BC3 POLICY BRIEF

PB 2021-03

www.bc3research.org

REPORT

BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

Sustainability, that's it!

COASTAL CLIMATE CHANGE ADAPTATION IN DAKAR

PARTICIPATORY APPROACHES FOR DETERMINING DECISION-MAKING BEHAVIOUR, RISK AND ADAPTATION PREFERENCES

Authors: *Ambika Markanday[1], Elisa Sainz de Murieta[1], Íñigo Aniel-Quiroga[1,2], Andrea Briones[1], Íñigo Losada[2], Alexandra Toimil[2] and Saúl Torres[2]*

[1] Basque Centre for Climate Change (BC3).

[2] IHCantabria - Instituto de Hidráulica Ambiental de la Universidad de Cantabria, Santander, Spain.

1. Introduction

Current policy agendas on climate change are focusing attention on how to help cities plan for adaptation[1].This requires understanding the projected magnitude of impacts across different sectors and affected communities, the drivers of vulnerability and a detailed assessment of the costs and benefits of measures, including co-benefits. Cities in developing regions, where a significant amount of urban growth is expected to take place in the coming years, are of particular importance since they are often faced with a variety of social, political and economic barriers to implementation e.g. economic inequalities, infrastructure backlogs and oftentimes significant financial and human resource constraints (Markanday et al., 2019; Shi et al., 2016). The need for adaptation is also higher in developing

[1] The Intergovernmental Panel on Climate Change defined adaptation as 'the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects' (Intergovernmental Panel on Climate Change, 2014).

HIGHLIGHTS

- The report collects information on stakeholder perceptions, attitudes, and preferences related to climate change risks and adaptation in Dakar
- Stakeholders perceive climate change impacts as being temporally close (already happening) but psychologically distant in nature (will have a bigger impact on those further away)
- When assessing risk acceptability according to various economic, health, social and environmental criteria, stakeholders rated a 1 in 25-year extreme coastal event as being generally unacceptable for Dakar
- Nature-based solutions and political measures were ranked as the most attractive adaptation solutions for Dakar
- Administrative and political effort, as well as financial constraints, were perceived as being the most critical barriers to adaptation implementation in Dakar

countries where there is lower adaptive capacity, greater reliance on resources sensitive to climate change, and where societies are more exposed and vulnerable to climate impacts, (Chambwera and Stage, 2010). West Africa in particular, has been identified as a focal climate-change hotspot, with projections of increased temperatures, decreased annual rainfall, increases in the intensity and frequency of heavy rainfall events and sea-level rise (USAID, 2012). Gaining special attention are coastal areas, which have been degrading at accelerated rates due to pluvial and fluvial floods, high winds and waves, storm surges, rapid urbanisation, and damages to natural protective ecosystems, such as mangroves and marine habitats. About 56% of coastlines in Benin, Côte d'Ivoire, Senegal and Togo are facing erosion, with rates and costs expected to increase substantially in the coming years (WMO, 2020). In Senegal, the coastline, stretching over 531km across 6 administrative regions (Saint-Louis, Dakar, Thiès, Louga, Ziguinchor and Fatick) and estimated to house over 60% of the its population (WB, 2013), is under particular threat. Estimates suggest that 74% of Senegal's coastal housing is vulnerable to climate change impacts (USAID, 2012). Of particular importance is Dakar, Senegal's capital city. Due to its status as the economic hub and social and cultural centre of Senegal, many in neighbouring regions are migrating to the capital. The city's rapid expansion and large concentration of population has made it a central point for building resilience and strengthening coastal adaptation efforts along the coastline.

Dakar comprises around 25% of Senegal's population, but encompasses less than 1% of the national territory. The main natural hazards facing the city are floods and coastal erosion, which are being intensified by climate change and sea-level rise (Wang et al., 2009; WB, 2013). The fast rate of urbanisation occurring in Dakar has meant increasing pressure on already inadequate infrastructures, with new housing projects often built in the coastal buffer zone. Due to increased rates of erosion and flooding, many of those located in low-lying coastal zones have been forced to resettle further inland. Many adaptation initiatives are underway in Dakar to try to slow rates of erosion and minimise impacts from flooding. Local communities, with the help of local and national government institutions, have been involved in constructing physical barriers, and there have been a series of community-led awareness raising campaigns to prevent the illegal extraction of sand and to highlight the importance of ecosystem-based adaptation. While there have been some national efforts to implement adaptation solutions, i.e. laws to prevent illegal sand extraction, building of physical barriers (e.g. dikes), and reforestation programmes, these measures are expected to be ineffective in the long-term due to a lack of law enforcement, monitoring and maintenance frameworks (DARA, 2013).

The Governadapt project aimed to tease out some of nuances and barriers to decision-making on adaptation in Dakar, identifying locally specific challenges and solutions. Along with a high resolution risk assessment of coastal flooding and erosion in Dakar under various climate change scenarios presented in the BC3 Policy Brief- Report PB 2021-02 (Aniel-Quiroga et al., 2021), the project also utilised stakeholder engagement processes to study the complexities of decision-making under risk and conducted a multi-criteria assessment of adaptation solutions to propose measures that could work in the region. Results of this stakeholder engagement process are presented in this report.

2. Climate change risk preferences and attitudes

Decision-making on adaptation is complex and multifaceted. Not only are adaptation strategies entirely context dependent, with measures varying according to the type of hazard, extent of risk, and temporal and spatial implementation scales, but decision-makers are also likely to have different considerations when deciding between adaptation measures, i.e. who is affected, costs and benefits, values and culture, uncertainties, flexibility, social and/or political acceptability, technological capacity and extent of financial and human resource required (Adger et al., 2007, 2005).

On top of this, there is growing literature documenting the importance of behavioural components when it comes to decision-making on climate change. Sociopsychological models have demonstrated that risk perceptions and willingness to adapt can be influenced by different cognitive and experiential factors such as past experiences, concern, beliefs, knowledge, trust and responsibility of actors, proximity to impacts, temporal and psychological distance, as well as key socio-demographics such as age, political orientation, education, and gender (van der Linden, 2015).

