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SPECIAL FEATURE: ORIGINAL ARTICLE

Traps! Expanding Thinking on Persistent Maladaptive States in Pursuit of Resilience

From robustness to resilience: avoiding policy traps in the long term

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Abstract The likelihood of being faced with trap-like situations is a worrisome aspect of long-term policy-making, such as for climate change adaptation. Even when a policy may be effective in the short-term, changes in problem or policy contexts may render it ineffective over time. The design of 'robust' policies, meaning those which are able to self-adjust to linear changes in their environment, can be contrasted with 'resilient' ones which are able to adjust not only to linear, but also non-linear shifts in their contexts. Building on Boonstra and de Boer (AMBIO 43:260–274, 2014)'s argument that traps should not be considered as a static phenomenon; rather their emergence and development is often directly influenced by history and path-dependency, this paper elaborates how trap-like situations can emerge with increase in climate uncertainty over time. Three strategies to address policy traps due to climate change form subjects of inquiry in this paper: avoiding traps in the first place, designing against traps, and overcoming traps once in them. Each requires a specific type of design thinking and practice.

Keywords Policy traps · Lock-in · Uncertainty · Climate change · Adaptive policies · Resilience · Robustness

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Climate change adaptation and uncertainty

Adaptation to climate change is a complex policy problem requiring individuals and policy-makers to formulate decisions with potentially long-term consequences, even though there is incomplete knowledge and uncertainty in the current decision period.[1] Given the likelihood of non-linearity in the future, the impacts associated with climate change may only be manifested to a certain extent in the current term (IPCC 2007). Policies that are unable to function effectively under dynamic and uncertain conditions in the future are likely to face difficulties in achieving their intended goals, become obsolete or irrelevant and/or impede the ability of social-ecological systems to adapt (Swanson and Bhadwal 2009). Determining the appropriate level of adaptation to match the scale of expected change in the climate and associated impacts, however, remains an ongoing challenge (Hall et al. 2012).

This paper specifically focuses on the aspects of long-term policy-making to address climate-change impacts, even though climate variability can pose several short-term risks and impacts. There are some important differences between how policy-makers respond to the short-term climatic variability versus climate change impacts that are likely to play out in the long-term. Climate variability considers changes in climatic variables over a period of months-to-years (short-term), whereas climate change typically considers impacts that are likely to be observed beyond a decade to several decades (long-term) (IPCC 2007). In addressing the long-term impacts of climate

[1] "What is uncertainty?", Climate-ADAPT, European Climate Adaptation Platform, accessed 16 December 2014, http://climate-adapt.eea.europa.eu/uncertainty-guidance/topic1#What+are+sources+of+uncertainty+in+adaptation+planning%3F.

change, agenda-setting and policy formulation are posed by the challenge of responding with only a partial understanding and sometimes disagreement, regarding the nature of the climate challenge itself (much different from observed climate today) and the appropriate policy response. An incomplete understanding of the system may result in solutions that are ineffective or even counterproductive to intended policy objectives (Swanson and Bhadwal 2009). In addition, responses to short-term climate variability are often intended towards developing temporary coping strategies (Huq and Reid 2004). On the other hand, policy responses to address long-term climate change can challenge conventional decision-making and necessitate policy choices and decisions that are innovative and sometimes even transformative in nature, i.e., completely new and radical compared with the current policy responses (Pelling 2011; Smith et al. 2010). The current coping strategies aim at building capacities of social-ecological systems in the short term by managing climate risks.

If decision parameters cannot be observed and measured, the traditional decision-making approaches based on deterministic models of future would need rethinking. Under the conditions of uncertainty associated with the policy environment, however, policy-makers often find it in their interest to delay action and wait for new information to emerge. A tendency to maintain status quo can also be attributed to inertia within the current policy regimes (Ramjerdi and Fearnley 2013).

There are also uncertainties that set limits to adaptation in terms of how much a policy or programme can enable adaptation depending on availability of financial resources for adaptation implementation, institutional barriers, and capacities of social and biophysical systems to adapt (Moser and Ekstrom 2010). Effective policy designs should take these constraints into account.

