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Institutionalisation of urban climate adaptation: three municipal experiences in Spain

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ABSTRACT

Comparative studies of urban adaptation have evaluated the progress, means and scope of adaptation planning. Practice on the ground shows that the local politics of climate adaptation advance through various strategies to align different interests and spheres of action or disrupt mainstream practices, which translates into a wide range of interventions. This paper focuses on understanding the dynamics and tools that enable the institutionalisation of adaptation practices in local governments, *i.e.* the means through which adaptation practices, beyond plans and policies, are embedded in the routines of urban governance. It presents a framework to analyse the institutionalisation of adaptation that maps stages and tools with the potential to deliver adaptation in urban areas. Adaptation is framed as a learning process involving overlapping phases of recognition (of needs, capacities and actors), groundwork (knowledge generation) and action on the ground (change). The framework compares three Spanish local government initiatives (Bilbao, Barcelona and Madrid). The analysis shows that adaptation can be effectively incorporated into standard rules, norms and practices using combinations of tools and spatial and temporal scales. The coupled stages of recognition, groundwork and action highlight the importance of long-term learning processes to engage with the temporal dimensions of adaptation governance.

POLICY RELEVANCE

Addressing the adaptation gap in urban areas requires the institutionalisation of climate adaptation as a routine part of decision-making. Institutionalisation refers to actions whereby adaptation to climate change is mainstreamed in urban practices, rules and norms, enabling the long-term impact of adaptation actions beyond the confines of adaptation plans. Using institutionalisation, adaptation goals can be integrated into urban governance and facilitate social learning. This paper examines the processes of

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implementation of adaptation and how they interact with and are shaped by existing contexts of infrastructure and institutions. Adaptation requires a gradual process of institutional change whereby adaptation becomes ‘institutionalised’ in municipal policy. Coupled phases of recognition, groundwork and action along a temporal scale are needed to deliver adaptation and advance learning and effective action. Three cases of urban adaptation in Spain demonstrate the various processes whereby institutionalisation occurs.

1. INTRODUCTION

Urban adaptation depends on integrating knowledge, actors, needs and capacities within current decision-making routines. The absence of a specific understanding of effective institutions for climate change adaptation has been, and continues to be, a long-standing concern (Anguelovski & Carmin 2011; Patterson 2021). Adaptation action must fit the context of intervention (Dodman *et al.* 2012). Recent thinking on adaptation calls for institutional changes to improve adaptation across sectors while addressing the structural factors that increase vulnerability (IPCC 2018; Noble *et al.* 2014; Revi *et al.* 2014).

Adaptation in urban governance is either managed separately or mainstreamed across sectors through existing processes, procedures and instruments (Patterson & Huitema 2019). Institutionalisation refers to actions whereby adaptation to climate change is mainstreamed in urban practices, rules and norms, enabling the conditions for the long-term impact of adaptation actions beyond the confines of adaptation plans. Institutionalisation makes climate change adaptation goals a norm in urban governance. Transformative adaptation depends on institutionalisation (Patterson 2021).

Urban planning processes are widely recognised as enablers of climate adaptation action (Carter *et al.* 2015; Davoudi *et al.* 2012). There is a wide range of adaptation actions in urban areas—within and outside plans—and a diversity of means available to prepare for climate change impacts even when resources are limited (Castán Broto & Bulkeley 2013; Klein *et al.* 2018; Lesnikowski *et al.* 2019; Patterson 2021; Tompkins *et al.* 2010). Recent assessments of urban climate adaptation have evaluated the contents, quality, means and scope of adaptation (e.g. Aguiar *et al.* 2018; Araos *et al.* 2016; Carmin *et al.* 2012; Guyadeen *et al.* 2019; Hunter *et al.* 2020; Le 2020; Lesnikowski *et al.* 2019; Olazabal *et al.* 2019b; Olazabal & Ruiz De Gopegui 2021; Reckien *et al.* 2018; Shi *et al.* 2015; Woodruff & Stults 2016). This body of literature offers an incomplete analysis of how urban adaptation is institutionalised (Patterson 2021). With a few exceptions (e.g. Hunter *et al.* 2020), assessments focus on identifying and evaluating adaptation policies and plans (Olazabal *et al.* 2021; Patterson 2021). Studies of the dimensions and diversity of adaptation institutions and their formation (Patterson 2018, 2021) have not yet engaged explicitly with integrating adaptation institutions into existing governance processes.

Frameworks to analyse adaptation capacities and preparedness focus on the factors and characteristics of institutions, communities, resources or infrastructures that enable adaptation (Engle 2011; Ford & King 2015). Previous work has emphasised factors that support (e.g. leadership, organisation, funding, stakeholders engagement) and limit adaptation (e.g. lack of knowledge, competencies or public support). Institutional barriers to adaptation include the lack of resources and capacities, the lack of political commitment to act, the lack of coordination and fragmentation across institutions leading to unclear responsibilities, and the limited access to diverse knowledge to support adaptation action (Aguiar *et al.* 2018; Capela Lourenço *et al.* 2019; Eisenack 2016; Eisenack *et al.* 2014; Fatorić & Biesbroek 2020; Sieber *et al.* 2018; Thaler *et al.* 2019). Barriers to adaptation interact at different scales and over time; therefore, they cannot be overcome in isolation but in an integrated manner. The institutionalisation of adaptation in urban governance is a strategy to tackle such barriers, for example, by making adaptation a default concern in sectoral policies and developing flexible institutions to respond to competing demands.

This paper focuses on understanding the dynamics and the tools (or combination of tools) that enable the institutionalisation of adaptation practices in local governments, that is, the means through which adaptation practices are embedded in the routines of urban governance. Although the barriers to adaptation have received significant attention in the literature (Adger *et al.* 2009; Biesbroek *et al.* 2013; Huitema *et al.* 2016; Moser & Ekstrom 2010), which elements enable adaptation and how they insert into practices and through time, is still underexplored. The paper develops a framework to understand the stages of institutionalisation of adaptation in urban areas and identify the tools that may enable such dynamics. The framework is tested through a comparative analysis of three local government initiatives in Spain that have shown preliminary signs of institutionalisation and adaptation value and have been recognised as good practices in the field. The three case studies reflect the broader political and institutional context in which adaptation actions are inserted and point towards disruptive changes that adaptation action can motivate (Moore *et al.* 2018; Pelling & Manuel-Navarrete 2011; Wolfram & Frantzeskaki 2016). The analysis demonstrates the need to understand adaptation processes beyond the delivery of specific outputs, focusing on the institutionalisation of adaptation.

