IMPROVING THE USE OF UNCERTAIN CLIMATE INFORMATION IN DECISION-MAKING: A BEHAVIORAL PSYCHOLOGY APPROACH
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EXECUTIVE SUMMARY

OVERVIEW

Climate change information is presented with a range of uncertainty about the extent of potential risks and the impacts of those risks that can be overwhelming to nonscientists. This is often an acknowledged barrier to the uptake and use of climate information to inform decisions, raising questions about people’s perception and planning in an environment of uncertainty, risk, and gaps in knowledge. This study applied principles from behavioral psychology to explore decision-making with uncertain climate information to explore the utility of these principles for influencing decision-makers to use uncertain climate information.

BACKGROUND

A review of the behavioral psychology literature identified three principles that are relevant to decision-making under the uncertainties of climate information—experiential information, the message-framing effect, and delay and probability discounting:

- **Information needs to target the experiential system.** The human brain relies on two processing systems to guide decision-making, the experiential and the analytical. Experiential thinking is more prevalent than analytical thinking. However, climate change information is generally communicated and presented in abstract and analytical language, especially to decision-makers. Some of the many ways in which information could be shaped to appeal to the experiential processing system include scenarios; translations of information into images, emoticons or stories; and tailoring to the emotional context of the audience.

- **Message framing can help to elicit action.** A number of studies argue that a solution to the possible inaction that results from communicating the uncertainties of climate change information may lie in the framing of uncertain messages. For example, framing a climate change message as either a loss or a gain may result in different levels of action on the message.

- **Willingness to take action is driven by the immediacy of the benefit or loss, no matter how small.** Because climate change information presents a long-term uncertain risk as opposed to a present risk, action is influenced accordingly. Behavioral psychology describes this as delay and probability discounting. In decision theory, discounting refers to how much the value of a reward (or punishment) is decreased when its occurrence is either delayed or uncertain. People generally prefer a small reward sooner over a large reward later, and it is generally assumed that this relates to the subjective value of a delayed reward being discounted, while an immediate reward is not. Responses to probabilistic rewards have been found to elicit similar effects, in that individuals would prefer a smaller certain reward over a larger probabilistic reward.
STUDY APPROACH

A practitioner workshop and a widely distributed survey garnered insights into people taking action under uncertainty. The workshop and surveys also tested the influence of different communication techniques on people’s propensity to act.

For experiential communication formats, the study explored climate risk narratives and infographics. Climate risk narratives are a set of text-based stories, each presenting a possible future, and the set spanning the range of uncertainty. These risk narratives were also presented as infographics, a visual representation with minimal text. The narratives and infographics were both investigated and compared in a workshop that was held with health sector specialists in Mozambique on 21 June 2017.

To test the effect of message framing, and due to the requirements for a large sample, online surveys were developed and distributed widely through sector-specific mailing list networks. This was undertaken in two phases: the phase 1 survey for the health sector garnered a total of 119 responses, though some of these were incomplete (leaving 102 for full analysis); phase 2 included two surveys, one for the health sector and one for the water, sanitation, and hygiene (WASH) sector, garnering 90 responses from the health sector and 58 responses from the WASH sector. Unlike the phase 1 survey, the phase 2 surveys included a sector-specific scenario for both a seasonal timescale (short term) and climate change timescale (long term). The inclusion of the climate change scenario allowed for investigation of the effect of delay discounting on decision-making.

KEY FINDINGS

EXPERIENTIAL COMMUNICATION FORMATS

In the workshop, practitioners generally preferred the infographic, with its clarity and ease of interpretation, to the more detailed climate risk narrative. They generally agreed, however, that the two are complementary and required for different purposes.

More importantly, people place a heavy emphasis on changing impacts as opposed to changing climate variables such as rainfall and temperature, which calls for more information on detailed impacts or solutions. Also, there was generally very little engagement on the influence of uncertainty on decisions. In fact, only when prompted by the facilitators did the group discuss uncertainties.

MESSAGE FRAMING AND DISCOUNTING EXPERIMENTS

The widely distributed surveys allowed for insight into the effect of message framing and delay discounting on action. With the goal of examining whether and how the framing of gain vs. loss influences policymakers and practitioners under uncertainty, the survey data revealed no statistically significant difference in action across the gain-and-loss framings. However, all experiments demonstrated that participants had a marked bias toward taking action, irrespective of the climate probability or framing assigned to the scenario.
To better understand these findings, the responses were analyzed qualitatively:

- Respondents made decisions using fairly simple *guiding principles, rules, or conventions*, adopting pre-existing “rules” to guide decision-making.
- Respondents appeared to focus on their **personal experience and the potential negative outcomes** of a scenario, regardless of whether the scenario was framed positively or negatively, and regardless of the probability of the described climate change.
- Respondents tended to ignore the information provided by the climate probability, and thus the **uncertainty** in the climate projections did not necessarily constitute a barrier to action.
- The respondents’ decisions were influenced by the **information that was provided**, as well as the information that respondents decided to focus on within what was provided.

**DISCUSSION AND OPPORTUNITIES**

**Dominant rules and principles for action**

In complex decision-making environments, it would appear that rather than take into consideration climate data, policymakers and practitioners rely on their known “tried-and-tested” strategies to guide decision-making, allowing them to make judgments quickly and efficiently. These “tried-and-tested” strategies may represent a form of status quo bias for general groups or sectors, rather than individuals. Hence, efforts to communicate climate information might benefit from:

(I) Understanding the dominant rules or principles for action to which decision-makers subscribe in particular contexts

(II) Determining whether those rules or principles naturally align with desired or ideal climate change adaptation and mitigation actions

**Bringing messages “closer to home” encourages people to act**

The results suggest that respondents applied their “tried-and-tested” principles for action not only because this is their fallback response, but also because they were sufficiently convinced that the risk was significant enough to require action. This aligns well with other research which suggests that proximizing climate change, bringing it “closer to home” for people, will make them more likely to engage with the issue. It is possible that the use of the climate risk narratives (which situate the respondent temporally close to the climate impact) may have had that effect.

**Fear-framing encourages action**

The surveys may have emotively struck respondents by being inadvertently “fear framed” through the use of emotive language in the decision scenario. Evidence from the field of psychology suggests that fear framing can indeed be effective in motivating change of various behaviors, which may, in part, explain the bias toward taking action.
Laying out a course of action encourages action
The literature suggests that a feeling of efficacy is one key determinant of action, and the messages most effective for achieving a change in behavior stress the negative consequences of the current behavior while recommending ways to avoid the negative consequences. Most respondents took action, and in part this might have been because the survey provided a course of action—which is consistent with recommendations for increasing people’s perceived efficacy to act.

Framing risks to communities rather than individuals encourages action
Framing climate change as a societal risk could increase its relevance for practitioners or policymakers who have to make decisions for communities or society at large. In practice, this suggests that individual decisions, where one is making a choice for oneself, will differ from decisions for a community or society. This could explain respondents’ bias toward taking action: many were decision-makers working for a wider community. Community risk and decision-making is a topic worthy of future investigation.

Climate data justified rather than influenced actions
Both in the workshop exercises and in the message-framing survey, there was generally little engagement with climate data and with the notion of uncertainty. Where survey respondents took climate information into account, they often interpreted the climate projection in ways that allowed them to justify decisions made on other grounds, rather than to “objectively” use the climate data in decision-making. The implication for the climate services/communication fields is that moderating the uncertainty in climate data—or even communicating such uncertainty more effectively—may not matter as much as has been assumed.

UNDERSTANDING DECISION DRIVERS THROUGH CO-LEARNING
Co-learning can foster greater uptake of climate information. Working with decision-makers to identify and design climate messages under specific decision contexts is also called transdisciplinary co-learning. Transdisciplinary co-learning enhances understanding of the decision context by making explicit the current knowledge, values, norms, and approaches to decision-making, not just among the decision-makers but all those with climate expertise and other relevant expertise, including climate scientists. See box below for more information on transdisciplinary approaches.

One example of a co-learning approach was the co-visioning exercise during the development of climate risk narratives to be used in the survey instruments. Together with practitioners, the research team envisioned, described, and documented (using their own terminology) a holistic future of their sector or region, excluding potential climate changes. This co-visioning makes explicit the goals and drivers of decisions in the sector. Understanding the goals and drivers is arguably more important for integrating climate information into decision-making than the end-product of the climate risk narrative itself.
SUMMARY AND RECOMMENDATIONS

The following approaches can help engage decision-makers on climate change issues:

- **Frame climate information, impacts, and solutions in ways that are consistent with the rules and principles** for decision-making within a sector.

- **Focus on providing information that resonates with the backgrounds, characteristics, and real-world experiences of decision-makers**, taking advantage of the effects of fear framing and perceived efficacy to act.

- **Target the experiential processing system** by providing examples of climate impacts that are concrete, personalized, and vivid.

- **Acknowledge that information alone will be insufficient to change behavior.** There will be situations where the status quo and context for decision-making do not align well with addressing climate change, and there will be situations in which the backgrounds, characteristics, and real-world experiences of decision-makers also may work against climate change decision-making and action. In these cases, there is an even greater need for sustained transdisciplinary approaches to integrate climate knowledge into decision-making.