The optimality of adaptation response to change in the climate has largely been viewed with reference to meeting the efficiency criterion, i.e., assessing and determining when a marginal increment in investment costs for adaptation will yield an equal marginal increment in risk reduction. This is possible, however, only for pre-determined scenarios that do not cover the broad spectrum of uncertainty surrounding climate change impacts (Klein 2003). Major shifts in the climate can cause social-ecological systems to cross critical thresholds, limiting the effectiveness of current policy responses to manage these systems (Kwadijk et al. 2010). Under such conditions, while delaying action or maintaining the status quo until conditions are clearer might seem logical, there could be substantial costs associated with such delays, including the opportunity costs of not being early adopters of relevant adaptation strategies. Furthermore, inaction or delayed actions can also 'lock-in' long-term risks (due to continuation of obsolete or maladaptive practices) which can be costlier and more difficult or impossible to correct in the future (Ranger 2013).

Policy design under uncertainty often aims to either reduce uncertainty where possible, or in other cases, to assess the range of uncertainty and, accordingly, identify policy measures that are expected to be robust within this range (Bredenhoff-Bijlsma 2010). Such policies can be contrasted with 'resilient' ones which are more reflexive and able to adjust not only to linear, but to non-linear shifts in their contexts.

Through a process tracing of selected cases of social-ecological traps that developed over centuries, Boonstra and de Boer (2014) argue that traps should not be considered as a static phenomenon or an outcome. They suggest that traps represent a process instead, in which historical conditions and path-dependency are not merely incidental factors, but can directly cause traps and influence the nature of their emergence and development. Building on Boonstra and de Boer's discussion of social-ecological traps as a process, this paper elaborates how trap-like situations can emerge with an increase in climate uncertainty over time. In addition, three strategies to address policy traps due to climate change form subjects of inquiry in this paper: avoiding traps in the first place, designing against traps, and overcoming traps once in them. Each requires a specific type of design thinking and practice.

Policy traps under climate uncertainty

Planned adaptation to climate change is complicated by a wide range of uncertainties that range from having limited knowledge about the level and type of change in the current policy environment over the long term to situations of deep uncertainty or 'unknown unknowns' (Walker et al. 2001). The climate adaptation literature, to date, has largely focused on policies and programmes for adjusting to change rather than actively focusing on developing policy alternatives in an anticipatory manner (O'Brien et al. 2012).

For low levels of expected change in climate, policy responses for adaptation might simply be of an incremental nature (Smith et al. 2010; Vermeulen et al. 2013). Under high levels of climate uncertainty, policy-makers may be faced with situations of 'surprise' (Lindenmayer et al. 2010) or abrupt changes to status quo (Wardekker et al. 2010). Under such conditions, adaptation response could include strategies that are potentially transformative in nature (Pelling 2011).

Rigidity traps (Carpenter and Brock 2008) related to uncertainty can occur due to change-averse attitudes and behaviour of stakeholders and policy-makers. An increase in uncertainty about pessimistic futures due to climate change for example can make people continue current behaviours (even if these are undesired and/or risky—'a bird in hand' strategy), and such high levels of uncertainty can seize an individual's sense of control over the future and thus render them defensive or in denial of the future (Morton et al. 2010). The choice between incremental and transformative strategies or rather their combination in a policy mix is contingent on many factors. For example, under conditions of high complexity and uncertainty, incremental approaches to policy-making have been argued to be better able to address and deploy policy responses (Lindblom 1959) to adapt to the problems "we know we have now" and can control while "factoring in a margin for them becoming worse" (Heazle et al. 2013). However, uncertainties related to how the climate, socio-economic, and political environment unfolds in the future, costs of transformation and that of any unintended impacts make adoption of transformative action rather risky (Rickards and Howden 2012; Kates et al. 2012).

A lock-in trap is characterized by low capacity for change, high resilience to change, and high connectedness among structural variables which may preclude change or render it rather expensive (Ranger 2013; Allison and Hobbs 2004). Policies typically emerge as 'bundles' or 'mixes' of policy tools through processes of policy change, with addition and subtraction of elements over time (Howlett and Rayner 2013). Any change in policy response, however, will typically be faced with resistance by stakeholders and beneficiaries of status quo policy arrangements. This makes it difficult to introduce any radical changes in the adaptation policy mix even if new policy objectives are put forth (Kern and Howlett 2009). Innovations for example would need to compete with existing institutions that have already been imbibed into the socio-economic context and attempt to fit through processes of "learning, coercion and negotiation" (Rip and Kemp 1998; Christiansen et al. 2011).

