is flooding acceptable? What would be an acceptable water level during a flood?* The human dimension is positioned at the centre of risk acceptability as values of democracy and equity permeate negotiations.

-Establishing parameters of value: Climate projections associated with hydrological models were used to estimate financial loss with regard to flood risk, sustaining a business-case rhetoric, where risk reduction strategies are framed as additional financial value.

-Establishing parameters for design and protection levels: Climate projections inform one that CBMP protection levels should respond to return periods of up to 100 years, while higher return periods are considered to be over-investing. The agreed financial costs set a cap on adaptation investment decisions, facilitating political-technical deliberation by framing the discussion within an agreed and understood financial framework.

b) Orienting design: Maintaining legitimacy is evidenced as a central concern for ensuring the implementation of the CBMP in the long-term, since despite a financial cap on adaptation investment having been established, future investment may be needed to cope with unforeseen climate conditions. Challenges regarding maintaining legitimacy are evidenced from two angles.

-The risk of overspending and the need to maintain political support throughout time is addressed by balancing short- and long-term benefits from adaptation, by reducing the present-day flood risk and expanding green areas; and a physical design where multiple small-scale catchment areas provide redundancy and flexibility for future upgrades.

-The CBMP responds to a vision of a safe and prosperous future assumed to be reached through technical and technological innovation. Challenges to maintaining legitimacy are thus also contingent on the capacity to deliver appropriate and timely innovations. Innovation potential and innovation needs are still uncertain, given the diversity of the context of project implementation. Consolidating an innovation landscape[74] and fostering new business opportunities is therefore a central goal for policy-makers.

In this context, the CBMP design seems to respond to a strategy that simultaneously anticipates threats and protects accomplishments, which are defined as core strategies for maintaining legitimacy (Suchman, 1995).

3.4.5.1. Drivers:

Three drivers were found to influence the use of climate information in Copenhagen:

- First, a legal obligation which since 2012 forces municipalities in Denmark to draft a local climate adaptation draw attention to climate information. The obligation came together with a palette of institutional resources to access climate information, to guide design and the implementation of adaptation solutions, including specialised task forces, and the development of networks for technological development and application.
- Second, a set of legal attributions grants autonomy to local governments in matters related to urban development, emergency preparedness and surface water management. Integrating water-risk urban development is not only an attribution, but also a responsibility which increases attention towards future climate conditions.
- Third, a policy window, which emerged as the need to ensure that rainwater meets environmental standards before reaching natural recipients, converged with recent cloudburst events. A policy window emerged as *"the threat for another similar or greater event, is perceived as being immediate"* (Solecki et al. in O'Brien and Selboe 2015, p.43).

3.4.5.2. Illustrating climate information:

Climate information use is illustrated through 5 constellations of practices: "Framing risk as value", "Outsourcing", "Formalising", "Collaborating", and "Data management". Practices

[74] https://www.callcopenhagen.dk/en/collaboratorium/

were distributed in two categories –Narrating and Articulating-, and were characterised according to their relationship with political, strategic or operational arenas.

3.4.5.2.1. Category Narrating:

The constellation of practices under "Framing risk as value" illustrates how climate information is used as input to appraise physical and financial risk, resulting in four narratives that inform about the design of the CBMP: "*No-regret", "Business case", "Never-ever approach", "Caring for everyone"*. These narratives represent a normative multi-criteria template which highlights that approval of the CBMP depended on risk being framed as an opportunity to provide additional value to the city, and ensuring value could be distributed as equally as possible. In this context, value becomes a discourse which does not only represent the world; but it also results in concrete actions and interventions upon it (Nicolini, 2012), and the CBMP is the means whereby value can be materialised. In this discourse, the CBMP becomes a development paradigm which, in establishing a novel concept of rainwater management, it becomes a branding image for Copenhagen, legitimating the "*ways of doing strategy"* (Wittinghton, 2006, p. 620) and establishing a form of practising which becomes stabilised by rhetorical closure, where alternatives to managing excess rainwater become virtually unthinkable outside the scope of the CBMP.

Uncertainty in the context of the CBMP underlined the fact that concerns mostly emerged in relation to either underestimating potential financial losses from cloudburst events; or the opposite, in the absence of floods, giving the impression of overspending; against which representing value in present times and ensuring flexibility were the responsive strategies. Beyond the sophistication reflected by this approach, what becomes more relevant for this research is to highlight how uncertainty became an accepted aspect in this planning context. Explaining the sources of uncertainty with the aid of robust scientific information (climate models, financial and risk assessments) granted transparency and trust to the decision-making process, assuming that the decision to embark on such a large programme was based on the best scientific information available -a central aspect for gaining procedural legitimacy according to Suchman (1995). Dealing with uncertainty was based on practices oriented by the explicit need to fully grasp and embrace the sources of uncertainty and complexity, which positions transparency as a normative criterion to assess the use of information.

The practice of "Outsourcing" emerges as a response to the need to fulfil particular tasks which cannot be achieved by an in-house capability. Outsourcing is a practice whereby two parties (intra- and extra-municipal actors) meet to strategize. The practice sheds light on how learning evolves between two parties through social interaction framed in three mechanisms: a) direct

validation of consultancy results -through seminars and meetings where consultancy results are discussed-; b) by shaping consultancy goals -through concrete and attainable terms of reference-; and c) by a synergistic relationship where consultancy services are shaped on demand as problems and solutions are co-established-. The significance of this practice arises from showing that outsourcing is not a practice between active mentors and passive learners. Outsourcing underlines the fact that municipal officials are not "*reactive administrators*"; but rather, they take on the role of "*active and accountable 'strategists'*" (Wittinghton 2006, p. 617) who shift roles from public administrators to risk managers, innovation entrepreneurs or financial advisors with a vision for adding value to the city.

3.4.5.2.2. Category Articulating:

The traditional structure of attributions for project implementation in Copenhagen (Permits, Development, Construction and Maintenance) proved ineffective to overcome institutional barriers to efficiently coordinate the implementation of the CBMP. A new institutional architecture was a requisite, since the original institutional order was not fit to address the interconnection among *"biophysical systems, environmental and resource regimes, and broader governance systems*" (Galaz et al., 2008, in Young et al. 2008, p.147) on a local scale. Particularly in the case of public administrations, *"hierarchies provide coordination through formalised structures of authority distribution and specialisation"* (Klausen et al., in O'Brien and Selboe, 2015, p. 66), which enable the delivery of concrete tasks to other departments since coordinative power is based on authority (ibid). By formalising the CBMP as the "backbone of development", attributions and functions could be re-distributed, imposing legal restrictions that affected the entire municipal jurisdiction and that influenced the articulation of work involved in water management: all new developments had to be accountable to the CBMP through the Adaptation Department.

While institutional reorganisation normally results in an ex-post response to shocks (Galaz et al., 2008), institutional reorganisation in Copenhagen came about as a means of overcoming a "*lack of resilience of institutional arrangements*" (p.149) that emerged in the early stages of implementation, as municipal officials realised that the original institutional jurisdictions were separately too small to grapple with the technical and administrative complexity demanded by the CBMP. Establishing a new institutional order was the way to respond to barriers that emerged as implementation was rolled out. Formalisation was the solution to respond to an emerging problem, and hence it illustrates the result of a process of validating and institutionalising practical knowledge.

The CBMP represented a new way of doing things not only for municipal officials, but for all actors. The practice of Collaborating underlines the challenge of generating engagement with multiple actors: colleagues from other departments, other municipalities, utility companies, and neighbours. Engagement is acknowledged as being a core aspect to change processes, and it involves *"enhanced capacities for perceiving, understanding and engaging with complexity"* (O'Brien and Selboe, 2015, p. 318). Engagement is a prerequisite for implementing the CBMP since the factors for successful implementation are distributed among actors who must perform activities and make decisions in synchrony (including making investments, implementing infrastructures and solving problems). Achieving engagement was contingent on mediating multiple interests, identities and norms (ibid).

The practice of "Collaborating" sheds light on the activities undertaken to engage stakeholders in implementing the CBMP. Since stakeholders would assess their commitment to engagement through different criteria, engaging activities had to be responsive to such variance. For example, democratic values, transparency and participation were central for citizens; reducing the risk of floods was central to utility companies; increased safety was important for neighbouring municipalities, and transparency was central for social interactions between municipal officials. The practice of "Collaboration" illustrates how material entities can facilitate engagement: software enabled citizens to engage in project design and implementation, thus responding to transparent, meaningful and democratic participation in the CBMP. Risk maps facilitated neighbouring municipalities to see how collaboration was central to ensuring safety, financial estimates were central for utility companies, and dynamic data-sharing platforms facilitated sharing among municipal officials.

Finally, Data management practices enabled the circulation of information to flow more freely and efficiently, facilitating the evaluation of emerging trends and reducing the costs associated with running specific a specific analysis. Real-time monitoring devices allow rapid trend identification (e.g., immediate input regarding the pollutant content in rainwater); facilitate datasets being updated more regularly, and allow the projection of changes in drivers and trends affecting urban water management and other critical services. Good data integration capabilities are associated with improved attribute information for specific sites -which better addresses spatial questions-, since the interconnection between *"planning levels, map scales and the corresponding spatial resolution"* can be improved (Dresden, 2011, p. 24), as illustrated by the use of the "KK catalogue".

3.4.5.3. Anchoring and enabling practices

Practices play different roles, and these could be characterised by observing the difference between anchoring and enabling practices (as conceptualised in previous sections). Anchoring practices include "Framing risk as value" and "Outsourcing". Enabling practices included "Formalising"; "Collaborating", and "Data management".

However, the boundaries sometimes overlapped, since some practices were observed to play both roles. For example, "Framing risk as value" did not only depend on the direct use of climate information, but it also paved the way for stabilising the use of climate information through rhetorical closure. The practice of Outsourcing is woven around the need to better understand the impacts of climate change, and in addressing this concern, it produces material entities (e.g., coupled hydrological models) that enable other practices to be enacted.

Enabling practices such as "Formalising" enable the use of climate information by setting new rules and restructuring the division of tasks so that attention to climate adaptation and risk management is prioritised. The practices of "Data management" are relevant in this context since sectorial, non-climate data is central to supporting climate impact modelling and vulnerability assessments. The practice of "Collaborating" touches upon usability more tangentially by expanding the network of engaged stakeholders, whose unique interests define different purposes to be served by the use of climate information (e.g. the better understanding of physical or financial risks through specific assessments, or illustrating the exposure level of private assets through GIS maps, etc.).

3.4.5.4. Observing the interplay between norms and practical knowledge:

The implementation of the CBMP demands coordinating multiple practices, procedures, decrees and forms of carrying out strategy and decision-making that are shaped by different social problems. The use of climate information participates in this coordination by sustaining CBMP's common orientation; while at the same time, the use of climate information resulted from the coordinated order established by the CBMP. The criteria used for assessing the use of climate information are thus inseparable from the criteria used for assessing the practices sustaining the CBMP. Informed by the three pre-defined arenas, three evaluative criteria were identified: normative-political, procedural and cultural criteria.

3.4.5.4.1. Normative-political criteria. Approval of the CBMP was to a large extent, a political decision. Normative-political criteria underline how climate information plays a central role in shaping political endorsement needed for implementing the CBMP. This is illustrated in two cases. First, values of democracy, equity and safety were core aspects to pragmatically represent value addition through implementing the CBMP. Climate information contributed to meeting

these normative criteria by supporting the setting of a cap on adaptation investment, by establishing risk thresholds, by informing the distribution of risk (through visualisation techniques such as risk maps) and the consequences that could have emerged, had action not been taken. Second, uncertainty is embraced in a scientific process where gaps in knowledge and information are acknowledged, making transparency as a driver for trust building.

3.4.5.4.2. Normative-procedural criteria: From normative-procedural criteria, the use of climate information can only be assessed in association with the working context through which it transpires. In these terms, rather than identifying specific procedures in which climate information becomes anchored, the case study about Copenhagen offers the opportunity to observe how climate information provides a rationale that orients the direction and design of municipal procedures and strategies. This rationale can be seen as a foundation underlying the principle of "*fixing more than one problem with an urban project*", where value addition emerges from tackling a climate problem, an urban problem and improving the quality of life. This rationale also reshaped the relationship between the municipality and the insurance sector by highlighting that insurance pay-outs are likely to increase amidst the projected changes in climate conditions, setting a new landscape where mutual collaboration becomes essential. It also becomes clear through the design of community engagement projects by providing a justification for neighbours to make private investment and make them become active agents in the implementation of the CBMP. But perhaps the most relevant example emerges from water management. As it was previously mentioned, the CBMP becomes the standard for managing excess rainwater and any alternative to such approach is not conceivable. In other words, managing water without the consideration of future climate conditions becomes unthinkable in the context of Copenhagen. These examples point out to a stage in usability which demands moving beyond the reflection as to whether or not the use of climate information complies with appropriate practice or whether it makes practices beautiful (Gherardi, 2012). The use of climate information in this case study is better weighted, by observing how usability becomes part of the normative criteria used for assessing procedures and strategies, and how usability equates with practising the norm.

3.4.5.4.3. Normative-cultural criteria: Collaboration was described as a cultural value strongly defended in the working culture in Copenhagen and it is considered central to implementing the CBMP. In collaborating with colleagues, the perspective that data is a collective good that provides benefits to all, incarnates the principles of equity, openness, transparency and collaboration as central values in the working culture. These values are aligned with corporate values commonly attributed to the Danish working culture, characterised by a decision-making

structure based on consensus, a mix of teamwork and individual responsibility that promotes involvement and autonomy; with absent hierarchies, and roles considered equally important, and where mutual respect, responsibility and trust are central (Preus, 2017). Normative-cultural criteria are also reflected in how participation mechanisms are designed in order to enable third parties to be active agents in the implementation of the CBMP, including neighbours and neighbouring municipalities. Bringing these values to a practical domain becomes a central aspect of social interaction: delivering transparency and inclusion in the relationship with neighbours demanded explaining the restrictions and technical challenges associated with surface solutions; while facilitating colleagues in the use of data demands mentoring.

3.4.5.5. Changes in practices

Practice change can be observed through engagement and social interactions underpinning the articulation of work sustaining the CBMP. Following Blue and Spurling, 2017 (in Hui et al., 2017) some of the core indications of practice changes are to be seen through:

3.4.5.5.1. Changing jurisdictions*:* CBMP has demanded a reconfiguration of authority where power becomes concentrated in the role of the Adaptation Department. The traditional order of functions and attributions changes as new relationships become compulsory, including the obligation to provide accountability to the Adaptation Department regarding any new infrastructure project in Copenhagen.

3.4.5.5.2. Through advances in the use of science*:* Changes in the overall water management regime are attributed in response to the use of climate information.

