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Abstract

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In this essay we highlight issues to consider when reframing conservation objectives and outcomes in the context of global change. We discuss (1) new framings of the links between ecosystems and society; (2) new relationships and roles for conservation science; (3) new models of how conservation links to society and social change and (4) new approaches for implementing adaptation for conservation outcomes. We argue that reframing conservation objectives requires conservation scientists and practitioners to implement approaches that are no longer constrained by discipline and sectoral boundaries, geopolitical polarities, or technical problematisation. We consider that a stronger focus on learning and inclusive co-creation of knowledge, and its interaction with societal values and rules, is likely to result in conservation science and practice that will be able to meet the challenges of a post-normal world.

Keywords: Global change, transformation, adaptive governance, values-rules-knowledge, adaptation pathways, adaptation services, co-production, co-learning

Introduction

Conservation science and practice originated in an era when ecological systems were perceived to be coherent, predictable and which changed gradually. In such 'normal' times, problems were identified as distinctive, discrete entities to be solved using theoretical and analytical foundations in the natural sciences, derived through principles of positivism and deduction. But contemporary times are significantly different; a post-normal world of rapid change is characterised by global complexity, chaos, and contradictions. In these times, 'nothing is definite, truly guaranteed or totally safe', and change is pervasive (Sardar 2010): knowledge is ambivalent, values and interests are contested, stakes are high, the need for decisions is always urgent, and there is a real danger of anthropogenic risks running out of control (Helbing 2013).

Some authors have interpreted 'post-normal' to imply that 'normal' science no longer 'works' because the world itself has changed. The world has always been a complex adaptive system: it is how people interpret it that has changed. Thus, in proposing "science for the post-normal age", Funtowitz & Ravetz (1993) emphasised that disciplinary science applied outside a systems framework has been of little use for defining and solving problems of social-ecological systems. In recognising these systems are dynamic and complex, "the science appropriate to this new condition will be based on the assumptions of unpredictability, incomplete control and a plurality of legitimate perspectives" and "requires an 'extended peer community' consisting of all those with a stake in the dialogue on the issue" (Funtowitz & Ravetz 1993 p. 739).

Climate change and other global drivers are having major impacts on ecosystems and biodiversity, though details of future changes at particular locations and ecosystems are unclear. Conserving ecosystems and biodiversity as they are may be a credible, legitimate objective under conditions of ecological change perceived as stationary or gradual, but not when change is likely to be rapid and widespread (Mori et al. 2013). Had we better understood the consequences of historical change on social-ecological systems, we might be better primed to address current and future change. We live in a world where ecological change is multi-scale (and now very large-scale), unpredictable and irreversible. We are starting to move away from managing biodiversity and ecosystems within a framing of localised, marginal change (Hagerman & Satterfield, 2014). Adaptation of conservation based on incremental changes to current approaches could prove ineffective and a transformative adaptation pproach is likely to be needed (Stafford Smith et al. 2011, Wise et al 2014, Siebentritt et al. 2014, Colloff et al. 2016a). By 'transformative' we mean "fundamental changes in structural, functional, relational and cognitive aspects of socio-technical-ecological systems that lead to new patterns of interactions and outcomes" (Patterson et al. 2016).

Transformation from current conservation objectives to 'global change-ready' conservation will (1) accommodate transformation of ecosystems (e.g. from ephemeral wetlands to permanent drylands), occurring in response to shifts in ecosystem drivers (e.g. water, nutrients, temperature); (2) remain relevant and feasible under a range of possible, uncertain trajectories of ecological change; and (3) be inclusive of the multiple dimensions of biodiversity and ecosystems experienced and valued by society (Dunlop et al. 2013, Heller & Hobbs, 2014). A transformative approach to adapt to climate change has generic value for global change adaptation.

A global change-ready approach involves reframing the purpose and objectives of conservation: whom and what it is for and what it can achieve. The transformative adaptation approach to conservation under major ecological change requires (1) acknowledgement that some ecosystems are undergoing, or will undergo, climate change-induced permanent transformation; (2) transformative shifts in the current decision context for adaptation in order to better respond to changes in ecosystems; (3) adaptive governance to support transformative adaptation. By 'decision context' we mean the circumstances that form the setting of the decision process; including the interconnected systems of values, rules and knowledge that form the ways of viewing and framing that process (Gorddard et al., 2016). By 'adaptive governance' we mean the structures and processes societies exercise for dealing with change and uncertainty in social-ecological systems, that address short-term perturbation and longer term transformation, and integrate knowledge systems and learning into inclusive, decentralised decision-making and action (Wyborn, 2015a).