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**TRANSDISCIPLINARY CO-LEARNING IN A NUTSHELL**

Transdisciplinary co-learning is a set of research approaches aimed at bridging boundaries between science and practice in order to develop knowledge that can help to solve or prevent societal problems. Originally applied to sustainable development, the approaches are oriented to real-world issues, accommodate complexity, and integrate different knowledge systems.

A variety of participatory dialogues and methods have been used to facilitate this research, including scenarios, Co-visioning, and institutional mapping, among others.

The aim of these approaches is to:

- Jointly produce targeted products for science, policy, and practitioners
- Integrate results to resolve or mitigate a problem
- Integrate the results into the scientific body of knowledge
1. INTRODUCTION AND CONTEXT

A critical problem of the climate change field is effective communication under uncertainty. Shortcomings of current approaches to climate change communication include the lack of tailoring to specific audiences and the use of jargon. This results in a disconnect between climate science and application in society, which is well documented in the literature. Climate change communication is often led by climate scientists and thus approached through a climate science lens, with little cognizance of other disciplines. Multidisciplinary approaches to solving problems are rare in academia. Applying knowledge from psychology, behavioral economics, risk analysis, and other fields may enhance/transform climate change communication, including “climate services.”

Overall, the study called into question the common perception that climate uncertainty is a prominent barrier to engagement with climate information. Rather than focusing on climate information, decision-makers tend to focus on impact and solutions-based information and rely largely on personal experience and pre-existing principles and rules.

WHAT ARE CLIMATE SERVICES?

According to the World Meteorological Organization (WMO), a climate service is a decision-aide derived from climate information that assists individuals and organizations in society to improve decisions.

Source: WMO 2013.
2. OVERVIEW OF THE LITERATURE

The climate change sector poses a problem known as “deep uncertainty” in the literature. Deep uncertainty in a problem is not likely to be reduced by additional research within the time in which a decision must be made. Decision-making under deep uncertainty is one of the most crucial problems in policymaking, and decision-making in climate change is complicated further by uncertainty about the actions to cope with the new climate conditions and impacts. The literature exploring the psychology of decision-making under uncertainty has much to offer climate change communication. The focus here is on the psychology literature that informed the methodology for the study: experiential information, the message-framing effect, and the role of delay and probability discounting.

2.1 EXPERIENTIAL VS. ANALYTICAL DECISION-MAKING

Decades of research in social, cognitive, and clinical psychology have shown that the human brain relies on two information processing systems (e.g., Sloman 1996; Chaiken and Trope 1999). One system is experiential: it is intuitive, automatic, emotional, and fast. The other system is analytical: it is deliberate, effortful, rational, and slow. While these two systems act together to guide judgment and decision-making, experiential thinking is more prevalent than analytical thinking (e.g., Slovic et al. 2005; Marx and Weber 2012). How we intuitively feel about a situation often has a strong influence on our decision-making. Climate change is studied in statistical terms (e.g., by analyzing long-term changes in temperature and precipitation patterns), and, hence, it is generally presented in abstract and analytical language, especially to decision-makers. This approach, however, assumes that people process uncertain information in a logical and analytical matter, an assumption that has been shown to be generally incorrect.

Marx and Weber (2012) reflect on using scenarios (worst case, best case, most likely case) to help people navigate making decisions with uncertain information. Although sometimes scenarios are criticized as not expounding the full range of uncertainties, they appeal to the experiential processing system. They are most effective if presented alongside contingency plans, especially for the worst-case scenarios. Winkler (2016) further recognizes that few decision-makers can directly use projections of climate variables. Instead, they respond better to information about the change in a parameter that is influenced by the altered climate, for example, frequency of floods (Tribbia and Moser 2008; Prudhomme et al. 2010).

Similarly, Marx et al. (2007) and Harold et al. (2016) suggest that analytical information is best understood when it is tailored to the context of the decision-maker’s situation. This tailoring is best achieved by translating information into images, emotions, or stories of relevance to the decision-maker. Climate information that is tailored to the emotional experiences of the audience has more impact and can attract more public attention. Scenarios, narratives, and analogies can help the audience to engage with climate information and envisage a future
where the potential consequences of climate change are played out. These influence both personal behavior as well as public policy and is more likely to result in contingency planning. Leiserowitz (2006) reiterates that communication about climate change should be tailored to the needs and predispositions of the target audience.

However, while it is beneficial to draw on experience-based decision-making in communication, experiential processing is beset with its own biases, such as the finite pool of worry and single-action bias, which refers to the tendency of people, when responding to a threat, to take only one action, even when it provides only incremental risk reduction and may not be the most effective option (Leiserowitz 2006; Shome and Marx 2009). There is also a recent trend in the research about finding ways of communicating that transcend audience segmentation. How does one communicate to a wide range of people across many different audiences in order to overcome the high transactional costs of tailored communication approaches (e.g., Corner et al. 2014)?

Marx et al. (2007) conclude that both systems—analytic and experiential—should be considered in the format and communication of climate information. If experiential decision-making is not taken into account, many decision-makers will not take into account climate information. The challenge remains to engage both analytic and experiential systems in both group and individual decision-making.

2.2 THE FRAMING EFFECT

All information is “framed” by its context. Framing involves emphasizing certain dimensions of an issue over others, setting the context for perception and discussion around specific causes, risks, policy actions, and costs/benefits that might result from these actions (Myers et al. 2012: 1106). For example, suggesting that a treatment has a 20% chance of death emphasizes a negative outcome, while suggesting that it has an 80% chance of survival highlights a positive outcome (Morton et al. 2011). Framing can have a significant impact on perceptions of issues and prescriptions for addressing them (e.g., Morton et al. 2011; Baumer et al. 2017). Thus, the framing effect is an example of cognitive bias in which people react to a choice in different ways depending on how it is presented. Framing effects have been studied in a variety of areas, and research on framing and climate change has shown the importance that framing choices can have on climate change perceptions and communication (e.g., Antilla 2005; Myers et al. 2012; Scannell and Gifford 2013). For example, framing a climate change message in terms of loss as opposed to gain is outlined in the prospect theory literature (discussed in subsequent sections).

A solution to the inaction resulting from the uncertainties of climate change communication may lie in the framing of uncertain messages (Bertolotti and Catellani 2014; Botzen and van den Bergh 2012; Kumarasiri and Gunasekarage 2017; Morton et al. 2011; Spence and Pidgeon 2010). For example, focusing on decision-making among executives in large Australian companies, Kumarasiri and Gunasekarage (2017) found that decision-makers are threat-biased and thus more likely to act on carbon emission management when climate change is framed as a threat rather than an opportunity. They further showed that financial pressure from regulations and threats to a company’s reputation were the main drivers of action among the executives.
However, the nuances that emerge in studies vary, reflecting how the loss-versus-gain framing is but one factor that interacts with other factors influencing communication. Bertolotti and Catellani (2014) go beyond the “simple” loss-and-gain framing, showing that other levels of message framing and the content of messages are also factors. For example, they found that policy messages on renewable energy sources are more persuasive when the positive outcomes of the policy are presented, especially when emphasizing the benefits to economic growth. However, policy messages on greenhouse gas emissions are more persuasive when the negative outcomes that can be avoided through policy are presented, with an emphasis on safety: for example, avoiding the risk from specific extreme events such as floods or droughts. Spence and Pidgeon (2010) explore the role of both the amount of information remembered from communications and the role of fear in attitudes and action on climate change mitigation.

2.3 DELAY AND PROBABILITY DISCOUNTING

Discounting refers to the decrease in the value of a reward (or punishment) when it is either delayed or uncertain (Richards et al 1999: 121). As an old saying goes, “A bird in the hand is worth two in the bush,” and, thus, people tend to prefer what is certain over what is uncertain (Jones and Oaksford 2011). Individuals have been found to prefer a small reward sooner over a large reward later, and it is generally assumed that this relates to the subjective value of a delayed reward being discounted while an immediate reward is not (Myerson et al. 2011). Responses to probabilistic rewards have been found to elicit similar effects, in that individuals would prefer a smaller certain reward over a larger probabilistic reward, and it is generally assumed that this relates to the value of a probabilistic reward being discounted while a certain reward is not (Myerson et al. 2011).

Various studies look at probability and delay discounting (also called temporal discounting), highlighting similarities but also emphasizing the differences. Richards et al. (1999) assess human impulsivity in the context of drug abuse by measuring delay and probability discounting. Their results indicate that there is a positive correlation between delay and probability discounting within subjects, meaning that an individual that displays steep delay discounting also displays steep probability discounting.

Delay discounting predicts that people will be risk-averse for delayed gains and risk-seeking for delayed losses (delay discounting is discussed in greater detail below). Empirical evidence for this effect parallels findings of similar effects on risk-orientation due to probabilistic uncertainty (the appropriate representation for expert judgments of uncertainty presented as a probability distribution for the unknown quantity of interest), as in Kahneman and Tversky’s (1979) prospect theory. Given the importance of prospect theory (Fiedler and von Sydow 2015), this review considers probability discounting through a prospect theory lens, discussed in further detail below.
DELAY DISCOUNTING
As defined by Odum (2011: 427), “delay discounting is the decline in present value of a reward with delay to its receipt.” Values have been found to decline hyperbolically as the reward becomes more remote. This is the case across different species and populations, as well as across different reward types (Odum 2011).