3.4.5.5.3. The reconfigured and extended configuration of experts that emerges from the re-distribution of roles and responsibilities.

As these three observations suggest, the constellation of working practices that sustains the connection between the use of climate information with the CBMP changes, and these changes are attributed to occurring through changes in the knowledge and material composition.

3.4.5.5.4. Changes in the knowledge composition are evidenced through three examples:

1) Learning experience emerges from both, tackling problems in a context-specific dimension and at the same time, applying a green-blue approach to designing these solutions. As the CBMP is a new endeavour for municipal officials, the convergence of these two aspects provokes a steep learning curve regarding how working practices must adapt to the CBMP implementation requirements. The success of the CBMP is based on innovation capacity. In making solutions responsive to specific contexts, the knowledge composition changes through learning by doing and experimenting: how to comply with the law, how to deal with water; how to apply and evaluate technological solutions, how to collaborate with other colleagues, etc.

The green-blue approach represents a new endeavour to municipal work. It has already been noticed in the literature that knowledge emerges from implementing nature-based solutions from "the active experience of making nature": "*initiatives experiment with nature-based solutions, learn-by-doing on how to adapt them to city-specific and place-specific situations and geophysical characteristics... create new narratives and understandings of their benefits. As thus, nature-based solutions are seeds of transformation of local practice and local space towards more sustainable ones*" (Franziskani, et al., 2017, p. 65).

2) Through new forms of collaboration: An essential aspect to foster innovation has been the capacity to collaborate with multiple stakeholders; and hence, an extended network of actors - each of whom bring new expertise- is integral to changes in the composition of knowledge.

3) By observing how the demand for climate information changes, as comprehension regarding climate risk and its implications becomes better understood. Since the CBMP is an ongoing implementation project, large volumes of data are needed and data requirements change throughout the project cycle; from downscaled climate projections, to coupled hydrological-climate models, or specific financial assessments. Demand progresses from general to more specific, which supposes presumes that a background understanding of the relationship between city functionality and climate change builds up. This becomes more prominently explained by climate information demands for specific projects, such as for upgrading the Metro and Copenhagen's airport (specified in annex 8).

3.4.5.5.5. Changes in the material composition: Observing the use of climate information in Copenhagen through the categories "Narrating" and "Articulating" shed light on the mutually shaping relationship between climate information and the CBMP. A "Narrating" category underlines how climate information enables the CBMP by sustaining its common orientation and by providing a scientific base to inform about its design, including projecting costs and the level of protection. At the same time, observing the use of climate information from an "Articulating" category stresses how climate information continues to be used in specific situations as enabled by the coordinating framework that is based on the CBMP. The interactional spiral continues to be reinforced as the implementation of the CBMP unfolds and requires additional or more specific information. In this relationship, three stages can be distinguished, each of which highlights a specific mechanism that triggers changes in the material composition affecting the constellation of practices that link climate information and the CBMP:

1) Stage 1). New material entities draw attention to climate information: the policy window that emerges from extreme floods and water-related biological problems responds to

new studies regarding the content of water pollution and to IPCC models that projected increases in precipitation.

2) Stage 2) Climate information enables the CBMP: New reports are issued as the design of the CBMP demands the coupling of climate data with hydrological models or socio-economic data, generating inputs to appraise physical and financial risk in more detail.
3) Stage 3) The CBMP enables the use of climate information: Changes in material entities occurring through the implementation of the CBMP further enable the use of climate information:
    a. Formal decrees are issued which sustain implementing the CBMP and which stabilise the use of climate information through legal and rhetorical closure;
    b. Implementing a new CBMP project: Climate information being used to communicate the benefits of CBMP to specific audiences (neighbours and businesses on sites where a CBMP project will take place);
    c. Calibrating flood models with climate data provided by insurance companies (flood maps compared the location of blue-spots with sites where insurance companies had to pay up due to previous flood damage);
    d. New urban developments: large projects extending far into the future demand consulting climate projections. Adapting Copenhagen's metro lines and Copenhagen's airport to the effects of climate change are examples of this.
    e. The four-year term revision of the CBMP demands permanently collecting diverse datasets that reflect social and economic trends that can inform about changes in vulnerability, exposure and capacity to respond to projected floods, in a constant search for improving risk modelling. Improvements to climate models are to be included in these revision periods.

Interim conclusion on the case study about Copenhagen

The case study about Copenhagen offers the opportunity to observe how climate information provides a rationale that orients the direction and design of municipal procedures and strategies: as the CBMP becomes the standard for managing excess rainwater, any alternative to such approach is not conceivable. In other words, managing water without the consideration of future climate conditions is unthinkable in the context of Copenhagen. Copenhagen underlines how usability becomes part of the normative criteria used for assessing procedures and strategies, and how usability equates with practising within accepted norms.

The use of climate information in Copenhagen has reached a degree of stabilization whereby climate information shapes the lens through which urban development is conceived, positioning usability as being mainstreamed in policy and practice. In this context, CBMP has played a key role since it provides a method to link climate information with decision-making; for instance, by establishing an accepted level of risk, a cap on investment, and a time-frame for implementation, all of which are based on a legal bedrock where decisions are ordered within the framework of administrative competences.

However, ensuring usability in the long-term cannot be taken for granted. While flexible designs, improvements in public space and new business opportunities, have counteracted present-day challenges to legitimacy, long-term commitments and the risk of overspending may bring about legitimacy concerns in the future. Bearing this in mind, the use of climate information in Copenhagen is in a "maintenance mode", which recognises the fact that while legitimacy has been gained, it still has to be "maintained" in the face of future changes in climate conditions, changes in urban patterns and potential changes in political agendas.

Chapter 4. Discussion

This research has built around the question as to how the use of climate information takes place in practice. On a conceptual level, the evidence gathered in this dissertation suggests that the use of climate information occurs as a result of multiple activities articulated through the ordering framework of working practices. As such, usability occurs within situations oriented by normative criteria that apply to work, it is shaped by working practices while it also shapes the practices of work. Disentangling this observation forms the argumentative line for discussing the findings of this research in response to the research questions.

4.1. Answering Q.1 & Q.2. *How does the use of climate information occur in practice? How does the use of climate information shape its own context of use?*

4.1.1. Working and using climate information

The evidence emerging from this research suggests that the use of climate information results from the coordination of work that occurs in a municipal context. Hence, usability encompasses aspects involved in how people interact, learn, assess work and become accountable for how they work. This observation is informed by examples framed in the different categories presented throughout the case studies: categories of "Reflecting", illustrate how municipal officials reflect about the implications of climate risk by applying their professional standpoints and perceptions; i.e., by establishing a rational connection between climate information and their functions and responsibilities within their scopes of action. A performative dimension of knowledge (Skelton, 2020) would suggest that if decision scope is large, then the uptake of climate information would be more fluid. However, "Reflecting" categories highlighted a more intricated reality: municipal officials also exerted their agency to shape the existing decision scope for increasing uptake of climate information; for instance, by framing discourses and narratives through practices observed in categories of "Narrating". Narratives did not only give life to new activities, as shown in categories of "Design"; but they also shaped how people collaborate and work, as shown in categories of "Articulation". Usability unfolded woven around agency, norms, knowledge and working rules. Within this dynamic, legitimacy would be sought, bargained and constructed.

These observations suggest that working contexts play a key role in mediating usability. But at the same time, the case studies also illustrate how the use of climate information affects working practices by establishing a common orientation between the implementation of municipal competences vis-à-vis climate change. This relationship implies that contexts of use and usability occur in a structuration process where they influence each other.

4.1.1.1. Contextual elements

Three contextual elements could be identified as mediating the use of climate information.

1) Administrative competences: Coordinating work is about coordinating attributions and functions given by administrative competences. By granting power over specific attributions and functions, administrative competences drove and determined the distribution of authority over urban development and determined the degree and form of participation in decisions regarding the use of climate information. However, in spite of their official structure, it could still be observed how the use of climate information influenced re-shaping official functions and attributions to different degrees (as in Klima2050; or the new institutional order established in the frame of the CBMP; or efforts to implement legal amendments, as in Bilbao).

The allocation of functions, attributions and responsibilities was found to have an effect on the use of climate information through the following mechanisms:

a) by regulating the resources, jurisdictions, priorities and methodologies that give shape to the activities undertaken by municipal officials;
b) by shaping the official relational space that distributes roles and responsibilities, hence, shaping social interaction in the workplace;
c) by restricting the administrative and policy environment within which usability takes place, particularly when authority over decisions that affect usability is placed on stakeholders whose agendas may not be conductive towards climate adaptation management;
d) by distributing responsibilities through sectorial/spatial functions, stimulating selective valorisation of information according to sectorial needs;
e) by disregarding activities that are not official or obligatory (strongly seen in Bilbao);
f) by forcing specific action based on legal demands (drafting adaptation plans (Copenhagen), forming communities of practice (Donostia)).

2) Historical patterns could be observed which influenced the use of climate information as events converged and provoked policy windows to emerge. Schatzki (2010) observes that *"...past phenomena circumscribe, induce-orient, and underwrite the public manifestation of – but do not cause or antecedently pin down- present activity"* (in Blue et al. 2017, p. 36). As observed in this research, history plays a central role by

a) orienting paradigms that shape and institutionalise risk perception to be associated with particular extreme events, affecting usability by granting value to specific information sets and by disregarding other less visible threats (the three cases highlighted flood over other threats such as extreme temperatures, despite the acknowledged exposure to high temperatures by vulnerable groups, such as the elderly);
b) inducing the establishment of urban development priorities (e.g., competitive, attractive, safe city), which become framed in policy, official mandates and financial structures; and which shape the criteria as to what counts as acceptable practice.

3) The surrounding enabling institutional environment: While analysing the intrinsic properties of the surrounding institutional network go beyond the scope of this research, it is acknowledged that the diversity of functions undertaken by the networks supporting usability is central. Interaction with external experts evidenced that municipalities needed a variety of specific services, ranging from capacity building, to granting support in order to explain complex phenomena to decision-makers, or to develop detailed risk assessments. Since not one single institution could provide all these roles, the diversity of options became important.

4.1.2. Stabilisation mechanisms: Positioning the use of climate information "*through*" practice, versus positioning it "*in*" practice.

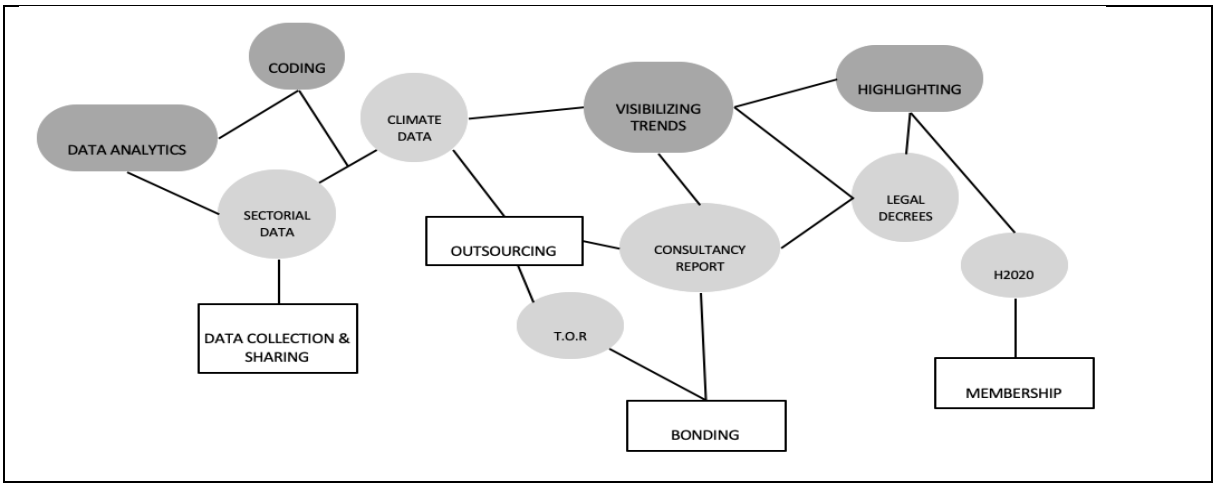
Usability could be observed to transpire through the interaction of a constellation of practices. The practices identified were characterised according to their roles and effects, resulting in two types of practices: anchoring and enabling practices.

a) Anchoring practices are practices that result in a direct connection with climate information sets. For example, "Framing risk as value" (in Copenhagen) is a practice that depended on the direct use of climate information which it was linked to financial assessments and return periods. But at the same time, anchoring practices can foster the stabilisation of other practices. For example, "Framing risk as value" also paved the way to stabilising the use of climate information for risk reduction activities, enabling multiple other practices to take place.

b) Enabling practices are practices that sustain essential processes that allow anchoring practices to be enacted. Enabling practices emerge from customary municipal working practices and are not necessarily related to climate change. However, their unfolding reproduction generates an enabling environment for anchoring practices to be enacted, either by providing required materials (sectorial non-climate data needed for coding processes), or by sustaining usability in normative grounds and building a consensus around its use.

Highlighting the difference between anchoring and enabling practices proposes that usability occurs as an inseparable aspect of work, and it sheds light on how usability occurs as a constellation of practices interacting and shaping one another, thus giving dynamism to the use of climate information and to its context of use. A constellation perspective is consistent with Schatzki's insights regarding organisational work, where work is observed as *"constellations of individual practices and arrangements forming a heterogeneous network linking to other practices and arrangements around it"* (in Splitter et al. 2018, p.12).

Figure 9: A network perspective on the constellation of anchoring and enabling practices



Anchoring practices (darker colour) are connected to different types of climate information and data; Enabling practices (white coloured) provide material entities or other supplies for anchoring practices to be enacted.

The distinction between anchoring practices and enabling practices highlights the difference between positioning the use of climate information *through* practice (through enabling practices), versus positioning it *in* practice (anchoring).

1) Positioning *through* practice, highlights a relationship of *dependency.*

Anchoring practices depend on activities that are inter-connected through a large network of practices which are mostly non-climate-related and which connect a diverse network of actors.

For example, in the Spanish cases the practice of Coding (an *anchoring practice*) is based on multiple practices that allow sectorial-non-climate information to be available. Data management practices are a requirement for coding because data and information provide specific facts and truths about the city (trends, changes) which are meaningful and highlight deficiencies, opportunities and facilitate the establishment of comparisons. If enabling practices such as data management did not perform well (data was scarce, incomplete or

outdated), they would affect the performance of anchoring practices by reducing the pool of available sectorial-non-climate data available for analysis and for contextualisation purposes.

A relationship of dependency acknowledges that usability can be stabilised by other customary municipal practices. This is the case when climate information becomes a feature of administrative competences and involved in working practices (procedures, techniques, standards and methodologies), as in the CBMP and Klima2050.