We consider transformative adaptation differs from adaptive management because it involves fundamental changes to governance for adaptation in order to support continuous improvements in decision making and learning (Abson et al. 2016). Although such improvements are in-principle components of adaptive management (Roux & Foxcroft 2011), intended results are often not achieved because of insufficient monitoring and inadequate stakeholder engagement (Aceves-Bueno et al. 2015). Moreover, while adaptive management and adaptive governance are often cited in discussions of climate adaptation, their durability in the context of transformative change has been questioned (Wyborn et al. 2016). Moving forwards requires shifts in world-views and interests of adaptation decision makers, from 'current' to 'global-change ready', as well as new ways to navigate the messy world of governance and the constraints of power and politics on implementing change.

In this essay, we aim to further discussions on reframing of conservation objectives in the context of global change (e.g. Cole & Yung 2010, Stein et al 2013, Wyborn et al. 2016). Previous authors have scoped what objectives might look like, but less attention has been paid to processes and structures for reframing them. We present a case for a transformative approach to conservation and a framework for linking global change-ready conservation with transformative adaptation, the TARA approach. We argue that setting objectives for global change-ready conservation needs co-production: engagement between decision makers and 'those with a stake in the dialogue' in order to learn and generate effective, legitimate, ethical solutions (van Kerkhoff & Lebel 2015).

New framings of the links between ecosystems and society

Changes in ecosystem structure, function and uses are generating new relationships between people and the environment, as are changes in peoples' expectations, values and perspectives of nature. Calls for change in conservation science and practice are not new (reviewed by Heller & Zavaleta 2009). Authors have stressed the need for an 'extended peer community' to be engaged in collaborative planning (Schultz 2011; Cross et al. 2012) and reframing of conservation in ways that re-evaluate 'naturalness' and societal values associated with it (Hobbs et al. 2009, Cole, 2012). The post-normal perspective does not imply that conservation science and practice were static during what were perceived as 'normal times'. Mace's (2014) typology of changing ideologies on conservation over the last 50 years identifies four approximate eras: 'nature for itself' (pre-1970s), 'nature despite people' (1970s-late 1990s), 'nature for people' (late 1990s-mid 2000s) and 'people and nature' (mid 2000s-present day). The short duration in which these shifts emerged has resulted in the plurality of perspectives represented in current conservation science and practice. Reframing

conservation in the context of global change is thus the next stage in the evolving relationship between people and nature and not some recent trend.

Many studies project wide-scale biodiversity loss under global change (e.g. Dawson et al. 2011, Foden et al. 2013, Urban 2015), but few consider the potential of conservation practices to mitigate impacts. Non-climate drivers of change are likely to be at least equally significant as climate drivers in the short-to-medium term, so regular contingent analysis is a way to ensure the interacting effects of multiple drivers are considered. Conservation strategies that reduce non-climate pressures, facilitate natural processes of species adaptation (Colls et al. 2009), and maintain ecosystem processes are likely to have positive benefits for biodiversity. In a post-normal world of global change, conservation faces unprecedented challenges from the conflict between maintaining ecosystem integrity and the increasing demands placed on natural resources by a rising human population. Climate change imposes additional stressors upon ecosystems that have already been altered in structure and function by land-use change and intensification (Oliver & Morecroft 2014).

Ecosystems and biodiversity face major threats from poorly-understood interactions between climate change and altered land use that leads to regime shifts (Leadley et al. 2014). These interacting stressors are considered rapid, non-linear and transformational (IPCC 2014). Yet impacts on biodiversity, and efforts to address them, are inextricably linked with sustainable development challenges 'to protect human well-being and life-supporting ecosystems simultaneously and in ways that are socially inclusive and equitable' (ISSC & UNESCO 2013).

Conservation science and practice that has global change-ready objectives can be enabled by (1) regarding climate change as an amplifying stressor to non-climatic drivers likely to cause large-scale, non-linear and undesirable change, and (2) by considering the interaction between what people need from nature and what they might realise under future constraints on ecosystems. Standard conservation practices such as habitat restoration and protected areas will remain important, but new approaches are needed given the rate and extent of anthropogenic change (Dunlop et al. 2013; Dickinson et al. 2015). The challenge is to factor plausible scenarios of change into conservation science and practice and shift from maintaining ecosystems in their current state to managing for dynamic responses to multiple drivers of change. Where these drivers cause transitions to alternative ecosystem states, emphasis will be on facilitating transitions, preserving ecosystem functions and services and minimising species losses.

