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A New Heuristic for Climate Adaptation

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Abstract

An influential heuristic for thinking about climate adaptation asserts that "natural" adaptation strategies are the best ones. This heuristic has been roundly criticized but is difficult to dislodge in the absence of an alternative. We introduce a new heuristic that assesses adaptation strategies by looking at their *maturity*, *power*, and *commitment*. Maturity is the extent to which we understand an adaptation strategy's effects. Power is the size of the effect an adaptation strategy will have. Commitment is the degree to which an adaptation strategy is difficult to test or reverse.

1. Introduction

For any given climate change impact—sea level rise, heat waves, drought, flooding, a growing burden of disease—there are many ways to try to adapt to it. A coastal community facing an encroaching ocean can, for example, build sea walls, restore wetlands, install offshore breakwaters, relocate away from flood zones, create sand dunes, plant aquatic vegetation, elevate roads and buildings, or redirect floodwaters.

But how does the community choose among these many options? It would be impossible—or at least extremely inefficient—to produce a comprehensive cost-benefit analysis for every possible strategy. Instead, the community can use heuristics, or reasoning shortcuts, to efficiently separate the wheat from the chaff—to separate the viable options from the unviable ones. Unfortunately, one of the most influential heuristics for thinking about climate adaptation asserts that "natural" adaptation strategies are usually the best ones. This heuristic has been roundly (and correctly) criticized, but useful alternatives are hard to come by.

In this article, we develop a new heuristic for separating the viable strategies from the unviable ones. Viability, as we understand it, is a precondition for overall effectiveness. Viable adaptation strategies are those that clear a certain threshold. They can then be evaluated in terms of further considerations such as cost-effectiveness and political feasibility. Our heuristic determines whether an adaptation strategy clears the threshold for viability by looking at its *maturity*, *power*, and *commitment*. Maturity is the extent to which we understand an adaptation strategy's effects and are ready to deploy it. Power is how much of an effect an adaptation strategy will have on the problems it is intended to solve. Commitment is the degree to which an adaptation strategy is difficult to test before implementation, or difficult to reverse once implemented. On our view, viability is a matter of where an adaptation strategy falls on these three dimensions, and thinking of viability in this way is a considerable improvement over the natural-is-best approach currently dominant in policy discourse.

2. Green versus gray adaptation strategies

Analyses of different climate adaptation strategies commonly classify them as either "green," meaning they are nature-based, or "gray," meaning they involve conventional or nonnatural engineering. Restoring wetlands is an example of green adaptation, while concrete seawalls are a classic case of gray adaptation. This distinction is intended to highlight the fact that "in contrast with many engineered solutions," nature-based solutions can support multiple adaptation goals at once, while also being cost-effective (Seddon et al. 2020, 2). The idea of nature-based solutions has become very popular very quickly. Since 2008, when a World Bank report became the first publication to focus on the concept, both governments and the private sector have taken the framework on board. They have pledged large amounts of money for green strategies like tree-planting initiatives and made nature-based solutions "a major pillar" of policy proposals and strategic agendas (Seddon et al. 2021, 1521–22).

But, as researchers have already noticed, there are problems with this green versus gray classification.[1] Not only is there ambiguity about what counts as nature based (Sowínska-Świerkosz and García 2022), labeling adaptation strategies as either green or gray feeds into a more general bias against what people perceive as technological and in favor of what they perceive as natural. This latter problem is especially important. Nature bias, or the idea that "natural is better," is pervasive (Meier et al. 2019). It is also wrong. There is already a large literature elaborating on this point, so we will not rehash it here.[2] Instead, we take it as our starting place.

Due to nature bias, there is a real risk that labeling adaptation strategies as gray or green creates a presumption against the former and in favor of the latter (Hansen 2006). But the available evidence does not support the claim that green adaptation is generally better than gray adaptation. We know that many gray adaptation strategies, such as sea walls, are highly effective in many cases (Tomlinson and Jackson 2019). But in other situations, gray strategies like flood insurance and infrastructure improvements can be maladaptive (Magnan et al. 2016). The effectiveness of nature-

[1] There are a number of problems that we do not take up in this article. For example, the worry that nature-based solutions are too easily co-opted to maintain the status quo (see Melanidis and Hagerman 2022), or that specific initiatives like tree planting are likely to involve the unjust appropriation of land (Seddon et al. 2021).