Governadapt aimed to explore some of these critical behavioural components of decision-making by conducting an online survey targeted at key stakeholders dealing with coastal climate risks in Dakar (Figure 1). The survey was comprised of 22 questions. The first set of questions gathered information related to: past experiences, concern, political priorities (section 2.1), climate change beliefs, proximity to impacts, knowledge and sources of information about climate change (section 2.2). The subsequent section collected information on the type of stakeholder, how coastal impacts rank according to other climate hazards in the region, and risk perceptions determined by the temporal and psychological

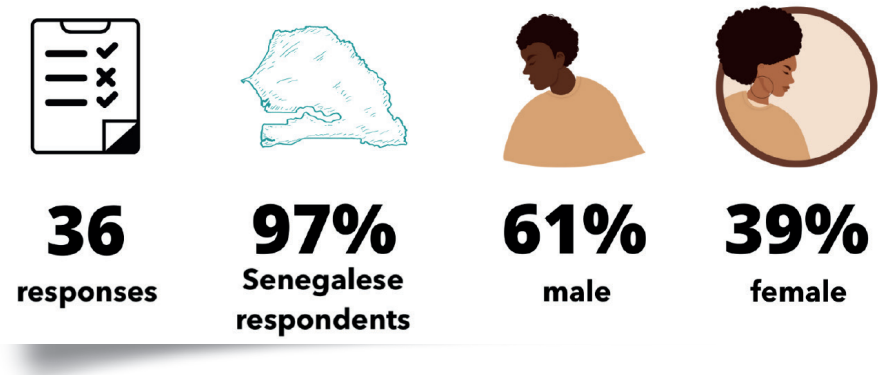


Figure 1. Descriptive summary of stakeholders participating in survey.

distance of impacts (section 2.3). Next, stakeholders were asked to answer questions focused predominantly on perceptions related to adaptation: the effectiveness and ranking of different measures, barriers, responsibility of different actors, and trust in government (section 3). The final set of questions gathered information on socio-demographics: nationality, age, gender, expertise, education, and number of household members.

The following results are based on 36 full responses from stakeholders including government officials (12%), academia (35%), civil society (18%), the private sector (9%) and citizens (26%) (Figure 1).

2.1. Previous experience and concern about climate change

72% of stakeholders had experienced extreme coastal events or flooding either personally or through close relatives and/or friends. While this number seems relatively high, previous reports have highlighted coastal erosion and flooding as two of the main risk factors in Dakar. With housing often built in the coastal buffer zone, threats from erosion and related flooding have already been forcing some local coastal communities to move further inland (DARA, 2013). The concentration of housing in coastal zones in Dakar is reflected in the fact that around 50% of stakeholders reported living within 3 km of the coast, and 20% live within 1 km.

Despite this high experience rate only around 50% of stakeholders felt either very or extremely concerned about climate change in Dakar (Figure 2). This could be explained by the fact that other political priorities are considered more important than climate change in political agendas, with climate change ranked 6th after public services and infrastructures, agriculture, health, urban planning, employment and crime[2] (Table 1). Concern about climate change comparative to other problems seems to vary across countries, but generally, it seems that climate change tends to fall short when listed against other directly experienced environmental problems or when compared to broader concerns such as the economy, health care, national security, and issues related to public policy (Wolf and Moser, 2011). Nonetheless, climate change is likely to have an effect on each

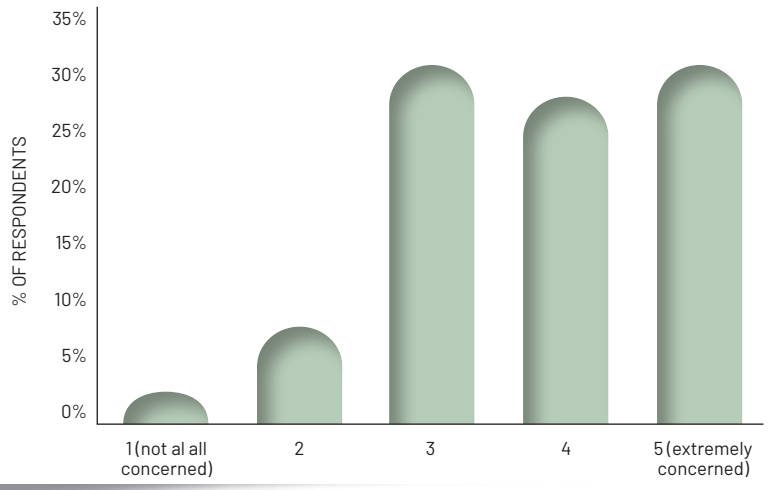


Figure 2. Stakeholder level of concern about climate chanfe in Dakar.

Political priority	Score (/360)	Rank
Public services and infrastructures	214	**1**
Agriculture	209	**2**
Health	208	**3**
Urban planning	206	**4**
Employment	206	**4**
Crime	205	**5**
Climate change and environment	**189**	**6**
Education	187	**7**
Pensions	182	**8**
Social protection	174	**9**

Table 1. Ranking of political priorities by stakeholders in Dakar.

Beliefs about climate change	% of stakeholders
Those believing that climate change is anthropogenic	89%
Those believing that climate change is a natural occurrence	11%
Knowledge about climate change	
Causes	72%*
Consequences	61%*
Solutions	90%*
Primary sources of information on climate change	
Scientific articles	56%
Television and documentaries	22%
Social media	11%
Magazines and newspapers	3%
Others	8%

*Refers to the number of respondents that answered correctly

Table 2. Stakeholder beliefs, knowledge and primary sources of information.

[2] Political priorities were based on the Spring 2015 Global Attitudes Survey (PEW, 2015) and consultation with our local partner (CSE).

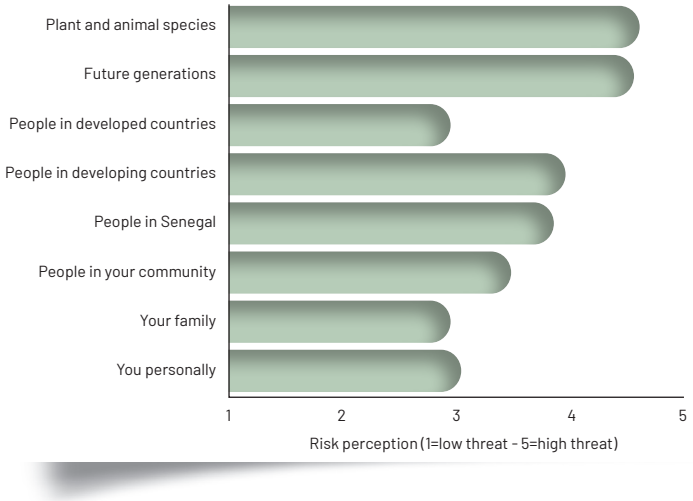


Figure 3a. Perceptions of climate change risks with psychological distance.