The choice between incremental and transformative adaptation presents a double bind for decision-makers that relates to decision lifetimes (Stafford Smith et al. 2011). Transformative adaptation may be deemed too difficult or unacceptable and so incremental approaches are selected instead. But by the time it becomes clear that incremental adaptation is inadequate to

address severe biophysical change, it may be too late to implement the required transformative approach. This problem is similar to that of 'time inconsistency', whereby a long-term plan is compromised by the incentive of short-term gains (Underdal, 2010). For conservation science and practice, incremental changes to current strategies may prove inadequate and require subsequent transformative approaches in response to major ecosystem change and biodiversity loss.

Resolving this double bind requires the broadening of planning options and decision making to consider not just longer decision lifetimes (Stafford Smith et al. 2011), but also how short-term gains can be reframed as disincentives because they may prove maladaptive by limiting future options. Adaptive, deliberative sequencing of decisions and actions as part of the adaptation pathways approach (Wise et al. 2014) is a means for addressing 'time inconsistency' problems. There is no generalized blueprint here: researchers, practitioners and communities engaged in transformative change have to co-produce decisions and actions relevant to their particular circumstances. Case study examples that practitioners might use to develop guidelines are detailed in the next section.

New models of how conservation links with transformative adaptation

To diversify options for adaptation, changes are needed to decision making and implementation. The TARA approach (Transformative Adaptation Research Alliance: https://research.csiro.au/tara/) can be used by conservation practitioners to position adaptation within co-production and learning processes that help diagnose constraints on decision making, and develop new objectives for conservation under global change. The three elements of the TARA approach (Fig. 1) are as follows:

The vrk perspective enables analysis of how decisions are influenced by the social-cultural circumstances in which they are made. It highlights that a mandated decision-making group (which may be local environmental managers, a network of regional bodies or a national agency) uses specific systems of values, knowledge and rules when defining and selecting options for adaptation. The *vrk* perspective enables analysis of the particular *vrk* systems used by the decision-making group and how these systems shape the decision context for adaptation (Gorddard et al. 2016; Fig. 1a).

The influence of the *vrk* systems used by the decision-making group is rarely explicit, and may place constraints on adaptation options because certain knowledge, rules and values are excluded. For example, current conservation paradigms (e.g. national reserves, threatened species protection, habitat restoration) focus on maintaining or enhancing existing species, habitats and ecosystems, consistent with perceived cultural values of society (e.g. Natural Resource Management Ministerial Council 2010). However, this focus may not be an appropriate values system under climate change and biodiversity decline. Also, a 'maintain and enhance' values system may be embedded in rules

(e.g. threatened species legislation) and knowledge systems (e.g. methods for prioritising objectives) of an established decision-making process and is thus difficult to change.

Gorddard et al. (2016) detailed an 8-step process to change decision contexts for adaptation using the *vrk* perspective, which can be adapted to the needs of practitioners. By changing the decision context, values and conservation objectives may shift as new knowledge on ecosystem change emerges: goals may be unattainable for species or ecosystems likely to undergo irreversible loss; positive societal values may be conferred on immigrant species (Hobbs et al. 2009), modified ecosystem remnants (Colloff et al. 2016b) or novel ecosystems (Collier 2015). Rules, such as conservation laws and practices, would then need to re-align with shifts in values and knowledge.

The adaptation pathways approach is a process for designing and implementing sequenced adaptation decisions based on alternative, uncertain changes over time (Wise et al., 2014). Adaptation pathways planning involves assessing trade-offs between the benefits of preserving flexibilities to respond to future uncertainties against the costs of maintaining 'business as usual'. The *vrk* perspective is used to analyse the decision context and options at each point on the pathway (Fig. 1b). Assessment by decision makers of predicted or actual changes to the social-ecological system determines whether decisions are likely to prove adaptive or maladaptive. For example, a decision to conserve alpine ash (*Eucalyptus delegatensis*) forest in south-eastern Australia by re-seeding after fire may be adaptive in the short-term, but maladaptive in the long-term under more frequent, intense wildfires (Colloff et al. 2016a; Doherty et al. 2016). Resources required for the expanding area of re-seeding may become prohibitive – an opportunity cost of other adaptation options forgone – and there is increasing likelihood that re-seeded areas may be burned again before trees reach maturity.