2. INSTITUTIONALISATION IN URBAN ADAPTATION

2.1 CHARACTERISING ADAPTATIONS

Adaptation depends on a variety of factors. Preparatory work attracts funds, increases social awareness, generates knowledge and helps gain technical capacities (Ford & King 2015; Heidrich *et al.* 2013; Neder *et al.* 2021; Olazabal *et al.* 2019a; Tilleard & Ford 2016). Implementation depends on effective collaborations across scales of governance (Betsill & Bulkeley 2006; Heikkinen *et al.* 2020; Sirku 2016). Finally, adaptation also needs ex-post work to monitor, evaluate, correct and replicate successful processes (Arnott *et al.* 2016; Meerow & Woodruff 2020; Woodruff & Stults 2016). At the same time, adaptation is a long-term, recursive process that cannot be reduced to specific actions, despite efforts to affirm the contrary in city and neighbourhood plans (*i.e.* the so-called portfolios of measures in planning documents) (*e.g.* Araos *et al.* 2016; Olazabal *et al.* 2019b).

Adaptation plans produced multiple outputs, including capacity-building, management, planning, practice or behaviour change, policy, information, physical infrastructure, warning or observing systems, green infrastructure, financing and technology (Biagini *et al.* 2014). Lesnikowski *et al.* (2011, 2015) distinguish between three types of adaptation-related activities across policy documents in relation to their outcomes: recognition, groundwork and tangible actions. According to them, recognition results in a collective acknowledgment of the need to adapt, but who and how adaptation groundwork and actions involve concrete outputs with different levels of tangibility. Groundwork describes work on the drivers and barriers to adaptation and hotspots for action. Action implies specific interventions on urban infrastructure and services. Lesnikowski *et al.* originally developed this categorisation to classify policy outputs in debates about the evaluation of adaptation (Le 2020; Olazabal *et al.* 2019b). However, this distinction also helps to understand the institutionalisation of adaptation processes.

This categorisation may also help describe the maturity of adaptation processes. Recognition involves understanding the need to adapt by groups, actors and sectors. It may also involve acknowledging the diverse levels of vulnerability and capacity to adapt across sectors and populations, across space and time scales, and considering contextual factors, solutions or enabling practices. The recognition of new actors, vulnerable groups and knowledge holders is also central to facilitating adaptation (Olazabal *et al.* 2021). Recognition also involves identifying and promoting new means for change, including recognising agency and power, their users and uses, to facilitate change and action or explain its lack (Avelino 2021). Recognition is where processes of screening and scope definition are established. Since recognition is essential to prepare the terrain for action on the ground, a thorough process of knowledge generation should precede it. Indeed, 'groundwork' involves activities and processes related to generating knowledge through impact, vulnerability and risk assessments, adaptation research, development of conceptual tools, stakeholder networking, knowledge coproduction, and the provision of policy recommendations

resulting from these knowledge generation activities. New processes of recognition (new elements recognised, including actors, contexts, solutions or enabling practices) would require new groundwork processes. Finally, action is related to the process of enabling a demonstrable change. It includes interventions directed to modulate policy and regulatory changes, organisational changes (working groups, ministries, departments), public awareness and outreach, training, surveillance and monitoring, infrastructure and technology-related investments, environmental conservation interventions, programme or policy evaluations, financial support for autonomous adaptation, or medical or social care interventions.

Most evaluative studies (mostly limited to the analysis of single uncontextualised plans and policies) show an adaptation landscape with a combination of groundwork and action interventions (Kuhl *et al.* 2020; Olazabal *et al.* 2019b). However, planning and capacity-building activities dominate (Kuhl *et al.* 2020). These activities are relatively inexpensive compared with more practical adaptation actions with long-term, durable impacts such as changes in regulatory frameworks, infrastructures and measures to address vulnerable groups' needs (Biagini *et al.* 2014). In the process of institutionalising the recognition of further actors, contexts, solutions and practices, the adaptation solution space broadens as processes become more inclusive and collaborative across temporal and spatial scales.

2.2 THE ADAPTATION SPIRAL

In this paper, the delivery of climate change adaptation is conceptualised as an expansive spiral model—the adaptation spiral (Figure 1)—to illustrate the long-term impact of adaptation actions, no matter how small, within a culture of learning-by-doing. Based on understanding adaptation as a process of learning through time, the model shows a legacy inherited alongside cycles of recognition, groundwork and action, expanding the proposal by Lesnikowski *et al.* (2011, 2015) described above. The arrow shape is an indication of maturity and cumulative learning rather than a marker of linearity in a policy process in which both collective learning and unlearning are possible.