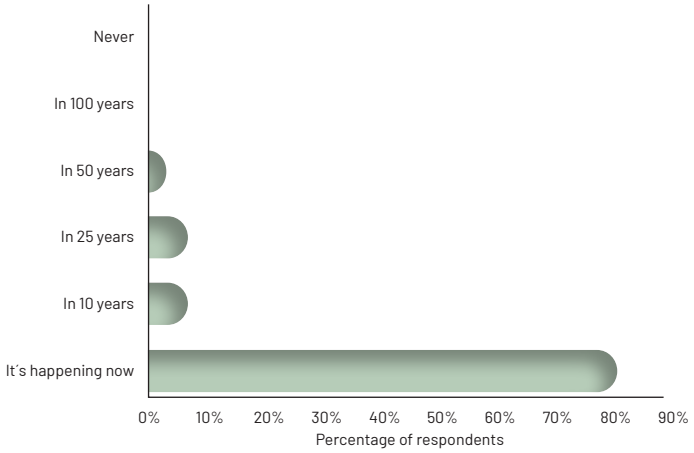


Figure 3b. Perceptions of climate change risks with temporal distance.

of the political priorities ranked first (Niang et al., 2014).

2.2. Beliefs and knowledge about climate change

Most stakeholders believed that climate change is an anthropogenic phenomenon, and a smaller, but not insignificant proportion of stakeholders believed that climate change is a result of natural fluctuations in the Earth's temperature (Table 2). These responses follow trends similar to that in developed countries where generally over half of surveyed populations believe in climate science (Hanson, 2010; Kohut et al., 2009; Pew Research Center, 2009; Riddell and Webster, 2009; Wolf and Moser, 2011), in line with the scientific consensus on the causes of climate change (Oreskes, 2018).

Knowledge was tested by asking stakeholders true or false questions on the causes, consequences and solutions to climate change. Generally, knowledge levels were high, but differed according to what was being tested. The question about the solutions of climate change scored the highest, followed by knowledge about causes. Knowledge about the consequences of climate change scored the lowest overall, but still with 61% of stakeholders answering questions correctly.

With regards to the sources of climate information, scientific articles are the main source of information, followed by television and documentaries and social media. This is an unexpected result given that scientific articles are not generally accessible to a non-expert audience. This could be due to a high representation of academics in our sample (approximately 35% of our sample was comprised of academics), but it is also possible that stakeholders considered other types of references to be included in that category, such as reports developed by institutions or grey literature.

2.3. Risk perceptions

General climate change risk perceptions were measured by studying how stakeholders rated the psychological and temporal distance of impacts. Psychological distance was measured by asking stakeholders to rate the severity of climate change impacts on the following items: them personally, their family, their community, their country, people in developing countries, people in developed countries, future generations and plant and animal species (Figure 3a). Most stakeholders perceived a medium risk to themselves or their family, at the same level as people in developed countries. However, risk was perceived to be higher to people in their community, Senegal and developing countries in general. Risk was highest for future generations and ecosystems and biodiversity.

Perceptions of temporal risk were measured by asking stakeholders when they believed climate change would occur: 'now', 'in 10 years', 'in 25 years', 'in 50 years', 'in 100 years', and 'never'. Over 80% of stakeholders agreed with the fact that climate change is already happening (Figure 3b).

2.4. Acceptable risk thresholds

After results from the risk assessment conducted during the first stage of the project were presented to stakeholders (see Aniel-Quiroga et al., 2021), a second survey was administered to determine acceptable risk thresholds in the city of Dakar. This approach was proposed by Galarraga et al. (2018) as a means to involve stakeholders in decisions about risk, which often occur in highly technical circles. Creating a shared space for policy makers and stakeholders to discuss decisions about risk can contribute to building trust and increasing acceptability of adaptation policies. Moreover, co-defining a risk threshold can also be an important input for deciding how much adaptation is needed and when it should be implemented. Stakeholders were asked to assess to what degree potential impacts from an extreme 1/25-year coastal event[3] might affect the city of Dakar[4]. The aim of this exercise was to qualitatively assess how the city of Dakar would cope given an event of this magnitude and de-

[3] This refers to an extreme event with a 1 in 25-year probability of occurrence.
[4] Stakeholders were told that this type of event would cause USD$45 million in damages and would affect 38,000 people in coastal zones, following the estimates by Aniel-Quiroga et al. (2021).

termine, in an illustrative way, where this type of event might sit on a risk acceptability scale. In order to achieve this objective, a simple risk scoring system was developed, which asked participants to score the level of impact based on various economic, social, environmental and health criteria. A total of 12 criteria were established, with each economic, social, environmental, and health category consisting of 3 each (Table 3). Stakeholders were asked to rate each of the 12 items on a 4-point Likert scale from 1 (low impact) to 4 (high impact). Overall risk scores for each participant were determined based on the sum of all 12 criteria scores. This allowed for a minimum risk score of 12 (1 x 12) and a maximum risk score of 48 (4 x 12). 4 risk categories were established to represent potential risk acceptability based on overall risk scores. Risk category 1 represented a predominantly acceptable level of risk with a very low overall impact score ranging between 12 and 20. Risk category 2 represented a tolerable level of risk with a low-medium impact score ranging between 21 and 30. Risk category 3 represented a tolerable level of risk with a medium-high impact score ranging between 31 and 39. Risk category 4 represented an unacceptable level of risk with a very high impact score ranging between 40 and 48. On average, stakeholders rated a 1/25-year event as a **low category 4 risk event (unacceptable)** with an average risk score of 41.7 (Figure 4).