Kaplan et al. (2014) look at the influence of the delay of an impact on concern about the impact and willingness to act. In their study on the discounting of an environmental loss, participants were given a short narrative that placed them as the owner of a farm exposed to groundwater pollution. Prompted by the time it would take for this impact to make their vegetables inedible, they answered questions about their level of concern as well as the time which they were willing to spend to solve the groundwater pollution challenge. This was repeated for delays of one month, six months, one year, three years, five years, and ten years. Interestingly, they found that with every delay, people discounted the willingness to spend time to solve the challenge at a higher rate than they discounted the level of concern.

While climate change projections are increasingly focusing on near-term timescales, to the extent that a climate change signal is evident in the near term, the strongest messages around projected change tend to focus on the medium-term (mid-century) and distant future (end of the century). Discourse among scientists, the media, and policymakers has mostly considered the consequences of climate change over varying timescales (e.g., 50 to 150 years). Many people view climate change as a psychologically distant, future threat (Leiserowitz 2005; Spence et al. 2012), which inhibits action. The influence of delays on prioritization and implementation of climate change adaptation is an interesting area of research to which the delay discounting lens could be applied. Frydman and Camerer (2016) note, in the context of decision-making under uncertainty in the financial field, that when people think about future rewards that are timed to personally important events (for example, saving for college), it increases their motivation, probably because such events make the future more likely and real.

PROBABILITY DISCOUNTING
Prospect theory is an account of probabilistic decision-making in economics. It is the most influential theory on decision-making under uncertainty (Botzen and van den Bergh 2012) and provides one lens for further understanding climate change decision-making. Prospect theory departs from the normative theories, which assume the rationality of economic agents; heuristically biased assessments of probability and utility had a strong impact on the theory (Kahneman and Tversky 1979). Developed to explain decisions under uncertainty, prospect theory is grounded in the notion that “decision framing influences the way individuals perceive a problem which then leads to different actions” (Elijido-Ten 2017: 958). In the most basic sense, if considering gains and losses of equal amount, prospect theory assumes that the threat of a loss is generally given more weight than the opportunity to gain (Elijido-Ten 2017). For just one example of the empirical support for prospect theory, Barberis et al. (2001) note that investors are more sensitive to reductions in financial wealth than to increases.
In some of their initial work on prospect theory, Tversky and Kahneman (1981) provided experiment participants with a choice between two competing disease treatment programs, one treatment representing risk and uncertainty and the other representing safety and certainty. These were presented through the lens of lives saved or lives lost, yet with the same absolute outcome. When framed in terms of lives saved, people chose the more certain option, while when framed in terms of lives lost, people leaned toward the more uncertain. Prospect theory thus considers people to be more inclined to take risks to avoid losses than they are to take risks when considering gains (Spence and Pidgeon 2010).

Prospect theory emphasizes decision weights over subjective probabilities, in that people are seen as giving more weight to the amount of a possible gain than to the probability of that gain (Myerson et al 2011). For example, people may be aware of the probability of winning when buying a lottery ticket; however, they give more weight to the amount of the possible win. In a similar vein, Botzen and van den Bergh (2012) note that people tend to either neglect or overweight low-probability risks, and that the way in which such risks are communicated plays a large role in shaping subsequent action or inaction. People also tend to neglect or overweight low-probability risks when their personal perception of risk is distant in both time and space.

For climate change decision-making under uncertainty, prospect theory has two major implications:

**People have a strong preference for certainty**, tending to overvalue options that are certain and be risk-averse for gains. Individuals would rather get an assured, lesser win than take the chance to win more but also risk getting nothing, even though the overall expected value, or outcome, of each choice is equal. Losses are treated in the opposite manner. When aiming to avoid a loss, people become risk-seeking and take the gamble over a sure loss in the hope of losing nothing. Again, both options have equal expected values. These effects could possibly explain why decision-makers are reluctant to implement adaptation measures where the costs exceed the benefits in the present. For example, increasing the design standard of a road surface to cope with possible future increased rainfall intensity only has benefits if that road has to withstand storms of such magnitude. This is an uncertain gain where predictions about future rainfall are uncertain. The costs, however, are incurred in the present. Thus, if decision-makers continue using current design standards, they face a sure gain (money saved) or avoid a larger loss, over an uncertain gain; whereas changing design standards is a sure current loss in return for a future uncertain gain or larger future loss.

**People are loss-averse** and therefore tend to give losses more weight than gains. Most people act to minimize losses, even though the probability of those losses is tiny. Loss aversion, combined with the tendency to overvalue small probabilities to guard against losses, means that even though the probability of a costly event may be tiny, people would rather accept a smaller, sure loss than risk a large loss. This explains why people take out health or crop insurance, preferring to make a small (but predictable and ongoing) payment to avoid a potentially large loss (usually a loss larger than the premiums they are willing to pay). People's reactions to losses are more extreme than their reactions to gains.
Communication of climate science poses a challenge in that details around timescales, magnitudes, and consequences remain uncertain. In the public eye, that uncertainty erodes the authority of science. The need for further research on integrating the findings of behavioral psychology in climate change communication is evident.

**CONCLUSION**

This literature review made evident the relevance of a better understanding of behavioral psychology and its applications to climate services. Awareness of the theories and research findings of behavioral psychology are valuable for those engaging with decision-makers directly or through websites or publications.
3. METHODOLOGY

The study methodology focuses on the elements of experiential communication, message framing, and delay and probability discounting.

3.1 EXPERIENTIAL COMMUNICATION: NARRATIVES AND INFOGRAPHICS

Narratives are an experimental approach to the communication of uncertain future climates that the Climate System Analysis Group (CSAG) has been testing through the Future Resilience of African Cities and Lands (FRACtAL) project. This study further develops CSAG narratives (described below) to communicate climate information, in combination with infographics.

Narratives were a response to frustrations with current climate change communication: “telling stories of future climate” was seen as a more engaging means for climate scientists to explain the science and to communicate for decision-making. Climate scientists assess climate projections for a particular location and describe plausible futures for decision-makers in a set of two to four “stories” that cover a range of future uncertainties. Each story places the reader in the future and describes the location (e.g., Maputo) as it would be 15 to 50 years from the present. For instance, the narrative may start “It is 2035 and average early summer temperatures are 1.5°C higher than they were back in the late 20th century, while winter temperatures are around 1°C higher. Heat waves (more than 5 days above 36°C combined with warm nights) are more common than they used to be....” The narrative goes on to hypothesize the experiential impact of the changed climate, for instance, “Wealthier residents have invested in air conditioning in response, but this, combined with rapid population growth, has contributed to increases in electricity demand, particularly during the summer months.”

In some cases, the stories vary considerably from each other. For instance, one narrative may describe a wetter future and another a drier future. Their critical importance, however, is that they describe the interconnection between climate indices in a way that analytical and graphical information cannot. Graphical information provides the scientific basis for the stories.

A few characteristics of relevance to the application of narratives include:

- Each of the narratives represents a possible future, within the range of uncertainty, but should not be seen as a definitive projection or representing a certainty about a particular future. They represent speculative futures based on the current evidence and scientific judgment.

- Each of these narratives should be seen as equally likely. Therefore, in considering decision-making using these narratives, all the narratives should be taken into account.

- These narratives should be used with the underlying evidence in the detailed projection analysis. They should not be used as stand-alone evidence, as they do not represent the entire range of possible futures.
A graphic designer produced infographics of the information in the narratives. One infographic was developed for each narrative to show explicitly that it was one of many possible future stories. The tabbed illustration at the top of each infographic illustrates and communicates this range of possible futures. The infographics were not accompanied by the graphical information used to develop the narratives. The narratives and infographics for Maputo are in Annex 1.

### 3.2 FEEDBACK ON THE NARRATIVES FOR DECISION-MAKING

To facilitate feedback on the narrative/infographic approach, a workshop was held with the health sector in Mozambique on 21 June 2017. The National Institute of Health in Mozambique (INS) helped to coordinate the workshop participants to get maximum participation in the event. The 18 participants ranged from national government health-related officials to heads of health programs and district health officials. There was also representation from the National Meteorological Service (INAM), the National Institute for Disaster Management (INGC), and Eduardo Mondlane University (Maputo).

One session of the workshop tested the utility of the narratives and the infographics for decision-making. Participants were initially given either the narratives, which included supporting evidence in the form of graphs displaying projections for various variables for Maputo, or the infographics, and asked to spend 15 minutes studying them. Their written answers to questions relating to their recall and comprehension of the information provided insights into the primary messages conveyed by both types of communication. The four discussion groups, each comprising between four to six participants, then provided qualitative feedback with the help of group facilitators.

All materials for the workshop, including narratives and infographics, as well as large parts of the workshop process itself, were translated into Portuguese. An in-house climate scientist from Mozambique translated climate-related workshop materials, and professional simultaneous translators were hired for the day of the workshop. For either of these translation processes, some nuances may have been lost or concepts misunderstood.

### 3.3 INVESTIGATING MESSAGE FRAMING

To test message framing on an uncertain message, a large data collection sample was required. An online survey was developed as a method to garner a large number of responses from two target audiences, health and WASH professionals working for development or planning agencies. Survey respondents were presented with a sector-specific scenario of the future in narrative form (see box on the following page and Annex 2).
The online surveying research was undertaken in two phases. Phase 1 surveyed 119 respondents from the health sector using a seasonal health-related scenario (Annex 2). The scenario was structured around the temperature drivers of malaria infection in the coming season.