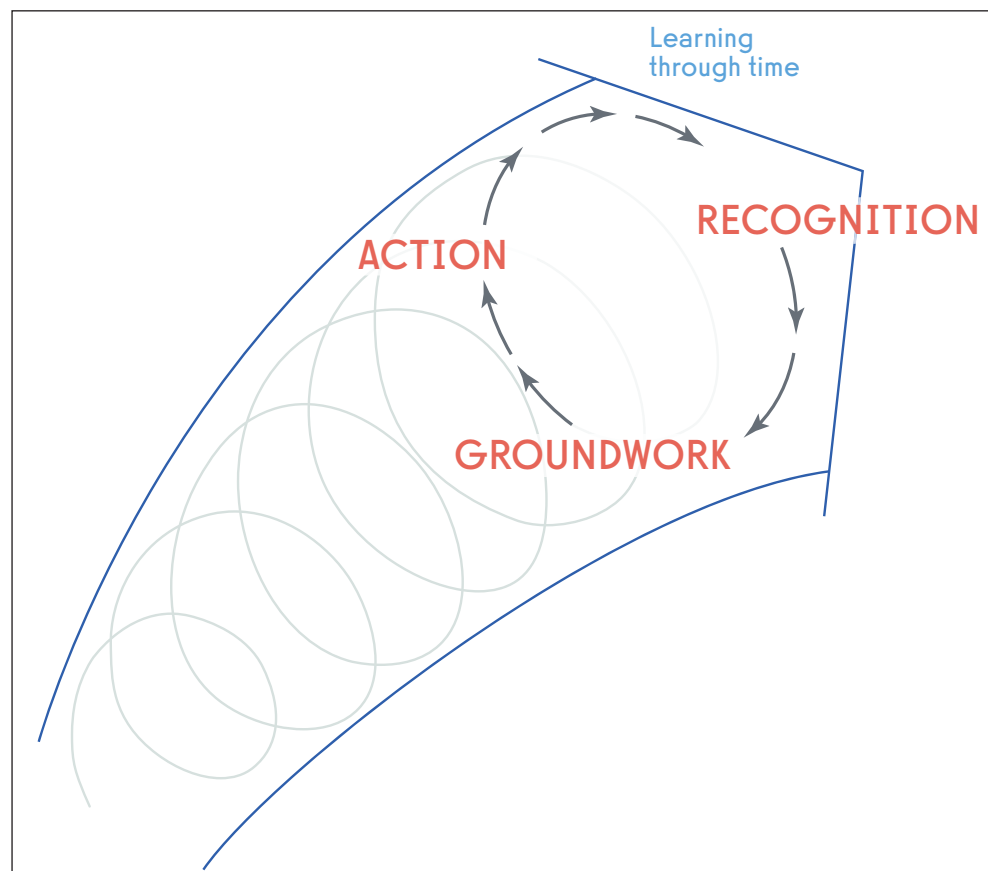


Figure 1: The adaptation spiral is a conceptual model for evaluating long-term adaptation action. Adaptation recognition, groundwork and action-related activities alongside an amplifying spiral where combinations of tools interact to enable the institutionalisation of climate change adaptation in the context of a learning process through time.

In the context of institutionalisation, recognition and groundwork pave the way to support adaptation institutions, through either the generation of new ones or the reconfiguration of existing ones. In contrast, actions are part of a consolidation process that demonstrates their efficacy and sustains them over time. This framework, which uses recent theories from the adaptation policy evaluation and social learning literature, resonates with the adaptation cycle of the socio-ecological systems (Gunderson & Holling 2002). It presents an idealised conception of a messy policy process in which the objective is to facilitate social learning. Advancing adaptation while broadening the adaptation solution space through learning-by-doing requires overlapping and interactive stages of recognition, groundwork and action, which specific combinations of tools can activate.

2.3 STAGES AND TOOLS FOR THE INSTITUTIONALISATION OF ADAPTATION

The adaptation spiral model (Figure 1) allows for the inclusion of different parts of call in policymaking and planning processes, monitoring and evaluation, and preservation of adaptation legacies. Thus, the model attempts to reimagine the traditional project cycle by engaging with institutionalisation and social-learning mechanisms that require a long-term view of urban adaptation.

Table 1 details institutional tools in urban areas as anchored in various stages (process, planning, policy, monitoring and evaluation, delivery, and legacy). Such stages are rarely isolated: they often concatenate or couple, mainly when they occur beyond or as an alternative to adaptation plans and strategies. Table 1 is a toolbox to facilitate decision-making processes where adaptation stages do not necessarily need to occur in succession, but in a complex political milieu.

Table 1 is the point of departure to examine the institutionalisation of adaptation and adaptation actions as they become part of the adaptation spiral described in Figure 1. Table 1 is also helpful in identifying tools that might be critical to advance through institutionalisation processes of recognition, groundwork and action in the adaptation spiral. It identifies, for example, that ‘process’ tools related to diagnosing, visioning, partnering and participation and ‘delivery and legacy’ tools related to knowledge-transfer and learning activities can deliver the ‘recognition’ of groups, actors, sectors, problems and action proposals (to mention a few). Groundwork is often advanced by ‘process’ and ‘management and evaluation’ and ‘delivery and legacy’ tools that facilitate the interaction of knowledge systems to understand and generate information around problems and adaptation solutions. Recognition and groundwork are key stages to foster concrete adaptation actions and advance through the adaptation spiral through a learning-by-doing approach. On the other hand, action is most often delivered through ‘planning’ and ‘policy’ tools and further institutionalised through ‘monitoring and evaluation’ and ‘delivery and legacy’ tools.

STAGES AND TOOLS FOR THE INSTITUTIONALISATION OF ADAPTATION	R	G	A
Process tools			
Tools and activities designed and delivered to increase knowledge, awareness, support, and capacities of systems and actors			
• Specific adaptation process tools to profile and diagnose exposure, vulnerability and risks and to evaluate climate change impacts and adaptation options	×	×	
• Training, research, development and awareness campaigns to produce and share information about risks, vulnerability or adaptation capacities		×	×
Other process tools may focus on understanding the current conditions in a neighbourhood or city from an interdisciplinary perspective. These include specific tools/processes/methods to ensure an open and transparent definition of multiple priorities and contrasting values that will inform the planning process. For example:			
• Process of visioning, including events and partnerships that bring together different stakeholders with different stakes to produce a city vision that matches their expectations and is aligned with the need of the city to adapt	×	×	
• Participatory tools to discuss adaptation alternatives and decisions within a planning process		×	×
Planning tools			
Develop a shared understanding of the city’s future through understanding how a city’s sectors interact with adaptation and the governance capacity. These may include:			

(Contd.)

STAGES AND TOOLS FOR THE INSTITUTIONALISATION OF ADAPTATION	R	G	A
• Main urban planning tools to organise urban land uses and (un)permitted activities such as master plans and local planning regulations			×
• Tools such as an strategic environmental assessment, health impact assessment or sustainability assessment provide a means to assess the impact of specific policies and programmes on the adaptive capacity of infrastructures, human population and communities, ecosystems or institutions			×
• The above are naturally embedded in upper-level planning instruments at the regional or national level that should seed and demonstrate the local commitment to adaptation			×
Policy tools			
These include various information, voluntary, economic and regulatory instruments. They may involve mandatory requirements through controls, bans, quotas, licensing and standards often applied when a specific outcome is required. For example:			
• Local plans, programmes, policies and laws where there is a recognition of the need to adapt through the establishment of adaptation-related objectives in the short, medium or long terms and establishing the minimum political, institutional and social conditions in which adaptation to climate change is possible			×
• Practices such as codes, labelling, management standards or audits on a voluntary basis can provide incentives for adaptation			×
• Taxes or subsidies that can be used to promote adaptive activities			×
Management and evaluation			
These include tools for the periodic revision of adaptation plans and policies. For example:			
• Systems to take measurements at regular intervals to specify progress against the objectives and revise the planning process		×	×
• Systems to guarantee the adequacy of the chosen adaptation options to the level of risk known and to provide means of learning based on a continuous knowledge generation around the impacts, risks and adaptation options consequences		×	×
• Benchmarking tools for comparison and adaptation surveillance in search of the best available adaptation		×	×
Delivery and legacy			
These include tools that guarantee the transfer of decisions and agreements into long-lasting palpable outcomes with adaptation value			
• Soft and hard infrastructure construction and management services and operations			×
• Protocols to guarantee compliance with laws, codes, regulations, or upper-level plans and policies			×
• Processes to guarantee the consideration of equity, environmental and social vulnerabilities in participatory, policy, planning and implementation processes			×
• Events and activities to transfer knowledge, facilitate training and harvest municipal leadership	×	×	×
• Upgrading protocols to escalate the best-performing options from experiment to transformative interventions			×
• City-to-city learning and international networking and commitments	×	×	×