Economy	**1**	Potential impact on the budget of the city of Dakar and the distribution of funds across services and departments
	2	Potential need for emergency disaster relief funds and international assistance
	3	Potential impact on GDP (i.e. loss of income, impacts on livelihoods – business, tourism)
Health	**4**	Potential impact on productivity, stress levels and mental health
	5	Potential impact on physical health (injuries, hospitalisations, deaths)
	6	Potential disruption to critical health infrastructure (hospitals, clinics, water and sewage networks)
Society	**7**	Potential impact on housing and settlements (need for evacuation, rehousing, establishment of emergency relief centres)
	8	Potential impact on vulnerable/ marginalised populations (i.e. low-income groups, women, the elderly, children)
	9	Potential impact on public perceptions and trust in government
Environment	**10**	Potential impact on green spaces, biodiversity and coastal habitats
	11	Potential impact on fisheries
	12	Potential impact on cultural and historical heritage sites

Table 3. Criteria used for the development of risk scores in the case of a 1/25-year event hitting Dakar.

3. Adaptation assessment

Adaptation was addressed in two different phases of the project. First, stakeholders were asked in the survey presented in Section 2, about their preferences on a number of adaptation options, including the perceived effectiveness and potential barriers to implementation. Then, following the analysis of coastal risks in Dakar, a review of previous reports and research was conducted and a portfolio of adaptation measures that could be relevant for

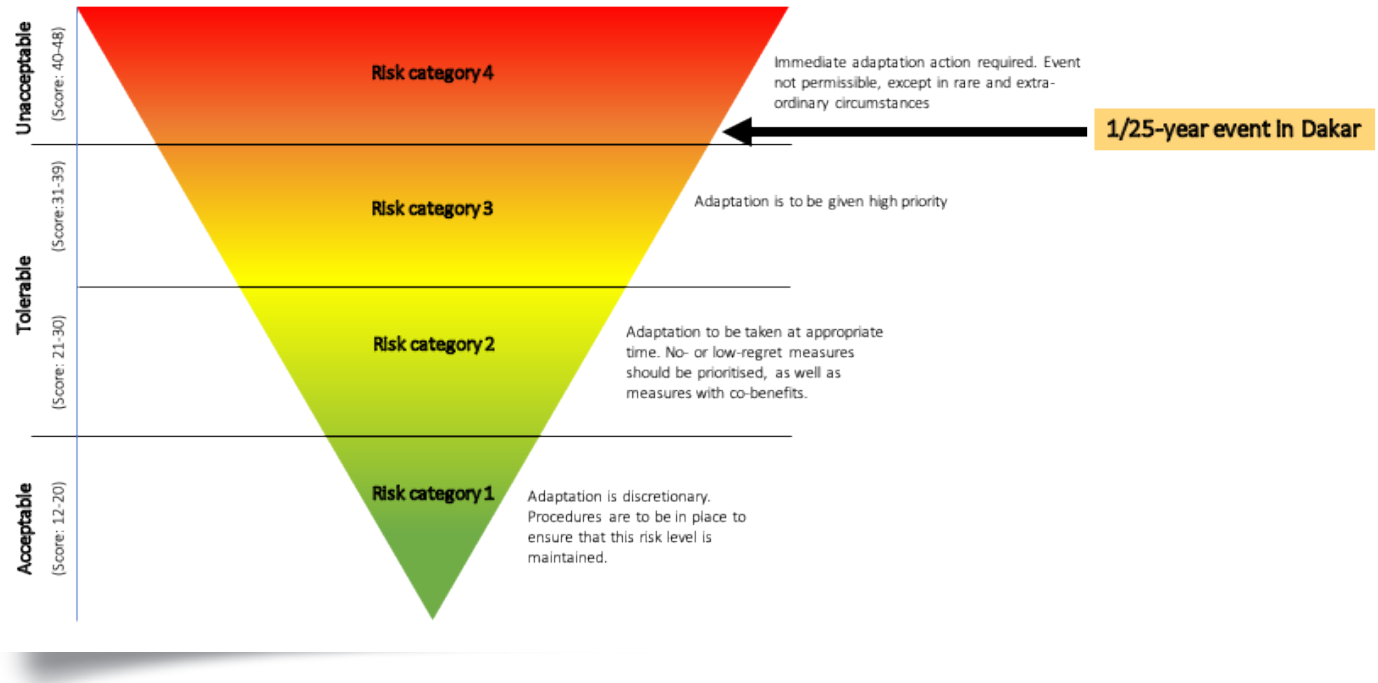


Figure 4. Risk acceptability level determined by stakeholders related to a 1/25-year event hitting Dakar.

dealing with coastal erosion and flooding in Dakar was developed. A participatory workshop was organised to analyse the characteristics of those measures and evaluate them according to certain sustainability criteria. The purpose of the workshop was twofold. Firstly, it intended to include different streams of knowledge and perspectives, which is considered good practice for improving the acceptability of public policies and considering the opinions of different agents (Akerlof et al., 2016). Secondly, it aimed to rate adaptation measures considering local needs so that those prioritised could be effective, whilst also offering multiple benefits and contributing to reducing vulnerability[5].

3.1. Perceived barriers, effectiveness, and prioritisation of adaptation measures

Stakeholders were asked two questions intended to measure their perceptions of a wide range of coastal adaptation solutions. The first question asked stakeholders to rate their perceived effectiveness of the adaptation measures. The second question asked stakeholders to rank the adaptation solutions according to how they would prioritise them. Assessing the two questions in conjunction was intended to tease out any potential barriers that may be a cause for why ranks and effectiveness ratings were not aligned. Results showed that ranks and effectiveness perceptions were more or less synonymous with the exception of one type of adaptation: nature-based solutions. While stakeholders perceived nature-based solutions as being the most effective among the solutions presented to them, they ranked it third in the prioritisation exercise (Table 4).

Stakeholders were then asked to rate certain barriers to adaptation according to how much of an obstacle they thought it would present to adaptation implementation in Dakar. Seven different barriers were presented to stakeholders: scientific uncertainty; public perceptions; timescales; financial constraints; social acceptability; political and administrative effort, and; technical difficulty. Political and administrative effort was ranked as being the biggest obstacle to adaptation implementation, followed by financial constraints, timescales, social acceptability, and technical difficulty. Public perceptions and scientific uncertainty were ranked as being the smallest obstacle to adaptation implementation (Table 5).