Phase 2 comprised two surveys for the health sector and the water, sanitation, and hygiene (WASH) sector, respectively. The health sector scenario was structured around heat wave impacts on health, and the WASH scenario focused on the sustainability of the water supply (see Annex 2). A total of 148 responses were received, 90 from the health sector and 58 from the WASH sector.¹

¹ A randomization error meant that a disproportional number of WASH participants (n=36) responded to one of the four scenarios, leading to a sampling bias.
While only two sectors could be investigated within the scope of the study, the similarities in results between the two sectors suggests that the broad findings could extend to other sectors, though further research will be required to confirm the theoretical generalizability of the findings.

Unlike the phase 1 surveying, the phase 2 surveys included a sector-specific scenario for both the seasonal timescale and climate change timescale (see Annex 2). The inclusion of the climate change scenario allowed for investigation of the effect of delay discounting in decision-making. Each respondent was first asked to make an action decision based on a seasonal scenario and, thereafter, the same respondent was asked to make a decision based on a longer-term climate change timescale.

The surveys were distributed widely through mailing list networks. Survey respondents took part on a voluntary basis (with no reward) and included a range of professional functions within each sector, from academics to private- and government-sector practitioners.
4. RESULTS AND DISCUSSION

Much of the analysis was exploratory and inductive, and therefore many of the insights from the workshop and surveys emerged as a result of the process.

4.1 EXPERIENTIAL FORMATS OF COMMUNICATION

Infographics were commonly preferred, with their clarity and ease of interpretation, to the longer and more detailed narratives. It was generally agreed, however, that they were complementary and required for different purposes. The narratives provided supporting evidence and the infographic provided an entry point and communication tool for those who do not need to understand the details and science. As noted by one participant, “I think from the middle level manager, he can read this [narrative] and communicate this to the top-level manager.”

In addition to this insight, a number of inductive insights emerged. The tasks and discussions provided initial support for the appeal of the impact- and solutions-based information ahead of climate information, as well as the appeal of experiential communication techniques. Importantly, the workshop began to highlight what appears to be a lack of emphasis on uncertainty. Both the focus on negative information and the lack of awareness of uncertainty are explored further in the results from the phase 2 survey. While the workshop methodology was exploratory and not intended to draw out quantitative or representative conclusions, these inductive insights are outlined in more detail below.

A FOCUS ON THE IMPACTS RATHER THAN THE DRIVERS OF CLIMATE CHANGE

The interactions with both the narratives and infographics reflect an emphasis on changing impacts as opposed to changing climate variables. This supports the argument in the literature that people are generally more responsive to changes in the parameter influenced by a changing climate than to a change in climate per se (Tribbia and Moser 2008; Prudhomme et al. 2010). The majority of the information that people remembered were impacts, especially health impacts. All but one person noted health impacts, and several people noted more than one health impact, reflecting that people are drawn to the impacts on their sector.

Group discussions also tended toward emphasis on impacts. Discussion of the climate variables was nearly absent. There was a sense that impacts are more tangible, “and you know the impact, it is something that is measurable, not abstract, yes you know,” yet that even more tangible impact information is desired: “So for decision-making, I agree with him, we need numbers. You cannot just say it is expensive, how expensive?” and “Maybe estimate the number of people, especially for the politicians, if they see the numbers, they can say, ‘Wow.’” This is nothing new. The call for more detailed impact information, and in particular the desire for costing, whether of the impact or of the adaptation option, have been widely documented. This shows the importance of ensuring that the impacts described in scenarios, whether presented in a narrative or infographic, are grounded in an understanding of the link between the climate driver and the impact. Much of the presentation will be context-specific.
and thus require thorough understanding of the local context. This raises ethical issues about who interprets scientific information and how their biases might play a role.

LACK OF AWARENESS OF SCENARIOS AND UNCERTAINTY
When prompted to speak about the four scenarios and their meaning, several discussants across the various groups emphasized the similarity of impacts in the two scenarios that they received. As noted in one group, “In both scenarios, they both have increasing temperature and it has impact on malaria,” and as noted in another group, “The majority of the impacts are similar, both in one or the other option.” In another group, a discussant merely noted that, “I would plan with [for] the worst [scenario],” while another sentiment expressed was, “So, it doesn’t matter which scenarios we choose, but because of climate change we’re going to have some impacts.” This nearly contradicts the above-noted call for more detail, yet it may reflect that unless the impacts in the scenarios are clearly distinguishable, people may not notice that there are two scenarios. This observation is supported by the statement, “When you come to this kind of thing, where you have two scenarios, for example, but I see the message is more or less the same. If we could get some information, extract some numbers.”

There was also the sense of increased confidence from the perceived similarity of the impacts: “Although the majority of the impacts are similar, both in one or the other option, the fact that they give us two options makes me think that there is no certainty regarding what’s going to happen. But if they were very different impacts, my doubts would be even bigger, but it is reduced because the impact is almost the same.” However, there was generally little engagement with the notion of uncertainty, unless prompted by the facilitators. In fact, when asked to write down what they could remember, having had 15 minutes to study either the infographic or the narratives, no one mentioned uncertainty, nor did anyone make any reference to there being two different scenarios and what this may imply. When asked to note down the predominant climate uncertainties from the scenarios, most participants just listed projections, with three exceptions—one response noted the uncertainty of the timing of rainfall projections, one noted the timing of temperature projections, and one noted greenhouse gas emissions into the future. Temperature was the most common variable listed, with the majority of responses mentioning temperature in some form, of which four focused solely on temperature. The emphasis on temperature, which was the more certain and consistent projected variable, indicates that the exercise itself was not sufficiently explained and understood, and/or that the concept of uncertainty is not well understood.

When asked to note down the predominant impact uncertainties, most participants (with a few exceptions) again seemed to misunderstand the exercise and/or uncertainty as a concept. Most just listed impacts in a manner that did not reflect a focus on uncertainty. Some answers, such as, “Buying air conditioning as a way of adapting,” “Need more prevention,” and “Local dam (pequenos Libombos) is generally dry,” further confirmed the sense that uncertainty as a concept was misunderstood. Only a few responses seemed to reflect on the uncertainty of an impact:

- “Mosquito developmental condition”
- “Changes in agricultural crops with changes in the beginning of the rainy season”
• “Increased number of malaria cases”
• “Socio-economic changes? How does this play out?”
• “Where exactly do coastal erosion impacts occur? Are there people in these places and/or infrastructures?”

Discussions of scenarios and uncertainty, while much prompted by the facilitators, did lead to some reflections and unpacking of nuances. While there were comments like, “One of these two will happen, and are happening now,” there were also comments such as, “It is difficult to measure what to expect in the future taking into consideration that the two realities are two extreme points.” And, “There is no “one plus one equals two” in the meteorological forecasts. So these are scenarios, these are forecasts but sometimes they fail.”

Narrative scenarios are not necessarily an educational endpoint tool in themselves. However, in workshop group discussions, narratives can trigger discussions on uncertainty, and, as noted by Marx and Weber (2012), help people navigate decision-making under uncertainty.

4.2 MESSAGE FRAMING EXPERIMENTS

Much research in the health field aimed at increasing the persuasiveness of promotional messages has focused on the effect of gain/loss message framing (Bosone and Martinez 2017). Less research on how practitioners and policymakers react to gain/loss framing appears to have been conducted (compared with that conducted on the general public). Further, no research appears to have been carried out on the effect of gain/loss framing on decision-making under uncertainty, when the uncertainty lies not in the outcomes, but in the climate driver in a scenario. Therefore, this study investigated how a gain/loss framing might influence the decisions of policymakers and practitioners under uncertainty on either health or WASH scenarios affected by climate parameters. The total number of respondents who voted yes or no to the action questions is summarized below. There were no statistically significant differences between gain framing and loss framing in the phase 1 and phase 2 health surveys (refer to Annex 3). While the WASH survey had strong significance, the test results are not reliable due to the highly skewed sample sizes among the four pairs of scenarios (Annex 3).

<table>
<thead>
<tr>
<th>Phase 1</th>
<th></th>
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<tbody>
<tr>
<td>Health Sector Seasonal Scenario</td>
<td>91</td>
<td>28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Sector Seasonal Scenario</td>
<td>56</td>
<td>34</td>
</tr>
<tr>
<td>Health Sector Long-Term Scenario</td>
<td>63</td>
<td>27</td>
</tr>
</tbody>
</table>

2 To mitigate the skewed sample sizes, a more uniform sample size was modelled for the WASH survey (using the percentages to extrapolate what would have been expected given 15 samples on each question), and the result was not significant at any reasonable probability for the WASH questions.
Neither the gain nor the loss framing had an effect on respondents’ choices. Thus, in these experiments, it would appear that a gain/loss framing approach cannot modify health or WASH practitioners’ or policymakers’ decision-making under climate uncertainty. On the other hand, all experiments demonstrated that participants had a marked bias toward taking action, irrespective of the climate probability or framing assigned to the scenario: in all surveys, the proportion of respondents replying “yes” to the decision to invest was statistically significantly higher than the proportion of respondents replying “no” (Annex 3). This preference toward taking action was particularly significant under the long-term climate change scenarios. The proportions of respondents replying, “Yes, they would invest” or “No, they would not invest” also did not change (in a statistically significant manner) between all the low-probability scenarios and all the high-probability scenarios, or between all the gain-framed scenarios and all the loss-framed scenarios, i.e., summing across all surveys (Annex 3). To better understand these findings, the respondents’ reasons for their choices were qualitatively analyzed. The main findings from the qualitative analysis are discussed below.