Table 1 is proposed as a guide to identifying potential tools, combinations of tools and planning stages where institutionalisation might occur through the three spiral stages of recognition, groundwork and action. The place dependency of overlapping tools listed highlights the context-specific nature of adaptation and the diversity of options (the list is not exhaustive).

3. THREE CASE STUDIES OF URBAN ADAPTATION IN SPAIN

The framework can be applied to understand comparatively three cases of urban adaptation in the cities of Bilbao (northern Spain), Madrid (central Spain) and Barcelona (eastern Spain). The cases are:

- the urban regeneration project of Zorrotzaurre in Bilbao as an opportunity to reduce flood risks
- the deployment of green infrastructure to adapt to climate change and increase Madrid's resilience and quality of life
- governance innovations for urban adaptation in the city of Barcelona

Although the transference of competence mediates national-level policies to regional authorities (The Autonomous Communities in the Spanish Constitution), the cases share a common regulatory framework for local governance and similar regulatory incentives to deliver adaptation action.

Table 1: Examples of tools for the institutionalisation of climate change adaptation in urban areas categorised according to stages of the planning cycle where they may intervene. It is indicated if they primarily enable R: recognition, G: groundwork or A: action, or a combination of those.

Source: Developed after the sustainability policy tools considered by UN-HABITAT (2016).

The three cases are well-known examples¹ of adaptation actions, programmes or processes within and beyond the Spanish context. The following criteria were used to select the case studies:

- evidence of implementation: the activities embedded in the case studies have taken place or are in the process of taking place
- evidence of finance: public and private funding has been allocated in each case
- early evidence of institutionalisation of adaptation through tangible changes in practices, norms and rules
- early evidence of adaptation value according to existing adaptation literature
- public documentation available and convenient access to local actors to verify collected information

Data were collected between July 2019 and October 2020, and included two steps. First, the authors reviewed and evaluated the existing documentation for each case (see **Table S1** in the supplemental data online). During this stage, evidence of the different tools outlined was sought and systematised following **Table 1** for each case. Second, the team worked closely with local professional experts (see **Table S2** online) working for local authorities and responsible for the oversight of the local processes under analysis in each municipality. Structured interviews and informal conversations were used to evaluate the findings of the document review. For the structured part, draft case study tables were shared with local experts in each city, who reviewed the results and provided complementary information that helped understand how the different tools operated in practice (concerning the adaptation spiral stages). Finally, after several iterations of feedback, the authors compiled the consolidated results (see **Tables 2–4** corresponding to the cases of Bilbao, Barcelona and Madrid, respectively).

4. RESULTS: ANALYSIS OF INSTITUTIONALISATION OF ADAPTATION IN THE THREE CASE STUDIES

4.1 REDUCING FLOOD RISKS IN BILBAO

The regeneration of Zorrotzaurre is an urban development project in the framework of Bilbao's metropolitan planning with a significant climate adaptation component. The project, which conception started in 2001, envisaged the regeneration of 'the industrial Bilbao' alongside the Deusto Canal opening (in 2018) and the transformation of Zorrotzaurre into an island (**Figure 2**, ongoing works). Opening the canal to adapt to floods was a pivotal strategy to legitimate the project and attract European Structural Funds for the river works (*Garcia Sanchez et al. 2018; Martinez-Juarez et al. 2020; Osés et al. 2012*). The project was designed by an international architect Zaha Hadid and followed an earlier experience that transformed the city of Bilbao through revitalisation (*Garrido Martínez 2004; Olazabal & Pascual 2015; Rodriguez & Martinez 2003*). A public–private partnership (PPP) (Management Commission of Zorrotzaurre) composed of public and private landowners managed the project. Social movements strongly contested the project since 2004, when the local government officially approved it because it threatened their ways of living. Participatory processes facilitated a minimal degree of integration of local knowledge and needs into the urban project (*Garrido 2018*).

Research to date highlights this case as an example of the incompatibility of democracy with the business of urban planning (*Garrido 2018*). The project entails developing a residential area that, so far, lacks connections to the city and its services. Furthermore, the project has immense social, cultural and economic implications for residents of the old and the new island. There are new economic and cultural opportunities. However, the project also threatens the survival of an area earlier considered at the heart of alternative culture and with a strong social identity (*Garrido 2018*). Plans to integrate a scientific and technological hub in Zorrotzaurre, with the participation of companies and research centres to enable innovation and sustainability, are feared to be fostering gentrification.



Figure 2: The Zorrotzaurre urban regeneration project is still unfinished. The Deusto Canal was an artificial channel whose use had become obsolete after opening the outer Port of Bilbao in 2006. The opening of the Deusto Canal (red) has converted Zorrotzaurre into an island and has reduced the flooding risk in various neighbouring areas.
 Source: Zorrotzaurre Management Commission (<http://www.zorrotzaurre.com/>).

Project implementation has been slow. To date, Zorrotzaurre is an island, but several project components, including the residential development, remain unfinished, and flooding protection parameters are still being adjusted. Zorrotzaurre is nevertheless a well-known example in Spain’s context of adaptation policy, particularly considering the deployment of PPPs to deliver adaptation alongside an urban regeneration project.

Table 2 presents a summary of the institutional tools for the case study of Bilbao.