In the policy sciences, one such form of 'trap' is 'path-dependency'. Past policies can create a situation of path-dependence that limits the available choices for policy-makers to make future policy decisions. Such policy lock-in is often a result of 'policy legacies' that actively generate institutional routines and procedures that force decision-making, in particular directions by eliminating or distorting the range of policy options available (Pierson 2000, 2004), such as fossil-fuel intensive energy system lock-ins (Unruh 2000).

Dealing with rigidity and lock-in traps: designing resilient and robust policies

The predominant idea during the early period of resilience studies has been that resilience marks the ability of ecological systems to return back to normal or an equilibrium state following a period of stress. Adaptation policies that do not consider the existence of diversity of risks, impacts, and responses in a system can end up as 'policy misfits' (Bunce et al. 2010) or may become counter-intuitive or maladaptive, as they increase risks in the long-run (Barnett and O'Neill 2010). This concept of policies adapting to changes in the policy environment over time has been adopted in the policy sciences and modified to include the elements of flexibility and adaptability, that is, the ability of the system to adapt and retain its key structure and functions under stress by being flexible (Davoudi et al. 2012).

A core characteristic of resilient social-ecological systems is their ability to self-organize under dynamic conditions and their capacity to learn and adapt with change (Carpenter and Brock 2008; Anderies et al. 2012). Whether or not this change relates to an ability to adapt to a range of circumstances in a linear or non-linear way is an ongoing issue of concern. Robust policies on the other hand are limited to being 'fail-safe' within a specified range of uncertainty without changing their underlying goal structure or content, while resilience, on the other hand, can be considered to be an 'emergent' rather than 'static' feature of systems and policies capable of non-linear adaptation (Park et al. 2012).

A key concern for policy-makers is that high levels of uncertainty can lead to a faulty overestimation or underestimation of the severity and causes of a policy problem (Maor 2012, 2014), characteristics of which may manifest fully only in the future. In the case of climate change, well-calibrated scenarios and judged ranges of uncertainty (using decision-analytic techniques) form the basis of most policies, but only capture a subset of the full range of uncertainty (Schneider and Kuntz-Duriseti 2002). Over-adaptation can result when too much significance is placed on the need to adapt to climate change, either when climate change has erroneously been identified as a key risk factor and/or when other significant non-climatic factors have been wrongly ignored. On the other hand, under-adaptation results when the need to adapt receives a little attention or no attention and risks associated with climate change have been underestimated (Willows and Connell 2003).

Table 1 presents a comparison of governance aspects of adaptation interventions aiming at robustness and stability versus those aimed at flexibility and resilience.

As van Buuren et al. (2013) argue, both robust and resilient design may be required to fulfil adaptation

Table 1 Characteristics of policy mix of interventions for governance of adaptation (adapted from van Buuren et al. 2013)

Planning component	Adaptation interventions with the goal of stability and robustness	Adaptation interventions with the goal of flexibility and resilience
Processes	Directed towards meeting policy objectives within specified timeframe	Directed towards "goal-seeking and exploration"
Content	Designing general principles of operation	Emphasize learning by doing and multi-stakeholder engagement for policy design and implementation
Organizational arrangements	Allocating general roles and responsibilities and rules	Emphasize collaborative approaches to problem solving
Area of application	When large-scale negative impacts of climate change are likely	When impacts of climate change are small, uncertain, or ambiguous

objectives, and promote decisiveness and flexibility at the same time and enable innovations and engagement of multiple stakeholders. However, when the climate signal is unclear or low, flexible mechanisms might be preferred, whereas when strong signal indicating radical changes become apparent, then robust strategies are needed to enable decision-making. When vulnerability of certain regions, communities, or resource systems becomes extremely high or climate change becomes so severe that the impacts cannot be managed by even the most robust strategies (Kates et al. 2012; Vermeulen et al. 2013) more resilient designs are required.