Some of these barriers might help to explain why nature-based solutions, despite their high effectiveness scores, are not given higher levels of priority. For example, long implementation timescales, ranked as the third biggest obstacle to adaptation, signal the need for immediate solutions to coastal flooding and erosion. Nature-based solutions could be seen as needing longer implementation times until they reach peak effectiveness levels. For example, the principal adaptation service of nature-based solutions such as mangroves may not be delivered for many years (Jones et al., 2012), with yearly growth rates for mangroves peaking at

Adaptation	Order of priority	Perceptions of effectiveness
Urban management and planning	1	79%
Regional and local political solutions	2	75%
Nature-based solutions	3	80%
Infrastructure measures	4	70%
Financial measures	5	65%
Adaptive social protection[6]	6	60%
Private property protection measures	7	53%

Table 4. Comparing stakeholder adaptation rankings according to prioritisation and effectiveness of measures.

Barrier	Rank
Administrative and political effort	**1**
Financial constraints	**2**
Timescales	**3**
Social acceptability	**4**
Technical difficulty	**5**
Public perceptions	**6**
Scientific uncertainty	**7**

Note: Ranking is from greatest to least perceived barrier

Table 5. Perceived barriers to adaptation implementation.

Perceived responsibility	Rank
National government	1 (most responsible)
Regional government	2
Citizens	3
Scientists and climate researchers	4
Local NGO's	5 (least responsible)
Trust in government	**61%**

Table 6. Perceived responsibility of actors and trust in government.

[5] Due to the COVID-19 pandemic, the workshop was organised so that it could accommodate stakeholders both online as well as in-person.
[6] Adaptive social protection aims to help poor and vulnerable households become more resilient to the effects of climate change. It integrates basic social protection interventions with disaster risk management and climate change adaptation measures (The World Bank, 2020).

Box 1.
Selected adaptation strategies for coastal erosion and flooding in Dakar

Type of measures	Selected adaptation strategies for coastal erosion and flooding in Dakar
Social protection	**Capacity building** Capacity building refers to the process by which individuals or organizations obtain, improve or maintain the skills, knowledge, tools, equipment or other resources necessary to do their jobs competently. Public awareness and knowledge development on the impacts of climate change and the need to adapt is normally the starting point of this process.
	Adaptive social protection Social protection aims to strengthen the resilience and adaptive capacity of the most affected and vulnerable populations as well as promote the use of social protection systems, i.e. through the delivery of key social services and local-level social protection initiatives aimed at vulnerable groups
Soft measures	**Early warning systems** Early warning systems work by detecting and predicting extreme storm and/or flood events so that the public can be alerted in advance and can undertake appropriate responses to minimise their risk.
	Beach nourishment Beach nourishment involves artificially placing sand onto an eroded shore in order to maintain the amount of sand present on the coast, thus slowing the rate of erosion. This type of adaptation can also protect against storm surges, depending on the type of material used (i.e. using gravel or small pebbles). Beach nourishment is normally aimed at maintaining beaches for tourism and recreation.
Nature-based solutions	**Restoration of coastal green ecosystems and wetlands** Coastal forests and wetlands provide storm protection, shoreline stabilisation and act as safety barriers for coastal communities against coastal risks such as coastal erosion and flooding. Mangroves and swamp forests absorb and reduce water flow, allowing space for water discharge. They also provide space for tidal overflows caused by storms or sea-level rise.
	Preservation and restoration of natural spaces Conserving natural spaces near urban areas can preserve habitats and biodiversity while increasing the ability of vegetation to hold water, thus providing an important benefits of stormwater management and flood prevention. Green spaces in cities can also cool with shade and better evapotranspiration, reducing the heat island effect that occurs in many cities.
Institutional measures	**Risk governance and urban planning** Risk management is generally organised into 5 stages: prevention, protection, preparedness, response, recovery and review, with urban planning playing an important role in risk prevention. The process involves strategizing and coordination to meet the needs of those affected while also enabling teams and communities to build working relationships that can make a crucial difference to the speed and effectiveness of risk management. This measure often consists of putting in place an institutional framework for climate governance and risk management that includes vertical coordination between national government and local authorities, but also horizontal coordination between regional actors, different sectors, and local communities
Hard infrastructures	**Dikes** Sea dikes are used to protect low-lying coastal areas from flooding by the sea under extreme conditions. Dikes are mainly earth structures consisting of a sand core, a waterproof outer protective later, foot protection and a drainage channel. These structures are designed to resist wave action and prevent or minimise overflows. Dikes have been widely used in countries such as Vietnam, Bangladesh, Thailand, and the USA. They have also been extensively used for flood protection in the Netherlands over the past century.
	Sea walls A sea wall is designed to protect the interior area from wave action and prevent coastal erosion. Protective walls are usually massive structures designed to withstand storm surges. The height of a protective wall will at least cover the difference between the level of the beach and the mainland, although the walls are usually built higher to protect against overtopping waves. Sea walls create a distinct separation between the beach and the mainland.
Financial	**Building insurance** Insurance transfers risk from an insured person, object, or organization to an insurer. Compensation depends on the assessment of losses caused by specific hazards (e.g., crop loss in agriculture, loss of houses due to flooding, forest loss by fires or storms). For extreme weather conditions, this is a valuable tool for ensuring that financial damage does not turn into long-term economic damage if a house or business can be rebuilt or compensated.
	Improving capacity to access climate funds Access to climate finance requires extensive knowledge and skills. It is not only a question of raising the awareness of local authorities on financing opportunities, but increasing their capacity related to understanding submission procedures, types of eligible projects, anchor structures, the best way to complete finance forms etc.

a stand age of 8 years and declining after which until maturity is reached at approximately 30 years (Moriizumi et al., 2010).

When asked about the responsibility of actors in finding solutions to climate change, stakeholders ranked national and regional governments as being most responsible. This links with the prioritisation of more government-led solutions,

such as urban planning or developing climate policies (Table 4). On the other hand, stakeholders' feelings of trust in government (i.e. to implement solutions in an effective and timely manner) were not particularly high, which aligns with perceptions of administrative and political effort as being significant barriers to implementation (Table 6).

3.2. Simplified multicriteria assessment

A simplified multi-criteria approach was developed to assess adaptation preferences according to local needs. A range of adaptation measures considered to be locally relevant were presented to stakeholders during a combined online and in-person workshop. Decision weights were established by asking stakeholders to rate the importance of specific environmental, economic, social and complexity criteria pertaining to adaptation. Those same criteria were used to help stakeholders determine scores for each adaptation option. The ranking of options according to most to least preferred was then determined by applying weights to scores.