**APPLYING PRE-EXISTING “RULES” TO GUIDE DECISION-MAKING**

In the first place, the qualitative analysis suggests that people in groups or sectors make decisions using simple guiding principles, rules, or conventions, for example, in the health field, the principle that “prevention is better than cure/treatment.” Understanding and being explicit about these “rules” may be important to understanding how a given audience will respond to certain scenarios and an important part of the discussion.

Respondents who replied, “Yes, they would invest,” to the decision statement in the phase 1 survey prevalently gave a “prevention is better than cure” reason to explain their decision (82% of those replying “yes”). This included both general “prevention is better than treatment” responses or qualified responses (i.e., prevention is better than treatment because it is more cost-effective, or because it saves more lives/prevents illnesses). Examples of typical responses include:

“**Preventing additional cases of malaria may result in lower future cost of treatment for malaria and therefore a potential reduction in spending on treatment.**”

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3 Naturally, a survey question cannot measure whether a participant would actually act or not act as stated if confronted by the same decision in a real-life situation, but can only provide a proxy measure.

4 In other words, the proportion of respondents replying “no,” for instance, did not change significantly under either high- or low-probability scenarios, or under gain or loss scenarios.

5 Please note that although in phase 2 a respondent replied to both the seasonal and the long-term climate scenarios, their responses were counted as if they were different respondents because the qualitative reasons for their responses were in many cases different for the different scenarios. Hence, when the word “respondent” is used, in reality it stands for “response.” Further, when total numbers of respondents are given, this refers to the total number of respondents who provided an answer to explain their decision. The minority of respondents who did not provide answers to explain their decision are not counted, as they could not be part of the qualitative analysis.
“The ‘proactive’ approach is way much better than the ‘reactive’ approach. Simply put, ‘prevention is better than cure.’”

“On balance [you] can reduce the burden of malaria disease more with prevention than treating the limited number of cases the budget will allow.”

Respondents who replied, “Yes, they would invest” to the decision statement in the phase 2 health survey also prevalently gave a “prevention is better than cure” reason to explain their decision (70% of those replying “yes”).

A similar principle explained the majority of responses in the WASH surveys. Respondents who replied, “Yes, they would invest” in response to both the seasonal change scenario and the climate change scenario usually cited this principle to explain their decision (76% of those replying “yes”). Typical responses illustrating the dominance of this principle in the WASH sector include:

“What is clear however is that the provision of a sustainable water service MUST [respondent’s own capitalization] be based on long term thinking. Therefore, we must make difficult decisions now that may only bear fruit in the medium to long term.”

“Water planning is [a] long term planning [activity] and not a reactive activity.”

The comments illustrate respondents’ belief that taking anticipatory action is more important than taking reactive action, regardless of whether the probability of the climate projection in the scenario was low (as in the case of the first comment) or high (as in the case of the second comment).

The reliance of practitioners/decision-makers on the “prevention is better than cure” frame could be interpreted as an example of status quo bias at work. The status quo bias is an example of a key behavioral economics concept relevant to decision-making (e.g., Matjasko et al. 2016). Status quo bias refers to the tendency of people to inertia and to not deviate from the default option or reverse their earlier decisions. When faced with difficult choices, people are more likely to choose the status quo (Fleming et al. 2010). In this study, practitioners and policy-makers deciding on an action under uncertainty and incomplete information may have relied on their known default response, that of “prevention is better than cure,” as evinced by the large majority of respondents who used this mantra to explain their decision. However, it is likely that the default responses guiding the decisions of practitioners and policymakers under uncertainty will vary by sector; “prevention is better than cure” is a principle long associated with the health sector, and apparently has relevance also for the WASH sector. But it may not guide or explain decision-making across all sectors.

A FOCUS ON POTENTIAL NEGATIVE OUTCOMES AND PERSONAL EXPERIENCE

Respondents appeared to focus on the potential negative outcomes of a scenario, regardless of whether the scenario was framed positively or negatively, and regardless of the actual climate probability. Thus, regardless of the probability of an outcome, the potential that such an outcome might occur appeared to “loom large” for respondents.
For example, regardless of a high or low chance that malaria prevalence might increase (as a result of an increase in temperature), and regardless of “lives lost” or “lives saved” framing, respondents appeared to focus on the fact that malaria could increase (or that heat-related deaths could increase, or that water demand might exceed supply).

In the phase 1 survey, 36% of the respondents who chose to take action (replied “yes” to the investment decision) showed a concern about the potential negative outcomes of the scenario in the explanation for their decision. In phase 2, this proportion was 25% for the health survey and 39% for the WASH survey. In the following comments, respondents express concerns with the size of the potential loss (first and second comment) and/or the consequences of the loss (third and fourth comments), as well as their focus on the possibility of negative outcomes, rather than the actual probability (second and fourth comments):

“My KPI [key performance indicator] is to reduce death/loss of life. 120 000 people is significant enough for me to justify expenditure.” (phase 1 survey, 65% probability)

“Although there is a low probability, the possibility of the projected 20% increase in deaths affected my decision.” (phase 2 health survey, 35% probability)

“Water is life! If you do not apply water restrictions, not only do people suffer, but industry and other services also suffer, with consequences way beyond a 15% loss in income.” (phase 2 WASH survey, 65% probability)

“There is a possibility that failure to implement restrictions will result in the city running out of water in the following season. Knowing this, yet failing to implement restrictions, is taking a gamble with stakes that are too high.” (phase 2 WASH survey, 35% probability)

As such, the respondents’ decisions might be influenced by the psychological bias of “negativity.” The negativity bias gives greater value to negative information than to positive information: the effect describes situations in which there is a greater impact of negative versus positive stimuli on a subject, and as such, evidence suggests that negative information in general has a stronger impact on decision-making than equivalent positive information. The effect embraces a wide range of empirical phenomena (Peeters and Czapinski 1990; Baumeister et al. 2001). In general, compared with positive information, negative information is more likely to seize attention, receives more thorough and conscious processing, and contributes more strongly to forming impressions (Baumeister et al. 2001).

Consistent with the literature, negativity bias was expected to manifest as loss aversion, which is an important concept of prospect theory. It predicts that losses motivate behavior more than equal gains (Kahneman and Tversky 1979). It was expected that respondents’ decision-making might be different under gain vs. loss framings, but no such effect was observed, as stated previously. However, the qualitative responses suggest that negativity bias may indeed be affecting respondents, but not in the framing of the scenario. Respondents appear to be swayed more by the possibility that a negative outcome might occur at all than by the frame in which the scenario is couched (or, as stated, by the probability of a negative outcome).
Quite simply, respondents in the health surveys appeared to care about the possibility that lives might be lost above other considerations. This may, of course, simply be a reflection of another dominant mentality in the health sector, that “lives cannot be costed.” However, this focus on negative outcomes appeared in the WASH surveys as well, even more strongly than in the other surveys. Respondents in the WASH examples appeared to care about the possibility that water might run out, a life-threatening situation, above considerations of the probability of this outcome or its framing.

Respondents’ focus on potential negative outcomes might be explained in part by their own experiences and knowledge of the “real world.” Some respondents explicitly drew upon their own knowledge and experiences to explain their responses, rather than the information presented in the scenario—10% of respondents across all surveys (and 84% of these were respondents who replied “yes” to the decision about whether to invest). Other respondents might also have been drawing upon their personal experiences without making this as clear in their responses.

A key behavioral economics concept relevant to decision-making is the availability heuristic, which refers to the tendency of people to judge the probability of an event by how readily an example comes to mind (e.g., Matjasko et al. 2016). Retrievability of an instance (cognitive “availability” of the instance) is critical for this type of heuristic and is favored by personal experience and the salience and vividness of the instance itself (Tversky and Kahneman 1974; Sunstein 2006). As such, the availability heuristic may have played a role in respondents’ decision-making because the surveys were sent primarily to participants in sectors directly related to the scenarios in each survey; i.e., health scenarios were primarily sent to participants from the health sector, and the WASH scenarios were primarily sent to participants from the WASH sector. Thus, it would have been easy for the participants to bring examples of the risks in the scenarios to mind. For example, Matjasko et al. (2016: S14) note that “diseases or conditions faced by a friend or which are the topic of news coverage and advertising tend to increase an individual’s perception of their personal risk of the disease.” In a similar vein, health sector respondents familiar with malaria (for example) might easily think of examples of malaria outbreaks, thus affecting their decision-making. The following quote is from a respondent who appears to have learned to take action from his experiences of malaria in his country:

“I come from a seriously infected malaria country […]. I know the impact on the community, especially on poor people.”

A WASH survey respondent provided an example of relying upon her recent and personal experiences with a water shortage event: the respondent is from South Africa and references “Day Zero” to explain her decision to take action. “Day Zero” is the day when Cape Town officials will be forced to cut off the normal piped water supply to 75% of the city’s households, following a severe 3-year drought (e.g., AFP 2018).