STAGE	INSTITUTIONAL TOOLS
Process	<ul style="list-style-type: none"> • Visioning: <ul style="list-style-type: none"> • Contracting a celebrated international architect to develop the urban development design • Creation of an innovative sustainable low-carbon district in Zorrotzaurre • Creation of a scientific and technological hub in Zorrotzaurre with the participation of companies, universities and research centres to enable innovation and sustainability • Management through a public–private partnership (PPP): the Commission for the Urban Development of Zorrotzaurre (also named the Management Commission of Zorrotzaurre) was founded in 2001, including public and private institutions at various levels (local and regional) • Baseline studies on cost–benefits and flooding, such as economic impact analysis of the opening-up of the Deusto Canal (Osés <i>et al.</i> 2012), and the flood assessments developed by the regional public water agency (Uraren Euskal Agentzia—URA, the Basque Water Agency) (as part of the Basque flooding planning process; see below) • Participatory processes with residents (the social movement Foro para un Zorrotzaurre Sostenible)
Planning	<ul style="list-style-type: none"> • Basque Flooding Risk Prevention Plan 2015–22 (developed by the regional public water agency, URA) • <i>Estrategia de Desarrollo Urbano Sostenible e Integrado</i> (EDUSI), the Sustainable Urban Development Strategy of Bilbao with a focus on Zorrotzaurre (2015) • Special Urban Plan for Zorrotzaurre (2015) • Modification of the General Plan for Urban Planning in Bilbao in Zorrotzaurre (2008) • Declaration of the existing neighbourhood as a Protected Rehabilitation Area in 2008 • Public consultation periods are required by law • Evaluation of the environmental implications of the projects through (strategic) environmental impact assessments
Policy	<ul style="list-style-type: none"> • Financing: European Regional Development Fund (ERDF) funds that have supported the development of the project • European Union’s Horizon 2020 Research and Innovation Program funds to invest in urban low carbon technologies (Decarb City Pipes 2050, Atelier H2020 project) and brownfield decontamination (POSIDON and BRODISE H2020 projects) • The Basque government, Bilbao City Council (through Surbisa, the public company for building rehabilitation) and the Management Commission of Zorrotzaurre funded a programme to regenerate the existing neighbourhoods in the area • Regulations: compliance with the urbanisation limits established by the regional public water agency (URA) that has defined the limits for the canal according to flooding parameters

STAGE	INSTITUTIONAL TOOLS
Management and evaluation	<ul style="list-style-type: none"> Management Commission of Zorrotzaurre stands as the body dealing with managing this project across its life and after use
Delivery and legacy	<ul style="list-style-type: none"> Contracting construction works (including the decontamination of polluted soils and execution of urbanisation) and services related to the design, environmental control and health coordination The city of Bilbao is a signatory of the Covenant of Mayors and Global Covenant of Mayors for Climate and Energy 2010

4.2 ADAPTING THROUGH GREEN INFRASTRUCTURE IN MADRID

With COP22 in Paris in 2015, the City of Madrid moved from sound scientific assessments to Madrid + Natural, a nature-based adaptation programme (2016) led by the local government. This programme aims to inspire models of nature-based solutions as demand-based urban projects. The programme had two main objectives: illustrating what adaptation might look like in Madrid (Figure 3) and generating a local communication flow connecting citizens, and public and private actors. Madrid + Natural emphasises a closer-to-the-ground approach and establishes a portfolio of nature-based solutions in the city that could be later deployed project by project.

Table 2: Main tools used for the institutionalisation of adaptation to flooding risks in Bilbao.

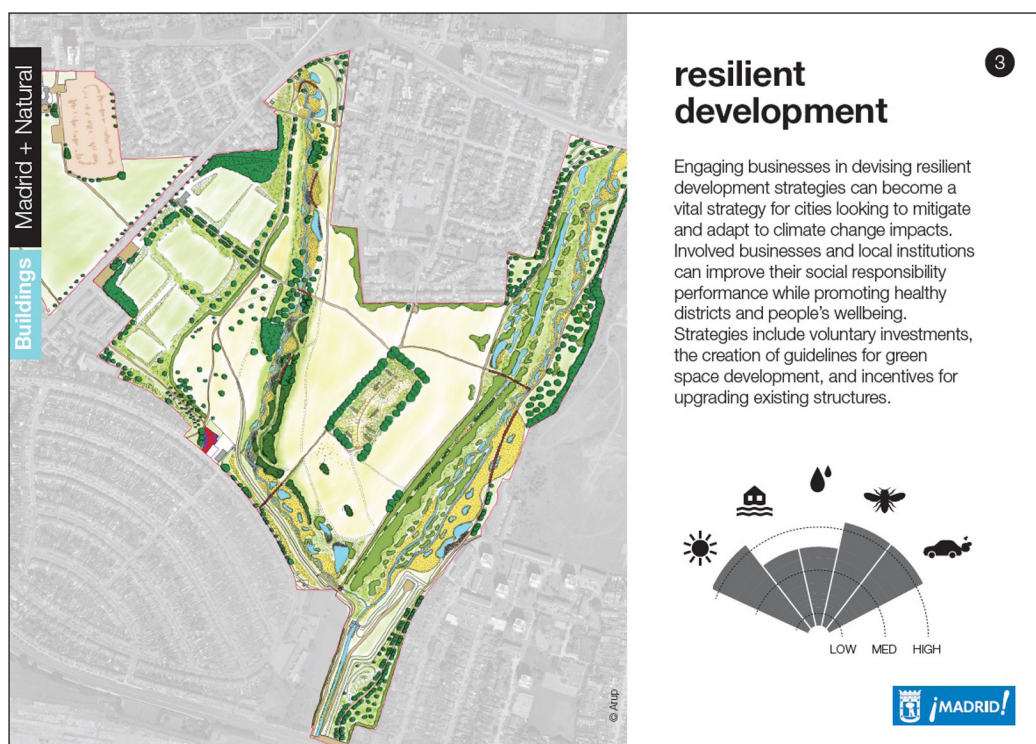


Figure 3: Illustrative example of Madrid + Natural programme. Solution #3 on Resilient urban development.

Source: Madrid + Natural portfolio of adaptation proposals (2016) (<https://www.madrid.es/>).