3.2.1. Selected adaptation measures

A range of adaptation measures considered suitable for the Dakar region were presented to stakeholders during the workshop. These consisted of social measures (capacity building; social protection), soft measures (early warning systems; beach nourishment), nature-based solutions (restoration of coastal ecosystems and wetlands; preservation and restoration of natural spaces), institutional measures (risk governance and urban planning), hard measures (dikes; seawalls), and financial measures (building insurance; improving capacity to access climate funds). A detailed description of each adaptation solution is presented in Box I. All measures are aligned with local plans such as Dakar's Urban Master Plan (Ministry of Urban Renewal, Housing and Living Environment and JICA, 2016), and Resilience Strategy (Ville de Dakar, 2016), national plans such as the Climate and Energy Plan (Ville de Dakar, 2021), the Economic and Social Development Plan (République du Sénégal, 2012), and the Emerging Senegal Plan (République du Sénégal, 2014) and reports (UN Habitat, 2020).

3.2.2. Determining weights for environmental, social, economic and complexity criteria

The first step of the multi-criteria assessment involved establishing specific evaluation criteria for assessing adaptation options. Economic, environmental, social and complexity criteria consisting of 3-4 items each were developed for this exercise. Before being presented with the adaptation options, stakeholders were asked to evaluate the importance of these specific criteria in terms of their ability to influence their decision-making on adaptation. Importance was measured using a 3-point Likert scale from 1 (low importance) to 3 (high importance). These importance scores were later used as weights during the adaptation scoring exercise. Environmental criteria were rated as being the most important overall (average weight of 2.28), with impacts on local habitats, biodiversity and green spaces scoring highest. This was followed by complexity criteria (average weight of 2.04) and social criteria (average weight of 1.99). Economic criteria were rated as being the least important criteria (average weight of 1.66), with reduction in economic inequalities scoring lowest overall (Table 7).

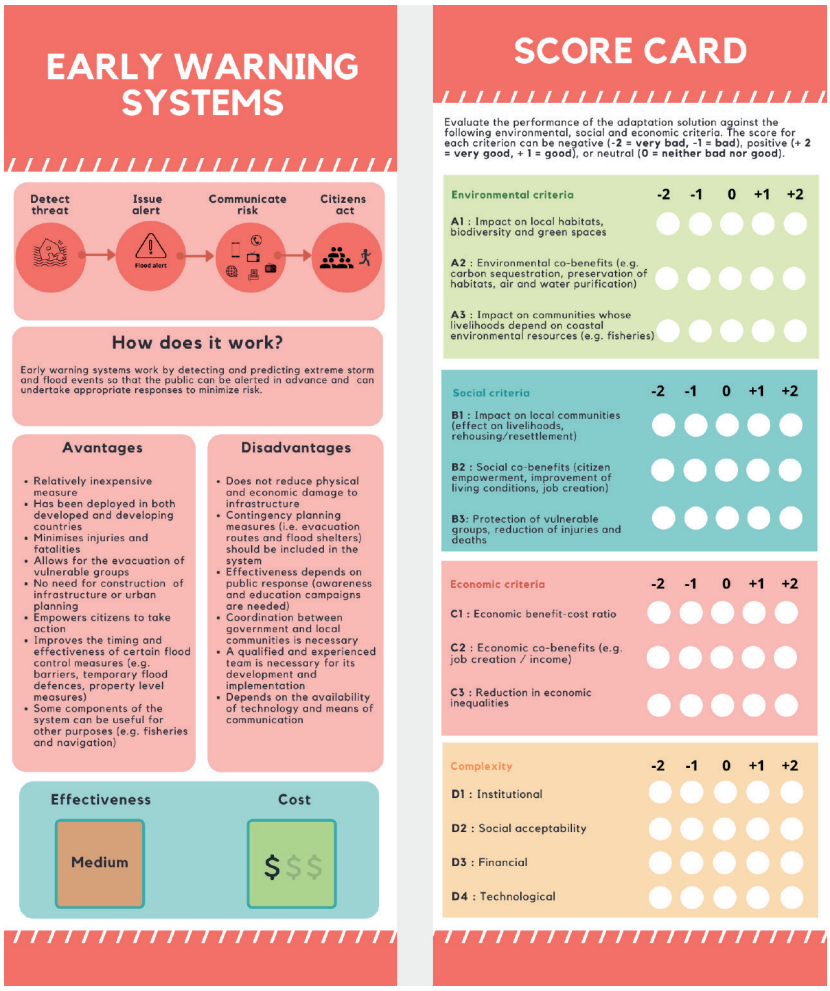
3.2.3. Adaptation scores and ranking of measures

Taking inspiration from Aguirre-Ayerbe et al. (2018), adaptation cards were developed for each solution consisting of the following: a schematic description or an image, a short summary describing how the measure would work in practice, a list of main advantages and disadvantages, a qualitative evaluation of effectiveness (meaning the ability of the measure to reduce impacts) and investment costs. Score cards, comprising the same environmental, social, economic, complexity criteria used in the weighting exercise (described in section 3.2.2), were developed. Unlike the weighting exercise, the score cards were designed using a 5-point negative to positive Likert scale. Stakeholders were asked to evaluate

Criteria		Weight
Environment	**Impact on local habitats, biodiversity and green spaces**	**2.50**
	Environmental co-benefits (e.g. carbon sequestration, habitat conservation, air and water purification)	**2.17**
	Impacts on local communities dependent on coastal natural resources (e.g. fisheries)	**2.17**
Social	Impact on local communities and effect on livelihoods, settlements	**2.33**
	Social co-benefits (e.g. empowering citizens, improving living conditions, creating employment)	**1.83**
	Protection of vulnerable groups, reduction in injuries and mortalities	**1.83**
Economic	Economic benefits compared to costs (i.e. protection of valuable assets and infrastructures)	**2.00**
	Economic co-benefits (e.g. generating employment and revenues)	**1.67**
	Reduction in economic inequalities	**1.33**
Complexity	Institutional	**2.17**
	Social acceptability	**1.83**
	Financial	**2.17**
	Technological	**2.00**

Table 7. Results of criteria weighting exercise, grouped by type of criteria, with highest and lowest scores highlighted.