2) Positioning *"in"* practice is explained through relationships of *influence.*

Relationships of influence can be observed as through using climate information new know-how emerges and shapes customary practices. Examples of this relationship are visible for instance, as climate change is established as a knowledge-object which links risk to sectorial municipal functions, triggering a series of changes in data collection practices by drawing people's attention to collecting *the right data* to serve coding purposes (as in Klima2050).

A relationship of influence underlines how climate information maintains stability by stabilising working practices and social interactions. When usability is based on legal decrees (as in Klima2050 and CBMP), the coordination of work is shaped by the imposition of legal restrictions that affect entire municipal jurisdictions, and demand a re-distribution of roles, resources and administrative competences. In these terms, stabilisation does not emerge by default. It results as people collectively prioritize actions and goals, adapt management systems to delivering long-term commitments; change data management practices; prioritise specific methods to solve problems (e.g., water management in CBMP); or become skilful in "*perceiving, understanding and engaging with complexity"* (O'Brien et al, 2015, p. 318), as explained through the identification of trends in Bilbao.

These observations suggest that stabilisation mechanisms transpire as a result of relationships of dependency and influence, informing how the use of climate information and working practices are mutually constitutive; more precisely, through the mutually constitutive relationship between anchoring and enabling practices: anchoring practices are shaped and facilitated by enabling practices, while they also shape the course of enabling practices.

4.1.3. Practice change

Stabilisation is by no means stagnation. Usability is provisionally stabilised given two aspects: first, usability changes because in engaging with climate information, *"new materials are invented, new standards are set, and users modify"* (Orlikowski, 2000, p. 411). Second, from the perspective of usability as being a subject of legitimation "*whose acceptability is being*

assessed", usability is based on gaining legitimacy, and legitimacy changes with time since "*criteria change over time"* (Deephouse et al. 2016, p. 4).

Changes in practices can be seen through the expiration of old practices, the emergence of new ways of doing things (Schatzki, 2002 in Shove 2012); and through the refinement of practice through its continuity (Gherardi, 2012). Specifically, in the three cities changes in the constellation of usability practices could be identified through changes in material and knowledge compositions.

4.1.3.1. Changes in material composition:

Change in the constellation of practices was dominated by availability, status or absence of material entities. Change could be identified through three mechanisms:

A. Climate information as a material entity provokes changes to working practices:

1) by becoming connected to existing practices: climate information would modify working practices by becoming a central node that re-orders the linking structure that connects several working practices (e.g., projected changes in precipitation provoked the design of the CBMP); simultaneously, increasing the network of practitioners added to the circuit of reproduction of usability practices (e.g. Klima2050 community of practice).

2) by enabling new practices to be enacted: This perspective builds on Gherardi (2012) who explains that material entities act as extensions (sort of prosthesis) that allow practitioners to do things that otherwise (without the material entity) could not be achieved. Examples of these include the possibility to run risk assessments that contemplate future changes in climate conditions or the design of tailored risk reduction action against projected climate change (noticeably in the financial-risk assessments used for designing the CBMP).

B. Usability would result from or would be supported by:

3) by changes in the material composition of other practices: this becomes visible for instance, as new material entities are generated for improving data management practices in order to better serve coding exercises, as in Bilbao and Donostia (new protocols for storing data are created, new classifications are applied in the selection of data).

4) by the enactment of other material entities: for example, the Udalsarea-21 indicators for climate change and the DOT (in Bilbao), are material entities supporting the acceptance of the use of climate information by rhetorical closure and legal limitation respectively.

5) by changes in the material status of infrastructure, which open up opportunities for climate information to be used. For example, when sanitation infrastructure must be renewed as the condition of materials worsens and projected changes in rainfall patterns demand increasing the carrying capacity of water collectors (e.g., in Donostia).

C. (6) The lack of climate information changes other practices by demanding the implementation of compensation mechanisms. For example, in Donostia, proxy indicators were designed and agreed upon in order to compensate for the lack of information regarding the impact of high temperatures on biodiversity.

4.1.3.2. Changes in knowledge composition

Practice theory proposes three perspectives to explore the unfolding dynamic of practical knowledge: knowledge observed as a process taking place within situated practices; knowledge and practice as two mutually constitutive phenomena; or as knowing how to perform a practice (Gherardi, 2012). These perspectives rest on the premise of knowledge as a *"collective social activity"* which is produced through participation in practices (Gherardi, 2018, p. 219).

The use of climate information could be observed through changes in the knowledge composition as evidenced through 4 mechanisms:

a) **New knowledge emerges through the experience of using climate information.** As actors were informed about future climate conditions, they could anticipate challenges to their capacity to implement administrative functions and respond with *"creativity, experience and experimentation... to change the given"* (Emirbayer and Mishe, 1998, in Abers & Kecks, 2012, p. 15). Actors would experiment to change the given through pilot projects (Bilbao) or by conceptualising urban problems in consideration of climate projections (through the formulation of categories as in Donostia).

b) **Changes in knowledge composition are provoked by an increased awareness** about the risk of climate change, evidenced as the demand for climate information becomes more precise as comprehension regarding climate risk and its implications are better understood.

c) **Supporting a common orientation:** The cases of Donostia and Copenhagen emphasise how climate information contributes to providing a common orientation needed for the articulation of work, as issues of mutual concern become linked by climate change. In some cases, municipal officials identified new forms to contribute to the use of climate information: for example, municipal officials became attentive about specific data that could support coding.

d) **New forms of coordinating and synchronising work are adapted** to support the use of climate information. For example, changing jurisdictions (as Klima2050 and CBMP) demanded a re-configuration of roles and responsibilities. These changes represented "*critical transitions*" with *"fundamental and potentially irreversible change...involving complete re-organisation of the policy regime system"* (Solecki et al. 2015, in O'Brien and Selboe, 2015, p.44).

4.1.3.3. Learning in practice

Changes in the constellation of anchoring and enabling practices feature usability as a dynamic process. Changes in practice are linked to changes in knowledge and material compositions through different mechanisms which expose the role of learning as both, a cross-cutting requirement sustaining changes in knowledge and material compositions, and as an outcome of changes in practice.

Learning and change are bonded together through processes of innovation, understood as the refinement from previous practices transformed into present practice (Gherardi 2012). Innovations can occur through "*deliberate activities that introduce discontinuities in working practices";* but can also be produced "*on a daily basis by all those who engage in routine work practices in their jobs"* (Gherardi, 2018, p. 219).

Observing learning as a requisite for and as an outcome of usability, proposes that users learn in practice as they learn "with" and learn "from" climate information.

1) Learning "*with*" climate information: the case studies suggest that municipal officials learn "with" climate information when the challenges for implementing municipal functions vis-à-vis projected climate conditions are recognised, demanding corrective action which can materialise for instance by establishing new forms of collaboration in order to reduce climate risk (as in Klima2050 and CBMP). As a *requisite for* usability, learning is mainly associated with innovation-as-deliberate-activity that introduces discontinuities in working practices (Gherardi, 2018) in order to change the given.

2) Learning "*from*" climate information: learning "from" using climate information highlights the almost invisible legacy of new understandings and awareness that influence the way people think, observe, judge situations, re-shape their interactions and position their participation in specific activities. Learning "from" climate information is about how people's membership and identity in the community of practitioners is constituted through the use of climate information. As *an outcome of* usability, learning is more associated with innovations produced on a daily basis as people work (Gherardi, 2018).

4.1.4. Hindering circuits of reproduction

From a system's perspective (Meadows, 2008), stabilisation and change result from the interplay between positive and negative feedback loops. From this perspective, if only enabling and anchoring practices were enacted, the constellation of practices where usability takes place would occur only through a positive feedback loop spiral. However, this was not the case observed in the case studies. Instead, the consequence of the reproduction of certain practices

(egoistic management of municipal data, restrictive environmental permits versus the need for rapid excess-rain water discharge, silo approaches to risk management) showed that the circuit of reproduction of certain practices was hindering or obstructing the use of climate information.

The perspective about circuits of reproduction hindering usability is proposed as an alternative explanation to understanding the frontiers of usability. From this view, the limits of usability are not to be explained through facts and factors; but instead, by the effects of some practices whose circuits of reproduction pose barriers or disturb the circuits of reproduction of anchoring and enabling practices.

The perspective of hindering circuits of reproduction acknowledges the fact that practices that respond to a situated logic may counteract the use climate information. Light is shed therefore on the practice that generates a barrier, as well as on the logic embedded in this practice which -while it makes it an accepted practice in a specific context-, it may simultaneously jeopardise usability.

Hindering circuits of reproduction informs that the use of climate information is mostly affected by two synchronisation problems, which relate to time and jurisdiction. Organisational patterns result as practices are synchronised either in a temporal or a jurisdictional dimension (Shove, 2020; Blue, 2017). A temporal dimension highlights the "*timing of particular operations in relation to the coordination of other practices"* (Shove 2012, p. 30); while jurisdictions determine categories of social problems around which expert tasks are organised in order to serve specific functions (Abbott, 1988 in Blue, 2017).

a) Temporal: Rhythmical mismatch:

Blue (et al. 2017) explains that practices occur on a temporal dimension that connects sequences of activities; hence, practices connect in time and their temporal occurrence has implications for other practices. Throughout this research it has been underlined that usability results from the synchronisation of working practices in connection with climate information. A time dimension sheds light on whether the legitimacy status, competences, material entities (availability of non-climate data), significance and meaning are synchronised with climate information and result in usability.

- The cases revised in this dissertation primarily underlined how material aspects were decisive in the rhythmical synchronisation of usability. The empirical data suggests that for climate information to be used, other operations must be synchronised in order to provide required material entities that enable usability. Activities are connected in time as "requirement" materials become available in the specific time (and quality) needed for usability

to be enacted. For example, whenever usability depended on legal grounds, material entities such as legal decrees were needed; or whenever coding took place, substrate sectorial non-climate information would be needed. Whenever these "requirement" materials were not produced/provided at the specific time and with the quality needed for climate information to be used, usability would be hindered. For example, the General Urban Plan in Bilbao was updated just before the updating of Bilbao's Planning tools –where climate change considerations were included-; the distribution of administrative competences could not therefore adapt to the requirements of usability. In another example, the enactment of Donostia's Adaptation Plan occurs before the enactment of the Klima2050 strategy and generates conflicts due to the overlap of administrative attributions over planning processes.

- The frequency of enactment between anchoring and enabling practices is also relevant. Anchoring practices are enacted more sporadically in response to specific stages in adaptation decision-making processes, while enabling practices occur with higher frequency since they are the customary response to the implementation of administrative functions. For example, sectorial-non-climate data needed for coding respond to a management system that differs in frequency to that of climate data. Frequency in sectorial-non-climate data generation is affected by the temporal validity of information, which at the same time is contingent upon tasks. The management of sectorial-non-climate data responds to the implementation of administrative functions, and administrative functions determine specific timing in data generation according to specific reporting schedules -daily, weekly, monthly, inter-annual-; which may vary according to fiscal years, political times or evaluation periods. In contrast, updating vulnerability and exposure factors according to newly downscaled regional climate projections may occur according to IPCC's Assessment Reports publication periods (GA2) or to previously established revision periods (as in the CBMP).

b) Jurisdiction: The use of climate information can be hindered by multiple definitions of social problems:

In the three case studies it could be observed that the use of climate information occurred as a complex interplay whereby a rather new policy subject (climate change) had to be immersed into highly official and strictly regulated policy contexts such as risk management and urban planning. In this context, the use of climate information depended on addressing multiple definitions of social problems that were fragmented across political, strategic and operational arenas, as explained by the three identified normative criteria. Normative criteria illustrated how multiple social problems challenged usability by multiplying the configuration of methods

and strategies needed to tailor responses to the demands of different endorsing audiences. This is the connecting link to answer questions 3 and 4, below.

4.2 Answering Q.3 and Q.4. How are such practices enacted and validated collectively? What practices act in legitimating the use of climate information?

The interplay between normativity and legitimacy was visible through activities undertaken to gain endorsement from actors whose consent was needed for using climate information. Actors' interests, needs and objectives are not uniform, and differences were characterised according to political, strategic or operational arenas. Knowing how to respond to diverse demands positioned the role of practical knowledge as central. This knowledge was practical and emerged from social interactions that were informative regarding how legitimators think, apply judgement and make decisions.

In the city of Bilbao, efforts are being undertaken in order to grant usability an official status. An official status is assumed to anchor the use of climate information in legally binding frameworks, enabling its integration in administrative competences, official instruments, procedures, methodologies and planning tools. From a legitimacy point of view, the use of climate information in Bilbao is in a "positioning mode", which implies that endorsement is being sought from decision-makers whose standpoint regarding the use of climate information is ambiguous and conditional on fulfilling sectorial needs rather than in response to an integrated climate adaptation agenda.

In the city of Donostia, the use of climate information is positioned in an "aligning mode", which recognises that while climate information is sustained by legal decrees; still, a number of policies, plans and decrees must be aligned, ensuring that transversal action is not jeopardised by sectorial functions or overlapping attributions. Hence, "aligning" is about attaining a congruence of behaviour (Suchman, 1995).

In the city of Copenhagen, a re-design of attributions and functions signals that the use of climate information is fully incorporated in official mandates and is based on administrative competences. However, the use of climate information in Copenhagen is in a "maintenance mode", which recognises the fact that while legitimacy has been gained, it still has to be "maintained" against potential changes in climate conditions (absence of extreme events during some periods may give the impression of overspending on adaptation projects), unknown urban trajectories and changing political priorities.

Serving the demands of diverse audiences operating in different policy arenas underlines the fact that usability is inseparable from a legitimacy dimension. In this context, the power of persuasion was not exclusively attributed to the quality of climate information per-se; but rather, on whether climate information could be intertwined with the needs and priorities of endorsing audiences, their judgements and value systems. In this context, evaluative criteria applied for assessing the use of climate information were characterised in three different forms:

4.2.1. Normative-political criteria

Describe how positioning climate information in policy environments is contingent on serving the needs of political audiences, and political endorsement normally resulted when the use of climate information supported politicians demonstrating that their decisions were appropriate. For example, when establishing CBMP's safety-level, values of democracy (which are associated with political correctness) where reflected in the political decision to provide an equal level of protection to the whole city. However, this principle did not apply to Bilbao on the same way. While in Bilbao, prioritising sustainable urban development was associated with positive political values that reflected politicians' commitments; it could also be evidenced that decisions to endorse the use of climate information resulted from other indirect influences, such as the perceived need to anticipate legal obligations.