“Being prepared well in advance costs less in the long run than ignoring the trend, and then having to spend in a hurry, without sufficient planning, when ’Day Zero’ is imminent!”
UNCERTAINTY IS NOT NECESSARILY A BARRIER TO ACTION
In general, the analysis suggests that people tend to ignore the climate probability, which was expected to help them navigate the complexity of the decision. In fact, the analysis demonstrated that only around a third of respondents mentioned the climate probability in their response (27% of respondents in the phase 1 survey, 36% in the phase 2 health survey, and 33% in the phase 2 WASH survey). A third of respondents is not a significant proportion because the climate probability was emphasized in the scenario.

The analysis suggests that participants’ pre-existing beliefs, perceptions, and/or knowledge might be playing a greater role in motivating their decision-making than the climate information in the scenarios. This inference comes from two main findings:

• 8% of respondents who replied "yes" to the investment decision in phase 1, 25% of respondents in the phase 2 health survey, and 13% in the WASH survey, brought up their expectation that climate change would make the risk outlined in the scenario more probable. While these proportions, apart from the phase 2 health example, are not high, they are interesting because the scenarios did not mention “climate change” per se and would thus not have prompted respondents to raise the issue (the same way the mention of the climate probability would have been expected to prompt them to mention this factor).

• Respondents who raised their beliefs regarding the impacts of climate change did so autonomously, and two-thirds brought up these beliefs as a reason for the decision in their responses without even mentioning the climate probability in the scenario. Some quotes of respondents who brought up their climate change beliefs as part of their explanations for their decision follow:

“With climate change, the temperatures may increase every year, meaning the malaria may become more of a problem. Malaria is so hard to contain. I would suggest the 10% increase from this year” (phase 1 survey, 35% climate probability)

“I recognize that heat waves are a consequence of climate change, and we need to be able to respond to such public health threats appropriately” (phase 2 health survey, seasonal statement, 35% probability)

“Investing in alternative water sources is good long-term planning. Even if rainfall does not decline within the period stated, investments in alternative water sources could pay dividends in future years or in the event of other types of emergency. With no evidence that the effects of climate change will reduce in severity in the out-years, this seems to be a reasonable budget expenditure for both the long- and short-term” (WASH survey, long-term statement, 35% probability)

As the quotes make evident, respondents did not bring up the climate probability and relied upon their pre-existing belief/knowledge of climate change to explain their decision, even when the scenario gave a low probability for temperature increase.
The **second** finding about the importance of participants’ pre-existing beliefs and perceptions was that respondents often appeared to read and/or “use” the probability in ways that justified their desired course of action, rather than “objectively” evaluating the probability.

Across all the surveys, similar proportions of participants who replied “Yes, they would invest” and “No, they would not invest” noticed the climate probability (30% of the “yes” respondents and 39% of the “no” respondents). However, interesting results emerge when considering whether respondents interpreted the climate probability in the manner/direction they would have been expected to, i.e., whether they interpreted it as “high” or “low” consistent with how it was set out in the scenario. Across all the surveys, when the climate probability was 65%, all the “yes” respondents who noticed the climate probability interpreted it “as expected,” i.e., they interpreted it as a “high” probability. When the climate probability was 35%, all the “no” respondents who noticed the climate probability interpreted it “as expected,” i.e., they interpreted it as a “low” probability. However, when the climate probability was 35%, the vast majority of the “yes” respondents who noticed the climate projection (85%, across all surveys), perceived it in a manner contrary to that which would have been expected: they did not perceive it as low, in some cases even interpreting it as evidence that the negative outcomes were, in fact, **likely** to manifest.

“Based on a 35% probability of an increase in temperature […] I would allocate 20% more.” (phase 1 survey, 35% probability)

“35% is not low - it is about 1/3.” (phase 2 WASH survey, statement based on seasonal scenario, 35% climate probability)

“The long-range prediction assures that there will be an event with severe consequences.” (phase 2 health survey, statement based on climate-change scenario, 35% climate probability)

“Yes, because you know with certainty that at least an additional 20% will die from heat-related illnesses.” (phase 2 health survey, statement based on seasonal scenario, 35% climate probability)

The first two quotes demonstrate how respondents take the 35% climate probability as sufficient for action, while the latter two quotes highlight how some respondents go so far as to take the 35% probability as a certainty that negative effects will occur. Finally, across all the surveys, when the climate probability was 65%, the majority of “No, they would not invest” respondents who noticed the climate probability, perceived it in a manner contrary to that which would have been expected (4 out of 5, i.e., 80%): they did not perceive it as high, or a sufficiently high probability.

Additionally, phase 2 respondents were significantly more likely to take action under the long-term climate change scenarios. This is surprising because of delay discounting and research reporting that many people view climate change as a psychologically distant, future threat.
(Leiserowitz 2005; Spence et al. 2012). Unfortunately, the qualitative analysis did not suggest any strong explanations for this finding. However, among the responses of participants to the long-term scenarios who interpreted a 35% climate probability contrary to what would have been expected, about two-thirds interpreted a 35% probability over the long term as being somehow “more convincing” (of a risk that a negative consequence would occur) than a 35% probability for one season. Research could explore people's understanding of probabilities over the short term and long term, and the effect this understanding might have on their decision-making.

In conclusion, respondents appear more likely to “use” climate data to justify decisions taken on other grounds, than to use the data for decision-making. This may be an instance of assimilation bias, or the tendency for people who hold pre-existing assumptions and expectations to mistakenly perceive new information or evidence as confirming those assumptions (discussed further in section 4.3). High uncertainty can be used to justify not taking action, and low uncertainty can be used to justify taking action, but high uncertainty will not stop people from taking action, and low uncertainty is not necessarily enough to prompt people to take action. In fact, because people were overwhelmingly action-biased, it would appear that climate uncertainty itself does not constitute a big part of their decision-making. As such, it may be necessary to question current efforts by the climate science community to “reduce” uncertainty, or efforts to get climate data users “more comfortable” with uncertainty in climate projections (Corner et al. 2015; Monroe et al. 2015). The results suggest further research to better understand the extent to which uncertainty in climate projections is itself a barrier to action.

THE CHOICE OF INFORMATION PROVIDED INFLUENCES THE DECISION

Across all the surveys, 39% of the respondents who chose not to take action mentioned the climate probability as part of their reason. As discussed in the previous section, the vast majority of this 39% had received a low-probability/high uncertainty scenario (35% probability of temperature increase), and all of them drew upon the low probability to justify their decision. More than a third of respondents who did not take action (36%) mentioned in their response that the scenario did not provide enough information to make an informed decision or that the scenario did not sufficiently represent the complexity of the “real world.” Of those answering “No, they would not invest,” 28% focused on potential negative outcomes, although in this case, they demonstrated concern with the potential negative outcomes of taking action rather than the potential negative outcomes of not taking action. The vast majority of these responses were in the phase 2 health survey, and the explanation appears to be that the scenarios did not quantify the number of deaths from heat-related illnesses but gave instead a percentage increase in deaths (20%). Thus, this scenario differed significantly from the phase 1 health survey, which quantified the number of people contracting (or being saved from contracting) malaria (120,000 people). The percentage increase in deaths given in the phase 2 survey appeared to make the scenario less “tangible” for decision-makers. They were unable to relate the percentage increase to actual numbers of people affected, as the following comments illustrate:
“I don’t have enough information to understand exactly how this translates into real-world risk. 20% additional people might be a very small number or a very large number. How many people will die from re-allocating those 10% of funds from other programs?” (phase 2, health survey)

“I need more info. I'm not sure what the numerator and denominator are. Does the 20% mean 2 fatalities are avoided or 2,000? Then I would compare it to the number of lives saved from the program from which I'm taking the funds” (phase 2, health survey)

This finding bears on the issue of “fear framing,” which will be discussed in the section below.

Finally, in the WASH survey, 26 respondents chose not to take action. The majority (17) received the seasonal scenarios, and the remainder (9), the long-term climate change scenarios. It is interesting to note that 59% of the “No, they would not invest” respondents to the seasonal scenarios provided the following reason for not taking action: they would defer the decision until later in the season and monitor dam levels in the meantime—a specific action that could conceivably be a standard approach (default option) for some officials in the water management sector. The following respondent highlights this approach as a default *modus operandi*:

“[… ] We would rather monitor the rainfall and decrease in dam levels through the season and call on whether to implement restrictions based on what actually occurs. We have dam level thresholds, per month, and if these are exceeded then we would look at implementing restrictions.”

For the long-term climate change scenarios, five of the nine “No” respondents mentioned that rather than investing in permanent alternative water production technology, they would choose a different approach to ensuring water supply. They were not necessarily averse to taking action to mitigate the risk of water demand exceeding supply but were simply averse to the suggested action.

4.3 DISCUSSION

The dominant decision drivers emerging from the communication format and message-framing experiments are discussed below.

DOMINANT RULES AND PRINCIPLES FOR ACTION

In complex decision-making environments, policymakers and practitioners appear to rely on their known, “tried-and-tested” strategies rather than considering climate data; this allows them to make judgments quickly and efficiently. These “tried-and-tested” strategies shorten decision-making time and allow people to function in complex situations with insufficient information and uncertainty. As discussed, these “tried-and-tested” strategies may represent a form of status quo bias. Hence, efforts to communicate climate information might benefit from:
• Determining the dominant rules or principles for action that decision-makers subscribe to in particular contexts. In both the health and WASH surveys, “prevention is better than cure” appeared to be the dominant principle.
• Determining whether those rules or principles naturally align with desired or ideal climate change adaptation and mitigation actions. The “prevention is better than cure” principle for decision-making is obviously consistent with both climate change mitigation and adaptation. This is an example of a “low regrets” strategy leading to measures that yield benefits even in the absence of climate change (Hallegatte 2009). In such contexts, reducing uncertainty or improving the communication of uncertainty to decision-makers may not be as important as generally assumed.