Box 2.
Example of the adaptation and score cards presented to stakeholders for the multicriteria assessment of adaptation options



each adaptation solution by reading the information provided in the adaptation cards then scoring each measure according to the criteria detailed in the score cards using a scale from -2 (very negative) to 2 (very positive) for each criteria. An example of the adaptation and score cards used for this exercise is shown in Box 2. Stakeholders attending the workshop online did this exercise individually, while those attending in person did the exercise in small groups[7]. Adaptation scores were then adjusted according to the environmental, social, economic and complexity weights established in the first exercise (see section 3.2.2).

The adaptations with the highest overall weighted scores were risk governance, restoration of coastal ecosystems and wetlands, and preservation and restoration of natural spaces. The high environmental and complexity scores for these measures make them attractive options for coastal adaptation in Dakar. In contrast, hard infrastructures (dikes and sea walls) and insurance, had the lowest weighted scores overall. Again, due to the weighting system, the lower environmental and complexity scores, deemed most important for influencing adaptation decisions, makes these types of adaptations undesirable for dealing with coastal erosion and flooding in the region (Table 8).

This type of valuation exercise is also useful for decision-makers who wish to select options based on maximising

Adaptation	Environmental score	Social score	Economic score	Complexity score	Total score	Rank
Preservation and restoration of natural spaces	17.47	12.01	7.67	11.98	**49.13**	**1**
Restoration of coastal ecosystems and wetlands	17.47	10.81	7.28	10.53	**46.09**	**2**
Risk governance	14.50	12.81	7.11	7.02	**41.44**	**3**
Capacity building	11.57	9.42	6.11	12.10	**39.20**	**4**
Improving capacity to access climate funds	13.10	8.65	9.42	7.11	**38.28**	**5**
Early warning systems	9.06	10.22	6.50	9.77	**35.55**	**6**
Social protection	5.01	14.35	7.58	7.15	**34.09**	**7**
Beach nourishment	1.21	8.11	3.17	7.26	**19.75**	**8**
Hard infrastructure (dikes)	-0.92	4.60	6.00	7.21	**16.89**	**9**
Hard infrastructure (sea walls)	-5.54	8.72	1.36	4.59	**9.14**	**10**
Insurance	0.93	8.67	0.00	-1.48	**8.12**	**11**

Table 8. Weighted scores and ranking of coastal adaptation measures.

[7] For the purposes of this report individual scores were combined to form an average group score. This was then added to the in-person group scores to provide an overall assessment of adaptation. Each group consisted of between 5-6 people, with 4 groups in total.

certain criteria. For example, adaptation solutions suitable for socially sensitive locations in Dakar, could be social protection or risk governance measures. Similarly, an example of an adaptation strategy with a greater economic benefit would be capacity building for accessing international climate funds.

It is important to note that the main reason the workshop was conducted partly online was to accommodate those that did not feel comfortable attending the workshop in person during the COVID-19 pandemic. Those that attended the workshop online did the adaptation scoring exercise individually, which was likely to involve a different process of decision-making compared to those that did the exercise in person and in groups. While it was beyond the scope of the project to properly assess the differences between online (individual) versus in-person (group) decision processes, it is reasonable to expect differences in aspects such as the time and efficiency of decision-making, feelings of accountability/responsibility, adequate representation of personal intuitions and views, and availability of different types of information/ representation of different groups across society. In a satisfaction survey completed by those that attended the workshop in person, stakeholders noted that they enjoyed the process of sharing their opinions, knowledge and experiences with other participants. 9 out of the 16 participants felt that their original opinion regarding certain adaptations changed throughout the course of the workshop, and all stakeholders agreed that they would not have preferred to do the exercise alone with one participant noting: *"it was really interesting to discuss and contrast knowledge with other participants."*

4. Conclusions

This report synthesises results from participatory approaches (surveys and workshops) aimed at measuring climate change behaviour, risk and adaptation preferences across a group of stakeholders in Dakar. Results show that despite high risk perceptions, levels of experience and concern about climate change in Dakar, it ranks comparatively low next to other political priorities in the city (e.g. public services and infrastructure, agriculture and health). Moreover, stakeholders rated a relatively high probability (1/25 year) extreme coastal event in Dakar as being above an unacceptable threshold when asked to assess its risk acceptability according to various environmental, social, economic and health criteria. When it comes to adaptation, stakeholders have a specific preference for nature-based solutions and political measures. These types of solutions also tend to be ranked highest when prioritising adaptations according to specific weighted (environmental, economic, social, complexity) criteria. However, perceived barriers to adaptation (factors such as political and administrative effort, timescales, financial constraints), trust in government, and the perceived complexity of measures could hinder their implementation.

Building an understanding of climate change attitudes and perceptions can help to fine tune risk communication strategies in order to yield positive behavioural and societal changes. From a policy perspective, this type of information can also be useful to help decision-makers identify potential barriers and drivers of adaptation, prioritise actions according to local needs and align them with stakeholder preferences. Encouraging a more open and participatory decision-making and policy process in this way can not only help to empower stakeholders to take action but can also reduce risks of maladaptation since it promotes a more holistic perspective of knowledge, needs, sectors and groups within decision-making.