An adaptation pathways approach involves learning and engagement, considers path-dependency (where past decisions constrain future options), timeframes that decisions remain valid, sequencing of decisions to avoid maladaptation, and shifting societal interests and values (Wise et al. 2014). Three Australian examples of co-creating adaptation pathways are for Eyre Peninsula (Siebentritt et al 2014), Southern Slopes region (Bosomworth et al. 2015) and Murray-Darling Basin (Abel et al 2016; Dunlop et al., 2016). These publications contain guidelines for practitioners on defining objectives, scoping futures, developing and implanting adaptation pathways, \monitoring, evaluating and learning.

Adaptation services are the set of ecosystem services that provide options for people to adapt to environmental change (Lavorel et al. 2015, Colloff et al. 2016a, 2016b). The relationship between ecosystem services needed for future livelihoods and wellbeing and what changing ecosystems can supply determines the adaptation challenge. Biophysical change then becomes a cue for discussions

on adaptation options, the future supply of adaptation services, and the reframing of governance arrangements on their use (Gómez-Baggethun et al. 2013, Collier 2015). The balance of social demands and ecological limits can then form a basis for exploring future options, including trade-offs among ecosystem services (Howe et al 2014). With the TARA approach, identifying and explicitly managing adaptation services is central to reframing of values, rules and knowledge systems that underpin conservation and ecosystem management because adaptation services provide future options for adaptation. These options can be realised by managing for services from those ecosystems that are likely to persist in the future, as well as by using new ecosystem services from those ecosystems that transform. As such, the concept of adaptation services is critical for designing adaptation pathways that incorporate social benefits derived from ecosystems. The identification of adaptation services represents new knowledge, but realising the benefits requires shifts in values and rules, as well as trade-offs between distribution of costs and benefits over the long and short term, involving deep engagement with the politics of adaptation (Wyborn et al. 2016).

Lavorel et al (2015) described a 4-step process for incorporating adaptation services into adaptation pathways planning, based on (1) characterising current ecosystems drivers and ecosystem services; (2) predicting effects of climate change on ecosystems and services; (3) identifying adaptation services related to ecosystem persistence or transformation and (4) scoping management options for adaptation services.

New relationships for conservation science and governance

Conservation agencies have begun to recognise the need for conservation science, policy and practice to be co-produced (Schuttenberg & Guth 2015, Wyborn 2015a, 2015b). This new approach involves reconsideration of major science questions in order to shift knowledge generation away from a 'knowledge deficit model' whereby "a linear, unidirectional flow of knowledge from experts to users" is assumed (Young et al 2014, Fernández, 2016). Co-production of knowledge between researchers, practitioners and citizens then "supports collective action and reflection directed towards improving the management of human and environmental interrelations": the social learning approach (Keen et al. 2005). Social learning provides an ethical basis for supporting new forms of learning required for adaptation (Collins & Ison 2009; ISSC & UNESCO 2013). Integrating co-production with 'nature-based solutions' (the use of natural design, ecosystems and their processes for improving human well-being; Potschin et al. 2016) is becoming a priority issue under climate change, for example via ecosystem-based adaptation (Vignola et al. 2009).

Co-production processes can be applied to diverse and difficult contexts. One example is the WWF REDD+ participatory scenarios of land cover changes in Tanzania (Capitani 2015). Implementing forest conservation for carbon stocks, and creating monetary value for them, provided incentives to reduce emissions from forested land and invest in low-carbon pathways for sustainability and poverty alleviation. In another example, collaboration between WWF Colombia and the Luc Hoffmann Institute is building capacity of protected area managers to conceptualise transformational change and incorporate responses into management frameworks (Wyborn et al. 2016). This effort includes a learning framework on how co-production processes can shift understanding, behaviours and capacities of all project partners; scientists and practitioners alike.

Focusing on the social, political and cultural dynamics of the decision context using the *vrk* perspective can highlight opportunities and constraints for co-production. This can enable targeted activities that build on existing strengths, such as strong relationships between researchers and decision-makers; or alert research project designers to social-political power dynamics that may affect the scale at which research can make the greatest contribution (van Kerkhoff & Lebel 2015). For example, Wyborn (2015) showed how histories of trust between conservation agencies and landowners strongly shape the possibilities for co-production. The dialogue critical to co-production can identify where capacity development is most useful to support collaboration between practitioners and researchers in ways that reframe power relations so that activities are not dominated by scientists (who may tend to assume control), but who are instead important but equal participants (van Kerkhoff & Lebel 2015).