[2] The "threshold problem" here is defining the concept of nature in the first place (Kaebnick 2014). It's a difficult problem because any successful account has to somehow set up the natural in contrast with human, while recognizing the important sense in which humans are part of nature. There are a range of sophisticated responses to this problem, but none support a simple, general "natural is better" heuristic.

based solutions also appears to vary, though the current evidential picture is still very patchy (Chausson et al. 2020). What we do not have support for is the idea that the green/gray distinction is a good proxy for viability, or overall effectiveness. Yet the distinction has taken on this role, and therefore underwrites an unjustified prejudice against certain promising adaptation policies while encouraging uncritical acceptance of others (Osaka et al. 2021). It also unnecessarily pits green and gray solutions against one another, when in fact both are crucial for effective adaptation (Seddon et al. 2020).

The green/gray distinction, then, is a powerful heuristic, but not a good one. The literature on climate adaptation has begun to recognize this. Recent papers are very focused on tinkering with the definitions and framing of nature-based solutions, but not on addressing the basic issue, which is that the green/gray distinction is not a reliable indicator of viability or effectiveness. If we want a heuristic that is, we need to look elsewhere.

3. The viability heuristic

Our proposal avoids the problems of the green/gray distinction. It captures the core considerations that determine viability while still being flexible and context sensitive. We begin by acknowledging that many considerations must factor into evaluating adaptation strategies, including ethical and political constraints, cost, practical considerations regarding implementation, potential trade-offs and synergies among different strategies, and even aesthetic considerations (e.g., Adger et al. 2009; Chu and Cannon 2021). These considerations are crucial in decision-making contexts, but here we set them aside to focus on what we have called viability: The quality of a particular intervention or policy such that it can be considered a candidate adaptation strategy in the first place. This sets our proposal apart from other, nonheuristic frameworks for assessing adaptations, which include as many as twelve separate criteria (e.g., Magnan 2014).

Although viability is just one piece of a larger puzzle when it comes to decision making about adaptation strategies, it is a helpful starting point because it is upstream of other considerations. Cost, political constraints, trade-offs, and so forth are not less important, but they come into play after an adaptation strategy has cleared the threshold for viability. One role for a viability heuristic is thus to contribute to deliberations about climate adaptation by separating the viable strategies from the unviable ones. As will become clear, the viability heuristic is also a good way to identify unknowns and uncertainties, as well as facilitate productive disagreement and discussion.

A successful heuristic is one that helps us solve reasoning problems to a degree that is sufficient for our practical purposes (Karlan 2021). In this case, the reasoning problem is how to evaluate and choose adaptation strategies. Unlike many reasoning problems, this one has an interpersonal character. We are not just trying to identify the best adaptation strategies individually; we are also trying to deliberate with others who may not share our assumptions. In the following text, we develop the viability heuristic and show how it meets this condition for success. We start by examining the three dimensions of viability in more detail. Then we introduce a visualization and discuss how to assess adaptation strategies in terms of the three dimensions of viability.

3.1. Dimensions of viability

Together, the three dimensions of maturity, power, and commitment form the basis of a good viability heuristic. Descriptively, they capture what policymakers and the public care about. For example, the scholarship on adaptation frequently cites reversibility (i.e., low commitment) as a reason to favor certain adaptation strategies (e.g., Hallegatte 2009). Opinion polling and research surveys often find that the public prioritizes maturity and is suspicious about novel strategies (e.g., Peterson St. Laurent et al. 2018). Capturing these intuitions matters, because to succeed, the heuristic needs to reflect the concerns and priorities of those who might use it.

Beyond their descriptive accuracy, these three dimensions also hang together conceptually. All else equal, high maturity, high power, and low commitment are all features we would like an adaptation strategy to have. But we may be willing to sacrifice any of these features, at least to some extent, provided that the other two are present. To see this, we'll discuss each one in turn, beginning with maturity.