How to design resilient policies to avoid policy traps: three strategies

In general, three strategies exist to avoid the policy traps cited above: avoiding traps in the first place, designing against traps, and overcoming traps once in them.

Avoiding traps in the first place through strategic foresight

A key challenge for adaptation policy-making is in terms of evaluating long-term impacts of climate change which would be felt decades or more after the implementation of the adaptation strategies (Piirainen et al. 2012). The switch to transformative options (when these are required) can be facilitated by incorporating flexibility into the suite of risk management strategies early on (Howden et al. 2010; Park et al. 2012; Giordano 2012).

Strategic foresight is a recent field that has emerged to help policy-makers and practitioners "broaden the boundaries of perception and to expand the awareness of emerging issues and situations" (Habegger 2010). This field holds potential to help policy-makers avoid traps in the first place and to design for resilience and flexibility by facilitating anticipatory policy planning, especially for 'wicked problems', such as climate change.

Strategic foresight attempts to integrate multiple perspectives and methods for identifying current and emerging issues and trends and help assess policy options for attaining a desired future. Based on experiences from the UK, Singapore, and The Netherlands, Habegger (2010) characterizes certain elements for successful foresight exercises. This includes having a scientific edge in terms of specific foresight methods and processes, allowing for innovation, fostering iterative interactions between stakeholders, and obtaining the trust and support of top bureaucrats to support the idea of exploring futures that may be quite different from the present conditions. Foresight can be instrumental for environmental planning by providing insights about a range of futures of social-ecological systems and critical thresholds, and thus aid in anticipatory planning to avoid adverse impacts (Bengston et al. 2012). Foresight can inform policy by enhancing the knowledge base for designing policies. This can be done by first, 'increasing the bandwidth' to allow a greater volume of information to be shared with policy-makers, second, 'optimising the signal', i.e., improvements in foresight content by ensuring better quality, relevance, usability, and timing of foresight studies, and third, by 'improving reception', i.e., enhancing the receptivity of policy-makers for foresight (Da Costa et al. 2008).

Apart from scientific uncertainty, political uncertainty can also impede necessary policy action, despite the presence of evidence calling for necessary policy response. Knaggård (2013) studied the long-term Swedish climate change policy process from 1975 to 2007 to identify the country's process of managing scientific uncertainty. The results indicated that under conditions of climate, uncertainty policy-makers preferred to depend on politically feasible options rather than scientifically desirable ones. Veenman (2013) makes a similar argument suggesting that while 'futures thinking' might present various scenarios

and alternative futures under uncertainty to the policy-maker, it still may not translate into robust decision-making under uncertainty. In the context of ageing in The Netherlands (an issue that has been an active topic of discussion in the country since the late 1990s), Veenman argues that while futures thinking might offer some respite from scientific uncertainty, it may not match the political agenda and thus may not effectively reflect in the policy decision. A similar result is indicated in a study of the US Environmental Protection Agency's implementation of federal pesticide regulations by Whitford (2014); that governments need to consider not only the scientific information pertinent to uncertainty but also the political and distributive effects of the policy decisions taken based on this information.

Under conditions where policy-makers are hesitant to openly share their policy strategies, strategic foresight can help to engage them in a shared vision process towards adoption of policy alternatives (Da Costa et al. 2008; Loorbach and Rotmans 2010). Marx et al. (2007) suggest that communication of climate uncertainty and forecasts should facilitate convergence between analytic and experiential processing systems to aid individual and collective decision-making in response to climate change.

Designing against traps through adaptive policy-making

Drawing a parallel between evolutionary biology and policies for sustainable development (both operating under conditions of change) Rammel and van den Bergh (2003) argues that given the changing conditions in the policy environment, the presence of a diversity of adaptation options and flexibility can contribute to adaptive policy-making. Swanson and Bhadwal (2009) suggest tools that can help policies adapt to a host of anticipated and unanticipated conditions and promote policy resilience to avoid traps. For example, adaptive policies can anticipate future conditions using integrated and forward-looking analysis, including scenario planning, multi-stakeholder deliberation to identify potential drawbacks and unintended impacts; and by monitoring key-performance indicators to activate automatic policy adjustments. In addition, adaptive policies can function effectively when faced with unanticipated conditions through regular and systematic policy review and improvement, enabling self-organizing and social-networking in communities, decentralizing decision-making to the lowest accountable unit of governance, and promoting variation in policy responses.