However difficult and time-consuming, co-production is happening; tacit knowledge held by stakeholders engaged in adaptation is increasingly being recognised, conferring legitimacy to scientific processes (Fernández 2016). Co-production is not straightforward, in part because it is caught in a bind between the driver of urgency (i.e. the need to facilitate stronger relationships between researchers and practitioners to speed up action and change), and the driver of deliberation (i.e. the need for such collaborations to learn and evolve, where such learning takes time). Both drivers serve to emphasise the need for skills and opportunities that can drive stronger engagement between science and governance (Diaz et al. 2015, van Kerkhoff & Lebel 2015).

New processes for implementing adaptation for conservation

A rapidly changing world requires of us greater emphasis on understanding and implementing the practice of intentional responses to change. Research on conservation and adaptation has rarely addressed how capacities for change can be realised. Knowledge that is abstract or 'teachable' tends

to dominate, rather than practical knowledge for implementing adaptation. Practical knowledge is typically developed experientially, is implicit and thus quite different from research-based knowledge (Boiral 2002, Fazey et al. 2005). We argue that scientific research needs to be complimented by experiential knowledge to implement transformative adaptation for conservation.

Intentional change includes learning from deliberative practices used to develop new strategies, shift world views, work with conflict, consider ethics, power and inter-generational equity in decisions and build consciousness and creativity that empowers agents to act (Frame et al. 2008). An example is the 'Three Horizons' practice, used to facilitate dialogue on moving from what is known to new ways of thinking and acting in the future (Fig. 2). This practice could be used as a means of implementing the TARA approach, whereby Horizon 1 represents current modes of conservation, including norms, framings, practices and how things are done. Horizon 3 represents new patterns and ways of operating, while Horizon 2 represents the intermediate steps that facilitate emergence of new ways of operating. The Three Horizons practice involves working with groups to help shape transitions towards transformation and can be used in situations of high contestability and diverse world views and values by empowering participants to plan for change (Sharpe et al. 2016).

Deliberative methods are emerging in conservation to facilitate dialogue between researchers and decision-makers, build capacity and support learning (Zachrisson 2010, Lundmark & Matti 2015). Certain practices may be more powerful than others in creating conditions for change, depending on context, end uses and users (Newell 2012). Some processes are complex, involving sophisticated modelling, which can inhibit transparency and exclude certain forms of knowledge. The notion of a 'powerful' practice thus emphasises the need to deal with complex issues in ways that are appropriate to the skills, knowledge and tools available to the users, and that simple approaches may generate greater agency than complex ones. The concept of 'requisite simplicity' applies here (Stirzaker et al 2010), whereby some detail can be discarded, but conceptual clarity and scientific rigor are retained in order to shift to a position where the users can benefit from new knowledge.

Concluding remarks

In this essay we bring together adaptive management, adaptation pathways, values, rules and knowledge (*vrk*), adaptation services, co-production and powerful practices for change. These concepts are related via a temporal perspective and their value as a basis to build adaptation for conservation (Fig. 2). Some help to understand how past changes and adaptations have shaped the present (adaptive management, co-production and *vrk* in part); others shape contexts into the future (*vrk* in part, adaptation pathways and services and powerful practices for change). An

understanding of how present adaptation decision contexts have emerged informs what needs to change in the future, contrasting where we have come from and where we need to get to.

Adapting to global change requires new ways of learning and thinking. We have not had to address such pressing challenges before and are yet to realise what these new ways might be. The *vrk* perspective provides a bridge between where we are and where we need to get to (Fig. 2a). Ways forward can emerge from deliberative processes based on interactions of evolving knowledge, rules and values. Thus, new knowledge would focus on the nature and extent of global change and ways for conservation science and practice to adapt. Emerging values would reflect preferences for different conservation outcomes based on evolving interests and world-views. Changes in rules would involve new governance arrangements, consistent with new knowledge and values, that can enable and facilitate agreed preferences for conservation outcomes.

Contestation is inevitable among stakeholders because of uncertainties about biophysical change and resistance to the need for transformative adaptation. Such conflicts cannot be reconciled with a set of guidelines. Rather, we have provided pointers to transformative approaches to conservation based on co-production and deliberative practices. The emphasis is on experimentation, learning and discovery. Abel et al. (2016) detailed processes for transformative adaptation that could be "inserted into stakeholders' long-held and strongly established environmental discourses, each one representing the continuing values, understanding, and aspirations of a particular group. The processes are intended to develop and expand debates and negotiations among those groups and lead toward transformations."