The programme emerged from a deliberate effort to engage with bottom-up nature management efforts after the city's experience developing a top-down vulnerability assessment (Ayuntamiento de Madrid 2015: 48) with mixed results. The council wanted to deliver a programme that would transcend political differences in a divided city to ensure the programme's legacy. Madrid + Natural became a transversal programme complementing the city's climate planning and urban regeneration processes. For example, the programme was developed alongside a strategic plan for urban regeneration (*Madrid Recupera* or *PlanMadre*—Mother Plan; last revision 2018), and it is part of Plan A: Air Quality and Climate Change Plan for the city of Madrid (2017).

Madrid + Natural encourages combinations of PPPs to develop and invest in nature-based projects across the city. Each nature-based project has different leaders, often local partners, building a sense of social ownership and independence from political cycles. These projects might be, for example, infrastructural projects using nature as a driving essence and awareness projects that illustrate green recovery through art to show what the urban space could look like (Figure 4). The programme has no dedicated budget, and budgets are thus assigned on a project basis. Still, most

projects are funded from the municipal budget (regular, participatory or financially sustainable investments (IFS) as defined by the Spanish government) under the specific departmental budgets. Some projects receive support from European programmes such as Horizon 2020 (H2020) or the LIFE Programme.

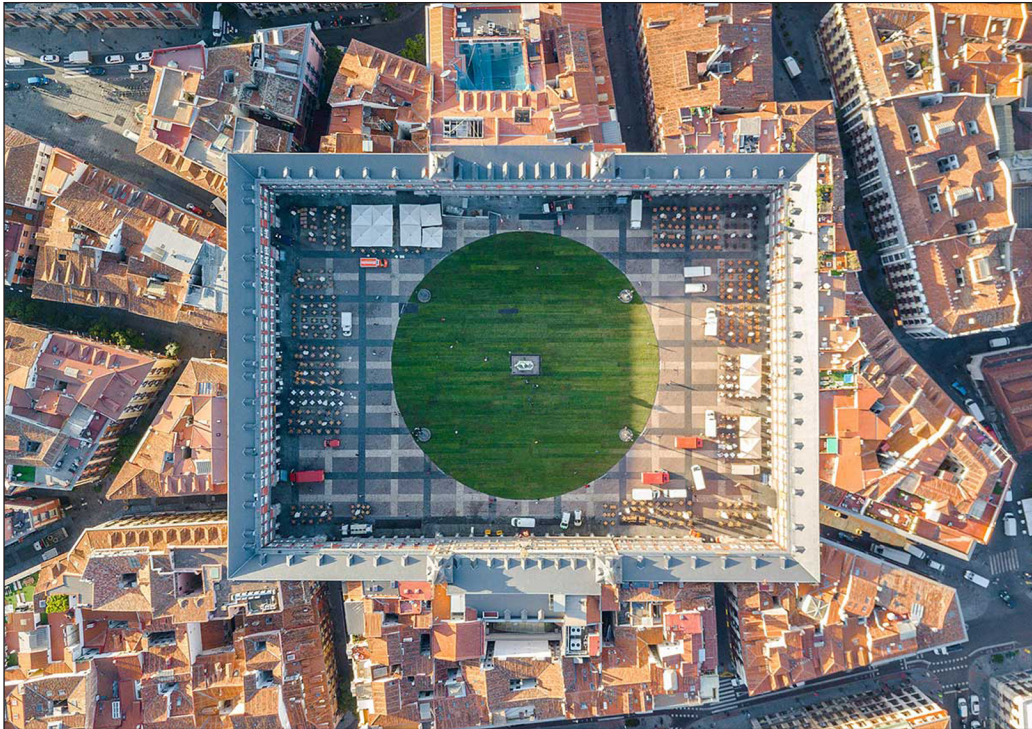


Figure 4: Temporal urban art project in Plaza Mayor, Madrid.
 Source: SpY (<http://spy-urbanart.com/>).

This form of project management has led to the decentralisation of competencies from the local government to the municipal boards (a district governance level), for example, regarding the management of degraded areas. The distribution of competencies has boosted bottom-up regeneration and greening activities and enabled the projects' social ownership and legacy. Table 3 shows the institutional tools for the process of adaptation through green infrastructure in Madrid.

STAGE	INSTITUTIONAL TOOLS
Process	<ul style="list-style-type: none"> • Visioning: creating a programme outside the formalities of planning processes to enable a long-term commitment beyond planning and electoral cycles • Information: 2016 public presentation and workshop with stakeholders from administration, academy and the private sector • Internal and external communication: programme being disseminated internally (workshops, meetings and presentations) and externally (public fora, national and international meetings) • Baseline studies on urban climate, vulnerability and nature-based solutions such as the Urban Climate Study of the City of Madrid (2017), Climate Vulnerability Study of the Metropolitan Area of Madrid (2015), and Green Roofs and Green Façades Inventory (2017) made accessible through Google Maps
Planning	<ul style="list-style-type: none"> • Madrid + Natural programme proposal made public in 2016 • Strategic Plan of urban regeneration of the city of Madrid (<i>Madrid Recupera</i>, also called <i>PlanMadre</i>—Mother Plan) (2017), which helps to integrate nature-based projects depicted in Madrid + Natural for urban regeneration purposes • Energy and climate change strategy for the city of Madrid (Plan A) (2017), which is the umbrella for both Madrid + Natural and <i>PlanMadre</i> • Madrid + Natural dossier of nature-based solutions (2019)
Policy	<ul style="list-style-type: none"> • Financing: projects mainly funded with the municipal budget (regular, participatory or extraordinary financially sustainable investment—IFS). Other projects have support from European programmes such as: Horizon 2020 (H2020), LIFE Programme, Development Education and Awareness Raising (DEAR) programme and European Institute of Innovation and Technology Climate Knowledge and Innovation Community (EIT Climate-KIC) • Some initiatives are starting to establish public-private partnerships (PPPs) • Decentralisation of competencies from the city council to the municipal boards regarding the management of degraded areas to boost the activities of regeneration and greening and facilitate social ownership and bottom-up action

STAGE	INSTITUTIONAL TOOLS
Management and evaluation	<ul style="list-style-type: none"> Budgeting: the programme has no budget associated. Projects that are included are funded by each municipal service that develops them
Delivery and legacy	<ul style="list-style-type: none"> Self-learning (no protocol) process around governance, financing, co-benefits, communication and engagement. These are used as they emerge to reorient critical priorities of the programme The city of Madrid is a signatory of the Covenant of Mayors and Global Covenant of Mayors for Climate and Energy 2008, Mayors Adapt 2014 and Compact of Mayors (C40) 2015

4.3 URBAN ADAPTATION GOVERNANCE IN BARCELONA

The city of Barcelona has a strong interest in becoming a hub of social innovation and science. The local government has built on this vision to create an organisational structure that enables robust science and policy processes and social innovation through partnerships and ad hoc participatory processes (Figure 5). For example, the Climate Office is a transversal municipal department institutionalised as a driving core for climate change resilience policy and planning. This municipal department includes an urban ecology commissioner, the Sustainability Culture and Strategy Office, the Energy Agency of Barcelona, and the Social Rights and Resilience Department. This transversality guarantees the integration of multiple perspectives and confers a certain degree of power due to direct communication with local governmental commissioners and the mayor's office.