Understanding what becomes important for legitimators and representing these values in an endorsing strategy became central. Endorsing strategies sought to increase awareness by facilitating comprehensibility regarding the implications of climate change on urban development; for example, by obtaining standards or by becoming members or participants in European programmes (Covenant of Mayors or H2020 projects); by demonstrating an imminent officialization of responsibilities with regard to climate adaptation (Bilbao); or by assessing the implications of non-action vis-à-vis future risk (Copenhagen). Facilitation normally came in association with specific narratives that contextualised climate change as a shared problem (notably visible in Donostia). In cases where endorsement is fully granted, as in Copenhagen, narratives resulted in rhetorical closure (Gherardi, 2012) and institutional re-organisation limited practices through legal decrees, and a form of practising in relation to water management based on the principles of the CBMP was acknowledged as the only way forward and other alternatives were excluded.

4.2.2. Normative-procedural criteria:

The criteria used for judging appropriate practice in the three cases underlined the fact that the use of climate information is facilitated when it conforms with established methods that are based on recognised standards and/or on socially accepted techniques that emphasise

performance and provide a skilful impression of management (Suchman, 1995). The examples suggest that in this way, climate information can be made operational through standardised administrative and procedural mechanisms traditionally used in municipal practices, since in this way, transaction costs are reduced compared to adapting traditional practices to new schemas. Key practices that emerged in this regard included:

1) The use of traditional measurement methodologies to categorise risk (including establishing thresholds and boundaries with regard to acceptable risks and damage). Categorising risk through these methods allows the prioritising of activities through an official indicator system associated with well-known metrics (such as return periods, financial estimates, mortality/morbidity rates, frequency of service interruption, etc.);

2) Risk was associated with specific control measures (hence, solutions were provided) which were organised through traditional planning methods, including specific time-lines, budgets, and with activities distributed based on administrative competences and against a widely-understood accountability system.

These activities highlight how working provides the guidelines that orient the use of climate information, as meanings, experience and sectorial lenses are applied to locate climate information in the context of working practices. For example, the practice of Coding (Bilbao and Donostia) illustrates how the transition from climate data to information is contingent on the addition of meaning, which occurs -for instance- through generating categories where risk is explained in terms of the elderly being more exposed to high temperatures, which later shapes the methods used to appraise and rank risk. Categories reflect the social meaning embedded in work and facilitate making climate information manageable, since the use of categories enabled the association of climate information with customary working procedures.

4.2.3. Normative-cultural criteria:

Normative-cultural criteria evidenced tacit rules, patterns of shared expectations and assumptions about how work is to be coordinated, underlining the fact that the coordination of work required for the use of climate information is based on people's interactions. Normative-cultural criteria are featured as central mediators of usability since they affect the quality of collaboration and coordination in the workplace and shape participation in practices.

Learning, experiential knowledge and normativity

Across the three case studies it could be observed how municipal officials learned about the expected pattern of behaviour that regulates people's interactions through experience. Social interactions at the workplace demanded learning what becomes sensitive, controversial and conflicting to other parties; how colleagues apply judgement to deal with specific situations; understanding how objectives are set and reached; knowing how to add value to people's work; comprehending the rhythm, sequences and timings that mark the pace of work. A deep comprehension about these features was key for articulating the use of climate information.

Cultural aspects influenced the enactment of practices differently across the three case studies, which become clearer through the example of data management. In the three case-studies it was observed that the information management system was deeply influenced by a smart-city approach in which updating datasets and generating large volumes of real-time data and information were a central goal. However, while in Bilbao and Donostia municipal officials highlighted the perception that data was a private good owned by those who generate the data, in Copenhagen data was seen as a common good that must be openly shared since it can deliver value to everyone's work. Differences in data ownership result in a myriad of cultural practices that range -for instance- from knowing how to request data, to voluntarily mentoring colleagues in new data uses. Differences across case studies show how data management practices (collecting, storing, sharing and analysing) were in some cases more supportive of coding and updating. Bilbao's data governance system informed of practices that resulted in data being scattered and organised in formats that did not follow a unique standard, making data circulation a difficult operation. Also, it could be seen that restricted access to information made participation in decision-making or deliberation processes to be exclusive to those who owned the information in detriment to those who did not have access to information. By contrast, Copenhagen displayed practices around a data governance system that facilitated data integration and circulation.

4.2.4. The dimensions of usability

The metabolism of usability is composed by the circulation of materials, knowledge and ideas that energise the enactment and coordination of collective activities. In this context, the documented case studies inform that usability transpires in at least four dimensions:

Table 32: The dimensions of usability

A legitimacy dimension	Which recognises usability as being legitimacy-dependent. Usability requires purposive, deliberate legitimating action. Usability is more likely to occur providing it complies with normative criteria of endorsing audiences in political, strategic or operational arenas. Usability is thus validated collectively.
An outcome dimension	As an outcome, the use of climate information is enacted in the context of and it depends on customary municipal practices (measurement systems, methodologies, administrative procedures) whose reproduction sustain essential processes that enable the enactment of usability practices (the provision of required material entities such as data for coding; or supporting building legitimacy). Usability is activated through activities associated to customary working practices.
A consequential dimension	Whereby the use of climate information provokes new practices to emerge and working practices to change. For example, as climate change is positioned as a social problem linked to the operations and missions of all municipal departments new institutional arrangements are implemented, affecting the conditions under which social interactions and collaboration take place.
A processual dimension	Which recognises the fact that the previous three dimensions unfold as intrinsic aspects of a structuration process, where working contexts mediate the use of climate information, while at the same time, usability shapes working practices, thus shaping its own context of use.

4.2.5. The practical drivers of usability

The characterisation of normative criteria reveals that articulation, engagement and collaboration needed for coordinating the use of climate information were contingent on multiple interests, identities, experience and norms. In this context, two key aspects could be observed:

1) working practices matter because they reflect the values, understandings and experiences that structure a contextual logic of how work is expected to unfold;
2) the use of climate information is subjected to a similar value framework that circumscribes municipal work; and it is therefore exposed to similar assessment criteria that apply to conventional working practices.

These aspects suggest that climate information is more likely to be used when:

a) Climate information can demonstrate a contribution to, or facilitates the implementation of administrative competences, by evidencing how climate risk affects the implementation of administrative competences; or by establishing a source of coherence that sustains a common orientation in relation to work;

b) Climate information can be aligned with official procedures, methods or standards: climate information can be treated through standardised administrative and procedural mechanisms that enable the distribution of roles and tasks according to administrative competences; climate information can support official measurement systems -it can be turned into thresholds that allow the comparison of progress between activities; climate information can be linked to officialised tools (such as hydrological models used in risk estimates);

***c) The use of climate information complies with the culture of work*:** using climate information does not provoke large disturbances to the rhythms and intensities of work; hence, usability does not demand radical and fast change to the traditional pace of work. However, in cases when radical change is more prominently seen -as in Copenhagen and to a lesser degree in Donostia- these changes come accompanied by modifications in legal decrees.

d) When climate information can be woven around the demands of endorsing audiences: the decision as to how about, and whether or not using climate information is never politically neutral and it goes beyond purely strategic or technical issues.

4.3. Answering Q. 5: What type of climate information enables adaptation to become a feature of institutions?

4.3.1. Mainstreaming the use of climate information?

The challenge of climate adaptation is far from being only technical, since adaptation demands *"changes in mind-sets, priorities, habits and loyalties"* which are embedded in *"the complexity of values, beliefs..."* (O'Brien et al, 2018, p. 6). For climate information to become a central component of municipalities' strategic approach to adapt to climate change, this dissertation has argued that this will ultimately imply and result from changes in working practices. In this context, the use of climate information will have to be woven around, be sensitive to, and react to changes in value systems, norms, priorities and legitimacy criteria in specific working contexts.

If usability demands changes in these dimensions, then positioning the use of climate information in the larger context of the adaptive transformative challenge brings up the question

as to how climate information is going to be accommodated as a permanent and guiding component of decision-making.

The term mainstreaming normally refers to "*a concept that brings marginal, sectorial issues into the centre of discussions, thereby attracting more political attention, economic resources and intellectual capacities"* (Gupta & Van Der Grijp, 2014, p. 67) in order to *"redesign policies, legal frameworks and to rethink the operation of institutions, investments and all the relevant processes for climate action across the sectors"* (Guzman, 2019. p. i). The term "mainstreaming" is normally applied in reference to bringing climate adaptation into development processes, with a particular focus on project design and evaluation, or connected to policy processes and evaluation mechanisms (ibid). Beyond its multiple foci, the concept of "mainstreaming" in these terms suggests features of stability.

The proposal brought forward in this dissertation follows Giddens (1984) and Orlikowski (1992) and adopts the position that this challenge will entail that the use of climate information must become involved "*as part of the rules and resources recursively involved as institutions"* that give *"solidity across time and space"* (Orlikowski 1992, p. 24) to urban planning. In other words, this perspective acknowledges that usability is linked to processes of institutionalisation. A common denominator to all three case studies is that long-term objectives and commitments are recognised as central for enabling the use of climate information. This raises the question as to whether the identified changes in usability practices can be said to be part of a larger institutional construction project.

Institutions can be defined in different terms. For Abers and Kecks (2012) institutions represent "*commonly accepted ways of doing things"* and the way *"people act upon the world*" (p. 5). Institutions are seen as the systems of rights, rules and decision-making procedures -(Patterson 2018) that emerge as sets of regularized practices that influence how multiple actors interact to make decisions and act (Schmidt 2010 in Friel 2017). According to Young, institutions "*give rise to social practices, assign roles to the participants in these practices, and govern the interactions among the occupants of the various roles*" (2008, p. 13). Suchman (1995) discusses the concept of institutionalisation in terms of its legitimating dimension, arguing that, "*legitimacy and institutionalization are virtually synonymous. Both phenomena empower organizations primarily by making them seem natural and meaningful"* (p. 576).

From a practice perspective, Blue (2019) builds on the work of Schatzki (1996) to assert that institutions can be understood as being constituted by configurations of practices connected through specific actions. For Gherardi, institutions affect practices by establishing the rules of accountability that are used for assessing the performance of a practice (Gherardi, 2012).

Institutionalisation in this sense plays a key role in providing practices with the stability necessary to facilitate human interactions by reducing uncertainty and transaction costs (Young, 2008). However, the notion that institutions are stable structures is deeply contested: "*institutions exist only because they are constantly being produced and reproduced by knowledgeable and creative actors*" (Lund, 2006; Berk and Galvan, 2009 in Abers and Keck, 2012, p. 12).

The relationship between practices and institutions is a central object of study in the literature of institutional works (Lawrence, 2010). Scholars in this field examine how practical actions act in creating, maintaining and disrupting institutions through intentional, as well as unintentional actions resulting from "*mundane... day-to-day adjustments, adaptations, and compromises of actors*" (Lawrence, 2010, p. 1). Scholars in this field explain that the accomplishment of creating institutions occurs through the reconstruction of rules and boundaries that define access to material resources (ibid).

Features of creating institutions could be observed through the institutional changes demanded for articulating the work necessary to implement Klima2050 and the CBMP. In both contexts, the official relational space was given a new order. In the context of the necessary long-term commitment, the transformation of these formal frameworks seems to enable the reconstruction of rules (establishing new standards for risk management) and boundaries that define access to material resources (re-distribution of budgets); displaying features of institutionalisation. However, these processes were less visible in Bilbao, primarily because usability is acknowledged to greatly depend on changes in legal regulations and these have not yet been changed.

A contribution towards a new institutional project can also be observed as new institutional arrangements are put into practice and produce what Young (2008) calls "institutional interplay" - "*the operation of one set of institutional arrangements affects the results of another or others*"- (Young et al. 2008, p. xvi). Young (2008) explains that institutional interplay manifests itself through a series of mechanisms including "*issue area overlaps"*[75].

Issue area overlap is observable in the implementation of Klima2050 and CBMP as climate change is positioned as a social problem linked to the operations and missions of all municipal departments. Climate risk becomes an issue overlapping the administrative competences of different departments, becoming the source of coherence for the structuration

[75] The authors also indicate other mechanisms such as intgrated strategies, strategic inconsistency and potential strength of institutional fragmentation (ibid. xvii).

of communities of practice and affecting the conditions under which social interactions and collaboration take place.

In these terms, usability in Donostia and Copenhagen can be associated with practices that represent the "institution of meaning" (Schatzki 2001) since they are *"socially recognized forms of activity"* (Barnes, 2001, in Alexander, 2015, p. 93).

The previous examples suggest that mainstreaming and institutionalising the use of climate information are two concepts that can be best associated with changes in practices, since they reflect changes in values, beliefs, knowledge and cultures of work. In this context, the challenge of usability resembles the challenge of institutional building, where meanings, norms, rules and understandings must be modified and adapted in order to allow the use of climate information to take place.

However, in line with Orlikowski (2000), it is suggested that since usability is performed as practice, it must be acknowledged that usability will always be temporarily stabilised; meaning that even when the use of a climate information has been legitimised and stabilized around certain activities, this status is only provisional. As shown through the multiple examples gathered in this dissertation, changes in working practices, changes in the climate system, changes in urban trajectories, in the politics governing the city and on perceptions of value linked to the adaptation to climate change, may change the criteria used for assessing the suitability of climate information in decision-making. Therefore, the need to better understand how practices are constituted and change, and how people interact with climate information in practical terms, becomes a central task for sustaining the use of climate information.

Chapter 5. Conclusions

5.1. Conclusion 1:

Evidence emerging from this dissertation suggests that usability is a dynamic phenomenon which transpires through social practices embedded in a working context. The dynamic of usability is rooted in processes of learning by doing, experimentation and negotiation that unfold as municipal officials engage with planning in the context of climate change and exercise their agency to position the use of climate information in political, strategic and operational arenas. In doing this, they provoke changes to how risk and urban development are perceived vis-à-vis climate change, affecting how people establish goals, assess achievements, establish new planning perspectives, interact and work.

While different drivers draw attention to climate information (extreme events -Copenhagen-; response to legal obligations -Bilbao-; increased awareness regarding future risk -Donostia-); however, these impulses were not sufficient for positioning the use of climate information in political, strategic or operational arenas. Usability always required a degree of persuasion to be activated. Sometimes, climate information did not contribute to specific projects or policy processes, or it was too foreign to traditional practices. However, in persuading, negotiating, accepting or disregarding the use of climate information, learning always emerged, since these decisions were collective and occurred through social interactions, where assessing the contribution of climate information to practice, policy or project was shaped by previous experiences, understandings, rules, meanings and norms. Usability could be observed as an outcome of people's decisions, shedding light on people's agency and recognising (in line with Giddens,1984) that what people do, matters for the course of usability and for how people work. Conclusively, this suggests that usability does not only include instances in which planning is informed by climate information. This is a contrasting perspective to the established criteria "fit/applicability" traditionally used to designate when climate information is usable (Lemos and Rood, 2010) (and where a lack of application and fit on decision-making processes becomes synonymous with a lack of usability). A practice perspective to observe usability informs about the changes that result as people interact with climate information, including the creation and validation of knowledge, the changes in working norms and overall comprehension regarding urban development and climate change. This suggest that usability occurs as both, as means and as ends of a process of institutional learning, building and change. These observations suggest that fit/applicability as criteria to assess usability obscures a profounder dimension to usability. Fit and applicability can only deal with final (successful) outcomes, but they cannot

embrace the complexity of learning processes that unfold and contribute to climate information becoming involved in working practices and transforming the way in which people work.