Recall that maturity is the extent to which we understand an adaptation strategy's effects and are ready to deploy it. Maturity also captures how much a strategy has been tested under varying conditions and in different contexts. When assessing maturity, we ask: Could this intervention be implemented tomorrow, or is further research required? Maturity clearly contributes to viability. This is easiest to appreciate by considering a fairly immature strategy, like gene drive technology. Immaturity is one of the major reasons that many people are hesitant about using gene drive to eliminate malaria-carrying mosquitos (Schairer et al. 2022). But while maturity contributes to viability, it is neither necessary nor sufficient for it. An immature adaptation strategy that is easily reversed (not committing) may still be viable because the costs of it going wrong are low. However, a very mature strategy that doesn't accomplish much (is not powerful) may not be viable at all.[3]

Similar considerations apply for power, that is, the magnitude of the effect an adaptation strategy will have on the problems it is deployed to solve. When assessing power, we ask: What can this strategy achieve? Like maturity, power contributes to viability, without being a necessary or sufficient condition. We generally prefer more powerful adaptation strategies to less powerful ones. If concrete seawalls are better than mangrove seawalls at absorbing energy from powerful waves during storms, this is a reason to prefer concrete seawalls. In fact, the more powerful the strategy, the more we might be willing to accept lower levels of maturity or higher levels of commitment. Less powerful strategies can still be viable too, but then there is less margin for immaturity or higher levels of commitment.

The final dimension of viability is commitment, the degree to which an adaptation strategy is difficult to test before implementation, or difficult to reverse once implemented. We also include in our notion of commitment the temporal and spatial

[3] One common worry about adaptation strategies is whether they will have unintended negative consequences. In our framework, worries about unintended consequences are jointly captured by maturity and power. Mature strategies are ones for which the potential negative consequences are largely known. If we are quite uncertain whether an adaptation strategy will have negative consequences, it will score lower on maturity. Known negative consequences, however, are factored into an adaptation's power score. How to deal with uncertainty in assessing maturity, power, and commitment is a separate issue, which we address in Section 3.3.

scale required for implementation. Adaptations that take a long time to work are committing, as are adaptations that cover or affect large areas. The question to ask when assessing commitment is: How locked into this intervention will we be? Low commitment is a good thing. Adaptations become more attractive to the extent that they are easy to test drive or reverse (Hallegatte 2009). As we've already discussed, however, commitment can be more or less important depending on how it interacts with power and maturity. Once again, we have a feature of adaptation strategies that contributes to viability, without being required for it or guaranteeing it.

The picture we are painting is one in which there are multiple paths to viability. Different combinations of maturity, power, and commitment can produce it. Put differently, the ideal adaptation strategy is one that is mature, powerful, and not committing. But adaptation strategies can still be viable while falling short of this ideal.

A fair question at this point is whether it is possible to determine maturity, power, or commitment in the abstract. We don't think that it is. Instead, our view is that assessments of where adaptation strategies fall on these dimensions should be made relative to particular goals and particular scales. A policy maker responsible for a coastal town might have in mind a general goal such as "adapt the shoreline for a changing climate," or a more specific goal like "keep out flooding." The degree to which a potential strategy will be considered powerful will change depending on the operative goal. A sea wall that keeps out all flooding, but that has no other cobenefits that could serve to make the shoreline more resilient to climate change in other ways may score higher on the power dimension for the more specific goal, but lower for the more general one. Where a strategy falls on these dimensions is also affected by the scale at which it is being evaluated. An analysis of the viability of a sea wall, considered generically in light of a general goal of adapting shorelines around the world, will be different from one that focuses on a particular shoreline with particular features. The flexibility of the viability heuristic thus threads the needle between retaining some level of generality while also being deeply context specific.

3.2. Visualizing viability

How exactly do assessments of maturity, power, and commitment produce overall viability judgments? To answer this question, we represent the viability heuristic visually, using a 3D matrix (Figure 1).[4]

The most ideal strategies, those that are powerful, mature, and require low commitment, are located in the upper, front, right-hand corner (viable 1, 1, 0).[5] But for many people, strategies that fall into the upper, front, left-hand corner are also viable (viable 1, 0, 0) because, although such strategies are still immature, they are potentially very powerful and require little commitment, meaning that a small-scale

[4] This is an adaptation of the same visualization strategy Godfrey-Smith (2009) uses to represent three dimensions of a Darwinian space.

[5] Again, what it means for a strategy to be maximally powerful, mature, or committing will be relative to particular contexts, goals, and scales. Defining the maximum and minimum values for these dimensions is an essential part of the deliberative process. Too often, we suspect these judgments are made in the background, perhaps even subconsciously. The viability heuristic allows them to be made explicit.