The adaptive policy-making process can be passive, i.e., operating on available 'best' scientific information till new knowledge comes up, or active, i.e., consciously experimenting with policy alternatives to identify better strategies as new conditions emerge (Walter 1992). Flexible institutional design and diversity of institutional arrangements can also help promote variation and prevent lock-in traps by facilitating experimentation and diversity of ideas (Schoon et al. 2011).

For long-term policies, both ex-ante and ex-post evaluation are necessary to capture the elements of uncertainty, risk, irreversibility, path-dependency, and any plausible lock-in effects (Ramjerdi and Fearnley 2013). Policy-makers thus have a critical role in amending any errors and evaluation. Under conditions when the policy problem is a politically sensitive subject, and there is uncertainty about the nature of the policy problem and the potential effects of certain policy decisions, policy-makers tend to "prefer innovation along the way, after little if any initial planning and analysis". This implies that in such cases, policy amendments or changes occur in the implementation stage (Deyle 1994).

Linder and Peters (1988) questioned whether the source of policy failure is faulty ideas or faulty implementation. The predominant notion has been that policy failure arises from "good ideas poorly administered" (Ingraham 1987; Linder and Peters 1988). Linder and Peters argue that the policy design perspective bundles ideas and the implementation aspects together and suggest that if the design itself is faulty "neither the specific programmatic idea nor its implementation will make any difference". Ingraham (1987) argues that in case ,errors in policy design are discovered during policy implementation stage, it is the political actors who are essentially entrusted with policy 'correction'. In this regard, the political actors operate as "continuous policy-fixers". This notion resonates with the concept of adaptive policies, wherein the functions of policy-makers are assumed to oscillate between that of a policy 'architect', 'facilitator', and 'learner' in the policy process to appropriately 'adjust' the policies in response to changing conditions over time (Swanson and Bhadwal 2009).

Swanson and Bhadwal also highlight that though some of the adaptive policy-making tools can be easily incorporated in the policy design stage itself; in practice, these are usually evident at the implementation stage. This can be attributed to the fact that the 'appropriation' of policy tools and instruments to best address the changing conditions is often initiated and/or applied at the implementation stage, as and when the new circumstances appear.

Overcoming traps once in them through 'smart patching' and 'packaging'

The task of policy formulation under uncertainty is becoming increasingly difficult, given the interdependence and complexity of systems and availability of diverse

policy alternatives. A key challenge for designing policies for the long term, such as for climate adaptation is to operate in a space, where there are pre-existing policy mixes, in which new tools and objectives have been piled on top of older ones, creating a mixture of inconsistent and incoherent policy elements (Carter 2012). Some of these policy mixes may be suboptimal owing to inconsistencies between new and old policy goals and the means to achieve these (Howlett et al. 2009).

When transformations are required, policy mixes may have to undergo complete reformulation or 'redesign' (Howlett and Rayner 2013). The idea of 'policy-packaging' is key here. Policy-packaging involves the implementation of a combination of measures instead of individual measures with the objective of increasing efficiency and effectiveness by enhancing synergies and reducing inconsistencies among the measures (Taeihagh et al. 2014; Howlett 2011; Howlett and Rayner 2013).

Developing custom made policy designs via policy-packaging, which deliberately seeks to exploit synergistic relationships between multiple policy instruments, was definitely the explicit or implied preference in most earlier efforts to promote enhanced policy integration and coherence[2] in designs across different policy domains (Meijers and Stead 2004; Briassoulis 2005; Meijers 2004). However, recognizing that policy mixes can also be intentionally designed through 'patching' or repairing inconsistencies in the previous policy mixes (Howlett and Mukherjee 2014) to overcome lock-in—much in the same way as software designers issue patches for their operating systems and programmes to correct flaws or allow them to adapt to changing circumstances—is a critical insight into design processes with which contemporary design studies are beginning to grapple with.

