A framework for assessing the potential effectiveness of adaptation policies: Coastal risks and sea-level rise in the Maldives

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A B S T R A C T

Effective policies that integrate climate change considerations are crucial for successful adaptation to increasing climate risks. While there is an abundant normative literature proposing potential effective ways to adapt, there is a lack of empirical literature on current risk and adaptation policy and its potential effectiveness. Studying existing policies can help to reveal existing constraints, draw inferences about performance and design future policies. However, there is no established method for assessing risk management and adaptation policies. Addressing these gaps, we developed an analytical framework, combining and extending existing approaches, to assess the potential policy effectiveness in dealing with climate risks. The framework merges aspects of climate integration, policy coherence and compliance. Applying this framework to coastal risk management and coastal adaptation policies in the Maldives, we conducted a desk review of policy documents and semi-structured interviews with coastal policy experts and stakeholders. We find five policies addressing coastal risks and adaptation. One of these integrates sea-level rise considerations but is not legally binding. A key constraint on policy coherence are static approaches that ignore the variance in hydrodynamic hazard across the archipelago. Moreover, compliance is constrained by low capacities to monitor actual land use, political influence on the allocation of coastal protections and insufficient coastal protection budgets. Based on these findings, we expect that coastal policies are ill-prepared for dealing with sea-level rise and that scaling-up sea-level rise integration into policy is a critical first step towards improving this.

1. Introduction

An increasing number of adaptation policies (AP) and the integration of climate considerations into existing risk policies can be observed around the world (Lesnikowski et al., 2016). However, knowledge on the effectiveness of these policies is scarce. While some studies have assessed the progress of implementing such policies (Lesnikowski et al., 2019; Runhaar et al., 2018; Saito, 2013) there remains a knowledge gap about the effectiveness of AP in dealing with increasing climate risks. Assessing the potential effectiveness of AP can help to reveal existing constraints like investment-gaps or unclear responsibilities and improve the ability of societies to successfully adapt to climate change. This is particularly useful for regions that are vulnerable to climate change, like small islands that face increasing coastal risks due to sea-level rise (SLR) (Klöck and Nunn, 2019).

One reason for the lack of knowledge on the effectiveness of AP is that the evaluation of AP is generally complicated. The key issue is that climate change impacts and hence the effect of adaptation can generally not be evaluated ex-post, because climate change is a long-term process and few impacts can currently be observed and attributed to climate change (Trenberth et al., 2015). One way around this pursued by the biophysical climate impact literature is to apply models to simulate future impacts of different adaptation measures and compare this to a no adaptation counterfactual in order to evaluate the potential effectiveness of measures. For example, Brown et al. (2019) assessed the potential effectiveness of various designs of coastal adaption measures in terms of current and future flood risk on Hulhumalé, an artificial island in the Maldives. The downside of this approach, however, is that it requires a lot of data that is often not available (e.g., bathymetric data, local observations of extremes, etc.) and resources, which renders its

application to, e.g., all 188 inhabited islands in the Maldives impossible. More importantly, this approach ignores the social side of developing and implementing AP and measures. This is a limitation because policies found to be potentially effective in model-based studies are often not implemented (Dupuis and Knoepfel, 2013).

Policy evaluation has received growing attention in the past (Runhaar et al., 2018). Yet, there is no established method for evaluating AP. Here, we address this limitation by drawing upon the social science literature that tries to assess the potential effectiveness of AP through characterising the current governance arrangements and assembling this into a framework. We then add to the empirical literature on current risk and adaptation policy by applying our framework to the coastal domain of the Maldives, one of the most vulnerable countries to SLR, to address two key research questions: What is the status of sea-level rise integration into coastal risk and adaptation policies in the Maldives? And what is the potential effectiveness of these policies under SLR? To address these questions, we used a qualitative research design, complementing a desk review of policy documents with semi-structured interviews with coastal policy experts and stakeholders.

We organize the paper as follows. The second section provides an overview of approaches that evaluate policy ex-ante and the state-of-the-art of coastal adaptation in the Maldives. Then, we develop our analytical framework and present our methods in the third section. In the fourth section, we present the identified coastal policies and their potential effectiveness. Then, we discuss our findings in the fifth section and motivate our conclusions in the sixth section.

2. Coastal adaptation policy

2.1. The Maldives

Small islands face increasing coastal risks due to rising sea-levels (Oppenheimer et al., 2019). In the Maldives, the dispersed geography and the low-lying character of the islands contribute to this vulnerability. The 188 inhabited islands are spread over a distance of circa 870 km from North to South, with average land elevations ranging from 0.5 m to 2.3 m above mean sea-level (MSL). Communities are confronted with increasing coastal risks (flooding, coastal erosion and salinization of groundwater) as sea-levels rise. Hence, the Maldives have formulated a Climate Change Policy Framework in 2015, which stresses the urgency of "climate change mainstreaming" as a guiding principle for strengthening current policies (Ministry of Environment and Energy, 2015a, p. 8). Nevertheless, while SLR driven flood risk is the primary adaptation challenge in the Maldives, many other challenges including migration, food and water security also require adaptation efforts in the future.

The latest report by the Intergovernmental Panel on Climate Change (IPCC) sees a >66 % chance that global MSL will rise 0.6–1.1 m by 2100 and 2.3–5.4 m by 2300, if greenhouse gas emissions continue to rise unabated (Representative Concentration Pathway 8.5) (Oppenheimer et al., 2019). Against this background, low-lying coastal zones would need to adapt to SLR e.g. by increasing and upgrading coastal protections.