5.2. Conclusion 2:

The evidence emerging from this research suggests that usability encompasses multiple aspects involved in how people work, learn, assess work and become accountable for how they work. Municipal practices show us the available resources, reflect contexts, institutional goals, governance structures, policy directions. They are maps that inform us about the interaction of these elements, about the spaces for innovation, experimentation, windows of opportunity, and how to make resources usable. Working reflects the values, understandings and experiences that structure a contextual logic of how work is expected to unfold, providing the assessment criteria to locate climate information in the context of working practices.

Conclusively, the examples illustrated in throughout this research suggest that the use of climate information is subjected to similar value frameworks that circumscribe municipal work and to the same assessment criteria that applies to conventional working practices. In this sense, working provides the guidelines that influence the use of climate information, implying that the use of climate information cannot be studied in isolation from working practices neither can it be understood as isolated phenomena, since usability also affects working practices, therefore changing its own context of use.

5.3. Conclusion 3:

Proposing that usability of climate information must be explored as a practice, avoids the assumption that exogenous and endogenous factors operating in causal chains mediate usability. It rather embraces complexity by acknowledging that the uniqueness of situations in which people coordinate work to act upon climate information is the result of the reproduction of practices which are sustained by norms, rules, experiential knowledge and transformative relations. In this context, the case studies suggest that barriers and enablers to usability are highly contingent on the enactment of practices; implying that barriers and enablers cannot be explained solely through factors. This research identified enablers as “enabling practices” and barriers as “hindering circuits of reproduction”.

5.4. Conclusion 4:

This research has shown that the practices of usability are tightly woven around practices enacted to build endorsement and to position the use of climate information across different policy arenas; to contextualise them within manageable and accepted procedures and to evaluate and to demonstrate their attributes in supporting planning and policy-making processes. Articulation, engagement and collaboration needed for coordinating the use of

climate information are thus contingent on responding to multiple normative criteria expressed in working practices. The purposeful devise of strategies to increase the endorsement of the use of climate information against these multiple criteria reflects the fact that the use of climate information is a result of legitimation. Simultaneously, climate information also contributes to legitimation activities by facilitating a better comprehension about how climate risk will affect the implementation of municipal competences. The connection between usability and legitimation is suggested as featuring a structuration process of mutual influence. In this context, the power of persuasion is not exclusively attributed to the quality of climate information per-se; but also, to whether climate information can be woven around the norms that orient appropriate practice in a working context.

5.5. Conclusion 5:

The use of climate information is shown to be the result of myriad practices occurring throughout time, through changes in practices and their effects on the structures that shape their use. The practice view to usability presented in this dissertation moves beyond the idea of mainstreaming climate information as presence in law, policy, infrastructure design or prescriptive documents by showing that mainstreaming and institutionalising the use of climate information are two concepts associated with changes in practices, since changes in practice reflect changes in values, beliefs, knowledge and working cultures.

In the three cities, climate information was very useful for detecting and informing about how climate change would increase risk in specific parts of the city or in municipal activities (e.g., through the blue map in Copenhagen or the red map in Bilbao). Solutions were prescribed in detail (for instance, the NbS map for Donostia; planning tools in Bilbao and the overall CBMP in Copenhagen). While risk could be defined in detail and solutions were proposed; still, solutions had to be framed in a designed process that enabled their implementation. A clear difference between the case studies regarding implementation was attributed to whether a process of implementation was linked to working practices. In Copenhagen, while the solutions proposed were multiple small-scale water treatment plants, the process of implementation was designed to fit existing practices, methodologies and standards. By contrast, in Bilbao solutions to climate challenges have been defined, but the implementation process has not been fully designed and it is not yet clear as to how it will be linked to municipal practice. This suggests that while climate information and climate services may be well-equipped to detect and define a problem and even provide the solution, acting upon that information will largely depend on the capacity to anchor implementation processes in practice.

Chapter 6. Innovation

This research has explained how usability occurs as a process of practice change in the context of work, and it has presented and explained core aspects sustaining these dynamics.

- The research has demonstrated how the use of climate information occurs through a constellation of anchoring and enabling practices;
- it has exposed how usability requires legitimation action;
- it has evidenced how usability is intrinsically connected to its working context through shared-evaluative criteria that apply to working practices and it has provided a point of comparison within these criteria;
- it has explained the mechanisms of practice change and processes of structuration (material and knowledge compositions);
- it has evidenced that barriers and enablers to usability are linked practice;
- it has shown that usability is a phenomenon occurring within institutionalisation processes.

From this perspective, the innovation of this research is conceptual; but in addition, by exposing conceptual gaps in the previous conventional understanding of usability, this research brings practical implications for better understanding the use of climate information in cities and for the design of climate services for cities. In these terms, this research can inform about:

- **The identification of users' needs from a practice dimension.** If working provides the guidelines that frame usability, then users' needs can be identified and understood from a working-practice dimension and thus inform about the particular procedures, standards, tools and modes of work that allow anchoring climate information in practice. While traditional users' needs assessments centre around existing resources (financial resources, technical competences), or cognitive aspects of information users, a practice-needs approach to usability would by contrast focus on identifying the procedures to which climate information will be linked, underlining how they are coordinated and synchronised, identifying which working practices are woven around these procedures and paying particular attention to whether these practices are perceived as enabling or as hindering circuits of reproduction.
- **The ex-post assessment of the impact of climate information and climate services:** defining impact in terms of changes to practices vis-à-vis the use of climate information, the effect and benefit provoked by climate information can be established in terms of

changes in activities, performances, awareness, behaviour, normative criteria and learning processes.

- **The design of practice-oriented policy intervention to increase the use of climate information**: by showing the prominence of some practices in enabling usability or hindering circuits of reproduction by acting as barriers, corrective action can be devised (for instance, methods for improving data management practices, which were widely discussed in this dissertation).

In order to materialise this conceptual innovation, an analytical framework for exploring the use of climate information in practice is presented in the following section. By outlining core concepts which emerged throughout this dissertation as being core to analysing usability practices in a working context, the framework represents a step forward for research in the field of using climate information.

6.1. A step forward: The Usability-as-practice analytical framework

The framework outlines key concepts which are explained in this dissertation as being central to orient the exploration of the use of climate information in city administrations.

The framework is designed for supporting three goals:

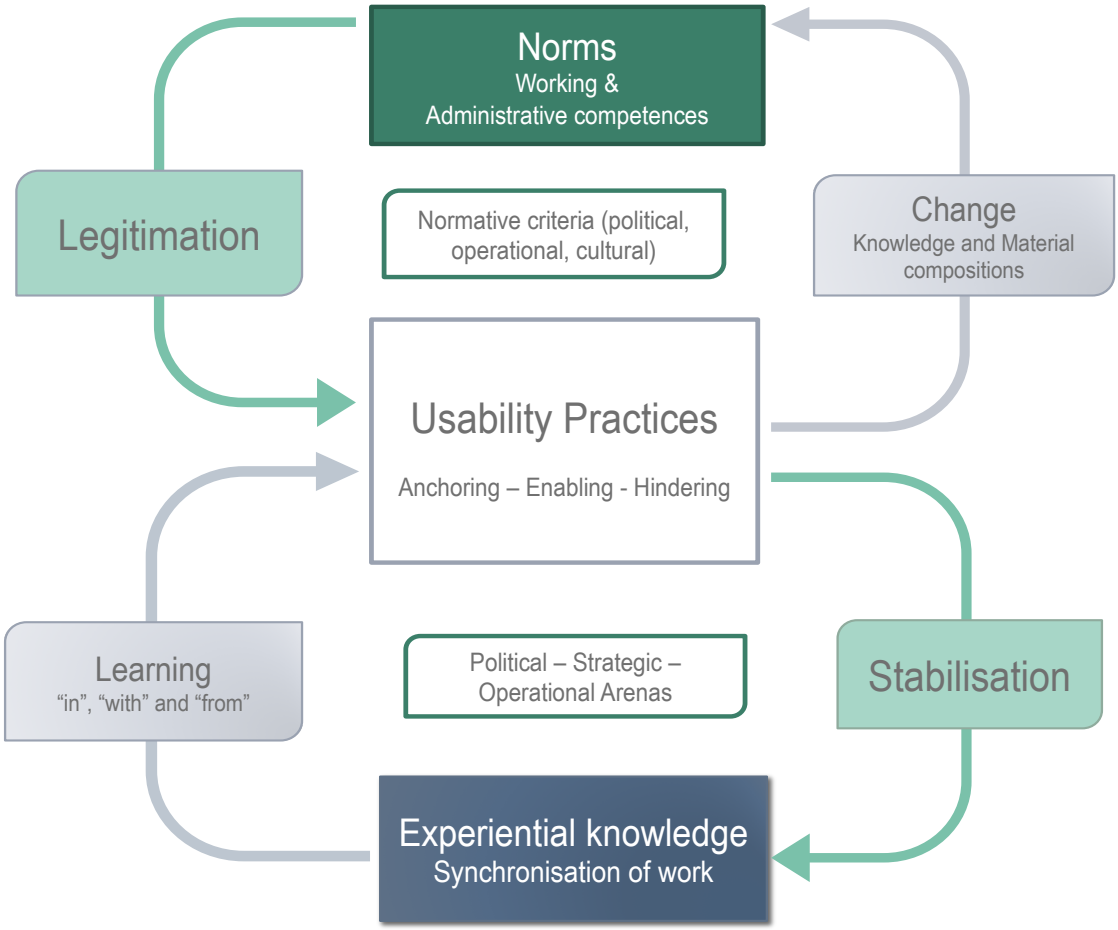
1) to identify pre-conditions for promoting usability in a new context where climate information is expected to be used (as an ex-ante assessment to identify gaps, enablers, drivers and barriers to usability in a given context);
2) to understand the degree impact of climate information on working practices (an ex-post assessment); and finally,
3) to facilitate gathering and systematising the collection of practical experiences around the use of climate information, and from this, to support improving the design of climate services for cities.

The analytical framework is composed of a conceptual framework and of a method for mapping out the use of climate information.

6.1.1. Conceptual framework

Figure 10: Conceptual framework: A relational connection of usability concepts

As a constellation of practices, usability results from the synchronisation of anchoring and enabling practices. Usability practices are linked through understandings and explicit rules (Schatzki 1996), experiential knowledge and norms (Gherardi, 2012); and are enacted only when they "*are answerable to norms of correct or incorrect practice"* (Rouse, 2001, p. 189) in a working context.



The framework is to be read departing from the box "Norms". **Norms** are structured within the orienting framework of **administrative competences**. **Legitimation** efforts are needed in order to enact usability practices against three **normative criteria** (political, operational and cultural). **Anchoring and enabling practices** are affected by hindering circuits of reproduction of other working practices. Usability practices become temporarily **stabilized** and, as usability becomes involved in the synchronisation of work, **experiential knowledge** emerges. **Learning** "in", "with" and "from" climate information occurs and **shapes the context of use** through changes in knowledge and material compositions, which **affect the normative assessment criteria** used for validating usability.

6.1.2. Method for exploring the pre-conditions for and the impact of, usability

The Method is organised around three areas which are identified in this research as central issues shaping usability in city administrations.

- *Area 1,* highlights key contextual elements that shape usability.
- *Area 2,* centres around the normative criteria that applies to judging the use of climate information in different contexts.
- *Area 3,* centres around the mechanics behind the use of climate information and it highlights the interaction between anchoring, enabling and hindering practice constellations vis-à-vis dynamics of stabilization and change.

Each area is then defined and linked to questions which facilitate and to support the exploration process. The questions are organised in two blocks, depending on the objective of the exploration:

- *Block 1,* is designed to yield a picture about the context where climate information is expected to be anchored (and thus support ex-ante assessments about the pre-conditions for usability).
- *Block 2*, is designed to orient ex-post assessments regarding the impact of climate information in municipal practices.

Departing questions to apply the framework are the following:

- What activities represent the use of climate information?
- What are the most relevant ones, and why?
- What sorts of challenges poses the use of climate information?
- Who influences the use of climate information?

With these overarching questions in mind, the next step for implementing the Framework are given in table 33 below:

Table 33: Method for exploring the use of climate information

Area		Description	Block 1: Ex-ante assessment	Block 2: Ex-post assessment
Area 1. Context of use	1.1. Administrative competences	By granting power over specific attributions and functions, administrative competences shape the distribution of authority over urban development and the degree and form of participation in decisions about usability.	*How do administrative competences affect the resources, jurisdictions, priorities and methodologies that shape practices? How do they affect the distribution and composition of responsibilities and roles regarding urban development?*	*Have administrative competences being modified in order to sustain/support/enable the use of climate information?*
	1.2. Historical patterns	Historical patterns influence the use of climate information by shaping development paradigms, priorities and perceptions of risk.	*How far is climate risk oriented by historical events? Are there other climate risks excluded from this paradigm? Which urban development priorities have become framed in policy?*	*Has climate information positioned previously ignored climate risks in official documents? Are there new practices organized around these risks?*
	1.3. Climate information providers	Municipalities need a variety of specific services in the field of climate information.	*What is the role of external information providers? Provision, Translation, Regulation, Distribution, Facilitation? Through which practices do they interact with municipal officials?*	*Has the interaction with external providers changed throughout time?*
	1.4. Social orders	Stakeholder interaction shapes the work needed for using climate information. Stakeholder interactions transpire through the establishment of arrangements; strategies and are shaped by their position regarding usability vis-à-vis urban development (based on Gherardi, 2012).	*What are key aspects shaping actors' positions/judgement regarding the use of climate information vis-à-vis urban development?*	*Has actors' positioning regarding the use of climate information, their strategies and arrangements of interaction changed since using climate information?*
Area 2. Normative assessment criteria		The use of climate information depends on addressing multiple definitions of social problems which are fragmented across political, strategic and operational arenas.	*What are key aspects that define assessment criteria that apply to usability across arenas? Which activities are undertaken in order to gain endorsement over usability?*	*Has practical knowledge emerging from usability being validated?*
Political Arenas	**2.1. Political criteria**	The use of climate information is weighted against the trade-offs between what is politically desired/acceptable. Endorsing strategies facilitate	*Are there standards, official programmes or memberships that facilitate comprehensibility regarding the implications of climate change on urban development?*	*Have social problems being re-framed in the context of climate information?*

		comprehensibility regarding the implications of climate change on urban development.		*Have assessment criteria applied to judge the use of climate information changed over time?* *Does climate information affect the conditions under which social interactions and collaboration take place?* *Has climate risk become positioned as a social problem linked to the administrative competences of different departments?* *Has climate risk become source of coherence for the structuration of communities of practice within the municipality?* *Is the official relational space that enables usability being given a new order? (long-term commitment, the transformation official frameworks; boundaries that define access to material resources).*
Strategic / Operational Arenas	**2.2. Procedural criteria**	The use of climate information is facilitated when it conforms with established methods that are based on recognised standards and/or on socially accepted techniques that emphasise performance and provide a skilful impression of management (Suchman, 1995). The use of climate information is weighted against the trade-offs between what is technically needed and feasible to do. Usability is assessed in terms of its contribution to ordering actions, resources, establishing goals, designing plans and strategies in the context of climate change.	*Does the use of climate information facilitate the implementation of administrative competences? Can the use of climate information be made operational through standardised administrative/procedural mechanisms, or through customary methodologies, planning and administrative methods traditionally used in municipal practices?*	
Cultural dimension	**2.3. Cultural criteria**	Cultural aspects influence the form of social interaction and collaboration that shapes the use of climate information.	*Does the use of climate information facilitate the articulation of work? Does it facilitate adding value to people's working activities? Does it affect the rhythms of work? Does usability affect people's membership and identity in a given community of practitioners?*	
Area 3: The dynamic of usability practices		Usability results as people collectively prioritize actions and goals, adapt management systems to delivering long-term commitments; change data management practices; prioritise specific methods to solve problems. Mechanisms of stabilisation and change transpire through relationships of dependency and influence, as anchoring practices are shaped and facilitated by enabling practices, while they also shape the course of enabling practices.		
3.1. Positioning *"in"* Anchoring practice		Anchoring practices are enacted in direct connection to climate information sets. Climate information affects working practices by becoming connected to existing customary practices or by enabling new practices to be enacted.	*Which practices are enacted around climate information sets?*	*Are these new practices? Are these new versions of old practices?* *Are customary practices adapting to support the use of climate information?*

3.2. Positioning *through* Enabling practice	Usability depends on multiple practices which provide required-material entities or which grant legitimacy to the use of climate information.	*What required material entities are needed to support usability? Which practices produce these material entities? How do they connect to anchoring practices?*	*Can changes in the material composition of other practices be linked to usability? Do jurisdictions change? are roles, resources or administrative competences re-distributed/reconfigured to support usability? Has demand for climate information became more precise?*
	New knowledge emerges through the experience of using climate information.	*Can actors anticipate challenges to implement administrative functions? Do actors respond with creativity? Has deliberative corrective action being applied to sustain usability?*	
3.3. Hindering circuits of reproduction	The circuits of reproduction of some practices pose barriers or disturb the circuits of reproduction of anchoring and enabling practices. Practices that respond to a situated logic may counteract the use climate information.	*Which practices generate barriers to usability? What logic sustains these practices? What makes them accepted practice? How do they affect usability?*	*Have hindering circuits of reproduction changed over time? Have they become enabling practices? Have their hindering effect being amplified by the use of climate information?*

Chapter 7: Limitations and future research

7.1. Research limitations

1) Ethnographic methods are an influential and indeed, recommended research methodology to undertake a Practice-Theory-oriented research (Gherardi, 2012; Nicolini, 2012). While in the initial research design, observation was positioned as a central aspect to data collection, nevertheless permission to observe daily activities or instances of decision-making in the city administrations was not granted, and the research methods had to rely on running in-depth semi-structured interviews and on secondary data sources.

Gherardi explains that what becomes important (from a researcher's perspective) is not so much what is being done, but how it is being done, "*what sense it has and the relations it establishes*" (2012, p. 196). Nicolini (2012) stresses the importance of sensitivity in order to grasp actors' value systems and to describe the practice as an accomplishment of discursive and non-discursive practices. Nicolini places a high emphasis on linguistics (both, verbal and bodily) as a form to observe and describe behaviour and thus to focus on the competences necessary to perform the practice. Consequently, in Nicolini's view, ethno-methodological research methods are central.

However, the emphasis on the use of language (verbal and bodily) in practice research is a source of debate among the practice community. For Shove, Pantzar and Watson (2012, in Rinkinen, 2018) linguistics is not central to the theory of practice, because Practice Theory shifts the focus from the subject to the action, and the trajectory of practices occurs beyond the situated time/space where the practice occurs. Indeed, in exploring how climate information was being used in the municipalities, it was virtually impossible to find explanatory power in one single practice. Rather, the use of climate information unfolded through a constellation of practices taking place in different locations, at different times and connecting different actors (and their experiences). Consequently, it was impossible to explore such connections in-situ, and rather, it was necessary to explore them as constellations of practices explained by different actors. Here, Shove's explanation of practices in the context of complex operations provides further clarity. Shove (2012) gives the example of docking a large cargo ship at a port. She refers to the fact that docking the vessel does not only demand the captain's skills and training, but also the operational skills of the official on the dock, coordination teams, and a plethora of artefacts coordinated simultaneously by other people in different spaces and at different moments. Intending to explain successful docking cannot be the result only of a captain

manoeuvring the cargo ship, as it would only provide a partial picture of the act of an unfolding complex operation.

Consequently, in the data collection methods, semi-structured interviews were designed to allow interviewees to move beyond their own single activities and reflect on the effect provoked by the aggregation of other activities sustaining the use of climate information. Furthermore, as a central task presented in the research goals was to identify normative and experiential knowledge emerging from practices of using climate information, these are elements that do not simply become explicit through observation. In this context, Bryman (2012) suggests that there are issues that are extremely difficult to discern only from observations alone. For instance, "*issues to do with leadership notions may not crop up on a regular basis, which would make observation a very extravagant method of data collection*" (p. 496). Qualitative interviews also present the opportunity to bring to the fore issues that may not be possible to simply observe, therefore, asking people directly about these issues may be the only plausible way to find out about them. Some of these issues consider the reconstruction of events to better understand how a certain series of events unfolded in relation to a specific situation (ibid). Finally, given that planning occurs in specific time-space contexts, then the research strategy had to consider the episodic nature of the practices involved in using climate information. In this context, Bryman suggests that organisationally and practically it makes more sense to rely on repeating interviews than repeating visits to the research settings (ibid).

In summary, while not complying with the demands of ethno-methodological or ethnographic approaches, the research could derive core observations that help characterise usability as a practice. Nevertheless, it is acknowledged that had permission to observe deliberation processes taking place within city administrations and to follow their course of action could have provided further insights as to how usability is negotiated in practice.

2) A second limitation of this research is that it could not engage with routine repetitions of practices. Blue (2019) explains that "*Viewing repetition as routine has the potential to introduce a closedness to practice and to following understandings of social life... the notion of routine has implications for conceptualising how practices connect and how practices and practice orders change" (p.928).* However, it is important to highlight that differences in rhythms of enactment between anchoring and enabling practices vary. It could be observed that anchoring practices were associated with specific instances when decisions were negotiated, while enabling practices were enacted as part of routine working practices. Following the routine reproduction of anchoring practices could not be carried out since they took place within complex institutional and governance processes occurring in non-routine contexts (negotiation

processes in round-tables, design processes occurring in task forces, or opportunistic urban experiments). Decisions as to how and when to use climate information are context-specific, and the variety of contexts makes it almost impossible to establish a pattern of repetition that results in usability being enacted in practice. However, across case studies it could be identified as to how usability follows common patterns that define routes of usability (legitimacy and endorsement building leading to usability), which suggest that routines exist which are common to municipal administrations and which are significant for the course of usability. Nevertheless, it is acknowledged that a focus on repetition -particularly on the role of enabling practices- could provide meaningful insights into better understanding the mechanisms that connect anchoring and enabling practices and to shed further light on the hindering effects of certain circuits of reproduction on the use of climate information.

7.2. Future research

1) Future case studies could contribute greatly to providing new insights to better understand how usability is mediated by the rhythms of the enactment of enabling and anchoring practices. Aspects such as practice transformation, the continuity and change of knowledge and changes in rhythms could provide more clarity regarding the dynamics that link work and using climate information. Running ex-post assessments about the impacts of climate information in working practices could yield unvaluable insights to better understand the mechanisms of practice change.

2) This research has empirically shown that decisions as to whether or not using climate information in an urban context occur within a working dimension, positioning the use of climate information as a result of the coordination of work. This suggests that usability and working practices cannot be studied in isolation: they are constitutive aspects of each other. Having established this, there is nowadays a need to understand how working practices are changing faster than ever before due to the Corona Pandemic. In these terms, this research suggests that there is a need to better inform about how changing practices and cultures of work can affect the use of climate information: identifying how learning dynamics change (for instance, through on-line interaction or facilitating access to new information and training schemes); how social distancing affects peer-to-peer interaction and the production of knowledge, or changes the norms that replace valuable conversations in the corridor with formalised on-line interactions; all of which are components of the practical experience of learning, knowing, validating and changing practices. Core questions orienting such research could include: Which practices change in the new dynamics of work? How does this change influence the use of climate information? How can usability profit from these changes?

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Annexes

Annex 1: Links between research questions and thematic areas.

RESEARCH-Q.	Thematic questions	Thematic area: scope and content
How does the use of climate information occur in practice?	What is the practice to be analysed?	Theme 1: Practice as entity: (Gherardi, 2012).
		Theme 2: Texture of practice (Hui et al. 2017)
	How are contexts made visible? How can we explore these elements in-situ? Context manifesting in-situ?	Theme 3: #What are the structures that promote knowledge dissemination? (Cohen et al. 1990) #How do absorptive factors influence the embeddedness process? (Cohen et al. 1990)
		Theme 4: Decision-making #How is the use of climate information influenced by decision-making contexts? #How does the practice manifest in the different decision-making context?
		Theme 5: Practice-as-performance / Situatedness 1: #Working is situated “knowing” which connects one activity to the next (Orlikowski, 2002)
		Theme 6: Practice-as-performance / Situatedness 2: Knowledge as a situated activity: #Emerges from the context of its production (is contextual) (Gherardi 2012)
		Theme 7: Practice-as-performance / Situatedness 3: Practical knowledge (Gherardi, 2012)
	STABILISATION OF PRACTICES: #How, when and why practices of using climate information become routinized, normalised and institutionalised? #What are the stabilising mechanisms that allow usability to pervade throughout time?	Theme 8: Repetition (Shove, 2012)
		Theme 9: Modes of ordering (Gherardi, 2012)
		Theme 10: Accountability and legitimacy define the character of power. They lend justification to the use of power (Deephouse and Suchman, 1995). Legitimacy "Legitimacy is about moral claims." (ESG, 2008) How do planners legitimise the use of climate information for planning?
What are the effects of climate information on practices and institutions?	What are the effects of climate information on working practices?	Theme 11: Learning
		Theme 12: Change and stability
	#What are the effects of climate information on institutions?	Theme 13: The effect of practices

Annex 2: Interview questions

1. Could you please describe your job?
2. What are core values that orient your work?
3. If you have to explain to a new member of your team how to do your job well, what would you say are the core activities that indicate that the job is being done correctly?
4. When did you start using climate information?
5. When and how do you use it?
6. Which activities represent the use of climate information? What are the most relevant ones, and why?
7. What sorts of challenges posed the use of climate information?
    - Did it affect how you run your operations?
    - Did it change your strategies and goal setting?
    - Were there new managerial considerations considered?
8. Could you describe the most important lessons you have learned from using climate information? (so that it becomes valuable to planning)?
    - *Are there unforeseen challenges that emerge when using climate information?*
    - *How do you design and implement solutions to these challenges?*
9. Who influences the use of climate information? How do you engage with these actors?
10. Which activities/strategies help you convince these actors about the importance of using climate information?
    - *How do you ensure that planning using climate information remain supported?*
    - *Has failure to use climate information provoked blame, damage reputation or demanded additional accountability?*
11. In which circumstances would you use these activities/strategies?
12. Have these activities changed throughout time?
13. Are you politically more influential since you started using climate information? How would you recognise this?
14. Do you add value to your job by using climate information?

Annex 3: List of Interviewees

Bilbao city council	7 municipal officials
Donostia/San Sebastian City council	7 municipal officials
Copenhagen City Council	9 municipal officials
Research and academia	6 researchers
Consultancy firms	5 consultants
Total:	34

Annex 4: Memo coding: Supporting material

CODING

Part I: Theoretical codes

1) Correctness of practice 2) Judgment process & attributes 3) De-coding 4) Routine pattern & frequency 5) Practice dynamics (Purpose, role, effect) 7) relevance/influence of practice 8) Practice change	9) Competence 10) Meaning 11) Knowledge 12) Knowing 13) Collaboration 14) Identity & positioning 15) Imaginaries 16) Authority

Part II: Grounding ideas (based on Orlikowski 2002)

Repertoire of practices, activities, and knowing		
Practice	**Activities comprising the practice**	**Knowing constituted in the practice**
Sharing identity	Engaging in common training and socialization Using common orientation to do development work Identifying with the organization	Knowing the organization

Sharing Identity Within the organisation		
Knowing in Practice	**Activities**	**Data from the organisation**
Knowing the organization through sharing an organisational identity	Creating a common orientation through participating in common training and socialization workshops Appropriating and using a common orientation to getting global product development work done Reinforcing one's connection to the organisation's by identifying with the organization	"We all learn the (organisation's) way of doing things."

Part III: INTERVIEW MEMO CODING PROCEDURE (to be filled after transcription has been done)

Coding number:
Interview/workshop number:
Date:
Place:
Institution:
Person:
Today I coded (object):
Overall impression:
How to improve the procedure:
Pattern to another memo (indicate memo code):
Further notes:
Relation to research question:
Relation to literature
(how do these small observations accrue to broader social phenomena?)