Table 3: Main tools used for the institutionalisation of adaptation through green infrastructure projects in the city of Madrid.



Figure 5: Barcelona's participatory project: *Compromís de Barcelona pel Clima* (The Barcelona Commitment to Climate).

Source: Barcelona City Council.

Barcelona's local government has adopted a socially informed approach to climate planning delivered in the shape of an action plan (Plan Clima 2018–30) that integrates adaptation and mitigation with a climate justice component. The local government has a long experience partnering with organisations of different nature to develop research and demonstration projects and establish the capacities required to develop Plan Clima, including sound technical knowledge and strong participatory networks. The plan follows previous environmental and sustainability commitments. Previous initiatives have expanded and sustained new actions emerging from bottom-up processes to inform sustainability and climate policies. The plan has also used technical assessments to identify priority areas of intervention (e.g. vulnerable neighbourhoods that may face energy poverty) or opportunity (e.g. boosting social action or green infrastructures). Plan Clima is the first local strategy to actively involve the local population in knowledge co-production (Satorras *et al.* 2020). The plan has used existing stakeholder networks such as the Barcelona +

Sustainable network that includes members adhering to the Citizen Commitment to Sustainability (2012–22). According to municipal documentation (Plan Clima; see the supplemental data online), around 85% of the policy measures were gathered in participatory processes.

The policy measures of Plan Clima were incorporated in Barcelona’s Climate Emergency Action Plan (2020–30) which makes a national call and includes recommended actions for multilevel public and private actors (e.g. airport, Spanish ministry) to act on the competencies that go beyond local administration (e.g. international and national mobility strategy that affect the sustainability of the city Barcelona).

Table 4 shows the institutional tools for adaptation governance in Barcelona.

STAGES	INSTITUTIONAL TOOLS
Process	<ul style="list-style-type: none"> • Visioning: creating a transversal municipal department as a driving core for climate change resilience policy and planning. This municipal department includes the urban ecology commissioner, sustainability culture and strategy office, the Energy Agency of Barcelona, and the Social Rights and Resilience Department. These form the Climate Office (resilience, energy and sustainability) • Strong process of knowledge co-production from screening and planning to implementation: social demand to develop an Adaptation Plan for Barcelona (<i>Compromiso de Barcelona por el clima</i>), participatory processes for plan creation and execution (nine projects 2015–17 and 11 projects 2018–22) • Baseline studies: climate projections and vulnerability assessments developed with the Barcelona Regional (BR) public entity using data from the Regional Meteorological Service of Catalunya and previous studies by the Barcelona Metropolitan Area • Awareness and information campaigns along the process of plan creation and implementation: Creation of Web Clima (http://lameva.barcelona.cat/barcelona-pel-clima/) where all supporting data for the plan and specific outputs of execution and implementation can be found. Information campaigns with visual resources in social networks (Facebook, Twitter, YouTube). Over 30 annual contributions to public events
Planning	<ul style="list-style-type: none"> • Benchmarking of adaptation plans analysing over 30 municipal plans worldwide (2014) • Development and implementation of Plan Clima (2018) in Barcelona • Creation of the Climate Emergency Plan for Barcelona (2020), with more than 100 actions affecting private and public multilevel actors
Policy	<ul style="list-style-type: none"> • Financing: using municipal budget lines and also strong/intensive participation in European-funded international projects, e.g. the H2020 project RESCCUE. Also, European-funded Urban Innovative Action (UIA) to convert 11 schools into climate havens • Municipal government regulations include the programme to boost renewables, the green infrastructure programme and the energy transition programme
Management and Evaluation	<ul style="list-style-type: none"> • Reporting: Barcelona reports mitigation and adaptation progress to the Carbon Disclosure Project (CDP), and C40 provides feedback • Monitoring: Plan Clima and the Climate Emergency Declaration include over 100 indicators that should be monitored annually • First Climate Change Monitoring report (2018) • Special Climate-Emergency Monitoring report (2020)
Delivery and Legacy	<ul style="list-style-type: none"> • Development of the Action Plan through participatory processes (each five to six years) • Pilot follow-up programme (called Project Monitor): if the experiment works, it will be applied to all municipal cross-cutting projects • Climate Emergency Commission and Action Plan 2020–25 • The city of Barcelona is a signatory of the Covenant of Mayors and Global Covenant of Mayors for Climate and Energy 2008, Mayors Adapt 2014, Compact of Mayors (C40) 2015 and Pact Mayors Climate and Energy 2017

5. DISCUSSION

5.1 DIVERSITY OF TOOLS AND ACTORS

Local governments can integrate adaptation into existing planning cultures and structures of urban governance in diverse ways.

The analysis confirms insights from urban adaptation governance research (e.g. Le 2020; Olazabal & Ruiz De Gopegui 2021; Woodruff & Stults 2016). For example, baseline studies move adaptation from recognition and groundwork into action. Policy tools, particularly those related to finance,

Table 4: Main tools used for the institutionalisation of strategic adaptation in Barcelona.

convert groundwork (mostly baseline studies) into action (projects, plans and programmes). However, the analysis also highlights other tools that have received less attention in urban adaptation governance research.