Coastal protections are already widespread in the Maldives. Between 2013 and 2016, 5.7 km of coastal protection measures were implemented in the Maldives. This is often accompanied with land reclamations. The Ministry of Environment and Energy (MEE) estimates that 1.300 ha have already been reclaimed from the sea until 2016 (Ministry of Environment and Energy, 2016a). The most prominent example is the artificial island Hulhumalé, raised 1.8–2.0 m above MSL, with an area of 400 ha (Bisaro et al., 2019). While this island was reclaimed at a higher elevation than the average Maldivian island, there is no knowledge how and to what extent SLR was considered and if a policy exists that addresses land reclamations.

2.2. Approaches to the ex-ante evaluation of adaptation policy

Evaluating the effectiveness of AP *ex-post* is often impossible, because APs are fairly new and outcomes can only be observed in the future (Hinkel, 2011). Instead, adaptation scholars have applied a range of different approaches to evaluate the *potential* effectiveness of AP *ex-ante* (Fig. 1).

A first approach (responsibility approach) assesses the potential effectiveness of AP by evaluating the distribution of formal responsibilities for adaptation governance of public and private actors. Applying this approach, Runhaar et al. (2016), e.g., find that the potential effectiveness of governance arrangements in the Dutch internet sector to adapt to climate risks increases with a comprehensive, transparent and legitimate distribution of responsibilities for adaptation.

A second approach (integration approach) assesses the potential effectiveness of AP by analyzing the extent to which climate change and variability considerations are integrated or mainstreamed into relevant policy sectors (Runhaar et al., 2018). For example, Lesnikowski et al. (2019) counted the number of policies that integrate climate considerations and assessed which policy instruments e.g. regulations or financial incentives were used by local governments in Canada, France, Germany, the Netherlands, and the UK.

The integration approach has also been applied to assess and compare national policy integration between countries, including the Maldives. For example, Saito (2013) assessed climate integration progress of the National Adaptation Program of Action (NAPA) into relevant sectoral policies in Least Developed Countries (LDC) in South and Southeast Asia and finds little to limited overall climate integration-progress and specifically limited progress in the Maldives. This is confirmed by Sovacool et al. (2017) who explored implementation of AP in five LDCs, including the Maldives, and find that implementing APs, formulated in the NAPA, is a major obstacle for authorities due to e.g. insufficient and uncertain funding.

A third approach (sectoral coherence approach) assesses the coherence between sectoral and regional policies in terms of conflicting objectives and mechanisms (Nilsson et al., 2012). This has for example been done by Scobie (2016), who finds that despite widespread recognition of the importance of coherent climate policies, mechanisms and objectives are incoherent across sectors and islands in the Caribbean. Reasons for this incoherence are e.g. data-management issues, lack of political will and lack of accountability.

A fourth approach (policy coherence approach) assesses the coherence between objectives and mechanisms of a *single* policy. This can, for example, be done by comparing "the chain of actions implied between the goals expressed in the policy documents on one hand, and the implemented measures, on the other." (Dupuis and Biesbroek, 2013, p. 1484). The policy coherence approach differs from the sectoral coherence approach in that it looks at a single policy instead of the set of policies and the way they are coordinated across sectors.

3. Materials and methods

3.1. Analytical framework for assessing potential policy effectiveness

We develop our analytical framework with New Institutionalism as our theoretical lens to combine the strengths and address the shortcomings of the above-mentioned approaches (Fig. 1). According to New Institutionalism, the governance system consists of institutions and organizations (Bromley, 1989). Institutions are the formal and informal rules that organize behavior (Hodgson, 2006). They can have various forms depending on if they are legal or customary, local or national and formal or informal. Organizations are groups of individuals bound by institutions to achieve goals, for example, the police that enforces social distancing during a pandemic (Coase, 1998). Public policies are a sub-category of institutions. Here, we understand public policies as "[p] ositions taken and communicated by governments – avowals of intent
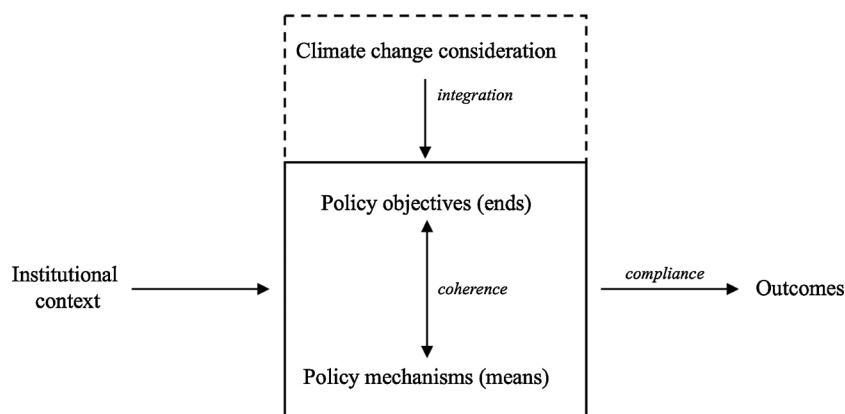
Fig. 1. Analytical framework and the three metrics (integration, coherence, compliance) used for assessing potential policy effectiveness.

that recognize a problem and in general terms state what will be done about it" (Dovers and Hezri, 2010, p. 222). Hence, this study focuses on formal policies, deliberately created by governments within the *institutional context*. For example, constitutional rules define the different roles and responsibilities actors have in developing policies. Policies are not independent from their environment, but they emerge in a context of already existing institutions. Finally, policy can be disentangled into its ends and means. We follow Schaffrin et al. (2015) and focus on the program level operationalization, namely *policy objectives* i.e. what a policy formally aims to do and *policy mechanisms* i.e. how instruments are used to achieve the objective.

Our framework uses three metrics to assess the potential effectiveness of coastal policies which combines and extends the above-mentioned approaches. The key strength of this framework is its wide applicability; the framework can be used to assess the potential effectiveness of any AP, not just coastal adaptation. The metrics are as follows:

3.1.1. Integration

The strength of the integration approach is that it gives an overview of climate integration progress in countries where integration has started. Integrating considerations of climate change into policy is clearly crucial for successful adaptation in the future (Runhaar et al., 2018).

The integration of climate change considerations into policy objectives can occur by altering already existing or by formulating new policies. Here, we focus on both for the coastal policy domain and refer to climate integration as the incorporation of SLR considerations into coastal policy objectives.

3.1.2. Coherence

Climate policy integration is not an end to itself and the integration approach falls short in assessing if the policy mechanisms and objectives, in which climate change considerations are or would be integrated, are in fact coherent. This shortcoming is addressed by the policy coherence approach. The strength of the policy coherence approach is that it analyzes the content of individual policies in much more detail than just counting the number of policies like the integration approach.

There are many reasons why the policy mechanism can be incoherent with the objectives. For example, the mechanism might be underfunded in terms of budget and/or workforce. Moreover, the measures foreseen by a policy mechanism might not be sufficient for reaching the policy objectives. Hence, we make coherence operational through the following indicators: available budget, available personnel and measures foreseen by the policy mechanism. However, while the two resource indicators can be assessed in a straight forward-manner, assessing the sufficiency of measures foreseen by the policy mechanism is more complicated. In fact, the design of the measure is highly context-specific and there is no established one-fits-all metric for small

islands. For example, depending on the topography and bathymetry, a seawall height of 2 m above MSL might provide sufficient flood protection in the south of the Maldivian archipelago but not in the north. Hence, it becomes clear that measures need to take local risks into account (Lincke et al., 2020), and those differ substantially in the Maldives due to differences in hydrodynamic hazard, which range from 2.2 m to 5.8 m for the 100-year significant wave height across the Maldives (Amores et al., 2020).

3.1.3. Compliance

Lastly, we complete our analytical framework with a metric that measures the extent to which policies are complied with, as this is what adaptation outcomes finally depend on (Hupe, 2014). While integration and coherence are necessary conditions for effective policies, they are not sufficient to infer the potential effectiveness. In fact, compliance to coastal risk management and adaptation policies is central to achieving successful adaptation outcomes (Falaleeva et al., 2011).

New institutionalist theory offers two perspectives to explain compliance. First, the rational-choice perspective posits that compliance of actors is based on a cost-benefit calculus. If punishment costs outweigh the benefits of non-compliance, actors will comply. This perspective suggests that central policies with sufficient sanctioning powers are most effective in promoting compliance (Kingston and Caballero, 2009). If, however, policies are non-binding and mere recommendations, costs for non-compliance would be low and hence we expect compliance to be constrained. Second, the sociological perspective posits that compliance of actors is based on their internalized norms and values, rather than cost-benefit calculations. If a rule is perceived as legitimate, actors will comply. This approach suggests that strengthening the actors' moral bases through education and persuasion is most effective in promoting compliance (March and Olsen, 2008). We make compliance operational with both perspectives by identifying constraints to compliance such as bindingness of policies (rational-choice) and perceived legitimacy of policies (sociological).

We disregard the responsibility approach. While this approach makes the convincing point that a comprehensive distribution of responsibilities within the governance system is likely to translate into effective AP, political theory emphasizes a myriad of different aspects of the governance system beyond responsibilities such as lobbying, vested interests and policy entrepreneurs that influence what kind of policies manifest (Sabatier and Weible, 2014).

3.2. Data gathering

Data gathering consisted of desk reviews and semi-structured interviews in a non-linear fashion. We conducted a desk review of policy documents to identify coastal policies and the extent of climate change integration. We reviewed laws, policy documents and environmental

impact assessments (EIA) (see Table 1) that were selected based on own research, existing literature and complemented with policy expert suggestions. Policies were considered if they were legitimized by a government organization i.e. laws, regulations and guidelines published by the Maldivian government. Relevance and completeness of the identified coastal policies were validated through consultation with three policy experts, an environmental consultant, a former cabinet member and an environmental analyst from the current government. Our analysis focused on coastal policies for inhabited islands only and excluded tourist and industrial islands as these can formulate individual policies.

We complemented the desk review with semi-structured interviews. In total, we conducted 20 interviews. Interviews took place in the Maldives in February and March 2018 and were recorded after obtaining informed consent. Selection of respondents followed the goal to cover all relevant organizations involved in the governance of coastal risks and adaptation across all governance levels and subsequent snowball sampling. See Table 2. for a list of respondents' affiliations and Supplementary Material 1. for the interview guide. Interviews were mostly conducted in English. Interviews with regional and local government representatives, however, where conducted in Dhivehi with the help of an interpreter. Interviews were transcribed, using MAXQDA 2018Pro and deductively coded (Saldaña, 2009). This means we coded our qualitative data with the set of concepts derived from our analytical framework namely integration, coherence and compliance. Each concept was split-up into categories e.g. SLR integration, policy objectives, policy mechanism, measures foreseen by the policy mechanism, available budget, available personnel, bindingness of policies and perceived legitimacy and constraints of coastal policies, in which we organized the relating in-vivo codes (Saldaña, 2009).

3.3. Data analysis

The potential coastal policy effectiveness is a latent concept. Given the difficulties to directly assess this, we followed four analytical steps. In combination – we argue – these reveal the potential coastal policy effectiveness.

First, we identified the objectives and mechanisms of the coastal policies. The identification of the policy objectives proved to be difficult for some policies. This problem is recognized in the public policy literature (Bovens et al., 2008), and policy goals are often inferred from "statements or pronouncements, or through dialogue with policy officials" (Vogel and Henstra, 2015, p. 112). We followed this strategy and complemented missing policy objectives with our interview data. Second, we assessed integration. We determined if SLR considerations were integrated in the policy or not. This means that a sole mention of SLR in a policy document does not suffice, it is rather necessary that considerations of SLR are integrated in the policy objectives. Although there are more nuances to the extent to which SLR considerations can be integrated into policy objectives e.g. by a linear SLR allowance added to elevation heights or by flood modeling exercises that determine

Table 1
List of laws and policy documents.

Document name/title	Year
Environmental Protection and Preservation Act	1993
Land Act (3 Amendments)	2002
Maldives National Building Code	2008
Maldives Decentralization Act	2010
EPA Regulation (4 amendments)	2012
EIA Regulation (4 amendments)	2012
National Adaptation Plan of Action	2012
EIA for K.Thulusdhoo Reclamation	2013
Guidance Manual for Climate Risk Resilient Coastal Protection in the Maldives	2015
EIA for K.Thulusdhoo Harbor Construction	2015
Climate Change Policy Framework Maldives	2015
Building Act	2017

Table 2
List of interview respondents' affiliation and type.

Affiliation	Type
Environmental Protection Agency	National government
Ministry of Environment and Energy	National government
Ministry of Housing and Infrastructure	National government
Ministry of Housing and Infrastructure	National government
United Nations Development Program, Maldives	International organization
Transparency Maldives	Non-governmental organization
Decentralization activist, Malé	Civil society
Women's rights activist, Malé	Civil society
Alliance of Small Island States, Maldives	International organization
Majlis, Malé	National government
Local Government Authority	National government
Atoll council, Kaafu atoll	Local government
Island council, K. Thulusdhoo	Local government
Local tourism business, K. Thulusdhoo	Private sector
Environmental consultant, Malé	Private sector
Environmental consultant, Malé	Private sector
Maldives Land Survey Authority	National government
City council, Gn. Fuvamulah	Local government
Former island council, Gn. Fuvamulah	Local government
Environmental activist, Gn. Fuvamulah	Civil society

elevation heights, we chose to omit these details here, because SLR integration merely occurred. Third, we assessed coherence. For this, we followed Dupuis and Biesbroek (2013) and identified constraints to our coherence indicators that impeded the chain of actions implied between the policy objectives and policy mechanisms. Constraints were either mentioned in the policy documents or interviews. Fourth, we assessed compliance. For this, we relied on reported constraints to compliance by our respondents. Given that no data on compliance of coastal and adaptation policies in the Maldives exists, this strategy allowed us to assess the expected compliance which is a sufficient condition to infer potential policy effectiveness.

4. Results

We identified four policies that address coastal risks and one AP that partly integrates SLR considerations. We find three regulations addressing coastal risks via Land Use, Building and Environmental Impact regulations. Additionally, we find two non-binding guidelines that address coastal protections and land reclamations. Generally, integration of SLR into formally binding policies has not occurred for now. Only the land reclamation guideline integrates SLR considerations in an ad-hoc qualitative manner. Table 3. lists the identified policies and their respective objective, mechanism and SLR integration. Furthermore, we assess the coherence and compliance of the coastal policies and find multiple constraints. Table 5. lists these constraints.

4.1. Building code

The Building Code has its legal basis on the Building Act 4/2017. Due to the recent ratification, implementation of regulations was still in process at the time of our data gathering. Yet, one of these regulations would require new public and private buildings to have an elevated ground level of 0.6 m to prevent water inflow from rain or coastal flooding. This was developed by the Ministry of Housing and Infrastructure as a flood risk management measure. The 0.6 m are a historical benchmark of the highest reported flooding from heavy rainfall in one island, GDh. Thinadhoo (Cabot Venton et al., 2009, p. 69). As a consequence, SLR considerations are not integrated in the policy mechanism.

While the general objective of building codes is to set standards for permissible developments, we find that one objective of the Building Code is to reduce risk from flooding. Albeit the static elevation of the ground levels by 0.6 m allows for a reduction of current flood risks, the policy mechanism is constrained in three ways. First, the static approach ignores varying hydrodynamic hazard across the archipelago. In some

Table 3
Coastal risk management and adaptation policies.

Policy	Objective	Mechanism	SLR integration
Building Code	Reduce flood risk	Requires 60cm ground level elevation for new dwellings	No
Land Use Plan	Reduce flood and erosion risk	Requires a 20m setback zone between the beach and rest of the island. Furthermore, recommends elevating and placing critical infrastructure in the center and elevated parts of an island.	No
Land Reclamation Guideline	Reduce flood risk and drainage problems	Recommends new islands to be reclaimed at 1,5 to 1,75 meters above MSL.	Yes
		Recommends land extensions to be at same level as existing island. Minimum distance to the reef edge of 30m.	No
Coastal Protection Guideline	Reduce flood risk and severe erosion	Identifies islands that require most immediate coastal protection measures.	No
Environmental Impact Assessment	Assess environmental impacts of infrastructure and development projects	Requires assessment of potentially negative environmental consequences e.g. human-induced erosion and flood risk in the application and design process of infrastructure and other developments.	No

parts of the country, a higher or lower elevation might be necessary or sufficient to reduce flood risk. Second, this policy mechanism is only applicable to new dwellings. Flood risk for existing dwellings is not reduced. Third, the measure foreseen by the policy mechanism is based on a historical benchmark instead of a comprehensive risk assessment that considers the local context of islands and integrates increasing flood risks from SLR.

Compliance with the Building Code cannot be assessed because: "We haven't released the code yet. We are in the process of formulating the codes" (respondent, national government).

4.2. Land use plan

The Land Use Plan has its legal basis on the Land Act 2002 and the Decentralization Act 2010. It is a spatial planning tool that manages the development and land use of inhabited islands. It requires islands to establish a static setback zone of at least 20 m wide, "consisting of vegetation […] around the outer periphery of the island between the beach and rest of the island" (Ministry of Environment and Energy, 2015b, p. 157). The 20 m setback zone mechanism does not integrate SLR considerations.

The objective of the Land Use Plan is to reduce flood and erosion risks. In general, the 20 m setback zone around the island reduces these risks in comparison to no setback zone. However, the measure foreseen by the policy mechanism is constrained by its static approach. A local approach, that would assess the required width of the setback zone for each island based on its hydrodynamic hazard would be more effective, because the factors that shape the local flood extent such as wave climate, reef direction and bathymetry differ strongly between individual islands and also within islands (Amores et al., 2020). Moreover, lack of data availability and monitoring capacities constrain the coherence of this policy:

"We need long-term data. But we don't have that actually. We are not able to refer to it. Even if we have new data from surveys. The land survey authority does not have the capacity to keep monitoring all of the islands. We are lacking this monitoring capacity to bring all this data together." (respondent, national government)

The implementation of inter-ministerial data-management strategies would be a first step to improve the coherence of the land use planning policy.

Compliance with the Land Use Plan is evidently constrained: "Currently, about 60 [out of 188] islands have a land use plan" (respondent, national government). This results from two key factors. First, the responsible department is understaffed in order to plan and update the Land Use Plans for all inhabited islands:

"We try our best to update the plans once every 5 years. But if that doesn't work we tend to go for 10 years. It all depends on our

manpower because we have to do the survey. So sometimes it is very difficult for us to update the survey of the islands because of manpower." (respondent, national government)

For example, the Land Use Plan of the third largest island Gn. Fuvamulah, "for some reason has never been updated by the ministry since 2008." (respondent, local government).

Second, the 20 m setback zone is often not enforced. The problem of spatial restrictions on the small islands is also recognized by the Maldivian government: "[…] Many islands do not have the luxury of having a 20 m inland vegetation line" (Ministry of Environment and Energy, 2015b, p. 157). Nevertheless, it remains unclear to what extent the 20 m setback zone is actually complied with in the 128 islands without a Land Use Plan.

4.3. Land reclamation guideline

The Land Reclamation Guideline is outlined in the Guidance Manual for Climate Risk Resilient Coastal Protection in the Maldives 2015. It addresses the lack of regulations regarding land reclamations and distinguishes between *new* artificial islands and land *extensions*. For island extensions, it recommends reclaiming new land at the height of the existing island, because uneven elevations of the new and existing land would cause drainage issues. For new islands, it recommends reclaiming at a "height of between 1,5 m and 1,75 m above mean sea level" (Ministry of Environment and Energy, 2015b, p. 67). This height recommendation integrates SLR considerations. The recommended elevation height was derived by a high end SLR-scenario of 1 m with the added tidal range of 0.6 m. Hence, the Land Reclamation Guideline for new islands is the only concrete AP we find.

The objective of the Land Reclamation Guideline is to alleviate flooding and drainage problems. In general, the recommendation to reclaim at 1,5 to 1,75 m above MSL achieves this objective in the current situation. However, the static approach again ignores the varying hydrodynamic hazard.

Furthermore, the measure foreseen by the policy mechanism is constrained because it does not recommend considerations of shoreline dynamics for land reclamations. Land reclamations have frequently caused severe erosion problems, impeding the natural sediment transfer. This was for example the case in K. Thulusdhoo: "After the land reclamation was done, we lost ca 5−10 m of beach due to erosion. We had a meeting area there. It is now gone." (respondent, local government).

Compliance with the Land Reclamation Guideline is unknown because no elevation or topographic data for newly reclaimed islands is available. Nevertheless, the non-bindingness of the policy is likely to constrain compliance.

4.4. Coastal protection guideline

The Coastal Protection Guideline was first formulated in 2014 on the

legal basis of the Environment Protection and Preservation Act of Maldives 1993. It was revised in 2016 but remains a guideline. It organizes a public investment scheme to implement coastal protections in exposed islands. These islands are prioritized based on the "rate of erosion, population, potential for population consolidation, economic activity, critical infrastructure, extent of direct impacts to community and mitigation measures undertaken by the community." (Ministry of Environment and Energy, 2016b, p. 93) Table 4. shows the severe erosion reports by the islands and the Maldivian coastal protection budgets of the last years. SLR considerations are not integrated in the prioritization process.

The objective of the Coastal Protection Guideline is to reduce coastal risks with a focus on islands with severe erosion. Policy coherence is constrained by the available budget dedicated to policy mechanism. Despite the many islands facing severe erosion, only a limited number of islands can be addressed. For example, the MEE approximated that USD 8,8 billion would be needed for the protection of all inhabited islands with hard measures (MEE 2016a). While the available budgets fall short for this, it is also not clear if protecting all inhabited islands with hard measures would be a meaningful strategy in the first place. Adding to this, protection heights are not regulated and varying hydrodynamic hazard also finds no consideration in the design of coastal protection measures, further constraining the coherence of the policy mechanism.

Compliance with the Coastal Protection Guideline is constrained by its non-binding character. The selection of islands to receive coastal protection measures is often influenced by politics and vested interests:

"Mostly selection is not very straight forward. Decisions are made in the Environment Ministry. But they somewhat change at the cabinet level. And at the parliament also. There they decide to give funds to certain projects and not to give to others. That's also some selection in an indirect way." (respondent, national government)

Thus, severely affected islands that would formally qualify for coastal protection measures could lose out to political decisions, leaving them exposed to further coastal risk. Additionally, over the period 2014–2019 the Maldivian government spent USD 45 million on coastal protection measures (Ministry of Finance, 2019). This is USD 7 million less than the budgeted amount (see Table 4.).

4.5. Environmental impact assessment

The EIA has its legal basis on the EIA Regulation 2012. It requires an assessment of potentially negative environmental impacts due to infrastructure or other major developments like harbors or land reclamations. The integration of SLR considerations lies at the hand of the EIA consultant but is not required.

The objective of the EIA is to assess environmental impacts of infrastructure and development projects. The policy mechanism is mainly coherent to achieve this objective. However, compliance with the EIA is constrained by two aspects. First, the EIA lacks standards and enforcement:

"The thing is the standard is low, because it is not regulated. There is a document which regulates it, but never really enforced or seriously looked into. I mean, we choose our own standards. When we want to do a good piece of work. We do a good piece of work. When we don't have time but still want to make money, we just do a lousy piece of

Table 5
Constraints to coherence and compliance of coastal policies.

Policy	Constraints	
	Coherence	Compliance
Building Code	• Static approach ignores varying hydrodynamic hazard • Applicable to new dwellings only • Historical benchmark not adequate	• Not legally binding
Land Use Plan	• Static approach ignores varying hydrodynamic hazard • Lack of data availability • Lack of monitoring capacity	• Not enough personnel to update and enforce land use planning
Land Reclamation Guideline	• Static approach ignores varying hydrodynamic hazard • Qualitative consideration of SLR • No consideration of shoreline dynamics	• Not legally binding
Coastal Protection Guideline	• Insufficient budget • No design standard for coastal protection measures	• Not legally binding • Political influence on allocation of coastal protection measures
Environmental Impact Assessment	• SLR consideration optional	• Low standards and enforcement • Dependency structures

work. Both pass through the standards. That's the problem with the EIA." (respondent, private sector)

Second, the EIA process suffers from dependency-structures that create incentives to make light of possibly negative environmental impacts:

"Obviously, we could have gone with the EIA and said: 'Ok, this is not the right thing to do'. But then the client will not submit that report and they will find somebody who will say it is ok and then submit it." (respondent, private sector)

5. Discussion

We find limited SLR integration in the coastal policy domain. In essence, there are no binding APs. And the only concrete AP (Land Reclamation Guideline) is constrained by its static approach. Nevertheless, these findings confirm other studies that highlight the slow progress of climate integration (Saito, 2013; Scobie, 2016). One possible explanation is limited capacity in the policy community for designing adequate policy mechanisms that integrate SLR considerations. To overcome this burden, knowledge transfers at the science-policy interface are needed. For example, Van der Pol et al. (under review) co-produced a decision-analytical method to determine robust land reclamation heights for Maldivian islands under various SLR scenarios. However, capacity-building may not always be sufficient to improve AP as they also face social barriers like local land use politics (O'Donnell, 2019). For example, implementing specific setback zones on an island (see 4.2.) would raise difficult questions of property rights and compensation and hence undermine adaptation efforts.

Table 4
Severe erosion reports and annual coastal protection budget. Notes: Annual budgets adopted from Ministry of Finance (2019). 2014-2017 budgets show four-year average. Data on erosion reports provided by the Statistical Yearbook of Maldives 2019 (National Bureau of Statistics, 2019). N/a = not available.

Year	2012	2013	2014	2015	2016	2017	2018	2019
Severe erosion reports	89	109	114	35	25	15	32	n/a
Coastal protection budget (million USD)	n/a	n/a	9.66	9.66	9.66	9.66	8.61	5.46

Next to limited SLR integration, we find many constraints on coherence and compliance. Taken together this lets us expect that the existing coastal policies will not be able to effectively deal with SLR. It is clear that scaling-up integration of SLR into policy is critical for improving this. Especially, taking into account the varying hydrodynamic hazard across the archipelago should be considered (Brown et al., 2019). Adding to this, improving individual coastal policy mechanisms should be considered as well. For example, the EIA-process in the Maldives has been criticized as a weak regulation (Zubair et al., 2011). Moreover, the dominant use of hard measures and land reclamations as means to adapt to SLR should be reconsidered. Here, studies suggest complementing hard measures with soft measures such as planting mangroves (Oppenheimer et al., 2019).

Another important milestone, is the translation of non-binding guidelines into legally binding regulations. This would likely (according to the rational-choice perspective) increase compliance. The climate adaptation literature often reports on the centrality of compliance for successful adaptation outcomes. In regard to this, two policies, namely the Coastal Protection Guideline and the Land Reclamation Guideline are important candidates to become legally binding. These are key for successful adaptation to SLR in the Maldives. Land reclamation not only allows for adaptation while generating public revenues, but also serves as the only real prospect for the survival of the Maldives under high-end SLR scenarios (Bisaro et al., 2019). In addition, developing a socially-just and science-based approach to allocate coastal protections across the archipelago would contribute to reducing vulnerability that is currently shaped by center-periphery conflicts and fewer access of the outer atolls to resources (McNamara et al., 2018). Here, the Maldives are confronted with difficult political decisions as the current budget for this is far away from being sufficient to combat current coastal risks across all islands and in the future the country may face the decision to reduce the number of islands into which to further invest.

The analytical framework we developed for this study is helpful for evaluating the potential effectiveness of a policy domain. Disentangling policy into relevant metrics i.e. objectives, mechanisms and outcomes, allowed us to integrate existing approaches and concepts from the public policy literature. The method developed here can be applied in other contexts and policy domains. It complements the evaluative approaches we outlined in the second section and paves the way towards much needed comparative studies that evaluate the potential AP effectiveness in vulnerable regions around the world.

6. Conclusion

This study evaluated the potential effectiveness of the coastal policy domain in the Maldives to deal with sea-level rise. We add to the scarce literature on theoretically-grounded empirical studies that evaluate adaptation policy. For this, we developed an analytical framework based on the theoretical lens of New Institutionalism and concepts from the public policy literature. Our framework distinguishes between three metrics namely integration of climate change considerations into the policy objectives, the coherence between policy objectives and policy mechanisms and compliance with the implemented policy.

We find that the existing coastal policies in the Maldives are ill prepared to effectively deal with rising sea-levels. We argue this on the basis of limited integration of SLR considerations in existing policies. Moreover, the coherence between policy objectives and mechanisms, as well as compliance with the identified policies is constrained by various aspects. These range from static planning approaches that do not consider variations in hydrodynamic hazard to small coastal protection budgets that are ineffective in addressing severe erosion on the islands. Key to improve this, is scaling-up integration of SLR considerations into existing coastal policies and the translation of non-binding guidelines into legally binding regulations to improve compliance. Moreover, the allocation of more funds for meaningful coastal adaptations like coastal protections seems to be inevitable if successful adaptation is the goal.

Future research should focus on identifying effective policy mechanisms that integrate SLR considerations. Especially methods to inform land reclamation and coastal protection policies are needed. These are key to improve the potential effectiveness of the coastal policy domain in the Maldives. Moreover, we encourage application or further development of the framework we developed here. The simple, yet comprehensive framework we put forward is widely applicable and can also be adjusted and applied to different contexts and regions outside of coastal adaptation in small islands to assess potential policy effectiveness. This is an important task, because scoping out if vulnerable regions are on track towards successful adaptation is key to avoid negative outcomes. Clearly, there is much to learn from the ex-ante assessment of adaptation policies in different contexts and regions.

CRediT authorship contribution statement

Geronimo Gussmann: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Visualization. **Jochen Hinkel:** Validation, Resources, Writing - review & editing, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare no conflict of interest related to this article.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.envsci.2020.09.028.

References

Amores, A., Marcos, M., Pedreros, R., Le Cozannet, G., Lecacheux, S., Rohmer, J., Khaleel, Z., 2020. Datatset from "Coastal flooding in the Maldives induced by mean sea-level rise and wind-waves: from global to local coastal modelling" [Data set]. Zenodo. https://doi.org/10.5281/zenodo.3886273.

Bisaro, A., de Bel, M., Hinkel, J., Kok, S., Bouwer, L.M., 2019. Leveraging public adaptation finance through urban land reclamation: cases from Germany, the Netherlands and the Maldives. Clim. Change. https://doi.org/10.1007/s10584-019-02507-5.

Bovens, M., 't Hart, P., Kuipers, S., 2008. The Politics of Policy Evaluation. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199548453.003.0015.

Bromley, D., 1989. Economic Interest and Institutions: The Conceptual Foundations of Public Policy. Basil Blackwell, New York.

Brown, S., Wadey, M.P., Nicholls, R.J., Shareef, A., Khaleel, Z., Hinkel, J., Lincke, D., McCabe, M.V., 2019. Land raising as a solution to sea-level rise: an analysis of coastal flooding on an artificial island in the Maldives. J. Flood Risk Manage. https://doi.org/10.1111/jfr3.12567.

Cabot Venton, C., Venton, P., Shaig, A., 2009. Cost Benefit Study of Disaster Risk Mitigation Measures in Three Islands in the Maldives.

Coase, Ronald, 1998. The New Institutional Economics. American Economic Review 88 (2), 72–74.

Dovers, S.R., Hezri, A.A., 2010. Institutions and policy processes: the means to the ends of adaptation: institutions and policy processes. Wiley Interdiscip. Rev. Clim. Change 1, 212–231. https://doi.org/10.1002/wcc.29.

Dupuis, J., Biesbroek, R., 2013. Comparing apples and oranges: the dependent variable problem in comparing and evaluating climate change adaptation policies. Glob. Environ. Change 23, 1476–1487. https://doi.org/10.1016/j.gloenvcha.2013.07.022.

Dupuis, J., Knoepfel, P., 2013. The adaptation policy paradox: the implementation deficit of policies framed as climate change adaptation. Ecol. Soc. 18, art31. https://doi.org/10.5751/ES-05965-180431.

Falaleeva, M., O'Mahony, C., Gray, S., Desmond, M., Gault, J., Cummins, V., 2011. Towards climate adaptation and coastal governance in Ireland: integrated architecture for effective management? Mar. Policy 35, 784–793. https://doi.org/10.1016/j.marpol.2011.01.005.

Hinkel, J., 2011. "Indicators of vulnerability and adaptive capacity": towards a clarification of the science–policy interface. Glob. Environ. Change 21, 198–208. https://doi.org/10.1016/j.gloenvcha.2010.08.002.

Hodgson, G.M., 2006. What are institutions? J. Econ. Issues 40, 1–25. https://doi.org/10.1080/00213624.2006.11506879.

Hupe, P., 2014. What happens on the ground: persistent issues in implementation research. Public Policy Adm. 29, 164–182. https://doi.org/10.1177/0952076713518339.

Kingston, C., Caballero, G., 2009. Comparing theories of institutional change. Journal of Institutional Economics 5 (2), 151–180. https://doi.org/10.1017/S1744137409001283.

Klöck, C., Nunn, P.D., 2019. Adaptation to climate change in small island developing states: a systematic literature review of academic research. J. Environ. Dev. https://doi.org/10.1177/1070496519835895, 107049651983589.

Lesnikowski, A., Ford, J., Biesbroek, R., Berrang-Ford, L., Heymann, S.J., 2016. National-level progress on adaptation. Nat. Clim. Change 6, 261–264. https://doi.org/10.1038/nclimate2863.

Lesnikowski, A., Ford, J.D., Biesbroek, R., Berrang-Ford, L., 2019. A policy mixes approach to conceptualizing and measuring climate change adaptation policy. Clim. Change 156, 447–469. https://doi.org/10.1007/s10584-019-02533-3.

Lincke, D., Wolff, C., Hinkel, J., Vafeidis, A., Blickensdörfer, L., Povh Skugor, D., 2020. The effectiveness of setback zones for adapting to sea-level rise in Croatia. Reg. Environ. Change 20, 46. https://doi.org/10.1007/s10113-020-01628-3.

March, J.G., Olsen, J.P., 2008. The Logic of Appropriateness. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199548453.003.0034.

McNamara, K.E., Clissold, R., Piggott-McKellar, A., Buggy, L., Azfa, A., 2018. What is shaping vulnerability to climate change? The case of Laamu Atoll, Maldives. Isl. Stud. J. https://doi.org/10.24043/isj.67.

Ministry of Environment and Energy, 2015a. Maldives Climate Change Policy Framework. http://www.environment.gov.mv/v2/download/418/.

Ministry of Environment and Energy, 2015b. Guidance Manual for Climate Risk Resilient Coastal Protection in the Maldives. Male', Republic of Maldives.

Ministry of Environment and Energy, 2016a. State of the Environment 2016. http://www.environment.gov.mv/v2/en/download/4270.

Ministry of Environment and Energy, 2016b. Second National Communication of Maldives to the United Nations Framework Convention on Climate Change. https://www.environment.gov.mv/v2/wp-content/files/publications/20161030-pub-second-national-comm-oct2016.pdf.

Ministry of Finance, 2019. Budget in Statistics 2019. Ministry of Finance, Male', Republic of Maldives. http://budget.gov.mv/en/downloads/BudgetBook.php.

National Bureau of Statistics, 2019. Statistical Yearbook of the Maldives 2019. National Bureau of Statistics, Republic of Maldives. http://statisticsmaldives.gov.mv/yearbook/2016/.

Nilsson, M., Zamparutti, T., Petersen, J.E., Nykvist, B., Rudberg, P., McGuinn, J., 2012. Understanding policy coherence: analytical framework and examples of sector-environment policy interactions in the EU: understanding policy coherence. Environ. Policy Gov. 22, 395–423. https://doi.org/10.1002/eet.1589.

O'Donnell, T., 2019. Contrasting land use policies for climate change adaptation: a case study of political and geo-legal realities for Australian coastal locations. Land Use Policy 88, 104145. https://doi.org/10.1016/j.landusepol.2019.104145.

Oppenheimer, M., Glavovic, B., Hinkel, J., van de Wal, R., Magnan, A.K., Abd-Elgawad, A., Cai, R., Cifuentes-Jara, M., DeConto, R.M., Ghosh, T., Hay, J.E., Isla, F., Marzeion, B., Meyssignac, B., Sebesvari, Z., 2019. Sea level rise and implications for low-lying Islands, coasts and communities. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. Chapter 4.

Runhaar, H.A.C., Uittenbroek, C.J., van Rijswick, H.F.M.W., Mees, H.L.P., Driessen, P.P.J., Gilissen, H.K., 2016. Prepared for climate change? A method for the ex-ante assessment of formal responsibilities for climate adaptation in specific sectors. Reg. Environ. Change 16, 1389–1400. https://doi.org/10.1007/s10113-015-0866-2.

Runhaar, H., Wilk, B., Persson, Å., Uittenbroek, C., Wamsler, C., 2018. Mainstreaming climate adaptation: taking stock about "what works" from empirical research worldwide. Reg. Environ. Change 18, 1201–1210. https://doi.org/10.1007/s10113-017-1259-5.

Sabatier, P.A., Weible, C.M. (Eds.), 2014. Theories of the Policy Process, third edition. ed. Westview Press, a member of the Persus Books Group, Boulder, CO.

Saito, N., 2013. Mainstreaming climate change adaptation in least developed countries in South and Southeast Asia. Mitig. Adapt. Strateg. Glob. Change 18, 825–849. https://doi.org/10.1007/s11027-012-9392-4.

Saldaña, J., 2009. The Coding Manual for Qualitative Researchers. Sage, Los Angeles, Calif.

Schaffrin, A., Sewerin, S., Seubert, S., 2015. Toward a comparative measure of climate policy output: Schaffrin/Sewerin/Seubert: comparative measure of climate policy output. Policy Stud. J. 43, 257–282. https://doi.org/10.1111/psj.12095.

Scobie, M., 2016. Policy coherence in climate governance in Caribbean Small Island Developing States. Environ. Sci. Policy 58, 16–28. https://doi.org/10.1016/j.envsci.2015.12.008.

Sovacool, B.K., Linnér, B.-O., Klein, R.J.T., 2017. Climate change adaptation and the Least developed Countries Fund (LDCF): qualitative insights from policy implementation in the Asia-Pacific. Clim. Change 140, 209–226. https://doi.org/10.1007/s10584-016-1839-2.

Trenberth, K.E., Fasullo, J.T., Shepherd, T.G., 2015. Attribution of climate extreme events. Nat. Clim. Change 5, 725–730. https://doi.org/10.1038/nclimate2657.

Vogel, B., Henstra, D., 2015. Studying local climate adaptation: a heuristic research framework for comparative policy analysis. Glob. Environ. Change 31, 110–120. https://doi.org/10.1016/j.gloenvcha.2015.01.001.

Zubair, S., Bowen, D., Elwin, J., 2011. Not quite paradise: inadequacies of environmental impact assessment in the Maldives. Tour. Manage. 32, 225–234. https://doi.org/10.1016/j.tourman.2009.12.007.