Distinguishing between policy-packaging and policy-patching as two methods of attaining the same goal—the heightened coherence, consistency, and congruence of complementary policy elements coupled with a better fit between tools and their context—is a needed step towards the design of more resilient and flexible climate change policies.

[2] Typically, policy goals are considered to be coherent if they logically relate to the same overall policy aims and objectives and can be achieved simultaneously without any significant trade-offs. Policy goals are considered to be incoherent if they contradict the previous goal, thus making the simultaneous achievement of all policy objectives difficult if not impossible. Policy tools are considered to be consistent when they complement each other and work in combination towards meeting a policy goal. Policy tools are considered to be inconsistent when they work at cross-purposes. Congruence determines the match between goals and means (Kern and Howlett 2009).

Conclusion

Even when a policy may be effective in the short term, changes in problem or policy contexts may render it ineffective over time. The likelihood of being faced with trap-like situations is a worrisome aspect of long-term policy-making.

The design of long-term adaptation policies needs to consider the ability of social-ecological systems to effectively prepare for multiple plausible futures and their flexibility, adaptiveness, and capacities to do so. Policy traps can arise due to inability to deal with unexpected change or unknown unknowns which may lead to the crossing of critical thresholds in social-ecological systems. Some of these changes may be non-linear in nature often making it difficult or impossible for policy-makers to respond from historical experience. Traps can also arise due to policy legacies and persistence due to path-dependencies. The general situation set out above is summarized in Table 2.

The bulk of the literature on the subject has urged the creation of 'robust' policies which are able to self-adjust to changes in the environment. Such policies can be contrasted with 'resilient' ones which are more reflexive and able to adjust not only to linear, but to non-linear shifts in their contexts. A major development in resilient studies has been this movement from understanding the world as a steady state to a dynamic one, where new and multiple equilibria are possible, some possibly being preferable under the new conditions. Designing and implementing 'robust' policies, it is argued, may exacerbate lock-in issues surrounding policy legacies, as these are designed to be "fail-safe" within a range of uncertainty and thus not promoting ongoing adaptation and learning which is a feature of resilient policies. While there have been several attempts to measure, quantify, and evaluate resilience, Rogers (2013) argues that standardization of 'best-practices' in resilience studies should be undertaken with caution, as this could create 'rigidity traps' by reducing context-specific flexibility of resilient policies.

Traps can also occur as a result of governance failure, inflexible systems, low capacities for change, and high resistance to change, all of which are affected by political factors as much as technical. Planned adaptation in a world facing increasing impacts of climate change will also require a mix of policy responses that consider a range of options from incremental to 'adaptive' and potentially transformative strategies. When the degree of climate change and/or vulnerability of certain regions, communities, or resource systems becomes high, transformative adaptation or a large change in adaptation response may be required (Kates et al. 2012).

Table 2 Dealing with traps in adaptation policy-making under uncertainty

How to deal with traps	Ways	Benefits	Unaddressed Issues/scope for future research
Avoiding traps in the first place	Foresight tools	Envision the range of likely future conditions and design policies and deliberate likely policy responses	Issue of Political acceptability of future uncertainty, Issue of differing risk-taking attitudes
Designing against traps	Adaptive policy tools	Build flexibility in policy design for a host of anticipated and unanticipated conditions	How are adaptive policies evaluated? How to develop a suitable mix of adaptive policy tools? Issues of stakeholder agreement on adaptive policy designs
Overcoming traps once in them	Patching	Error correction	Challenges in filling gaps in existing policies compared to crafting new ones
	Packaging	Creating synergistic combinations of policy means and ends	How to create a stable policy design?
			How to monitor effectiveness of the new policy designs?

Uncertainty makes it difficult to identify effective adaptation policies and more so, the correct 'policy mix'. Thus, while improving the knowledge/information base is critical to reduce uncertainties and 'avoid traps' in the first place using tools, such as strategic foresight, the role of policy-makers in engaging different stakeholders and introducing policy flexibility is essential to 'design against traps'. Policy mixes can be 'intentionally' designed to be consistent by appropriately 'patching' and packaging these mixes to correct the inconsistencies to 'overcome traps once in them'. In addition, the possibility of complete policy redesign or overhaul should be considered, in case, large-scale systemic transformations are required.

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