Annex 5: Progressing from theoretical themes and theoretical codes to empirical categories

Theoretical themes and theoretical codes		Empirical Codes (added from empirical data)	Resulting Categories
Theoretical themes	**Theoretical codes**		
Theme 1: Practice as entity: Theme 2: Texture of practice Theme 5: Practice-as-performance /	1) Practice 2) Practice-Opportunity 3) Practice-Challenge 4) Use of CI.	10)Sectorial Municipal Data 11) Data storage 12) Data share 13)Data contextualization 14) Contexts of use 15) Administrative competences 16)Legitimation practice	# Practice # Know-how # Norms & contexts # Legitimation # Information management # Challenge
Theme 4: Decision-making arenas	5) Decision-making		
Theme 3: knowledge dissemination Theme 6: Practice-as-performance / Situatedness 2: Knowledge as a situated activity: Theme 7: Practice-as-performance / Situatedness 3: Practical knowledge Theme 11: Learning	6) Know-how, learning		
Theme 13: The effect of practices Theme 9: Modes of ordering Theme 8: Repetition	7) Effect		
Theme 12: Change and stability	8) Change and stability		
Theme 10: Accountability and legitimacy	9) Norm, Legitimation		

Annex 6: Climate Information considered for case studies Bilbao and Donostia

Name and year	Description
URA (2018). Estimación del efecto del cambio climático en la frecuencia y magnitud de las crecidas fluviales en la CAPV. Nota técnica nº1. (2018) Estimación del efecto del cambio climático en la inundabilidad de la ría de Bilbao.	RCP4.5 and 8.5 (considering changes in precipitation, temperature and sea level), were introduced into the TETIS v8.1 hydrologic model (Francés et al., 2007; Bussi et al., 2013, 2014), in order to obtain potential peak-discharges for different return periods. As a result, URA updated the flood risk maps for 10-, 100- and 500-year return periods, with hydraulic modelling being carried out using the HEC-RAS v4.1 model (Pappenberger et al., 2005).
ECONOADAPT: Description of adaptation options and their costs and benefits	#Loss-damage curve for Bilbao, which shows the relationship between flood risk probability and associated economic impacts. #The study aims to appraise infrastructural measures of adaptation to river and coastal flood in Bilbao. The case study focuses on the analysis associated with the opening of the Deusto canal.
RAMSES	Reconciling Adaptation, Mitigation and Sustainable Development for cities (EU FPVII, 2012-2017) Comisión Europea. Proyecto RAMSES. Reconciling Adaptation, Mitigation and Sustainable Development for cities (2012-2017). URL: http://www.ramses-cities.eu/cities/
Assessment of the urban heat island effect Published within the European Commission financed FP7 project RAMSES and authored by VITO and Tecnalia as D4.1 "Validation of agglomeration-scale climate projections" (2014).	The urban heat island effect of Bilbao was modelled using the UrbClim tool on the scale of an urban agglomeration and its nearby surroundings and the Enviro-HIRLAM model (at micro-scale model).
"Agglomeration-scale urban climate and air quality projections" (2015). Published within the European Commission financed FP7 project RAMSES and authored by VITO and Tecnalia as D4.2	Statistical scheme developed to linking PM10 concentrations to climatic parameters readily available in climate projections.
Review of climate change losses and adaptation costs for case studies. Published within the European Commission financed FP7 project RAMSES and authored by LSE & SENECA as D5.1 (2014).	The aim of this report is to provide an overview of climate change losses and adaptation costs in cities, particularly in the RAMSES case study cities in Bilbao as well as London, Antwerp, Bogota, Hyderabad, Rio de Janeiro and New York.
Lobaccaro, G., Acero, A. (2015). Comparative analysis of green actions to improve outdoor thermal comfort inside typical urban street canyons. https://doi.org/10.1016/j.uclim.2015.10.002	The study, conducted in collaboration with the municipality of Bilbao (Basque Country, Spain), presents a comparative analysis of green actions to improve outdoor thermal comfort conditions.
URA Cartography	a) "Estimation of the effect of climate change on the flooding of the Ría de Bilbao" for the return period of 100 years. b) Cartography: extension of the current flood zone by a 500-year flood return period for Bilbao.

Climate change impacts of coastal and pelagic environments in the south-eastern Bay of Biscay (2011). Report produced by AZTI - Tecnalia (2011).	Analysis on current sea level rise in the Bay of Biscay, and projected extremes in temperature.
Inundabilidad de los estuarios y costa de Bizkaia por ascenso del nivel del mar mediante LiDAR topográfico y batimétrico: cartografía y evaluación de impactos. Agencia Vasca del Agua; AZTI-Tecnalia, 2013	Analysis of the threat from rising sea levels. Local identification of flood risk areas. Cartography of the risk of flooding of estuaries due to rising sea levels; Evaluation of the impacts on estuarine ecosystems, estimation of the affected area in natural habitats.
Proyecto ACCESIT (Amenazas del Cambio Climático a las infraestructuras críticas urbanas: Efectos en la red de Saneamiento e Interdependencias con la red viaria de Transporte y movilidad). Produced by TECNALIA 2018.	Surface runoff and storm flood simulation; Combined analysis of heavy rain and river / coastal flooding threats.
PROYECTO ACCION-lurrAdapt: Propuesta de aportaciones 1 documento de Aprobación Inicial del PTP-BM. Tecnalia 2018	"Adaptation to climate change in spatial planning instruments in the framework of revision of the Territorial Planning Guidelines (DOT)" - of the Klimatek 2017 program. Progress of the Partial Territorial Plan of Metropolitan Bilbao (PTP-BM).
Design solutions for Urban Heat Island mitigation in the City of Bilbao. Published within the European Commission financed FP7 project RAMSES and authored by NTNU and Tecnalia (2014).	This study presents the results of a heat wave analysis in the city of Bilbao. Evaluations of wind behaviour. In addition, recommendations and design solutions for areas affected by the UHI effect as well as general guidelines on how to integrate the findings into the Bilbao master plan are given.
Description of adaptation options and their costs and benefits 2013. Published within the European Commission financed FP7 project ECONADAPT and authored by Paolo Scussolini (VUA), Kateřina Kaprová and Jan Melichar (CUNI), Elisa Sainz de Murieta (BC3), Alina Tepes (BC3), Ibon Galarraga (BC3), Josselin Rouillard, Jenny Troeltzsch and Manuel Lago (ECOLOGIC INSTITUT)	This document contains a general catalogue of options for adaptation to an increasing flood-risk, presents the methodological approach to the cost-and-benefit analysis and examines adaptation measures that are currently in place or planned for the future for the two case studies in the Vltava river basin and the city of Bilbao.
Analysis of effectiveness of measures against the urban heat island effect Published within the European Commission financed FP7 project RAMSES and authored by NTNU and Tecnalia as D4.3 “Urban Adaptation effects on Urban Climate” (2016).	The effectiveness of a number of measures was assessed via the Envimet tool. This report contains the results of advanced numerical modelling and on-site measurements of the impacts of climate change adaptation on the urban climate.
Adaptation to Urban Floods by Planning and Design. Guidelines for an Adaptive Management to Urban Floods and Stormwater Use. A Case Study of the City of Bilbao Published within the European Commission financed FP7 project RAMSES and authored by NTNU (2014).	The study proposes a set of adaptive strategies and design solutions to manage floods and storm water in Bilbao from the perspective of an architect and urban planner to minimise the effects of the extreme precipitation and adapt to new climatic conditions while maximising the opportunities.

Osés Eraso, N., Foudi, S., Galarraga, I. (2012), Análisis del impacto socio económico del daño por inundación en la Ría de Nervión: un cambio de escenario ante la apertura del Canal de Deusto. Informe de Avance del Proyecto. BC3 Basque Centre for Climate Change, Bilbao.	A previous study commissioned by the Bilbao City Council estimated the economic benefits of the opening of the Deusto channel in terms of avoided damages under present-day climate. The results obtained show a significant reduction of damages in the adaptation scenario.
Environmental and economic impacts of sea-level rise on the Basque Coast - 2016 Elisa Sainz de Murieta Zugadi. Tesis doctoral. Universidad del País Vasco.	Environmental and economic impacts of sea-level rise on the Basque Coast
Estimación del efecto del cambio climático en las avenidas fluviales de la CAPV - 2016 Elaborado por SENER para la Agencia Vasca del Agua.	Estimation of the effect of climate change on river avenues in the Basque Country
Identificación de zonas de riesgo torrencial potencial en la CAPV en previsión de un escenario de cambio climático - 2017 Elaborado por Creatividad y Tecnología (CYTSA) para la Agencia Vasca del Agua en el marco del proyecto Interreg POCTEFA H2O GUREA.	Identification of potential torrential risk areas in the Basque Country in anticipation of a climate change scenario

Annex 7: Actor constellation in climate information management in Basque Country

1) IHOBE Public Environmental Management Society that supports the Basque Government by developing technical guidelines for adaptation for local governments (IHOBE, 2011; IHOBE, 2017-A-B). IHOBE has been involved in the development of high-resolution regional climate change scenarios for the Basque Country -Klimatek project[76] (IHOBE, 2019-A-B). Based on Euro-CORDEX data for precipitation and temperature (RCP4.5 and RCP8.5), several indicators were calculated for the entire Basque Country at a spatial resolution of 12km x 12km for the historical (1971-2000) and future periods (2011-2040, 2041-2070 and 2071-2100) (ibid). Once the indicators were obtained at a spatial resolution of 12km x 12km, they were also obtained at a resolution of 1km x 1km, using the Delta method[77].

The indicators are presented on an ESRI-ASCII format, generating the so called "Climate Atlas"[78] -making it compatible with GIS systems. The Atlas is an on-line tool that includes data on 1) daily accumulated precipitation; 2) Mean daily temperature; 3) Maximum daily temperature; lowest minimum temperature; 5) evapotranspiration. It uses 12 regional projections obtained with different couplings of GCMs/RCMs of the initiative EURO-CORDEX (IHOBE 2019-B).

The scenarios inform about the KLIMA2050 strategy[79] through the generation of multicriteria analysis that portrays impact chains provoked by climate change for specific sectors. Impact chains are featured on a municipal level; therefore, provide scope for comparability across municipalities. The impact chains consider 1) impacts related to heat-waves on human health; 2) flood impacts on urban settlements; 3) sea-level-rise related floods impacting on urban areas; and 4) drought impact on economic activities. As a result, the 251 municipalities of the Basque country are classified according to risk and by quintiles (ranges from 20 to 20 percentiles) (IHOBE 2019-A).

2) Geoeuskadi is the reference geoportal of the Spatial Data Infrastructure of the Basque Country. GeoEuskadi offers an on-line map viewer, containing sets of information on GIS and a large data catalogue[80].

3) Euskalmet Basque Meteorological Agency: Provides weather forecasts, it publishes early warnings and supports the regionalization of climate scenarios. It outsources part of its work to specialized companies.

4) Water Agency of the Basque Country URA: It belongs to the Basque Government. The Cartographic viewer provided by the Basque Water Agency provides hazard and risk mapping of all the flood-risk areas of the Basque Country[81]. So far, for hydrological assessments URA has been using data from climate models based on SRES scenarios. More recent RCP scenarios have

[76] Klimatek is presented in a report format and it integrates daily precipitation and temperature data for the years 1971 to 2016 (at 1x1 km) for correction purposes. Climate datasets were extracted from AEMET (State Meteorological Agency), EuskalMet (Basque Meteorological Agency) and URA (Basque Water Agency), which were complemented with variables derived from a digital elevation model in order to develop a regression model that reflected the spatial variability of precipitation and temperatures which was later interpolated with the Ordinary Kriging method, producing a high resolution cartography (1km x 1km) with daily data on precipitation, maximum temperature, minimum temperature and average temperature for the period 1971-2015 (IHOBE, 2019-B).

[77] The difference ("delta" or signal of change) between the indicator of the simulated future period and the simulated historical period (12km x 12km) is calculated; and, later, it is applied on an observed historical period (1km x 1km), assuming that the model biases disappear when considering these "deltas". Thus, the mentioned indicator is obtained for the same future period but with a higher spatial resolution (1km x 1km) and adapted to an observed historical serias (IHOBE 2017b)

[78] Available at https://www.euskadi.eus/web01a2ingkli/es/contenidos/ds_informes_estudios/atlas_climatico/es_def/index.shtml

[79] The scenarios were crossed with high-resolution socioeconomic and demographic indicators available at EUSTAT (Basque Institute for Statistics) and according to the indicator system used within the Agenda21.

[80] http://www.euskadi.eus/web01-a2inguru/es/contenidos/informacion/estatistika_ing_200206/es_def/index.shtml http://www.eustat.eus; http://www.geo.euskadi.eus/s69-15375/es

[81] Viewer available in http://www.uragentzia.euskadi.net/appcont/gisura/

been used as an exercise to integrate climate change into current return period estimates. New definitions of flood hazard probabilities were created under RCPs 4.5 and 8.5 scenarios considering changes in precipitation, temperature and sea levels as part of a scientific collaboration (Frances et al. 2018). Scenarios were introduced into the TETIS v8.1 hydrologic model (Francés et al., 2007), in order to obtain potential peak-discharges for different return periods. As a result, URA updated the flood risk maps for 10-, 100- and 500-year return periods, based on HEC-RAS v4.1 hydraulic modelling (Pappenberger et al., 2005).

5) The Spanish Cities Network for Climate (RECC) is a voluntary network of municipalities with the goal of promoting the integration of climate change considerations into municipal planning through the establishment of adaptation strategies and plans.

6) Udalsarea 2030 - Basque Network of Municipalities for Sustainability, is the forum for coordination and cooperation that promotes the execution of Local Agendas 21 in 186 Basque municipalities.[82].

7) Private consultancy firms and research centres support local governments gaining access to climate information and contextualising it by inviting them as beneficiaries into European research projects, providing specific studies and capacity building schemes.