However, some of the rules or principles for decision-making in a sector will not necessarily be consistent with climate change action. The seasonal WASH surveys potentially represent such an example. In the seasonal WASH scenarios, most respondents who replied, “No, they would not invest,” said that they would defer the decision until later in the season and monitor dam levels, which, as mentioned in the preceding section, might represent the status quo approach for some in the water management sector. The most dominant rule guiding decision-making across the WASH survey was clearly “prevention is better than cure.” But the sizeable proportion of “no” respondents who would defer the decision suggests there are other rules for decision-making in the water management sector. A “defer until later” strategy might not align with ideal climate change adaptation actions as nicely as the “prevention is better than cure” strategy, given, as one example, the possibility that respondents could wait until too late to trigger water restrictions.

MESSAGE PROXIMIZING AND RISK PERCEPTION
Respondents applied their “prevention is better than cure” principles for action not only because this is their fallback response, but also because they were sufficiently convinced that the risk was significant enough to require action. This conviction did not appear to come from the climate probability or gain/loss framing. What, then, might have convinced respondents of the significance of the risk presented? Climate change is, for many people, a psychologically distant issue. This means that people are expected to perceive it as being most likely to impact “distant” people and places (Lorenzoni and Pidgeon 2006; Spence et al. 2012; McDonald et al. 2015; Jones et al. 2017). Such research has led to the hypothesis that bringing climate change “close to home” for people will make them more likely to engage with the issue (Jones et al. 2017). In part, the surveys may have had that effect, as evinced by respondents who drew upon their own knowledge and experiences of the “real world” to answer the question; the majority of these respondents indicated that they would take action to prevent the potential consequences in the scenarios.

The risk perceptions literature has established that concern for an issue follows from people personally experiencing threats or hazards (e.g., Weber 2006). Personal experiences can raise strong emotions, therefore making them more memorable and dominant in information processing (Loewenstein et al. 2001). Indeed, people’s emotional reactions to risks often depend on the vividness with which negative consequences can be imagined (Loewenstein et al. 2001; Weber 2006).
FEAR-FRAMING EFFECT
More significantly, the scenario-based surveys may have emotively struck respondents by being inadvertently “fear framed.” Spence and Pidgeon (2010: 658) describe fear framing as “in effect a more extreme version of a negatively focused loss frame.” They highlight that gain and loss outcomes can be described simply, for example, as whether people will live or not live, or, in the case of the phase 1 survey, as whether people will contract malaria or be saved from contracting malaria. Spence and Pidgeon go on to explain that the threat content of a message can, however, be more strongly emphasized, for example, by describing the size and consequence of the potential loss, e.g., the number and type of deaths. Such language is much more emotive and expected to provoke a greater emotional reaction, and as such, could constitute fear framing. Evidence from the field of psychology suggests that fear framing can indeed be effective in motivating change across various behaviors (e.g., Witte and Allen 2000). The surveys might have, with their language, unintentionally evoked fear framings. They focused on numbers of additional people at risk of contracting malaria, on the percentage of additional people at risk from heat-related illnesses, as well as on the risk that water demand might exceed supply. In retrospect, the surveys used other potentially emotive language when setting the scene, such as “malaria is a life-threatening disease […] malaria is a major cause of illness and death, especially among children,” “extended and severe heat waves leading to an increased number of deaths due to heatstroke, respiratory disease and cardiovascular disease,” “Your city relies solely on dam storage for water supply […] would not be sufficient by a significant margin to meet the demand for water.” The hypothesis that fear framing was inadvertently a part of the surveys is strengthened by the anomaly encountered in the phase 2 health survey, in which (unlike in the phase 1 or WASH surveys), a sizeable proportion of the “No, they would not invest” respondents focused on the potential negative consequences of not taking action. This appeared to be explained by the fact that the scenario provided them with a percentage increase in deaths, rather than an absolute number. Respondents in this survey might have had fewer emotional reactions to the risk compared with, for instance, the phase 1 survey scenario, in which numbers of people contracting (or being saved from contracting) malaria were given.

EFFICACY TO ACT
As stated above, the literature has shown that fear-based, threatening messages can be effective, but the literature has also shown that these narratives are likely to be counterproductive—because they drive down people’s feelings of self-efficacy—unless they are coupled with messages that are empowering. Thus, the messages most effective for changing behavior stress the negative consequences of the current behavior while providing recommendations for avoiding the negative consequences (e.g., Witte and Allen 2000; O’Neill et al. 2013). This study supports this notion: many respondents focused on the size and consequence of the potential losses under the scenarios. At the same time, most respondents chose to act, and in part this might have been because the survey scenario provided a course of action.
PERSONAL VS. SOCIETAL FRAMINGS
On a side note, people distinguish between personal and societal impacts of climate change, and they judge their personal risks of climate change to be lower than the risks to society (e.g., Leiserowitz 2005). Thus, framing climate change as a personal risk could lead people to underestimate the problem. It is also possible to extrapolate from such studies that framing climate change in terms of societal risks could increase the relevance of the issue for practitioners or policymakers who have to make decisions for national or urban populations. Such an extrapolation could potentially explain some of the action bias that was observed in the surveys and is a topic worthy of future investigation.

THE ROLE OF CLIMATE DATA AND UNCERTAINTY
Finally, there was generally little engagement with climate data and with the notion of uncertainty. In the workshop exercises, where participants explored experiential information formats through narratives and infographics, the two future scenarios in either of these formats received no mention except when prompted by facilitators. In the message-framing experiment, the majority of respondents did not appear to take the climate information into consideration. Where they did, respondents appeared more likely to interpret the climate projection in ways that allowed them to justify decisions taken on other grounds, than to “objectively” use the climate data in decision-making. This finding might be a result of assimilation bias/biased assimilation, which is the tendency for people who hold pre-existing assumptions and expectations to mistakenly perceive new information or evidence as confirming those assumptions and expectations—in other words, to be assimilated into pre-existing assumptions and expectations (Lord and Taylor 2009). Biased assimilation, for instance, has been used to explain why people less sceptical and more sceptical about climate change evaluate in markedly different ways the persuasiveness and reliability of newspaper editorials that make opposing claims about the reality and seriousness of climate change (Corner et al. 2012). However, as was illustrated in the workshop, scenarios presented through experiential information, such as narratives and infographics, can trigger exploration and discussion of climate-related uncertainty and what it means in a local or specific context. Hence, co-exploration of experiential information, to work toward strengthening robust decision-making under climate uncertainty, may be warranted.
It is important to note that the qualitative results are exploratory and are to be viewed as theory-generating and not theory-testing. The strength of qualitative analysis lies in its in-depth, inductive approach, rather than an extensive or numerical approach. It is employed to develop hypotheses, as opposed to testing them (Malterud 2001).
5. MOVING BEYOND CLIMATE INFORMATION: UNDERSTANDING DECISION DRIVER THROUGH CO-LEARNING

While the overall feedback from providing experiential communication techniques (narratives and infographics) to the decision-makers was positive, there was a perceived gap between the information provided and the information required for decision-making. This gap was expressed as a lack of information on specific impacts within a particular sector, and a lack of information pointing decision-makers toward solutions or responses. This latter reason, in particular, raises a question about the limits of climate information and whether the expectation of solution-oriented information is achievable within the current approach to climate services.

A fundamental gap lies in understanding the context of decision-making and the principles and rules guiding decision-making. The solution to this challenge possibly lies in transdisciplinary co-learning (outlined in the next section) to make explicit the knowledge, values, norms, and approaches to decision-making among all people with knowledge to contribute, including producers of information, intermediaries, users of information, and climate scientists. We outline a case study of the most recent evolution of climate risk narrative development using co-learning process.

5.1 CO-VISIONING THE CLIMATE INFORMATION DECISION CONTEXT

During the early stages of testing the concept of climate risk narratives, the draft stories were first written solely by the climate scientist, meaning that they mainly represented a single perspective of someone detached from the context. These stories were then relayed to the intended users to add nuance and correct inaccuracies (as was the case for the workshop narratives in this study). As the climate risk narrative process has evolved, so has the need to shift the responsibility for story development from the climate scientist to the users. The users are tasked with envisioning, describing, and documenting (using their own terminology) a holistic future of their sector or region, excluding potential climate changes. These visions typically include sociodemographic changes, infrastructure changes, and political stagnation or transformation and are more accurate for the sector than could be written by an outside scientist. Projected climate information is then integrated into the story to form multiple possible futures.

As primary responsibility has shifted from the climate scientist to the user, it has become evident that the development process itself is more valuable than the final climate risk narratives. The development process elucidates rich information about the decision context, dominant mindsets of the target audience, and the terminology that resonates with them. Participant comments expressed this sentiment:
If nothing else, the narrative process provided a great platform for information sharing and learning what others are actually doing. This is an ongoing challenge.6

“Discussion was so valuable; especially discussions around worst-case scenarios.”6

“Allowed me to think broader.”7

The climate risk narrative process has shifted from developing a communication device to co-producing, making knowledge explicit, and integrating knowledge across knowledge holders in a decision context. Making this contextual knowledge explicit increases user awareness of and buy-in to the potential impacts of a changing climate, and it starts discussions about actions that could mitigate climate change.