Visioning was an integral part of the institutional process across the three cases. It facilitates the recognition of values, actors and practices, alongside previous groundwork activities that have mobilised tangible action. For example, Bilbao succeeded in framing adaptation as an opportunity for regeneration and development through the Zorrotzaurre project. The island's vision, designed by an internationally celebrated architect, kicked off the partnership process and highlighted the project's adaptation value. Institutionalisation has happened through policies, regulations and PPPs that have expanded a previously successful formula for the regeneration of the industrial Bilbao. In contrast, the goal behind the vision of Madrid + Natural was to generate evidence of success through local nature-based solution projects to attract other interested parties, creating a more robust city-wide green network, including diverse and multiple green initiatives. The programme's transversal nature and vision aimed to safeguard its legacy and, to a certain extent, enabled a process detached from traditional political and planning processes. Finally, the institutional change brought by Barcelona's case followed a scientific and social vision mirrored within the organisational structure of the local government. Plan Clima, one of the outputs of Barcelona's process along the adaptation spiral, follows previous recognition and groundwork processes. A key aspect in Barcelona is the organisational change that has inspired new transversal practices, such as, for example, the use of climate justice and citizen action as the main urban transformative agents across mitigation and adaptation objectives.

Institutional innovation (Patterson 2018), in multiple forms, can also be identified as an important part of mainstreaming adaptation. In Bilbao, the project's engine was a partnership of public and private actors, and social participation allowed a modest inclusion of community demands. In Madrid + Natural, the focus was to foster bottom-up initiatives from neighbourhood communities, civic organisations or private companies. Those actions included, for example, the deployment of cool and green roof projects and the creation of urban community gardens. In Barcelona, in addition to the role of science and scientists in elaborating a knowledge base for the creation of Plan Clima, the planning process involved established community groups through the Barcelona Commitment to Climate. This initiative, presented at the COP21 Paris Summit, received numerous instances of recognition, including the Transformative Actions Program by the global network ICLEI—Local Governments for Sustainability. It involves more than 800 social entities linked to the Barcelona + Sustainable network. Across the three examples, there is evidence that actors have been recognised at different stages of the adaptation spiral, allowing its escalation.

5.2 EVIDENCE OF INSTITUTIONALISATION OF ADAPTATION

The comparative analysis shows that institutionalisation may result from traditional and innovative tools, alone or in combination. Process tools (those related to diagnosing, participation and visioning) play a critical role in facilitating the institutionalisation of adaptation. In each case, there is evidence that visioning is one of the main triggers that enables institutionalisation through combinations of existing institutions, which is critical to facilitating adaptive processes over time. However, different institutional tools can facilitate moving along the adaptation spiral, as shown by the different strategies adopted in three cities that share similar policy and planning cultures.

The three cases show positive adaptation value. The projects in Bilbao and Barcelona build on existing trajectories of change and suggest long-term adaptation capacity. The diversity of adaptation styles and institutional approaches across the three cases illustrates the singularity and contextuality of local adaptation and the lack of a 'silver bullet' for institutional innovation in climate change adaptation (Patterson 2018). Experiences and contextual factors affect the institutional innovation capacity (Patterson & Huitema 2019). Madrid + Natural shows that interventions to address thermal comfort require different approaches depending on the type of space and its use. For example, school communities have been seriously impacted by heatwaves in the past (e.g. summer 2017). Madrid + Natural has promoted three publicly led pilot projects to integrate nature in schoolyards in joint co-creation with school communities, to showcase the transformative value

of these initiatives that not only benefit schools but also neighbouring communities that make use of these public spaces. Another example is the public–private initiative to regenerate abandoned areas through greening in the process of co-creation with communities and local businesses. In the neighbourhood of La Latina, in central Madrid, this has addressed thermal comfort and the demand for communal sharing spaces.

Taking a long view on adaptation also helps address social, environmental and economic conflicts within the process, also seen as maladaptations (Schipper 2020). In Bilbao, for example, the social movement contesting the project has well-supported arguments and disagrees with the discourse of inclusive growth. The project apparently cancels a local cultural identity rooted in its port-linked industrial heritage. In addition, recognising and addressing urban sustainability and resilience trade-offs, including emissions increase due to this new urban development, will be critical for the project's long-term outcomes. There are policymaking innovations that can support such long-term processes of adaptation. For example, Madrid has used visual tools to emphasise adaptation's local character and enhance communication across municipal departments, developers, investors and final users, and enable long-term collaborative partnerships.

6. CONCLUSIONS

Urban areas use and combine various tools to institutionalise adaptation and deploy adaptation projects. The institutionalisation of adaptation must match the capacities and needs of each local context to deliver climate adaptation. Even within the same national policy context, local governments may take very different approaches, as shown in the comparative analysis of Bilbao, Madrid and Barcelona. The three cases show that multiple parallel processes of institutionalisation—from demonstrative, visual actions to collaborative delivery mechanisms—may operate to deliver integrated adaptation planning. This suggests that even in contexts where resources may be limited, facilitating process of collaboration and visioning may be the first step towards enrolling a wide range of actors in adaptation governance. The adaptation spiral suggests not a linear process of institutionalisation, but a complex process of enrolment of planners and policymakers in new routines that embed adaptation actions in the long term.

Institutionalisation challenges, however, relate to sustainability trade-offs, and the ways in which adaptation interacts with urbanisation processes with the risk of compounding further processes of urban differentiation and the inequities that they may cause. Maladaptation emerges as a phantom over the rush and urgency for action: How do we know that what we do does not hinder future adaptation efforts? Institutionalisation is one of the processes that could cause maladaptation, for example, by emphasising urban regeneration that fosters gentrification and further reduces people's adaptive capacities. There is an urgent need to examine institutionalisation, particularly across countries with different levels of attention to adaptation action.

Considering the analysis and above conclusions, three key points are identified that would benefit from further research:

- the development and implementation of approaches for effective monitoring to enable social learning and an adaptation legacy process
- more extensive comparative analyses to bridge in-depth insights from case studies and systematic comparisons across multiple localities
- given the role of recognition, groundwork and action in the advancement of adaptation through the spiral, research needs to be directed to the exploration of the particular dynamics of these stages across temporal and spatial scales and to the analysis of their relationship with processes of institutional innovation, power and justice as well as processes of maladaptation

New studies could unveil patterns and models to escalate local adaptation based on examining specific mechanisms (and combinations of tools) that trigger transformative changes in the rules-in-use for local adaptation.

- 1 Case studies and projects of these three cities are, for example, show cased in the European Commission's database of good practices Climate-Adapt (<https://climate-adapt.eea.europa.eu/>) and in its Spanish counterpart (<https://www.adaptecca.es/>).

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COMPETING INTERESTS

The authors have no competing interests to declare.

ETHICAL CONSENT

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SUPPLEMENTAL DATA

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