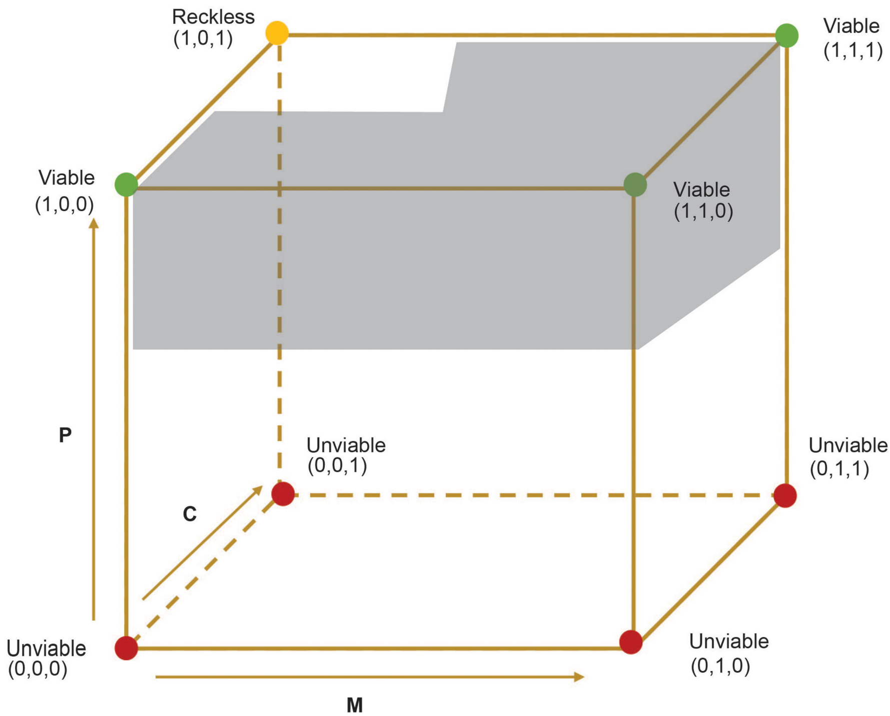

Figure 1. Spatial representation of the dimensions of viability: maturity (M), power (P), and commitment (C). Shaded area is one determination of the space of viable adaptation strategies.

implementation could be quickly shut down if found to have adverse effects. Likewise for the upper, back, right-hand corner (viable 1, 1, 1) because such strategies, while requiring high commitment, are mature enough that a full-scale implementation should carry with it few risks. The "reckless" coordinate (1, 0, 1) represents those strategies that are extremely powerful, but that have low maturity and high commitment. There can be reasonable debate about the viability of these strategies, which will depend in large part upon one's goals and perhaps the direness of the situation for which an intervention is required. Interventions which have no power, and therefore no capacity to address climate impacts, are located at the bottom of the cube and are considered unviable. Most strategies will fall somewhere in between these extremes.

This 3D matrix constrains, but does not fully settle, the actual space of viable strategies. We leave it to particular deliberators in particular contexts to define an area of viability space within the matrix. For some people, strategies we have labeled reckless might be viable. For others, not. In some contexts, policy makers might only consider viable those strategies which have very high power. In others, medium to low power strategies may make the cut. Very often, people will disagree about how to define the viability space. One advantage of the viability heuristic is that it is easy to make these disagreements explicit. Figure 1 shows one of many possible ways to define the viability space. Figure 2 depicts two different ways of defining the viability space for the same context and goals.

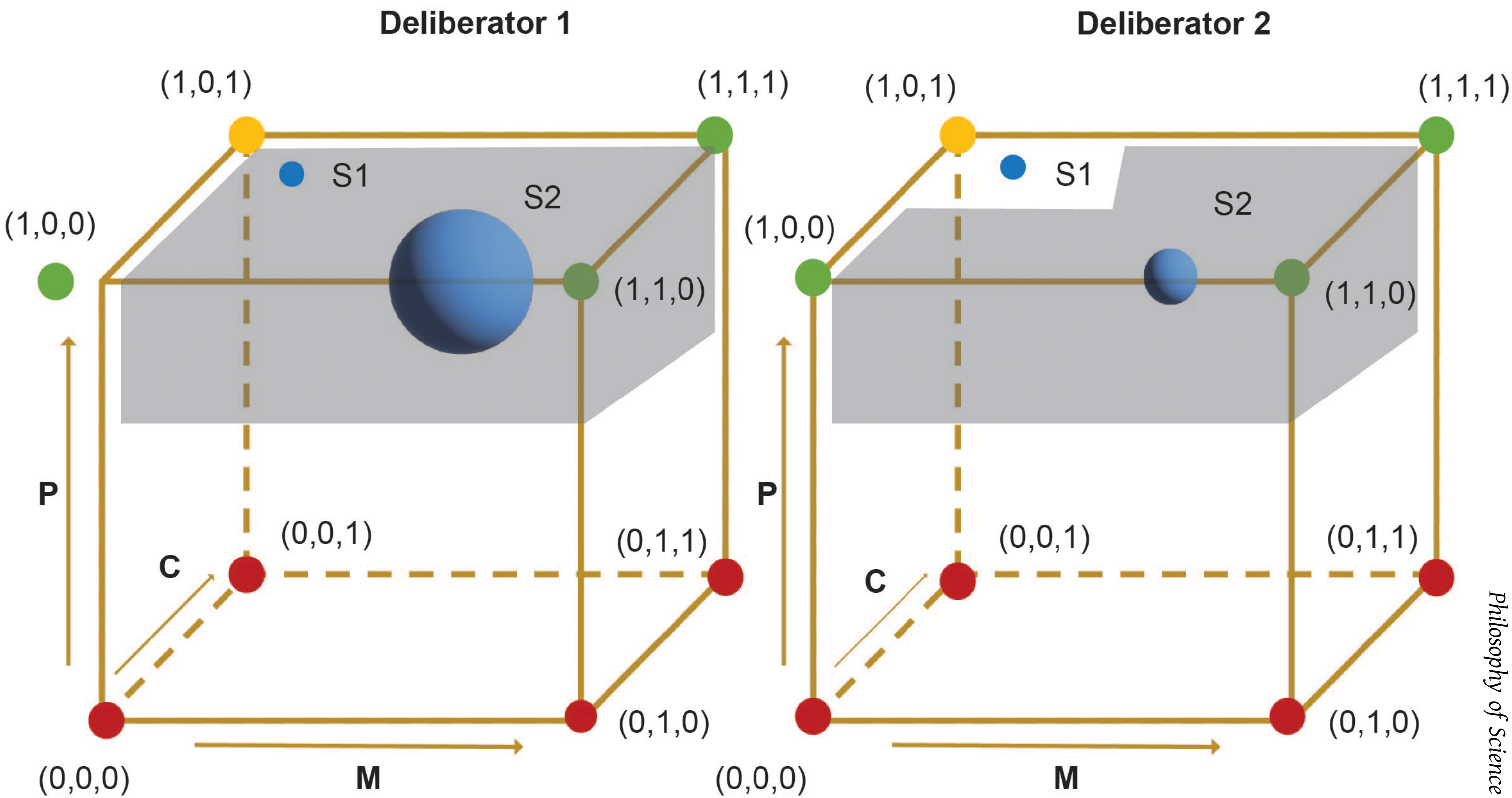

Figure 2. Comparison of two different viability spaces and assessments of particular adaptation strategies. Deliberator 1 and Deliberator 2 have different viability spaces. For Deliberator 1, both Strategy 1 and Strategy 2 are viable. They are uncertain about Strategy 2 and not about Strategy 1. For Deliberator 2, only Strategy 2 is viable. They are less uncertain about Strategy 2 than Deliberator 1 is.

Once a viability space is defined, deliberators can plot particular adaptation strategies within the matrix to see if they fall within the viability space (see Figure 2). Assessments of power, maturity, and commitment are scalar, but they yield a categorical judgment: An adaptation strategy is either viable or not. We still retain the idea of an ideal adaptation strategy, and our approach does not preclude labeling some strategies as "borderline," or marginally viable. But the viability heuristic does preclude a full rank ordering of adaptation strategies from most to least viable. That's because, for example, two adaptation strategies that have the same power score but inverted maturity and commitment scores count as equally viable.[6] (For a very similar analysis of a different concept, see Justus's [2021, 65–73] account of ecological stability.)

3.3 Plotting adaptation strategies

The viability heuristic is a tool for (a) defining viability space and (b) plotting adaptation strategies within that space to determine if they are viable. We now turn to the latter purpose: gauging how mature, powerful, and committing particular adaptation strategies are. There are two related issues here: measuring adaptation strategies and representing uncertainty.

Very often, we expect that judgments of maturity, power, and commitment will have to be qualitative. And, very often, qualitative judgments can be sufficient for deliberative and heuristic purposes. So, a simple high/medium/low classification (or a classification on a 5-point scale) made on the basis of the available evidence may be the most common and realistic way of assessing an adaptation strategy's maturity, power, or commitment.[7] More precise or sophisticated measures may also be possible, or preferable, depending on the context. The viability heuristic is neutral among different measures; the relevant standard is adequacy for purpose (Parker 2020).

No matter what measures we use, in many cases there will still be uncertainty around an adaptation strategy's viability score. When deliberators *aren't* uncertain about how powerful, mature, and committing an adaptation strategy is, they can plot the strategy as a single point in the 3D matrix. When they *are* uncertain, rather than plotting the strategy as a point, they can plot it as a 3D shape that extends in space according to whichever dimension(s) they are uncertain about. Of course, different people may disagree about how much uncertainty there is in a given case. In Figure 2, we show how two different deliberators who disagree about the amount of uncertainty locate the same two adaptation strategies within their respective viability spaces. The contrast here is between cases with no uncertainty with cases of

[6] Our visualization of the dimensions of viability suggests that maturity, power, and commitment are all equally important in assessing viability. But this feature of the heuristic is flexible: In contexts in which some dimensions of viability are considered more important than others, one can, for example, adjust the lengths of the relevant axes. But in such a case, there will still be viability "ties," and a full rank ordering of adaptation strategies will still be impossible.

[7] For these sorts of qualitative measures, an important step toward putting the viability heuristic into action is to develop a classificatory rubric for each of the three dimensions of viability, but that is beyond the scope of this article.

equal uncertainty about all three dimensions of viability. But it would be just as easy to represent uncertainty about only one or two dimensions, or unequal amounts of uncertainty about all three.

4. Concrete versus mangrove seawalls

We close with a very brief example that illustrates the advantages of the viability heuristic over the green/gray heuristic. One of the big questions in the discussion about nature-based solutions is whether mangrove seawalls are as (or more) effective than concrete seawalls as a climate adaptation solution. The green/gray heuristic says that they are, but the available evidence is not sufficient to support this claim (Chausson et al. 2020; Morris et al. 2018). Worse, it is widely acknowledged that hybrid coast defenses—that is, those that incorporate gray and green elements—are probably the best of all options. Thus, this is a case in which the green/gray heuristic gets it wrong.

The viability heuristic gives a clearer and more accurate picture of the situation. Both strategies are quite mature, but concrete seawalls are better studied, giving them an edge over mangrove seawalls. How powerful the two strategies are depend to an extent on one's goals: Mangrove seawalls do better when a wider set of ecosystem services are taken into account (Khazai et al. 2007). Given the differences in available evidence across the two strategies, there is a greater degree of uncertainty regarding the power dimension of mangrove seawalls and less uncertainty for concrete seawalls. Finally, both concrete and mangrove seawalls are low commitment. We can test both on small scales, and we can replace them when they fail. For these reasons, we think both kinds of seawalls are uncontroversial candidates for viability.

This example illustrates how the viability heuristic is useful even in cases where the strategies under consideration all come out as viable. First, how one decides on the goals matters. Without making the goals explicit, it can be easy to arrive at very different assessments of viability without understanding why. By building in a stage where deliberators identify and agree on adaptation goals, the viability heuristic prevents miscommunication. Second, the viability heuristic is a helpful way of diagnosing how and why strategies differ in ways that affect where they fall in the viability space. One lesson from the seawall case is that mangrove seawalls may be at a disadvantage relative to concrete seawalls when it comes to judgments of power and maturity simply because we haven't been studying them as an adaptation strategy for as long. But this may change in the future, and the analysis here highlights the importance of addressing this knowledge gap. It also shows that less evidence/more uncertainty need not translate into a judgment of unviability.

5. Conclusion

Although it is useful to rely on a heuristic when making complicated decisions, the naturalness (green/gray) framing is not adequate for decision making about climate adaptation. Our alternative heuristic, the viability heuristic, can help individuals and groups of researchers, policymakers, and the general public think more clearly about the merits of different climate adaptation strategies. Not only is it a tool for efficiently separating viable strategies from unviable ones but it is also a tool for uncovering hidden assumptions, resolving disagreements, and identifying important next steps in the research process.

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