We may not yet know how to learn and adapt to global change. But we can start by deliberating on likely consequences of various adaptation approaches, avoiding maladaptation and identifying future options via the *vrk* perspective, adaptation pathways and services. While we cannot avoid trade-offs, we are more likely to be successful when adaptation is framed as a social learning challenge than as an attempt to resolve contestation. For conservation science to remain relevant to the rapidly-changing nature of conservation practice will require reflexive approaches to research. The eight knowledge gaps for conservation identified by Velasco et al. (2015) all focus on 'people and nature' and involve transdisciplinary research collaboration, inclusion of indigenous and local ecological knowledge and engagement in knowledge co-production. Similar calls have been made for more reflexive approaches to climate adaptation research (Fazey et al. 2010, Preston et al. 2015).

By re-framing adaptation to change in social-ecological systems from reformist to transformative approaches (Bassett & Fogelman 2013), we can move towards conservation science and practice that is no longer constrained by discipline and sectoral boundaries, geopolitical polarity, or is haunted by the ghost of technical problematisation whereby every issue is a dilemma to be solved

using specialist scientific or technical content knowledge (Funtowicz & Ravetz 1993). Science that can exorcise the spectre of technical specialisation will be based on ethical virtues of humility and multiple accountabilities (Jasanoff 2003). Processes of co-production involves reframing the relationship between science and society as one of co-evolution and deliberate engagement with the normative elements that shape decisions about what we do and how we act in the world (Jasanoff 2004). In post-normal times, we need accountability and responsibility for the production and use of scientific knowledge. We need humility to acknowledge the limits of our understanding and our capacity for prediction, control and management of the environment (Clark et al. 2016).

To be effective and relevant into the future, conservation science and practice needs to change. This does not mean that scientists and practitioners all need to become experts in integration and transdisciplinarity. Rather, they may benefit from engaging with new and changing environmental, political and social circumstances in which they operate in order for their research to find effective application. The map they may choose to follow is still being drawn, and will be subject to continual revision. Processes that bring together and value diverse knowledge and perspectives of conservation biologists, social scientists, integration scientists, communities, policy makers and practitioners may enable the conservation community to collectively figure out the pathway.

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Legends to Figures

Figure 1. The linkages between (a) the values, knowledge rules concept (*vrk*) and (b) an adaptation pathway, incorporating the use and future option value of adaptation services.

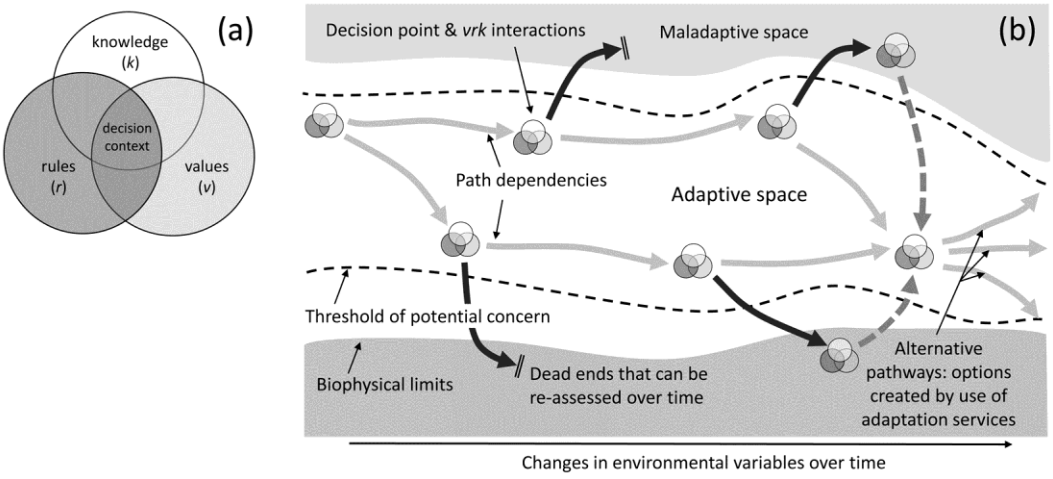

Figure 2. Two representations of the relationships between the concepts and tools for conservation and adaptation outlined in this essay: (a) 'Three Horizons' framing: Horizon 1 represents what is happening with conservation now; Horizon 3 represents successful conservation in the future and Horizon 2 is what needs to change in order to get there; (b) according to application either as conceptual framings or as tools for a basis for implementation, as well as their use in understanding how the past has shaped present adaptation decision contexts or how adaptation decision contexts can be shaped in the future. Positions on the quadrat indicate how concepts and tool are intended to be applied and are used currently. Over time, positions may change and some concepts and tools merge.