[82] http://www.udalsarea21.net/paginas/ficha.aspx?IdMenu=17d05e9d-8396-438d-9530-d4a94ea60184&Idioma=es-ES

Annex 8: Climate information considered in case study Copenhagen

Name and year	Description
Methodological framework, analytical tool and database for the assessment of climate change impacts, adaptation and vulnerability in Denmark (2012)[83]	This document presents a data inventory of relevant data for integrated assessment of vulnerability, exposure and risk towards the impacts of climate extremes. Historical climate data is publically available for the period 1950-2012 as an output of the EU project ENSEMBLES (van der Linden P., and J.F.B. Mitchell 2009) The document displays the Climate projections for Denmark (hosted by DMI): Temperature: Min, mean and max temp. 2021-2050 & 2071-20100, monthly, seasonal and annual (25km); PP: Mean pp (2021-2050 & 2071-2100), monthly, seasonal and annual, (25km)
Fremtidige klimaforandringer i Danmark 2014[84]	DMI presents the latest results based on IPCC, BACC, European studies and the Danish CRES project where a number of climate simulations performed with several regional and global climate models. Projections on temperature & precipitation until the end of the century. RCP 2.6; 4.5; 6.0; 8.5, based on IPCC AR5. Simulation model CMIP5 and CRES. Data presented: ENSEMBLES 2009, http://ensemblesrt3.dmi.dk/; CMIP5, Coupled Model Intercomparison Project, http://cmip-pcmdi.llnl.gov/cmip5/index.html; CRES, Centre for Regional Change in the Earth System, http://cres-centre.net; BACC II: BALTEX Assessment of Climate Change for the Baltic Sea Basin 2009-2014 kapitel 4.3.4: Changes in the Baltic Sea Level.
Flood screening using the Lidar-based Danish Elevation model	High quality Lidar based data, elevation model and derived hydrological products are freely available for research, innovation and commercial applications (https://download.kortforsyningen.dk) -Data from the Danish national elevation model (DEM) includes hydrological elevation models in 0,4 m grid, hydrological adjustment data (lines and horseshoes) and hydrological products (maps) for screening of flood risk due to cloudburst and storm floods. -A production system has been built to support high quality and efficient updating of DEM. A strategy for updating is expected in 2018. -Open source python script “malstrøm” is freely available for further surface flow analysis -DEM data and webservices are widely used by researchers, engineering and consulting companies, citizens, emergency agencies , insurance companies and housing associations to assess flood risk from storm floods and cloud bursts .
COWI (2010) Possibilities and consequences of climate change adaptation of Copenhagen in relation to flooding	Return periods: 20 and 100-year return period and 100-year return period in 2100 (with climate change). Surface water levels in relation to extreme rainfall events with various return periods. The various scenarios are presented in the Climate Adaptation plan of the municipality of Copenhagen (lately published in 2012)

[83] https://backend.orbit.dtu.dk/ws/files/51692889/Methodological_framework.pdf
[84] https://www.klimatilpasning.dk/media/854031/dmi_-_klimaforandringer__2014_.pdf

Local control on precipitation in a fully coupled climate-hydrology model (2015)	Hydrological catchment, regional climate model domain and observed precipitation and temperature during the study period of the Skjern River hydrological catchment on the Jutland peninsula. Two RCM evaluation domains of 9 and 23 grid cells (UNC-9/COU-9 and UNC-23/COU-23) in the coupling domain (representing either a 100% overlap or grid cells with at least a 50% overlap respectively), the 16grid cell RCM control domain (UNC-ctrl/COU-ctrl) and the 18grid cell edge effect area (EDGE-18). MIKE SHE hydrology model coupled to hydrostatic RCM HIRHAM version 5. MIKE SHE and HIRHAM components were modified for compatibility with the OpenMI open source coupling protocol. Regional climate model (RCM) coupled to a distributed hydrological catchment model to enables a realistic representation of local precipitation.
Methods to predict and handle flooding on highways: The blue spot concept (2010)	SWAMP project targets the critical issue of finding the most vulnerable parts of the road network, and how to prepare them for flooding. LEVEL of analysis 1 - Screening using terrain analysis 2 - Rain sensitivity for individual depressions 3 - Hydrodynamic model of surface reservoirs and depressions
Methods used in the Danish Climate Atlas DMI Report 19-17, 2019	Observation data calibrated against 15 RCM (Euro-Cordex) to provide PP and T indexes Indexes provided: Mean temperature; Mean precip. mm/day; Daily-max precip. Mm; 5-day max precip. Mm; 14-day max precip. Mm; Days with over 10 mm. Daily precip. Days; Days with over 20 mm Daily precip. Days; Number of cloud-bursts per year events; Hourly precip. in 2-year events mm; Hourly precip. in 10-year events mm; Hourly precip. in 100-year events mm; Daily precip. in 2-year events mm; Daily precip. in 10-year events mm; Daily precip. in 100-year events
DMI Historical Climate Data Collection 1768-2018 (DMI Report 19-02)	This report contains the available DMI historical data collection 1768-2018 for Denmark, including observations (atmospheric pressure), long daily, monthly and annual series of station based data, country-wise values and a list of storms. The report also serves as the DMI contribution of daily values to the European Climate Assessment & Dataset (ECA&D). ECA&D was initiated by the European Climate Support Network (ECSN7) which is a project within the Network of European Meteorological Services (EUMETNET8).
DMI Report 19-10: Guide to Climate Data and Information from the Danish Meteorological Institute (annual update (June 2019) of the "DMI Guide to Climate Data and Information")	This report presents the kind of climate data and services the Danish Meteorological Institute can provide, suitable for climate information and research. Guide/catalogue to climate data and information containing all key variables such as locality, parameters, time period, resolution, quality, data formats and metadata -country wide values-.
DMI Report 19-11: World Weather Records 1991-2018 - Denmark, The Faroe Islands and Greenland	A number of climatological data series are published in this report. These are monthly-/annual values for 1991-2018 and decadal averages for the periods 1991-2000 and 2001-2010 plus 30 years averages for the periods 1971-2000 and 1981-2010 for 5 locations in Denmark.
Adaptation Plan Copenhagen (2012)	The City of Copenhagen has used the IPCC's A2 scenario as a basis for assessing future climate impacts.

	A mathematical runoff model known as MIKE URBAN is used to analyse existing conditions and project the impact of climate change on floods. This model can simulate flow in the sewer network and in watercourses as well as the spreading on the land of the water that the sewer network cannot accommodate. The projections contained in the plan can be used to illustrate the consequences of the possible climate changes focused on in this plan.
Climate change adaptation Denmark: Denmark's future climate	Changes in extremes up until 2050 (based on A1B) Climate change in Denmark calculated with the Danish Meteorological Institute's regional climate model HIRHAM5 on the basis of projections carried out with the global climate model ECHAM5 in connection with the EU project ENSEMBLES. All figures in the table show changes for the period 2021/2050 relative to the normal period 1961/1990.
Economics of cloudburst and stormwater management in Copenhagen (City of Copenhagen 2014)[85]	1) Estimation of costs of the CBMP; distribution of roles (construction responsibilities) and establishment of financing methods; 2) correlation between adapting Copenhagen to climate change and the part of an insurance premium for properties that concerns insurance against dam- age due to heavy rain: Insurance conditions for the municipal properties have substantially worsened in the City of Copenhagen following the extreme rainfall event of 2 July 2011. Prior to the cloudburst event, there was an insurance excess for the municipal properties of DKK 25 million in claims per year and an excess per claim of DKK 100,000. An excess per extreme rainfall event of DKK 50 million has now been introduced. Implementing the measures adopted in the climate adaptation plan dramatically reduces the risk of damage to buildings during intense rain; 3) Adding value to property market: At the same time, climate adaptation can contribute to creating more stable frameworks for the Copenhagen property market, which contains 300,000 homes and 355,000 jobs.
Impact assessment for the city of Copenhagen against projected extreme rainfall[86]	The recommendation regarding the most likely cli- mate change impacts on extreme precipitation in Denmark used by the Copenhagen Municipality is based on Arnbjerg-Nielsen (2012)[87]. The recommen- dation has recently been revised based on an assess- ment including different climate forcing scenarios, climate model projections and statistical downscaling methods (Gregersen et al. 2014)[88]. A key input to the revised recommendation is the use of a multi-model ensemble of regional climate projections in Europe from the ENSEMBLES project (van der Linden & Mitchell 2009)[89] and application of 3 different down-

[85] https://climate-adapt.eea.europa.eu/metadata/publications/economics-of-cloudburst-and-stormwater-management-in-copenhagen/11258638

[86] K. Arnbjerg-Nielsen, L. Leonardsen, H. Madsen: Evaluating adaptation options for urban flooding based on new high-end emission scenario regional climate model simulations. Contribution to CR Special 30 'Effects of extreme global warming in northern Europe' CLIMATE RESEARCH Clim Res/Vol. 64: 73–84, 2015. Doi: 10.3354/cr01299 https://www.int-res.com/articles/cr_oa/c064p073.pdf

[87] Arnbjerg-Nielsen K (2012) Quantification of climate change effects on extreme precipitation used for high resolution hydrologic design. Urban Water J 9:57−65. Additional source: Arnbjerg-Nielsen K, Willems P, Olsson J, Beecham S and others (2013) Impacts of climate change on rainfall extremes and urban drainage systems: a review. Water Sci Technol 68:16−28

[88] Gregersen IB, Madsen H, Linde JJ, Arnbjerg-Nielsen K (2014) Opdaterede klimafaktorer og dimensionsgivende regnintensiteter (Updated climate change factors and extreme precipitation used for design intensities). Paper no. 30. The Water Pollution Committee of The Society of Danish Engineers. Available at https://ida.dk/sites/prod. ida.dk/files/svk_skrift30_0.pdf

[89] van der Linden P, Mitchell JFB (eds) (2009) ENSEMBLES: Climate change and its impacts. Summary of research and results from the ENSEMBLES project. Met Office Hadley Centre, Exeter. Available at http://ensembles-eu. metoffice.com/docs/Ensembles_final_report_Nov09.pdf (accessed February 2015)

	scaling methods (Sunyer et al. 2015)[90]. In addition, results based on a high-end scenario are included using a projection of the RCP8.5 scenario (Mayer et al. 2015)[91] downscaled by means of a stochastic weather generator (Sørup et al. 2015)[92]. The direct change factor approach is based on esti- mating the changes in extreme precipitation statistics from the regional climate model projections. In this case, climate model simulations are available for the periods 1976−2005 and 2071−2100 (Christensen et al. 2015). For each period, a regional extreme value analysis is applied that includes all land points covering Denmark. The regional model uses a partial duration series (PDS) approach, similar to the method applied in the analysis of Danish rainfall extremes by Madsen et al. (2002). Considering the projected changes in extreme sea surges used by the Copenhagen Municipality and the changes projected by the A2 scenario (Table 1), it is more than likely that the adaptation plan also accounts for the impact of the RCP8.5 scenario.
Vulnerability assessment for precipitation and sea surge hazards.	The report presents the costs associating to flooding in present and future (2100) climate under the A2 scenario for Copenhagen.
Adaptation in the Metro of Copenhagen[93]	The climate change impact assessment shows that heavy rainfall affects metro operation and passenger safety.
Contingency plan for Copenhagen airport (2013)	The report presents the calculation of the capacity and flow in the pipes of Copenhagen's airport for five-year and ten-year events using the calculation tool MIKE Urban linked with a surface run-off model.
The finger plan: A strategy for the development of the greater Copenhagen Area (2015) Ministry of the Environment of Denmark	Strategic urban giddance linked to transportation. The Planning Act requires an overall plan for the Greater Copenhagen area. Since 1947 overarching urban model; city linked to city fingers connected to railways and radial road systems.
Local control on precipitation in a fully coupled climate-hydrology model (2015)	MIKE SHE hydrology model coupled to hydrostatic RCM HIRHAM version 5. MIKE SHE and HIRHAM components were modified for compatibility with the OpenMI open source coupling protocol. Hydrological catchment, regional climate model domain and observed precipitation and temperature during the study period of the Skjern River hydrological catchment on the Jutland peninsula. Two RCM evaluation domains of 9 and 23 grid cells (UNC-9/COU-9 and UNC-23/COU-23) in the coupling domain (representing either a 100% overlap or grid cells with at least a 50% overlap respectively), the 16 grid cell RCM control domain (UNC-ctrl/COU-ctrl) and the 18 grid cell edge effect area (EDGE-18)

[90] Sunyer M, Madsen H, Ang PH (2012) A comparison of different regional climate models and statistical downscaling methods for extreme rainfall estimation under climate change. Atmos Res 103:119−128

[91] Mayer S, Fox Maule C, Sobolowski S, Christensen OB and others (2015) Identifying added value in high-resolution climate simulations over Scandinavia. Tellus Ser A Dyn Meterol Oceanogr 67:24941

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[93] https://climate-adapt.eea.europa.eu/metadata/case-studies/integrating-adaptation-in-the-design-of-the-metro-of-copenhagen/#source

Annex 9: Actor constellation in climate information management in Copenhagen

A strong and diverse network of institutions is involved in the management of climate information. Relevant institutions facilitating access to climate information sets for the case study about Copenhagen include the following:

The Danish Meteorological Institute (DMI) was established in 1872 under the Danish Ministry of Energy, Utilities and Climate [94]-[95]; it publishes biased adjusted Cordex data in a 1x1 km grid high-resolution for two emission scenarios (RCP4.5 and RCP8.5) and four time periods (1981-2010; 2011-2040; 2041-2070; 2071-2100). The DMI develops climate indexes which are made available for municipalities (DMI, 2019)[96] through a dedicated website, the Climate Atlas[97]. Information includes drainage basin and coastal stretch levels showing future changes in temperature, precipitation, extreme precipitation, relative sea-level and storm- surge heights.

Danish Geological Service (GEUS)[98] is a research institute within the Danish Ministry of Energy, Utilities and Climate and it has an advisory role to the ministries, local authorities and the water industry. It is responsible for the national database on geology and water resources and the national hydrological model (integrated groundwater/surface water). GEUS conducts research on the effects of climate change on water resources: it integrates climate scenario data in hydrological modelling; it quantifies the effects of climate change and the effectiveness of climate adaptation measures.

HOFOR, the municipally-owned Water Utility Company provides utility services to Copenhagen (clean water and wastewater systems, district heating and cooling, town gas and energy). HOFOR deals with rainwater and wastewater and it cooperates with the municipality on issues regarding flood protection.

Klikovand (Climate, Municipalities, and Water[99]) is a cooperation between 22 municipalities and 9 utility services and it supports municipal fund-raising in the area of climate adaptation by facilitating project proposal drafting, articulating actors and generating capacity building workshops (CD4).

Consultancy firms: The private firm Rambøll was chosen as the advisor for the implementation of the Copenhagen flood-protection system, designing solutions on the basis of the service target level/accepted risk set by the Municipality of Copenhagen. Also, the firm COWI runs impact assessments and cost benefit calculations on storm-surge adaptation measures (Hastrup, A . et al. 2015).

[94] Source: https://public.wmo.int/en/resources/bulletin/data-driven-–-way-through-storm
[95] Source: https://climate-adapt.eea.europa.eu/countries-regions/countries/denmark
[96] Source: https://public.wmo.int/en/resources/bulletin/data-driven-–-way-through-storm
[97] Source: http://www.dmi.dk/klimaatlas
[98] Source: https://www.geus.dk/natur-og-klima/tilpasning-til-klimaaendringer/klimaeffekter-paa-vandkredsloebet/
[99] https://klikovand.dk/about-klikovand/ visited 09.09.2020

Eidesstattliche Versicherung

Ich, Cristobal Tomás Reveco Umaña, versichere [1] an Eides statt, dass ich die Dissertation mit dem Titel „Exploring the Use of Climate Information in Practice“ selbst und bei einer Zusammenarbeit mit anderen Wissenschaftlerinnen oder Wissenschaftlern gemäß den beigefügten Darlegungen nach § 6 Abs. 6 der Promotionsordnung der Fakultät Wirtschafts - und Sozialwissenschaften vom 18. Januar 2017 verfasst habe. [2] Andere als die angegebenen Hilfsmittel habe ich nicht benutzt. [3]

Ort/Datum Unterschrift