References

- *Adger, W.N., Agrawal, S., Mirza, M., Conde, C., O'brien, K., Pulhin, J., Pulwarty, R., Smit, B., Takahashi, K., 2007. Assessment of adaptation practices, options, constraints and capacity.*
- *Adger, W.N., Arnell, N.W., Tompkins, E.L., 2005. Successful adaptation to climate change across scales. Global environmental change 15, 77–86.*
- *Aguirre-Ayerbe, I., Martínez Sánchez, J., Aniel-Quiroga, Í., González-Riancho, P., Merino, M., Al-Yahyai, S., González, M., Medina, R., 2018. From tsunami risk assessment to disaster risk reduction–the case of Oman. Natural Hazards and Earth System Sciences 18, 2241–2260.*
- *Akerlof, K.L., Rowan, K.E., La Porte, T., Batten, B.K., Ernst, H., Sklarew, D.M., 2016. Risky business: Engaging the public on sea level rise and inundation. Environmental science & policy 66, 314–323.*
- *Aniel-Quiroga, I., Sainz de Murieta, E., Markanday, A., Briones, A., 2021. Coastal flooding and erosion under climate change: a risk assessment for Dakar (BC3 Policy Brief No. PB 2021-02). BC3 Basque Centre for Climate Change, Leioa, Spain.*
- *Chambwera, M., Stage, J., 2010. Climate change adaptation in developing countries: issues and perspectives for economic analysis (No. 978-1-84369-775-6). International Institute for Environment and Development, London, UK.*
- *DARA, 2013. Risk Reduction Index in West Africa: Analysis of the conditions and capacities for disaster risk reduction Cape Verde, Gambia, Ghana, Niger and Senegal (No. M-31513-2013). Fundacion DARA Internacional.*
- *Galarraga, I., de Murieta, E.S., Markandya, A., Abadie, L.M., 2018. Addendum to 'Understanding risks in the light of uncertainty: low-probability, high-impact coastal events in cities.' Environmental Research Letters 13, 029401.*
- *Hanson, F., 2010. Australia and the world: public opinion and foreign policy. Lowy Institute for International Policy.*
- *Intergovernmental Panel on Climate Change, 2014. Adaptation Needs and Options, in: Climate Change 2014 - Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects: Working Group II Contribution to the IPCC Fifth Assessment Report. Cambridge University Press, Cambridge, pp. 833–868.*
- *Jones, H.P., Hole, D.G., Zavaleta, E.S., 2012. Harnessing nature to help people adapt to climate change. Nature Climate Change 2, 504–509.*
- *Kohut, A., Doherty, D.C., Dimock, M., Keeter, S., 2009. Fewer Americans see solid evidence of global warming. Pew Research Center for the People & the Press, Washington DC.*
- *Markanday, A., Galarraga, I., Markandya, A., 2019. A Critical Review of Cost-Benefit Analysis for Climate Change Adaptation in Cities. Climate Change Economics 1950014.*
- *Ministry of Urban Renewal, Housing and Living Environment, JICA, 2016. Project for urban master plan of Dakar and neighbouring area for 2035 (Final Report Summary).*
- *Moriizumi, Y., Matsui, N., Hondo, H., 2010. Simplified life cycle sustainability assessment of mangrove management: a case of plantation on wastelands in Thailand. Journal of Cleaner Production 18, 1629–1638.*
- *Niang, I., Ruppel, O.C., Abdrabo, M.A., Essel, A., Lennard, C., Padgham, J., Urquhart, P., 2014. Africa, in: Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada,*

Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., White, L.L. (Eds.), ClimateChange 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working GroupII to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1199–1265.

- Oreskes, N., 2018. The scientific consensus on climate change: How do we know we're not wrong?, in: Climate Modelling. Springer, pp. 31–64.
- PEW, 2015. Spring 2015 Global Attitudes Survey Q66. PEW Research Centre.
- Pew Research Center, 2009. Economy, jobs trump all other policy priorities in 2009: Environment, immigration, health care slip down the list.
- République du Sénégal, 2014. Plan Senegal Emergent 2014.
- République du Sénégal, 2012. SNDES 2013-2017: Statégie Nationale de Développement Economique et Social.
- Riddell, P., Webster, B., 2009. Widespread scepticism on climate change undermines Copenhagen summit. The Times Online 14.
- Shi, L., Chu, E., Anguelovski, I., Aylett, A., Debats, J., Goh, K., Schenk, T., Seto, K.C., Dodman, D., Roberts, D., 2016. Roadmap towards justice in urban climate adaptation research. Nature Climate Change 6, 131–137.
- The World Bank, 2020. Sahel Adaptive Social Protection Program (ASPP) [WWW Document]. URL https://www.worldbank.org/en/programs/sahel-adaptive-social-protection-program-trust-fund (accessed 5.26.21).
- UN Habitat, 2020. Making cities sustainable and resilience, 2016-2020 (Evaluation Report No. 3/2020). Un Habitat.
- USAID, 2012. Climate Change Adaptation in Senegal Fact Sheet [WWW Document]. Climatelinks. URL https://www.climatelinks.org/resources/climate-change-adaptation-senegal-fact-sheet (accessed 5.26.21).
- van der Linden, S., 2015. The social-psychological determinants of climate change risk perceptions: Towards a comprehensive model. Journal of Environmental Psychology 41, 112–124. https://doi.org/10.1016/j.jenvp.2014.11.012
- Ville de Dakar, 2021. Plan Climat Énergie Territorial de la Ville de Dakar 2021-2025. Ville de Dakar, Dakar.
- Ville de Dakar, 2016. Dakar Reslience Strategy. Ville de Dakar, Rockefeller Foundation, 100 Resilient Cities, Dakar.
- Wang, H.G., Montoliu-Munoz, M., Gueye, N.F.D., 2009. Preparing to manage natural hazards and climate change risks in Dakar, Senegal: A spatial and institutional approach. GFDRR.
- WB, 2013. Economic and spatial study of the vulnerability and adaptation to climate change of coastal areas in Senegal (Synthesis Report No. 83783). The World Bank.
- WMO, 2020. State of the Climate in Africa (No. WMO-No.1253). World Meteorological Organization, Geneva, Switzerland.
- Wolf, J., Moser, S.C., 2011. Individual understandings, perceptions, and engagement with climate change: insights from in-depth studies across the world. Wiley Interdisciplinary Reviews: Climate Change 2, 547–569.

GARAPENERAKO LANKIDETZAREN EUSKAL AGENTZIA
AGENCIA VASCA DE COOPERACIÓN PARA EL DESARROLLO

EUSKO JAURLARITZA
GOBIERNO VASCO
BERDINTASUN, JUSTIZIA ETA GIZARTE POLITIKETAKO SAILA
DEPARTAMENTO DE IGUALDAD, JUSTICIA Y POLÍTICAS SOCIALES

This work has been developed with the financial support of the Basque Cooperation Agency, eLankidetza.

bc3
BASQUE CENTRE FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

Sustainability, that's it!

EUSKO JAURLARITZA
GOBIERNO VASCO
HEZKUNTZA SAILA
DEPARTAMENTO DE EDUCACIÓN

EXCELENCIA MARÍA DE MAEZTU
jul. 2018- jun.2022

AGENCIA ESTATAL DE INVESTIGACIÓN

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES