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Integrated Water Resources Management and Policy Integration: Lessons from 169 Years of Flood Policies in Switzerland

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Abstract: In times of increasing pressures on water resources, the integrated management of the resource is a central policy objective. While there exists encompassing research about the concept of integrated water resources management (IWRM), much remains to be studied regarding the integration of water-related policies. Water resources management profits when policy actors coordinate their demands and actions across policy sectors, territorial entities, and decision-making levels within a water basin. However, actors are bound by the policy framework, which organizes water resources management in defined sectors and, over time, develop into independent and specialized policy pillars. A growing number of policies increases the need to integrate those policies over time following the institutional resources regime (IRR) framework. However, an increasing number of policies also proves challenging in establishing an integrated, coherent regime compliant with IWRM. In this study, we analyze flood risk management policies and find an almost exponential increase in policies over time, while flood risks and damage have not decreased in parallel. We address this empirical puzzle with an in-depth analysis of the design of Swiss flood risk management policies over time. To this end, we survey the opinion of 146 flood experts on the importance of ten policy design indicators in three flood-prone regions in Switzerland. Flood risk management experts attribute particular importance to policy designs characterized by integration, a sufficient budget for policy implementation, and coercive instruments and sanctions. We then compare survey results to the ways in which Swiss policies have been designed in legislation across policy sectors related to flood risk management over the last 169 years. We find that policy designs follow a national policy style. Placing these results in local contexts, we explain why the design of policies represents both a challenge and opportunity for policy-makers involved in flood risk management.

Keywords: IWRM; policy integration; policy design over time; policy design preferences; policy indicators; flood risk management

1. Introduction

Integrated water resources management (IWRM) has evolved as one of the guiding principles of water management today. The European Water Framework Directive, among others, has introduced an integrated approach to the management of water basins within its member states; other parts of the world similarly employ IWRM as a guiding approach. The goal of IWRM is to ensure that the multiple functionalities of the resource water, e.g., as a source of drinking water, recreation, energy production, biodiversity, or as a sink for wastewater and the protection from water, work smoothly

together. In order to promote the sustainable management of the resource water, the concept of IWRM puts forward that diverse water users need to coordinate horizontally across sectors and vertically across scales (from the local to the international scale). In fulfilling its goal to integrate various demands and activities, IWRM is bound by the policy framework that regulates uses and users of a resource [1]. Policy frameworks tend to develop into specialized sectors over time, whereby each sector consists of its own set of public policies regulating specific territories and levels. Coordinating the diverse water interests across sectors, levels, and territories successfully is contingent upon the integration of these specialized sectoral public policies into a coherent regime, but such orchestration also proves a major challenge. This article therefore focuses on the integration of policies towards IWRM.

The question of how to integrate water-related policies towards a coherent management of water resources represents a field of research that has inspired scholarship across disciplines. In particular, public policy research has a long tradition of thought on cross-sectoral policy integration. Scholars have analyzed cross-sectoral policy integration [2–4], horizontal coordination [5], scales in multilevel water governance [6], and a fit between biophysical structures and actor coordination [7,8] for water and other sectoral policies. Using the concept of Functional Regulatory Spaces, Varone et al. [9] combine the integration of policy sectors, institutional territories, and levels of government. While these studies posit that integration is vital for sustainable resource management, they do not analyze the relationship between policy evolution and integration, or the ways in which the need to integrate evolves over time [10].

In contrast to the above-mentioned studies, we analyze the evolution and integration of public policies over a long period of time in order to better understand the need for integration. With this goal in mind we ask: (1) Why is policy integration as emphasized by IWRM vital for water management, particularly in the long-term? (2) From where does the need for integration come? In addressing these questions, the article connects two streams of research, IWRM and public policy scholarship, with the goal to cross-fertilize scholarship across disciplines.

We first draw attention to the undertheorized temporal dimension of IWRM. The integrated management of water resources is not only a matter of integration across levels and sectors, but also of integrating policies over time into a coherent regime. Public policy theories have highlighted the temporal dimension of policies through the concept of path dependency [11,12]. The ensuing results suggest that policies, once introduced, place societies on a specified trajectory from which deviation is unlikely or difficult to occur. As a result of path dependency, policy action is dependent on formerly adopted policy decisions. The temporal dimension of policies has been formalized into a coherent theoretical framework in the Institutional Resources Regime (IRR) [13]. The IRR sets forth that, over time, more policies tend to be adopted to regulate the management of a natural resource. As more policies are in place, the overall regime becomes more complex and less coherent unless effort is invested into coordinating the multiple policies to achieve a coherent regime. This temporal dimension complements the IWRM approach, because the need to integrate water-relevant policies across levels and sectors is a function of the policies that have previously been introduced.

Secondly, we draw attention to the design of policies. There exists a large body of literature on policy instruments and their design cutting across disciplines of public policy, political science, public administration, and economics. Such design-thinking is valuable for IWRM, because the coordination of sectors into a coherent regime does not function independently from policy design. Policy design refers to the calibration of single policy instruments to specific target groups or administrative levels, for example. Regimes are unlikely to lead to the sound management of water resources if the policies exhibit design deficiencies, which include, among others, cases where policy designs insufficiently take into account existing water structures, actors' behavior and natural or climatic conditions, or their changes over time. We deduce from this literature that paying attention to the design of water policies can prove fruitful to generate a coherent, integrated, and adaptable policy regime in order to ensure the sound management of water resources.

We illustrate the implications of our theoretical arguments by taking the case of flood risk management. Flood risk has been increasing on a global scale in the last decades [14,15], with tremendous long-term

economic and humanitarian impacts [16]. Major flood events, such as in the Danube-Elbe catchment in 2002, the UK in 2007, Southeast Europe in 2014, or Northwest Europe in 2016 [17], prompted international policy action, including the 2007 Floods Directive and the 2015 Sendai Framework for Disaster Risk Reduction. Such policies outline the growing importance of flood risk adaptation. As adaptation policies gain in importance, it is worth drawing lessons from past flood policies.

Flood risk management represents an integral part of IWRM [18]. Many IWRM processes evolve around conflicts between protection from water (i.e., flood risk management) and use of water (i.e., agriculture, land use, and drinking water). Public policies address conflicts between different water resource interests by regulating access to and use of water bodies. Therefore, the case of flood risk management illustrates well the policy dimension of IWRM.

Flood policies have long existed, especially in water-rich European countries such as Switzerland, which has been adapting to flood risks since medieval times [19]. This article focuses on Swiss flood risk management policies that have developed from engineering approaches into integrated risk management strategies based on regional planning in order to provide water with its necessary space. These developments allow us to study the evolution of the policy regime in the Swiss case. While the number of flood-related policies has almost exponentially increased in Switzerland, flood risks and damage have not decreased respectively [20]. In order to understand this mismatch between policy activity and remaining flood damage, we analyze policies' precise design.

The article is structured as follows. First, we provide a brief overview about IWRM as a concept and highlight some of its shortcomings from a political science perspective; to address these gaps, we connect the IWRM approach to the IRR framework. The latter builds on two dimensions: extent and coherence. We analyze both dimensions, thereby complementing the dimension of coherence with literature on policy design. In the data section, we explain our mixed data approach. We (a) compiled a dataset on Swiss flood policies over 169 years (1848–2017), (b) performed a survey with 146 Swiss flood risk management experts, (c) coded the precise calibration of 92 inventoried policies over time, and (d) conducted in-depth case studies with interviews and field research. After presenting our results, we conclude with insights into the evolution of public policies over time in order to inform adaptive and integrated water governance in the future.

2. Theory

2.1. IWRM—A Concept and its Roots

IWRM is a concept to facilitate the coordinated and integrated planning, allocation, and management of water and related resources. Typically, the boundaries of IWRM are defined hydrologically at the river basin-level [1], a system of ground and surface waters that flow into a common endpoint (e.g., a lake) [21]. IWRM is fundamentally concerned with the management of different, often conflicting, water interests relating to the use of, protection of, and protection from water [1]. IWRM also remains a widely debated concept with ambiguous definitions, contents, and outcomes [22].

IWRM historically developed from a hydraulic engineering paradigm of water management (1930–1970s), and is therefore often understood as a technical concept originating in the natural sciences [23]. Beginning in the 1970s, a priority shift from hydraulic engineering to water quality and environmental sustainability took place [24]. In the early 1990s, the IWRM concept gained importance in the political arena [25]. Inspired by watershed- and ecosystem-management approaches, IWRM was reflected in the 1992 Dublin Principles on water as well as in the 1992 Earth Summit's Agenda in Rio [24]. Today, IWRM is applied in several promising political contexts and international agreements, such as the EU Water Framework Directive (2000/60/EC), the Murray-Darling River Commission in Australia, or the Delaware Commission in the United States [25].

Beyond its technical relevance, IWRM has received increasing attention in political science literature. Water is understood as a basic human right [26] with a strong link to environmental and social justice (e.g., issues of water quality, global water access, etc.) [27]. As water has multiple uses

and users, it is a politically contested resource. Rivalries and conflicts around the use of water (e.g., in agriculture or industry), the protection from water (e.g., with flood risk management), and the protection of water (e.g., water quality) evolve across policy sectors, decision-making levels, and territories [1]. IWRM aims to integrate these interrelated, often conflictive interests and to seek a balanced solution between the various water use(r)s [9]. The involved actors' interrelatedness is relevant to cost–benefit analyses of IWRM, with one interest's costs or benefits often contingent on the demands of other interests [28]. As a result, implementing IWRM raises important issues such as cost-effectiveness of integrated solutions, cost-loss aspects of parallel management activities, and governments' willingness to pay for an approach with unknown outcomes [28,29].

Although IWRM is a highly developed approach [30], the literature identifies several weaknesses including complexity, operationalization, feasibility, and cost-effectiveness [22,25,31]. From a political science perspective, the major problem with IWRM is the neglected policy dimension [24,25,32]. IWRM does not take place in a vacuum, but in the context of institutions regulating water resources [33]. Such institutions refer to the policy regime, i.e., the entirety of policies, legislation, and regulations; the coordination between national, regional, and local decision-making levels; the integration of public and private actors and their demands and actions; and policy sectors' different interests significantly influencing the management of water resources [1]. Integration and coordination therefore must occur between the management process of conflicting water interests and the policy regime in which IWRM takes place [1]. The policy regime delineates the setting (e.g., public policies defining goals, budget, or responsibility) for the effective implementation of IWRM. Public policies in place to regulate different water interests matter when applying an IWRM approach; therefore, we turn to public policy research on institutional regimes and policy design, whereupon we elaborate on the underdeveloped policy dimension of IWRM.

2.2. Cross-Fertilizing the Concept of IWRM with Public Policy Theories

Public policies are tailored to regulate the management of the resource water, but the aspect of public policies and their integration remains undertheorized within IWRM. By contrast, the literature on public policies has analyzed the ways in which policies evolve over time. From this knowledge, we can draw insights into the challenges that accrue in the integration of different water interests in IWRM over time.

2.3. Institutional Resources Regime and Path Dependency: Drawing Attention to the Temporal Dimension of IWRM

Emphasizing IWRM's policy dimension does not only highlight integration across policy sectors, decision-making levels, and territories, but also points to the integration of public policies over time into a coherent regime. The temporal dimension of policies has been formalized into a cogent theoretical framework in the IRR, which combines ownership and property rights to a resource (private law) with public policies regulating the use and protection of a resource (public law) to explain the (un)sustainable use of natural resources and its development over time [13,34,35].

The natural resource (e.g., water), as the unit of reference in the IRR, generates goods (e.g., drinking water) and services (e.g., energy production) used by different resource users (public vs. private actors). However, to use a natural resource sustainably, it is only possible to exploit its goods and services to the extent that the resource's reproduction capacity is not at risk. Property rights and public policies limit the use of a natural resource by defining the resource users and steering their behavior related to the use of goods and services provided by the resource. To obtain exclusive use rights of a resource, actors either need to acquire property rights or receive advantages by the implementation of public policies that allow use of the resource for a fixed period of time [13]. Changing demands in the use of a resource (e.g., infrastructure change) may occur and lead to adapted policies and the redistribution of property rights [13]. Such amendments may incentivize users to contribute to the conservation of a resource, or in contrast, lead to situations of exclusion or competition either between users of the same

goods and services of a single resource, or between users of different goods and services of several competing resources [36]. Moving from single-resource use to multiple-resource uses tends to lead to an increase in regulatory complexity as well as an increase in the number of policies in the regime [13].

Institutional regimes can be classified by evaluating two dimensions: extent and coherence. Extent describes the total number of goods and services regulated by the regime at a given time, whereas coherence refers to the degree of coordination between the different sets of rules, which regulate goods and services [13]. The IRR argues that extent and coherence are linked, since over time, the number of regulated resource uses increases in parallel with the number of regulations constituting a regime. With more regulations in place (extent increases), the overall regime tends to become more complex and less coherent (coherence decreases). Inconsistencies between regulations grow, unless effort is invested into coordinating the multiple regulations to achieve an integrated regime.

Four different types of regimes can be differentiated by combining the dimensions extent and coherence (see Figure 1) [37]: A nonexistent regime (low extent, low coherence) describes the situation when a resource's goods and services are not subject to any kind of regulation. A lack of regulation can indicate governments' missing acknowledgements of resource overexploitation. A simple regime (low extent, high coherence) indicates a limited quantity of goods and services, which are regulated in a coherent way. With a low number of regulations, the risk of noncoordination and incoherence is lower. In contrast, a complex regime (high extent, low coherence) describes the situation of a high quantity of regulations that incoherently regulate the use of the resource. The more goods and services regulated, the greater the likelihood for conflicts and incoherencies to occur between regulations. Finally, an integrated regime (high extent, high coherence) regulates all goods and services provided by the use of a resource in a coherent way. The IRR framework hypothesizes a causal relationship between the regime type (i.e., extent and coherence) and the sustainable use of the resource [13,36]. Drawing on the IRR framework, we posit that the temporal dimension matters for IWRM.

In the previous paragraphs, we gave a generic overview about the IRR framework. In what follows, we focus on the IRR's two dimensions, i.e., extent and coherence, and link each to two streams of the public policy literature—path dependency (in the next paragraph) and policy design (in Chapter 2.4)—respectively.

Public policy theories have theorized about the temporal dimension of policies through the concept of path dependency. The idea of path dependency is based on the historical institutionalist approach and posits that today's policy action is dependent on formerly adopted policy decisions. Studies of path dependency suggest that policy-making systems tend to be conservative and defend existing patterns of policies and institutions. Policies then become resistant to any change, i.e., they remain stable or, as often termed, "sticky" [38]. Sticky policies place societies on a fixed path, which proves difficult to change [39]. When changing the existing policies is unlikely, policy action, too, is likely to halt, or, is forced to move to different policy sectors. Adopting policies in new sectors ultimately contributes to growing policy regimes, which makes it increasingly challenging to integrate the different sectoral policies. Since coordination across independent policy sectors is difficult [40], path dependent and stable sectoral policies also challenge the integration of different water-relevant interests in IWRM. As a result, public policies must be considered and integrated over time in IWRM. We thereby deduce a first empirical expectation from the literature on path dependency and IWRM: The more stable policies remain, the more likely the policy regime will grow over time (extent). With an increasing number of policies (extent), there is a greater need to integrate policies in IWRM in order to coordinate diverse interests of the resource water.

The IRR framework complements the idea of path dependency with an explanation for why policies tend to grow in extent over time. Following the IRR, demands for the use of a resource can change over time. With growing uses, regimes can move from single-resource use to multiple-resource uses. This trend often goes along with more policies and increasing regulatory complexity [13]. With a high quantity of different sectoral policies in place, coordination and integration represent a major challenge for the sustainable management of the resource water. The need to integrate the growing

number of water-relevant policies in different sectors and across various decision-making levels and territories increases temporally due to multiple resource uses. We deduce a second empirical expectation from the literature on IRR and IWRM: The higher the number of policies over time, the more likely the policy regime becomes complex. With increasing regime complexity, there is a greater need to integrate policies in order to achieve coherence in IWRM. The first and second expectations build on each other since the theory projects policies to be sticky and therefore to grow in extent over time. With more policies in place, regime complexity increases accordingly, which then increases the need for policy integration to insure coherent IWRM.

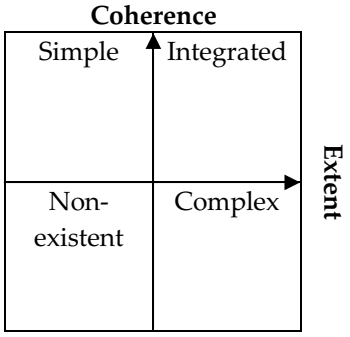

Figure 1. Different resource regime types according to their extent and coherence [37].

2.4. Scholarship on Policy Instruments and Design: Drawing Attention to the Calibration of Policies in IWRM

We have highlighted above literature arguing that policies are sticky, which can lead to growing policy portfolios over time. Even though the adopted policies may be difficult to withdraw or comprehensively reform, policies may nevertheless be adaptable in their detailed design. In the following, we explore the idea of adaptable policy designs, which may contribute to regime coherence.

In order to deal with increasingly large and complex policy portfolios, IRR emphasizes coherence, i.e., the coordination between the different policies regulating a resource. Deciding what constitutes a coherent policy regime is disputed by scientists and practitioners alike. We break down the IRR's second dimension of coherence by analyzing the precise design of policy instruments that constitute the regime.

Policy design pertains to the calibration of policy instruments adopted to achieve defined political goals and allows for an in-depth analysis of coherence. The term public policy has been employed to refer to three different levels of abstraction: (1) whether or not policy goals are clearly formulated, (2) which policy instruments (e.g., emission standards or environmental taxes) are adopted to pursue defined goals, and (3) how these policy instruments are calibrated to specific target groups or administrative levels [41]. When we employ the term policy design, here, we mean the latter, i.e., the calibration of policy instruments. The value of such a narrow focus is to strive for more than counting the policy instruments in place, which has been labeled the density approach [42]. As public policies tend to grow in extent over time, counting policies in the form of the density approach is likely to capture the length of a policy field's implementation along with the extent of its attention from legislators, rather than its ability to coherently address a policy issue such as flood risk management. A detailed analysis of policy design over time, by contrast, can reveal subtle policy changes, which may prove crucial for the coherence of a policy regime in IWRM.

Ever since the early, path-breaking work dating back to the 1950s [43,44], a large body of public policy literature developed that highlights multiple aspects of policy design. This literature holds valuable insights into calibrating policy instruments as a means to ensure sound implementation, and, as such, complements the focus of IWRM on integration. From a policy design perspective, successful implementation of a policy crucially depends on, among others, who is mandated to implement a policy and on which governance level; the target groups of a policy; and how strongly behavioral changes of target groups are incentivized, or misbehavior sanctioned. Various streams of literatures have generated insights about policy designs with the aim of creating appropriate conditions for future

implementation and management, including research on policy change [45], policy processes [46], policy instruments and portfolios [47], policy diffusion [48,49], policy outcomes [50], and policy indices [42,51]. Building on a literature review, we deduce ten indicators from the diverse streams of the public policy literature in order to cross-fertilize the IWRM concept with insights into policy design beyond the extent of the regime.

Subsequently, we provide a brief overview of ten aspects of policy design that are intended to cross-fertilize the concepts of IWRM and IRR (see Appendix A for a more encompassing description of each indicator). We start with the idea of policy integration and subsequently enlarge our focus to include further aspects of policy design that may prove pertinent in water resource management beyond integration:

1. Policy integration, in the public policy literatures denotes the coordination of policies and actors across sectors [2,3,52]. The goal of policy coordination across sectors is to avoid contradictory or conflicting manifestations of political action in order to create coherent means to achieve an overarching objective.
2. Coercion or pressure on target groups: Coercion centers the role of the state, and the extent to which state intervention is necessary to successfully steer society [53]. One of the most influential policy typologies identifies three broad classes of policy instruments based on a decreasing extent of coercion [54]:
    - Sticks: regulative/command-and-control instruments, e.g., prohibitions or standards
    - Carrots: incentive-based financial policy instruments, e.g., charges or trading schemes
    - Sermons: persuasive, information-based instruments, e.g., public campaigns or best environmental practices
3. Sanctions are a decisive element of policy designs as they limit target groups' freedom to choose noncompliance by imposing a financial or social cost on defection [55]. Sanctions require enforcement capacities with defined agencies responsible (and sufficiently staffed and resourced) for controlling compliance, as well as for imposing and pursuing sanctions where necessary.
4. Inclusiveness to target groups: An essential element when designing public policies is the question of whom the policy targets [56–59]. A policy can be considered inclusive of many target groups when it addresses a maximum of societal groups or sectors (such as agriculture, industry, etc.) that contribute to a policy problem. However, the more inclusive policies are, the more difficult it may be to adopt, implement, or monitor them.
5. Proportionality of scale: The indicator refers to the scale (international, national, regional, or local) towards which a policy is calibrated [60,61]. Proportionality involves the idea of matching the scale of problems to the scale of solutions [51,59] whereby local problems deserve local solutions, while problems occurring at higher scales justify attention on a corresponding scale.
6. Directness or implementation: When designing policies, it is crucial to keep in mind who is responsible for implementation [62–64]. Salamon popularized the term directness, which refers to the concentration of implementation duties in the hands of one or a few authorities ([62], p. 1654). In direct policy designs, the decision-making authority is also involved in financing and implementing, or at least in supervising implementation.
7. Bindingness: Policy designs also vary with regard to their level of bindingness set by the hierarchy of norms in democracies. Constitutions are placed on the highest rung, followed by laws, ordinances, decrees, and, finally, oral agreements [63,64]. Constitutional or legal acts signify high bindingness, because they cannot be altered as easily or as quickly as decrees, ordinances, or plans.
8. Objectives: The level of specificity of formulating policy objectives represents a decisive element of policy design and can vary from precisely to broadly formulated policy goals [42]. When a government defines precise and ambitious objectives, it indicates that the government is dedicated and committed to that policy. It also provides a benchmark against which target

groups' behavioral changes or the government's success can be evaluated. By contrast, broadly formulated goals offer the possibility to adapt to changing contexts.

9. Budget, i.e., whether a policy is equipped with (financial) resources for its implementation and from where to draw financial resources. These questions are decisive in policy design, because attributing costs to certain societal groups creates (re)distribution processes and winner-loser divides [56].
10. Monitoring: Evaluation of an implemented policy against its goals; it creates feedback mechanisms that induce policy learning in order to adapt policies to changing circumstances. Monitoring obligations can be obligatory (or voluntary), conducted regularly (or occasionally) by either external and independent organizations or the implementing agency itself [42].

Some of the policy design indicators may conceptually capture similar policy design aspects. For example, the indicators bindingness and objectives are both a signal for the government's commitment, but they are based on different ways of designing a compelling policy, either through the hierarchy of norms or the formulation of policy objectives. As we seek to empirically evaluate which of those indicators matter most for designing a successful policy, we list them here as independent evaluation criteria. In the final chapter, we discuss which indicators are most central for policy design.

We seek to explore whether policy designs that are flexibly adapted to new conditions, will improve integration and coordination of different interests, and thereby, coherence of the policy regime in which IWRM takes place. We deduce a third empirical expectation from the literature on policy design: The more a policy exhibits a flexible design, i.e., changes its policy design over time, the more likely the policy regime is coherent and in line with principles of IWRM.

3. Data and Methods

This study follows a mixed-data approach with data on an inventory of Swiss flood policies since 1848, survey data of 146 flood risk management experts, a detailed analysis of the calibration of Swiss flood policies over time, and in-depth case study interviews and field research.

3.1. Policy Inventory

We compiled an inventory of 169 years (1848–2017) of Swiss flood policies. We gathered this data with the help of government reports [65–67] by analyzing the content of Swiss legislation (legal texts are online available at www.admin.ch or on www.lexfind.ch) relevant to flood risk management, and by consulting previous research on Swiss flood policies [68,69]. The unit of analysis is single policy instruments, whereby a policy document (e.g., law) can contain several instruments. Such instruments involve, for example, the setting of spatial plans (in German: Richtpläne/Nutzungspläne) as required by the Spatial Planning Act (SR 700), or water body maintenance as required by the Hydraulic Engineering Act (SR 721.100).

3.2. Actor Survey

We conducted a survey with flood risk management experts in Switzerland in order to evaluate the aspects of policy design that matter most to them. In 2017, we surveyed a total of 206 public and private actors out of which 146 responded either fully or partially to the respective survey question (response rate: 71%). Respondents encompass actors working in the policy field of flood risk management, including national, cantonal, and local government actors; business, environmental, water, energy, engineering, and recreational associations; and scientific actors. The sample includes a diversity of actors across sectors, levels, and types in order to obtain a representative overview of actors' perceptions of policy designs (see Table 1). Actors were selected for the survey based on their involvement in flood risk management projects throughout Switzerland, and more specifically, in the three regions of the Aare, the Kander, and the Thur rivers. The latter are among those Swiss regions that are regularly and severely affected by flood events. The surveyed regions are also located in different policy settings in

two Swiss states (Aare and Kander rivers in the Canton Bern; Thur River in the Canton of Zurich), which vary in terms of implemented regulations and policies. We therefore control, to some degree at least, for case specificities; we are also able to understand those public policy aspects that consistently matter across cases despite differing cantonal policy settings.

We asked actors to evaluate the importance of the ten policy design indicators exposed in the Theory section above (see Appendix B for the survey question). We contrasted two opposing settings for each of the ten policy design indicators (e.g., low vs. high pressure on target groups) and asked respondents to rate the importance on a two-dimensional four-point Likert scale ranging from full agreement for one policy design setting (e.g., high pressure on target groups) to full agreement for the other setting (e.g., low pressure on target groups). Results from the survey responses help us to highlight ideal designs for flood policies from the cumulative experience of experts. We contextualize survey results with in-depth case knowledge from field work conducted between December 2016 and January 2017, and between August 2017 and October 2017, culminating in 22 in-person interviews.

Table 1. Overview of the actor sample with the number of survey responses per actor type.

Actor Type	Number of Responses			
	Aare	**Thur**	**Kander**	**Total**
Federal government	4	4	4	12
Canton	11	7	8	26
Municipality	18	6	5	29
Commission	0	2	4	6
Regional association	8	1	3	12
Nature conservation & sports/leisure organization	14	11	7	32
Economy & infrastructure	6	2	5	13
Engineering office	4	1	5	10
Science	3	1	2	6
Total	68	35	43	146

3.3. Data on the Calibration of Policies over Time

We coded the identified 92 different flood risk management instruments against the ten policy design indicators. To this end, we constructed a database by means of a content-based coding procedure conducted by an independent coder, verified by one of the authors, and validated by a flood risk management expert (personal interview on Nov. 10, 2017). Table 2 provides an overview of the coding questions and the range of coding values for four exemplary indicators. Appendix C contains the complete coding scheme for the ten indicators. Each indicator should be understood as a categorical variable without intrinsic ordering. Higher values do not signify higher performance, but simply point to one of a limited number of qualitative properties. The resulting data allows us to illustrate flood policy design over time.

3.4. Case: Flood Risk Management in Switzerland

Switzerland has a long history of floods and flood policies due to its location at the source of major European rivers including the Rhone or the Rhine rivers. Learning from past experiences in flood risk management and drawing lessons from effective policy designs is vital for shaping future flood governance in countries like Switzerland, which are projected to suffer from increased flood risk with climate change and melting permafrost [70].

Together with the Federation, the Swiss states (cantons) are responsible for flood risk management, and consequently, flood policies can differ in the 26 Swiss cantons. In this study, we start with the

analysis of national flood policies and thereby capture the framework legislation that pertains to all cantons.

Existing literature on Swiss flood policy highlights a paradigm shift in flood risk management from construction-oriented approaches since the 19th century to a spatial planning-oriented regime since the 1990s, towards an integrated risk management since 2010 [19,65,66]. Our overview of Swiss national-level flood policies additionally indicates that, on the legislative level, not only infrastructural solutions but also environmental protection, e.g., through protective forests (Federal Constitution Art. 24; SR 101), has been one of the pillars of flood risk management since the late 19th century. The monitoring approach to flood risk management started only later with the foundation of the Swiss Meteorologic Central Office in 1901, which was responsible for monitoring weather conditions and water levels. Only in the 1990s were further monitoring instruments institutionalized, e.g., through hazard maps. Civil protection and emergency planning approaches have existed since 1957 where alerting systems have been rendered mandatory for dams, but were broadened only in the 1990s and early 2000s, e.g., through the foundation of the National Emergency Operations Centre, early warning systems (Hydraulic Engineering Ordinance (HEO) Art. 24; SR 721.100.1), and mandatory emergency plans for all cantons (HEO Art. 27; SR 721.100.1). Today's Federal Hydraulic Engineering Act (Art. 3, SR 721.100) establishes that spatial planning and water body maintenance constitute the main pillars of flood risk management. In fact, spatial planning instruments have been adopted since 1979 and instruments on maintenance since 1991. Likewise, an insurance approach to flood risk management has been endorsed by national policies since 1992.

Table 2. Coding scheme for policy design indicators and values; four examples.

Indicators	Coding Question	Coding Values	
Integration	Is the policy integrated in a package/ framework?	0	Policy is not integrated in a package or framework
		3	Policy is integrated in a package or references other policy instruments or sectors
		5	Policy is a framework policy or refers to a framework policy
Pressure on target groups	Likelihood that target groups take action	1	No policy instruments adopted
		2	Policy instrument mix relying on persuasion/nodality/information at most
		3	Policy instrument mix relying on economic incentives at most
		4	Policy instrument mix combining economic incentives with some sort of control/state authority
		5	Policy instrument mix mostly relying on state authority/sticks
Sanctions	Portion of deterred target groups	1	No existing sanctions
		2	Existing sanctions deter small parts (less than half) of the target group
		3	Existing sanctions deter half of the target group
		4	Existing sanctions are high enough to deter important parts (more than half) of the target group
		5	Existing sanctions are high enough to deter the entire target group
Budget	Is there a specific budget for implementation?	0	No budget assigned to policy implementation
		3	Budget assigned from Federal/state-tax revenue
		5	Specific tax introduced to budget the policy

4. Results and Discussion

4.1. Flood Policies in Switzerland

Figure 2 shows the ensemble of 92 Swiss national-level flood policies, adopted since 1848 in 29 legislative texts, and classified into seven approaches (from bottom to top): emergency/civil protection, environmental protection, infrastructure, insurance, maintenance, monitoring, and spatial

planning. Each point in Figure 2 refers to a newly introduced policy instrument; labels reference the act and article through which the instrument was adopted; colors indicate the type of policy approach, and the x-axis shows the timescale in 5-year intervals.

Figure 2 illustrates that the number of adopted flood-relevant policies has increased dramatically over time, especially since the late 1980s. Each instance whereupon a new policy instrument was introduced, the majority of previously adopted policies remained in place. Out of 92 flood-relevant policies adopted longitudinally, 27 policies were terminated, i.e., replaced by a newly introduced policy. The majority of policies, once introduced, remained stable in Swiss flood risk management as expected by path dependency.

Despite growing policy attention and density, flood events have not decreased in Switzerland; on the contrary, they have become more frequent—and costlier—since the 1970s [71]. The Swiss Federal Institute for Forest, Snow, and Landscape Research (WSL) has systematically collected information on floods and their damage since 1972. Since then, Switzerland was marked by eight particularly costly flood years, where temporal intervals between major events have become shorter over time: 1978, 1987, 1993, 1999, 2000, 2005, and 2007 (these years of major flood events are highlighted by grey vertical lines in Figure 2) (https://www.wsl.ch/de/naturgefahren/hochwasser-und-ueberschwemmung/unwetterschadens-datenbank/grossereignisse.html). Between 1972 and 2007, the total financial damage caused by floods amounts to 7110 million Euros (taking inflation into account). The average annual financial cost of damage is approximately 220 million Euros, encompassing floods and inundation, debris flows, landslides, and rockfalls, with floods causing by far the largest share of damage [20]. Yearly damage costs have begun to exceed the annual average of 220 million

Euros with increasing frequency: Twice in the 1970s (1977 and 1978), once in the 1980s (1987), three times in the 1990s (1990, 1993, 1999), and four times in the early 2000s (2000, 2002, 2005, 2007), with 2005 constituting the costliest year in Swiss flood history, exceeding 1800 million Euros in damage costs [20].

While studies have shown that "adaptation measures have the potential to greatly reduce present and future flood damage" [16], Figure 2 depicts an increasing number of Swiss policies adopted over time. Despite policy activity, Switzerland continues to suffer from extreme flood events that cause increasingly high damage. Policy extent alone, i.e., the number of policies, seems to provide insufficient insight into the relevance of policies for flood risk. In order to gain a complete picture about flood risk management, one needs to also consider the level of regime coherence. Through its focus on integration, coherence is emphasized by IWRM, which denotes particular importance as policy portfolios grow over time. Our results convey that the necessity to integrate the wealth of policies accrues over time due to growing policy portfolios. In the following section, we delineate the calibration of policy instruments in order to assess the coherence of the policy design.

4.2. Experts' Perspective on Policy Design

In order to understand how policy instruments need to be calibrated for a coherent policy design, we surveyed experts in three flood risk management cases at the Aare, Thur, and Kander rivers. Figure 3 illustrates flood experts' assessment of policy design indicators. Horizontal bars display experts' preferences for competing calibrations of the ten policy design indicators. For a first group of indicators, actors exhibit a particular design preference, i.e., bars lean towards the right or left across cases (i.e., more than 50% of responses in one direction). Agreement across cases signifies trends that are generally considered important by experts when designing policies, at least in the cases studied here. By contrast, for a second group of indicators, actors exhibit design preferences specific to one of the three cases (Aare, Thur, and Kander).

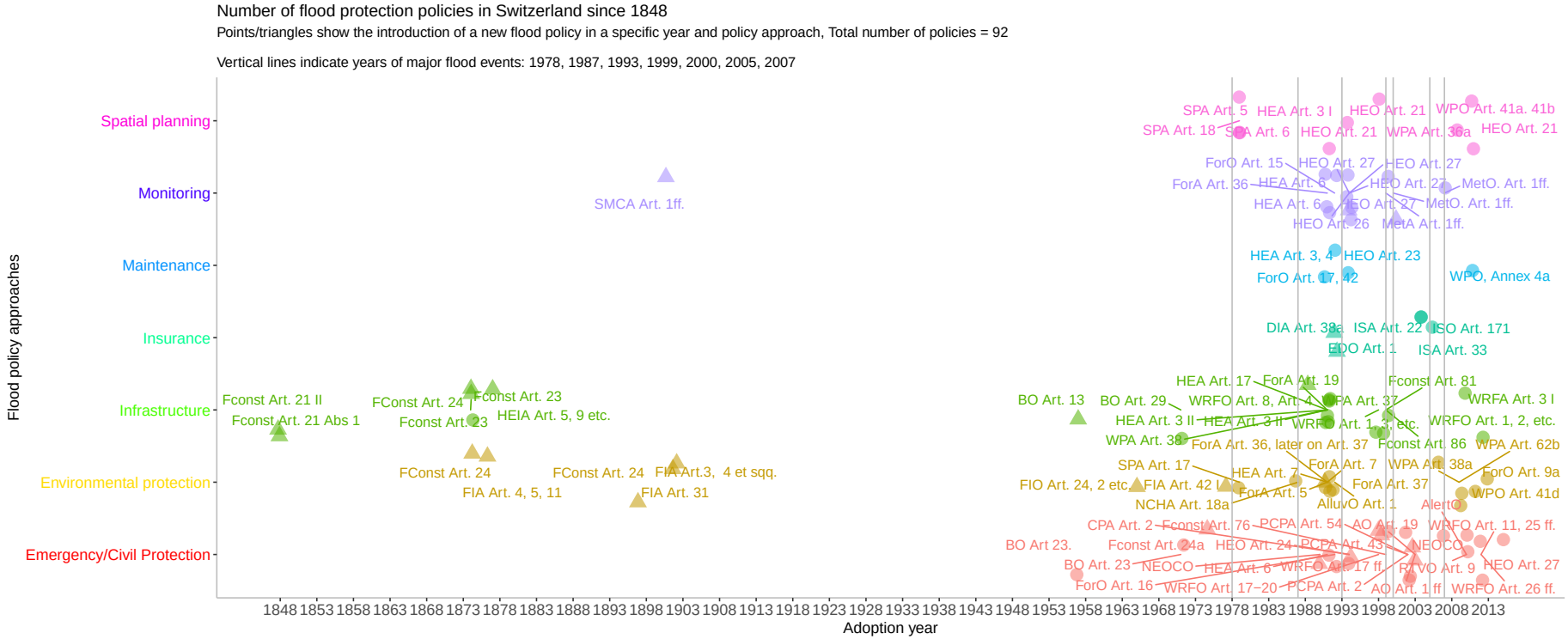

Figure 2. Flood policies in Switzerland over time. Legend: circles = introduced policies that are still in place; triangles = introduced policies later terminated/replaced; AlertO = Alerting- and Security Ordinance, AlluvO = Alluvial Areas Protection Ordinance, AO = Alerting Ordinance, BO = Barrage Ordinance, CPA = Civil Protection Act, DIA = Damage Insurance Act, EDO = Elemental Damage Ordinance, FConst = Federal Constitution of the Swiss Confederation, FIA = Forests Inspectorate Act, FIO = Forest Inspectorate Ordinance, ForA = Forest Act, ForO = Forest Ordinance, HEA = Hydraulic Engineering Act, HEIA = Hydraulic Engineering Inspectorate Act, HEO = Hydraulic Engineering Ordinance, ISA = Insurance Supervision Act, ISO = Insurance Supervision Ordinance, META = Meteorology And Climatology Act, METO = Meteorology And Climatology Ordinance, NCHA = Nature and Cultural Heritage Act, NEOCO = Ordinance of the National Emergency Operations Centre, PCPA = Population- and Civil Protection Act, RTVO = Radio and TV ordinance, SMCA = Swiss Meteorological Central Office Act, SPA = Spatial Planning Act, WPA = Waters Protection Act, WPO = Water Protection Ordinance, WRFA = Water Retaining Facilities Act, WRFO = Water Retaining Facilities Ordinance.

4.2.1. Experts' Highly Valued Policy Design Indicators Across Cases

Four of the ten policy design indicators stand out across cases, because experts consistently exhibit a clear preference for a specific policy design. Policy actors agree that (a) the integration of individual policy instruments within a broader framework, (b) high pressure on target groups, (c) sanctions for noncompliance, and (d) a defined and publicly allocated budget are decisive elements of policy design. These results illustrate a certain trend as they are based on policy actors' similar experiences with policy design across the three cases.

More precisely, policy experts agree that integrating diverse flood-related policy instruments into a broader framework is central to policy design. Flood governance concerns sectors as diverse as spatial planning, hydraulic engineering, and environmental or forest protection. Experts may highly value integration in order to prevent conflicts between diverging sectoral interests and stakeholder groups or to coordinate competing demands by promoting collaboration across sectors.

Apart from integration, policy experts endorse placing high pressure on target groups in the context of flood risk management. One potential explanation for such a stance entails coercion representing the most straightforward method to steer heterogeneous target groups towards the common goal of flood risk management. Stakeholder groups are heterogeneous (agriculture, nature conservation, forestry, citizens, etc.) in each of the cases of the Aare, Thur, and Kander rivers and hold competing interests that are difficult to channel towards one common policy pathway. In such contexts, flood risk management experts seem to value state intervention in order to successfully steer the quantity and diversity of involved stakeholders towards a common goal.

Pressure on target groups goes along with the indicator sanctions for noncompliance. Sanctions are a generally crucial element of policy design as they increase the likelihood of compliance. In the case of flood risk management, experts may perceive sanctions as particularly important, after having experienced policy violations in the past whereupon buildings had been constructed in flood hazard zones, or minimum distances to rivers were ignored. In these cases, however, sanctions did not come to fruition.

Policy experts consider a defined and publicly allocated budget an important indicator for policy design. In the Swiss context, strong financial solidarity is typical, where flood risk management represents a joint task of the federal government, the cantons, and the municipalities. Solidarity may constitute a central theme for policy experts, because public and private actors profit from flood risk management through the protection of public infrastructures (e.g., roads, bridges, drinking water wells, etc.) and private buildings. Its dense population is also unique to Switzerland. In the regions of the Aare, Thur, and Kander rivers, people live close to one another and municipalities comprise close-knit communities. It is thus in the interest of flood risk management experts to conceive of integrated flood risk management tools and shared policy instruments in order to leverage synergies and share costs across upstream and downstream municipalities within a catchment area.

Although less pronounced, results also show that experts exhibit preferences for specific design features of another four indicators across the three cases. For the indicator inclusiveness of target groups, most respondents across cases agree that flood risk management should target society as a whole and not just specific target groups. When it comes to the indicators proportionality and directness, however, responses are less clear. In the Aare case, responses for both indicators are very close to the 50% threshold. Responses are divided between high versus low proportionality, and distributed versus concentrated implementation duties. These findings suggest that respondents hold diverging views with regards to those aspects of policy design. By contrast, a majority of experts in the Thur and Kander case favor low proportionality, whereupon actors prefer harmonizing flood policies on higher levels in order to avoid discrepancies across jurisdictions. Harmonization may be particularly important in cases where strong interdependencies exist among upstream and downstream municipalities. With regard to directness, most Thur and Kander actors prefer concentrated, clearly defined implementation duties. Finally, a majority of policy experts across the three cases value high levels of bindingness to target groups. Concerning governing flood risk, experts prefer policies that

are binding and formally regulated in laws rather than nonbinding policies that are more flexibly and less formally regulated.

In summary, eight indicators exhibit consistent trends across the three cases whereby trends are particularly pronounced for four indicators. From an expert perspective, a coherent policy design in flood risk management benefits from policy integration, a sufficient budget for policy implementation, coercive instruments, and sanctions.

4.2.2. Case Specificities

Results for the two indicators objectives and monitoring differ across cases. We contextualize those case specificities with in-depth case knowledge from field work and expert interviews.

Aare River case: Severe floods have repeatedly (1999, 2005, and 2007) affected the Aare region and its infrastructures of national and regional importance, e.g., airport, highway, railway lines, and several drinking water wells. Additionally, the Aare Valley is characterized by high population density, which restricts space for additional flood risk management instruments. In this context, nearly all of the surveyed experts evaluated monitoring as highly important. Flood risk management experts seemingly advocated for monitoring in order to successfully implement existing instruments rather than adopt new spacious instruments. Monitoring is also vital for preventing damage to infrastructures and communities in the area.

Thur River case: The Thur River was restored in a long-term correction and flood protection project (1983–2017), where hydraulic engineers and nature conservation organizations were in strong opposition with one another. Additional conflicts occurred due to the late involvement of the local population into the project, which comes contrary to Swiss direct democratic tradition and, hence, intensified conflicts of interests between agriculture, nature conservation, forestry, and other policy sectors. This conflictual context is evidenced in policy experts' divided responses. For instance, responses for indicator objectives and monitoring are divided, i.e., close to the 50% threshold. A narrow majority of experts favors policy designs with clearly defined policy objectives. Nevertheless, almost half of the respondents prefer policy designs that formulate flexible objectives and are adaptable to changing circumstances. Likewise, results for monitoring are nearly divided between preferences for obligatory and voluntary approaches.

Kander River case: The ongoing flood risk management project at the Kander River is embedded in a large-scale cantonal project to improve the general economic, ecological, and social context of the Kander Valley. The Canton Bern is omnipresent, overseeing managerial decisions in the project. As such, the project is already working towards harmonization across municipalities in the Kander Valley. Additionally, numerous working groups exist in which municipalities, the population, or target groups participate. In this coordinated context, experts appear to value policy designs that formulate flexible and adaptable objectives. For monitoring, results are similarly divided as they were in the Thur case. A narrow majority of respondents opt for obligatory monitoring, while nearly half of the experts prefer a voluntary approach.

In summary, results from the experts' survey highlight that several aspects factor into a coherent policy design, whereby policy integration constitutes one such aspect, among others. Results also indicate that going beyond a numerical count of policies, by delving into their detailed design, reveals important insights into flood risk management's role within the local context. Four indicators in particular—integration, pressure, sanctions, and budget—are considered important aspects of policy design across cases. The following section encapsulates the temporal dimension of policy design.

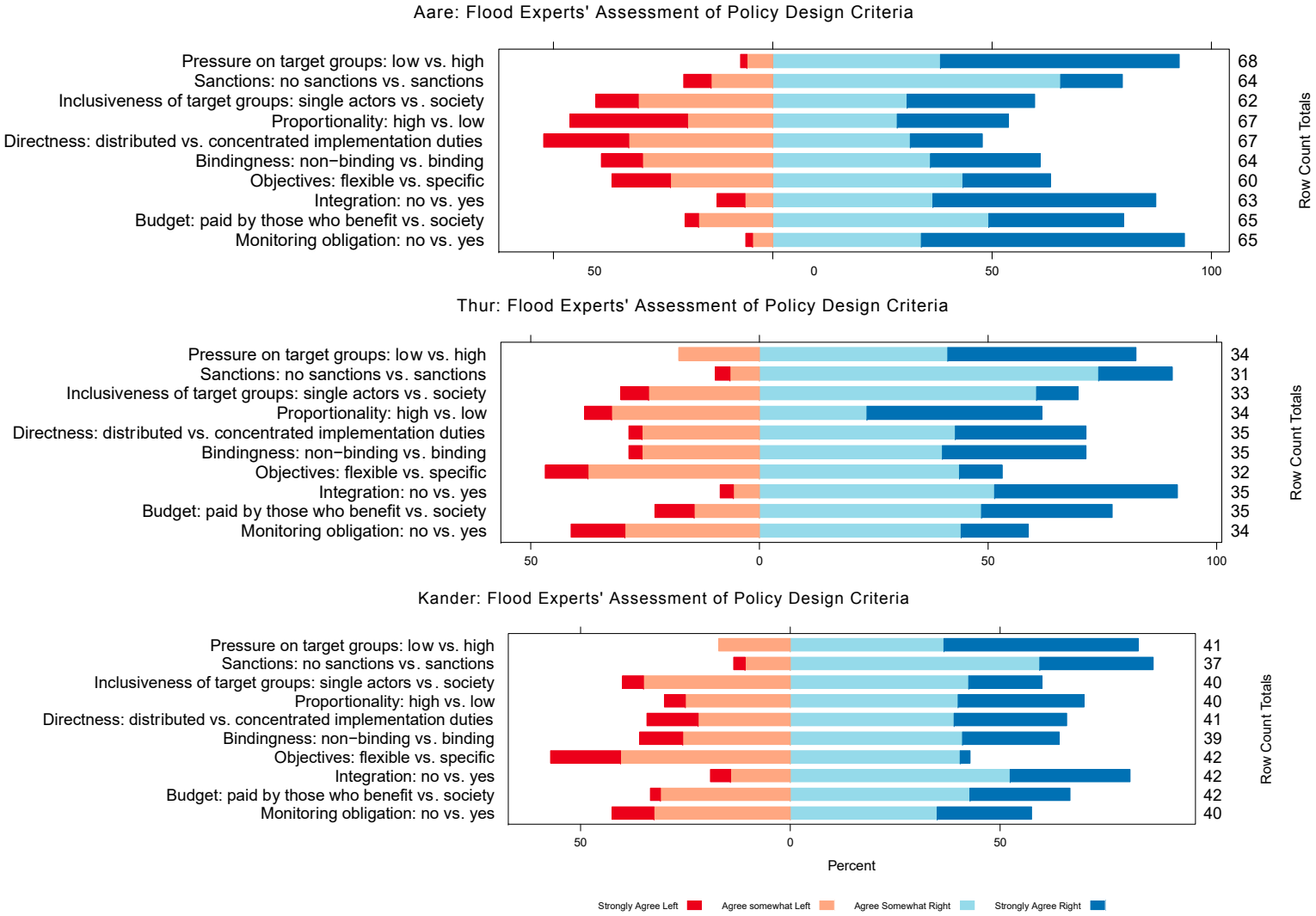

Figure 3. Flood experts' assessment of policy design indicators.

4.3. Policy Design Over Time

Results displayed in Figure 4 illustrate policy design trends, i.e., how Swiss national-level flood policies have been designed throughout history. The panels illustrate scores over time for the 92 flood risk management instruments (the same instruments as displayed in Figure 2) on the four policy design indicators that experts considered particularly important across cases.

The panel for budget in Figure 4 (top left) signifies that instruments exhibit diverse types of designs, but that this trend has been rather consistent throughout history. Flood risk management instruments have been designed with a special budget (value = 5), with budget from tax revenues (value = 3), and without any budget (values = 1) for implementation.

Results for the indicator pressure on target groups (bottom left) show that flood policies have predominantly been designed as coercive requirements rather than as economic or voluntary instruments. Intrinsic to Swiss flood policy design is their potential to compel target groups to change their behavior and adapt to flood risks.

The panels for integration (top right) and sanctions (bottom right) indicate trends for only little integration and sanctions, whereby results from the survey reveal that experts highly value integration and sanctions. In the case of sanctions, Swiss flood risk management policies have predominantly been designed without, or with minor, sanctions to prevent or manage infringements. Results for the indicator integration highlight that flood risk management instruments tend not to be adopted within broader framework policies, but instead reference other types of flood risk management instruments, or stand alone.

Contrary to our third expectation, policies follow a certain design trend throughout history in our case of Swiss flood policies. We conclude that not only policies, but also their design, can be regarded as stable, thereby reflecting sectoral or national policy styles [72] that establish over time.

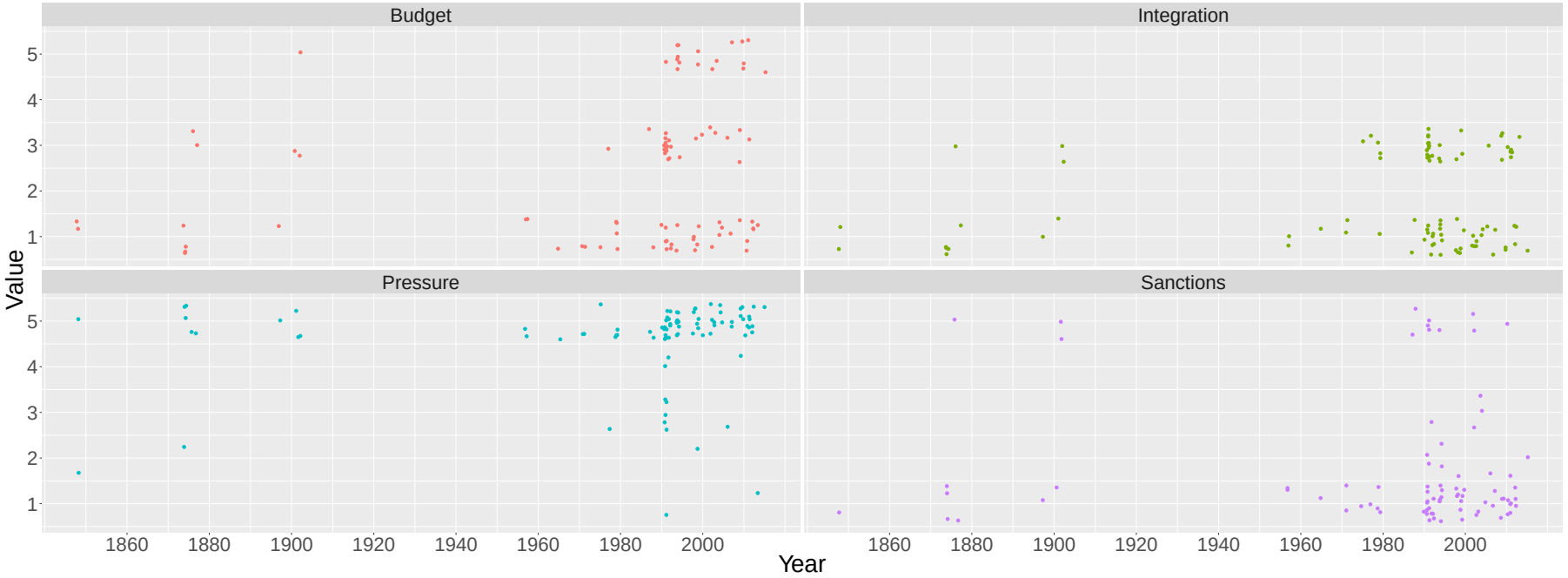

Figure 4. Policy design trends. Note: Panels show four policy design indicators; dots stand for 92 Swiss national-level flood policies; x-axis indicates time frame of analysis between 1848 and 2017; y-axis shows the categorical values, between one and five, of policy design indicators (see Table 2).

5. Conclusions

Understanding the policy framework and the ways in which public policies evolve over time constitutes a prerequisite for successful and adaptive water governance, which has become increasingly important in times of climate change and related flood risks [70]. Today, water management rests on IWRM as a guiding principle in many countries, including Switzerland [73]. IWRM centers the integration of different water interests, but fails to recognize that the need to integrate accrues over time as policy portfolios evolve. We connect scholarship on IWRM with insights from public policy research as a means to shed light on the relationship between the evolution and integration of public policies. In this study, we link IWRM with the literatures on (a) path dependency [39], (b) IRR [13], and (c) policy design [42,51].

This article's goal is to cross-fertilize IWRM with public policy scholarship in order to strengthen the currently underdeveloped aspect of policy integration in IWRM. We argue that from existing public policy theories we can learn about the integration of different interests and the sound management of water resources in IWRM. Public policy literature can contribute to IWRM through its insights into policy stability, extent, and coherence; as well as through the insight that policy designs constitute an important point of leverage for adaptive policy in IWRM. Therefore, including the policy dimension into IWRM provides an important added value to the concept of IWRM.

Our analysis of Swiss flood risk management policies since the mid-19th century reveals that policies tend to remain in place, whereby only few policies are terminated over time. As a potential consequence of this policy stickiness, we observe that Swiss flood policy portfolios grow in extent over time. The trend of growing policy portfolios over time has not been paralleled by decreasing trends in flood events and damage across locations in Switzerland. Policies are adopted with the aim of reducing flood risk, but the mere increase in the number of policies seems to be insufficient to attain this goal. With more policies in place, the need to integrate policy sectors, decision-making levels, and territories increases as well. Returning to our initial research questions, we find that the emphasis of integration in IWRM can be explained by the evolution of policy portfolios over time. Survey results confirm that Swiss flood experts perceive integration as important when designing flood policies. Apart from integration, experts find importance in equipping policies with a sufficient budget for policy implementation, and with coercive instruments and sanctions to steer target groups towards desired flood risk management goals. Prior to conducting this study, we expected policy designs to be adapted over time; however, our results reveal that national policy styles prevail [72]. Consequently, not only polices, but also their design, appear sticky. Such stickiness of policy designs restricts possibilities to adapt designs to changing circumstances over time and thereby impacts internal coherence of policy portfolios. Nonetheless, adapting policy designs to future climatic changes or social transitions will be of utmost importance for climate change adaptation. Future research is necessary that addresses the question of how to render policy designs more adaptable. This article contributes to answering this question by highlighting that four aspects of policy design in particular (integration, coercion, sanctions, and budget) should be reevaluated regularly by policy-makers in order to create a coherent and adaptable policy regime. A promising agenda for future research could be to analyze the conditions under which policy-makers perceive the need to adapt policies in their design.

Despite its empirical and theoretical contribution, the study bears a number of limitations that future research could address. First, the evolution of policies targeted at reducing flood risks in Switzerland may represent a unique case that cannot be applied ubiquitously across multiple contexts. Particularly visible and damaging flood events have triggered policy attention and provide a partial explanation for the increasing policy density that we observe [74]. Future research could extend beyond the specific focus of flood risks and analyze policy evolution in other policy sectors less targeted by external shocks [75].

Secondly, policy experts' perception of preferable policy designs could be specific to the sector of flood risk management. In order to reduce risks from natural disasters, experts might exhibit an exceptionally positive attitude towards coercive policy designs with strict sanctions, harmonized

on higher levels of governance. By contrast, in other sectors, such as nature conservation, energy production, or emission reduction, actors might show greater criticism towards government steering. It is therefore necessary to validate findings from this study with survey results in other sectors.

Thirdly, results should be complemented by an analysis of policies' impact on flood risk. While many studies on public policies contribute valuable insights through an in-depth analysis of a specific policy at a specific point in time in one sector, our study analyzes policies and their design over time utilizing a more quantitative methodology. In order to address the trade-off between breadth versus depth, we have included survey data and case knowledge from three flood-prone regions in Switzerland (Thur, Kander, Aare). Nevertheless, further research could more deeply explore the implications of diverse policy designs on flood risk over time by addressing the following interdisciplinary research question: What are the effects of (sectoral) policies, their diverse designs, and their (lack of) integration on flood risk? Such research would involve flood risk models, which consider diverse types of policy data for their projections, additionally to the conventional geomorphological and socio-economic variables.

Lastly, our study explores the evolution of policies over time in a descriptive manner, but further research is necessary to better comprehend which (combination of) factors prompt the adoption and change of flood risk management policies. Major flood events appear to constitute one such potential trigger for policy action. In general, policy-makers have thus far responded to major events by adopting policies, but this approach represents a reactionary one. Ideally, policy-makers would instead act preemptively in order to prevent damage. In order to facilitate a better understanding of policy responses to shocks, future research would necessitate controlling for other factors that may trigger (preemptive) policy action.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Description of Ten Policy Design Indicators

Policy integration, in the public policy literatures [2,3,52], denotes the coordination of policies and actors across sectors. While public policies have traditionally been organized into specialized and independent sectors, the resulting pillarization has been called into question due to existing interdependencies between policy sectors. The coordinated integration of policies across sectors, e.g., via framework policies [42], may avoid contradictory or conflicting combinations of political action, and may instead create coherent means to achieve an overarching objective [2,3,52]. With growing policy portfolios, there comes a higher need to integrate diverse policies, but also a greater administrative burden requiring financial and human resource capacities to integrate the many policies [13].

Coercion or pressure on target groups: The concept of coercion enjoys a long tradition. Lowi [56] was one of the first scholars to draw attention to the coerciveness of policy intervention defined as the degree to which a policy constrains individual or group behavior. Coercion represents an essential aspect of policy design as it centers on the question of the role of the state, and the extent to which state intervention is necessary to successfully steer society [53]. One of the most influential policy typologies identifies three broad classes of policy instruments based on a decreasing level of coercion: sticks, carrots, and sermons. The label sticks alludes to regulative command-and-control instruments, which rely on state authority, such as prohibitions or standards. The term 'carrots' refers to

a family of incentive-based financial policy instruments, such as charges or trading schemes. Sermons denote persuasive, information-based instruments, such as public campaigns or best environmental practices [54]. Whether regulative, financial, or voluntary instruments perform better at achieving defined political goals remains an open empirical question. Proponents of market solutions argue against state intervention [76–78], while etatists (or welfare) scholars advocate for strong government steering [79]. Empirical studies indicate that command-and-control and incentive-based instruments can achieve policy change based on a set of criteria [60,80]. While some studies highlight social norms as a more powerful steering mechanism than governmental coercion [59,81], others reveal that such voluntary societal measures have only limited capacities to spur desired changes if not supported by government intervention [82].

Sanctions represent a decisive element of policy designs as they limit target groups' freedom to choose noncompliance by imposing a financial or social cost on defection [51,55]. While sanctions appear a reliable means to calibrate policies towards desired policy goals, the general assumption of "the higher the fine, the more effective it is" has been called into question. Enterprises with large budgets can purposefully take fines into account in order to continue with an undesired, but profitable practice [51]. Moreover, sanctions alone do not suffice; rather, they require enforcement capacities with defined agencies responsible (and sufficiently staffed and resourced) for controlling compliance, as well as for imposing and pursuing sanctions where necessary.

Inclusiveness: An essential element when designing public policies is the question of whom the policy targets [56–59]. A policy can be considered inclusive of many target groups when it addresses a maximum of societal groups or sectors (such as agriculture, industry, etc.) that contribute to a policy problem. Establishing policy inclusiveness requires achieving a point of maximum horizontal policy efficiency, where the policy targets the entirety of groups contributing to a problem, but neither more nor less [51]. It remains an open question as to whether policies should be calibrated such as to include all target groups contributing to a problem (or as much as possible), or whether policy designs should prioritize targeting fewer, but precise target groups. A policy design that centers multiple target groups can risk covering too broad a scope, and can therefore be difficult to adopt, implement, or monitor. Policies with a narrow focus, in comparison, can be calibrated to a specific target group, which may allow for more effective policy implementation.

Proportionality: The scale (international, national, regional, or local) toward which a policy is calibrated has received vast scholarly attention in literatures on multilevel governance, polycentricity, and EU integration, among others. Following the subsidiarity principle, local problems deserve local solutions, while problems occurring at higher scales should be approached with corresponding higher-level solutions. Subsidiarity thus involves the idea of proportionality, which entails working towards a point of maximum vertical policy efficiency [51,59], whereupon policies apply to the same jurisdictional level (local, regional, national, or international) as the elements contributing to the problem. A growing body of literatures on polycentricity, local governance, self-regulation, and globalization argues that causes or consequences of policy problems are generally local, and therefore best dealt with locally [60,61]. Other literatures (e.g., on the European Union) argue in favor of harmonizing policies on higher levels of governance in order to avoid distortions between jurisdictions, which can create gains in efficiency and may be valuable even at the expense of proportionality (the fit between problem and solution scale).

Directness: Another important aspect of policy design concerns the actor(s) responsible for implementation [83,84]—i.e., how to design implementation duties in order to increase the chances of proper policy implementation? Salamon popularized the term directness, which refers to the concentration of implementation duties ([62], p. 1654). In direct policy designs, the decision-making authority is also involved in financing and implementing, or at least in supervising implementation (while other levels of government or private actors directly implement and finance the policy). Principal agent theories suggest that direct policy designs reduce the risk of divergence between the goals of those deciding (principals) and those implementing (agents) ([85], p. 139). By contrast, dispersed

implementation duties provide leverage to adapt, change, or soften policy design, such that its impact on behavior or processes differs from its intended outcome. While self-regulation is proposed in this stream of literature ([61], p. 6), New Public Management Reform and privatization literatures emphasize efficiency gains and professionalization of the public sector [86]. From this perspective, outsourcing the implementation of public tasks to private companies is recommended even at the expense of directness. Proponents of federalism also approve of indirect policy designs with the argument of task sharing in multilevel governance [87].

Bindingness: Policy designs also vary with regard to their level of bindingness set by the hierarchy of norms in democracies. Constitutions are placed on the highest rung, followed by laws, ordinances, decrees, and finally, oral agreements [63,64]. On the one hand, regulating a policy issue on the level of a legal act can prompt policy commitment on a longer-term horizon, because laws or constitutions cannot be altered as easily or quickly as decrees, ordinances, or plans. On the other hand, legal acts, especially in the form of laws and constitutions, often create a framework, and are therefore vaguely formulated. In order to interpret such broadly formulated legal acts, ordinances, policy plans, or implementation guidelines exist. Even though these documents are less regulated, they still represent central policy documents in their detailed delivery of policy designs. Additionally, policy documents that receive lower levels of bindingness allow for the swift adoption of policies to new circumstances [60], or for the formulation of policies that are unlikely to gain parliamentary majorities. In summary, bindingness can be regarded as an indicator whereby higher levels of bindingness symbolize higher policy commitment. From a competing perspective, along with lower levels of bindingness come flexibility gains or precision, thereby successfully contributing to problem solving.

Objectives: Policy objectives can vary from precisely to broadly formulated policy goals [42]. The definitions of precise and ambitious objectives call for commitment by the government as well as for the promotion of progress. These objectives also provide a benchmark against which target groups' behavioral changes or the government's success can be evaluated. According to a competing argument, policy objectives should not be too narrow, but instead long-term oriented. Policy design can gain problem-solving capacity whereupon policy goals are broadly formulated and therefore offer leverage to adapt to future circumstances.

Budget, i.e., whether a policy is equipped with (financial) resources for its implementation, matters as an element of policy design. From where to draw financial resources is a crucial question, because attributing costs to certain societal groups creates (re)distribution processes and winner-loser divides [56]. Resources can be allocated from the public budget (i.e., taxes) or from a specifically introduced tax [42]. While the latter signals commitment and also secures policy budgeting, it can also increase the difficulty of passing a policy. Parliaments, or other decision-making bodies, may reach majorities more easily when factoring out budget-related questions, among others, because such financial debates increase the perception of a policy's costliness [88].

Monitoring: Policy designs can vary with regard to their monitoring obligations. Monitoring concerns evaluating an implemented policy against its goals; it creates feedback mechanisms that induce policy learning in order to adapt policies to changing circumstances. An academic debate centers on the question of how to design monitoring obligations, which can be obligatory (or voluntary), and conducted regularly (or occasionally) by either external or independent organizations, or by the implementing agency itself [42].

Appendix B. Survey Questions (translated; survey language: German)

Question on flood risk management measures

Whether flood risk management measures are effective depends on, among other factors, how they are designed in financial, human resource, and organizational terms. How should measures be designed from the point of view of your organization in order to be effective?

Response options

Please indicate your organization's degree of agreement to the respective opposing options to design flood risk management. For each line, you can choose either option 1 (a = strongly agree; b = mostly agree) or option 2 (c = mostly agree; d = strongly agree). If you do not agree to either option, please choose "both unimportant". Please place only one cross per line.

Option 1		**Option 2**	Both unimportant
High degree of state intervention.	☐ a strongly agree to Option 1 ☐ b mostly agree to Option 1 ☐ c mostly agree to Option 2 ☐ d strongly agree to Option 2	Low degree of state intervention.	☐
Sanctions for noncompliance with clearly defined enforcement responsibilities.	☐ a ☐ b ☐ c ☐ d	No sanctions for noncompliance.	☐
Society in general as target group.	☐ a ☐ b ☐ c ☐ d	Concerned actors as target group.	☐
Uniform definition of responsibilities between federal, cantonal and municipal level.	☐ a ☐ b ☐ c ☐ d	Responsibilities defined according to the extent of the flood-prone area and subsidiarity.	☐
Decision-making, implementation, and financing competences bundled in one authority.	☐ a ☐ b ☐ c ☐ d	Decision-making, implementation, and financing competences shared between several authorities.	☐
Measures should be regulated in legally binding form.	☐ a ☐ b ☐ c ☐ d	Measures should be regulated in guidelines or plans, which are less formally binding.	☐
Clear and ambitious political objectives.	☐ a ☐ b ☐ c ☐ d	Objectives formulated in a way that adjustments to new conditions are possible.	☐
Coordinated with measures in other policy sectors.	☐ a ☐ b ☐ c ☐ d	Stand-alone measures.	☐
Costs paid by those who benefit from measures.	☐ a ☐ b ☐ c ☐ d	Costs paid by society.	☐
Effectiveness of implemented measures should be monitored regularly.	☐ a ☐ b ☐ c ☐ d	No regular monitoring required.	☐

Appendix C. Coding Scheme for Policy Design Indicators and Values

Indicators	Coding Question	Coding Values	
Pressure on target groups	Likelihood that target groups take action	1	No policy instruments adopted
		2	Policy instrument mix relying on persuasion/nodality/information at most
		3	Policy instrument mix relying on economic incentives at most
		4	Policy instrument mix combining economic incentives with some sort of control/state authority
		5	Policy instrument mix mostly relying on state authority/sticks
Sanctions	Portion of deterred target groups	1	No existing sanctions
		2	Existing sanctions deter small parts (less than half) of the target group
		3	Existing sanctions deter half of the target group
		4	Existing sanctions are high enough to deter important parts (more than half) of the target group
		5	Existing sanctions are high enough to deter the entire target group
Inclusiveness/ Scope	Ratio of target groups to causes	1	No defined target groups
		2	Small parts (less than half) of the groups/individuals causing the problem are targeted by the policy
		3	Half of the groups/individuals causing the problem are targeted by the policy
		4	Important parts (more than half) of the groups/individuals causing the problem are targeted
		5	The entirety of groups/individuals causing the problem are targeted
Proportionality	Ratio of solution level to problem scale	1	No defined solution level
		2	The defined solution level is much smaller/larger than the problem scale (e.g., less than half the size or more than 1.5 times the size)
		3	The defined solution level is somewhat smaller/larger than the problem scale (e.g., less than quarter the size or more than 1.25 times the size)
		4	The defined solution level is only slightly smaller/larger than the problem scale (e.g., less 0.125 times the size or more than 1.125 times the size)
		5	The defined solution level corresponds exactly to the problem scale
Directness/ Implementation	Dispersion of implementation duties	1	No defined implementation duties
		2	Implementation (and funding) is passed on to the private sector or to other levels of government without control by the authority deciding
		3	Implementation is controlled by the authority deciding, implementation (and funding) is passed on to the private sector or other levels of government
		4	Implementation is controlled and funded by the authority deciding, implementation is passed on to the private sector or other levels of government
		5	Authority deciding is also (funding) and implementing
Bindingness	Type of policy document	1	No existing legal document
		2	Existing document, but nonbinding
		3	Short-term binding (e.g., ordinance, degree, etc.)
		4	Medium-term binding (e.g., law)
		5	Long-term binding (e.g., constitution)
Objectives	What is the policy objective with respect to policy performance?	1	No specific target formulated
		2	Vague and not ambitious target formulated
		3	Specific, but not ambitious target formulated
		4	Ambitious targets, but vague target formulated (e.g., significant CO2 emission reductions, but not specified by how much/compared to which baseline)
		5	Specific and ambitious target formulated

Indicators	Coding Question	Coding Values	
Integration	Is the policy integrated in a package/ framework?	0	Policy is not integrated in a package or framework
		3	Policy is integrated in a package or references other policy instruments or sectors
		5	Policy is a framework policy or refers to a framework policy
Budget	Is there a specific budget for implementation?	0	No budget assigned to policy implementation
		3	Budget assigned from Federal/state-tax revenue
		5	Specific tax introduced to budget the policy
Monitoring	Is there a specific monitoring process and by whom?	1	No monitoring
		2	Monitoring but unclear by whom
		3	Monitoring by the implementation agency
		4	An existing, but external group is responsible for monitoring
		5	A special group/institution is established for monitoring

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