The case study described below documents a recent climate risk narrative development process and the learning associated with it.

CASE STUDY: CLIMATE RISK NARRATIVE DEVELOPMENT IN THE MAPUTO WATER SECTOR

Through the Future Resilience for African Cities and Lands (FRACTAL) project, a City Water Dialogue was held with 22 representatives of the water sector in Maputo in February 2018. Water sector representatives included local, regional, and national government entities, parastatal organizations, and scientific institutions. Several institutions are responsible for water governance in Maputo. During the dialogue, the participants were tasked with undertaking a “three time horizons” mapping’ exercise (Figure 1). Participants first documented the challenges inherent in the current water supply system as experienced by each institution. Second, they performed a group visioning of an ideal scenario for the sector in 2040 alongside a worst-case scenario. Finally, elements of the transition phase were identified—elements that would allow the sector to transition from its current form (business-as-usual) to that of the ideal 2040 scenario. This process also allowed for identification of “seeds” of the current situation that may act as catalysts for the transition to an ideal future scenario.

Using the results of this visioning exercise, a FRACTAL-embedded city researcher and a FRACTAL climate scientist jointly collated the vision into a set of climate risk narratives for the Maputo water sector. These will be used as a basis for discussion during the next Maputo city water dialogue.

While the aim of the process was to develop a climate risk narrative for decision-making, the climate risk narratives have not proved the most beneficial part of the co-productive process. The visioning process provided a forum for rich debate and discussion about the failings and achievements of the water supply sector in Maputo. It brought together actors from across the water sector who had previously not interacted with each other and, thereby, started a process of network building that is essential for the sustainability of the water supply. It elicited discussion of the goals and principles that drive decisions within the Maputo water sector, which brought to light critical contextual knowledge.

6 Quoted from feedback on the narrative development process in Blantyre.
7 Quoted from the feedback on the narrative development process in Gaborone.
In addition to the transdisciplinary visioning process, there are many potentially useful approaches to making explicit the guiding principles and rules for decision-making, such as stakeholder and institutional mapping, discourse analysis and sociocultural studies. For climate services, however, the visioning process may be a first step toward better integration of climate information into decision-making.
Figure 1: Visioning long term change in Maputo

Three time horizons: long-term change
Strategic conversation about the future of water in Maputo

Note: The results of the three horizons (H1, H2 and H3) mapping exercise performed for the Maputo water sector (Maputo city learning dialogue: FRACTAL project). Source: Steynor et al. 2016
6. SUMMARY AND RECOMMENDATIONS

While the study set out to test the effect of message framing and format on the uptake of uncertain climate information, the results were inconclusive and raised further questions. However, the secondary learning that resulted from the process was arguably more informative than the original learning objectives.

It appears that people act on a future risk (whether it is short term or long term) based on sector-specific, generically applicable rules or principles for taking action in situations where a risk may increase. For both the health and WASH sectors, the main principle for action appears to be “prevention is better than cure.” Meanwhile, people’s perceptions that a risk might increase and lead to negative outcomes appear to be informed by (i) whether the decision scenario and outcomes are sufficiently “fear framed”; (ii) their background/characteristics, including their pre-existing beliefs, and (iii) their experiences and knowledge of the “real world.” Through both the workshop and the surveys, it also emerged that decision-makers be provided with a specific solution or action they can take to deal with the risk (for example, the decision to reallocate budget in a specific suggested manner), which might increase their perceived efficacy to act.

Again, through both the workshop and the survey, the uncertainty in the climate information did not appear to play a significant role in influencing decision-making. Most people in the study did not note differing future scenarios as a barrier to engagement and instead focused on particular messages of impact that were interesting to them. In addition, when a climate probability was introduced, they did not appear to notice it, nor to be influenced by whether it was “objectively” high or low. They seemed to prefer instead to “read” it in a way that was consistent with their chosen course of action.

Under these conditions, focusing on communicating climate uncertainty to decision-makers may be less important than other strategies. The study suggests the following approaches for engaging decision-makers on climate change issues:

- Through transdisciplinary co-learning approaches, gain a common understanding of the problem space, the actors within that space, the real nature of the problem (which is often poorly understood and even contested) and the rules and principles that guide decision-making. One potential approach is co-visioning to explore scenarios of change and options to mitigate unwanted changes/impacts (see section 5). Through the understanding gained in a transdisciplinary process, consider framing climate information, impacts, and solutions in ways that are consistent with the rules and principles for decision-making within a sector. Do the rules or principles align with desired climate adaptation and mitigation actions? If the rules and principles do not align, consider changing the status quo through sustained transdisciplinary engagements and other engagement mechanisms (see final point).
• Assess whether the backgrounds, characteristics (e.g., values and beliefs), and real-world experiences of decision-makers might already lead them to believe that a particular climate-related risk is significant and that it will result in negative outcomes. Communication and engagement efforts can focus on resonating with the backgrounds, characteristics, and real-world experiences of decision-makers, using fear framing and increasing perceived efficacy to act. For instance, climate-related messages and engagement techniques can be tied to the risks and negative consequences that people experience in their personal or professional capacities, and, through co-exploration processes, outline courses of action to avert the risks.

• The above is consistent with the literature suggesting that information on climate change should be presented in ways that are concrete, personalized, and vivid, i.e., that it should target the experiential processing system of the brain (e.g., Marx and Weber 2012). Most often, however, climate information is communicated in an analytical format.

• There will be situations where the status quo and context for decision-making do not align well with dealing with climate change (as already noted). Further, there will be situations in which the backgrounds, characteristics, and real-world experiences of decision-makers also may work against climate change decision-making and action. As such, and as widely noted in the behavior change literature, the provision of information alone (as much of the current climate services field relies on) will not be sufficient to change behavior (e.g. McKenzie-Mohr 2011). In these cases, there is an even greater need for sustained transdisciplinary engagements to integrate climate knowledge into decision-making.

• Finally, the behavioral economics literature suggests that people’s tendency to follow the status quo—i.e., to choose the “default” option—can be used to influence their decision-making by making the desired option the default option. Matjasko et al. (2016) provide examples from the health field of shifting people to healthier diets with strategies such as substituting sliced apples for French fries in children’s meals or limiting portion sizes in restaurants and other catering environments. In climate change, Weber (2015: 577) also notes that behavior change can be facilitated by “innovative no-choice defaults” and “changes in the status quo.” She cites the example of Germany and other countries that outlawed incandescent lightbulbs, thereby changing the status quo for consumers (by making compact fluorescent lightbulbs the status quo). These examples of using strategies from the fields of behavioral economics and psychology have been discussed primarily in terms of influencing decision-making of the general public and consumers. More work will be required that considers modifying the context in which practitioners and policymakers operate, to make their default choices—when faced with uncertainty—consistent with desired climate change mitigation and adaptation actions.
7. REFERENCES


Monroe, M.C., Bode, C.L., and Megalos, M.A. (2015). Challenges in communicating climate change to extension audiences. FOR324, School of Forest Resources and Conservation, UF/IFAS Extension.


ANNEX 1: MAPUTO RISK NARRATIVES AND INFOGRAPHICS

MAPUTO NARRATIVES

Narrative 1: Warmer and decreasing rainfall
It is 2035 and average early summer temperatures are 1.5°C higher than they were back in the late 20th century, while winter temperatures are around 1°C higher. Heat waves (more than 5 days above 36°C combined with warm nights) are more common than they used to be in the summer months, which starts causing an increase in heat-stress–related health problems, particularly for the elderly. Wealthier residents have invested in air conditioning in response, but this, combined with rapid population growth, has contributed to increases in electricity demand, particularly during the summer months.

Higher average temperatures mean that the malaria season is now longer in the city and surrounds, as mosquitoes and parasites are able to breed more rapidly when temperatures are higher. While reductions in rainfall have reduced the occurrence of standing water to some extent, this hasn’t mitigated the effect of increasing temperatures except for particularly dry years. In addition, while the frequency of very wet summers has declined, they do still occur, and when they do, the combination of high temperatures and standing water produces acute rates of malaria infection in the city and more so in the surrounding peri-urban areas.

Rising sea levels and storm surges associated with tropical cyclones and strong tropical storm systems have caused extensive erosion along unprotected sections of the coastline, impacting newer residential and tourism developments along the coastline.

The peri-urban areas around Maputo have shifted their small-scale agriculture to different crops because average rainfall has dropped, and the season has shifted towards later. Higher temperatures mean that some crops commonly grown in the late 20th century are now no longer viable. Wealthier farmers have implemented irrigation, drawing from groundwater.

The city has resorted to increased groundwater extraction to match the rapidly growing demand for water in the city as a result of urbanization and population growth. Groundwater levels are now critically low and associated costs are climbing. The local dam (Pequenos Libombos) that used to provide water to Maputo is now generally dry and the city is actively investigating alternative water sources, including pumping water from the Limpopo River 200 km to the northeast. Energy demand for water extraction and transfers compounds with the increased energy demand for cooling, stressing the energy supply networks and limiting water supply options.
A reduction in rainfall and reduction in the frequency of heavy rainfall events means the flooding is typically less of a problem in Maputo than it used to be. However, high sea-levels mean that drainage rates have changed and many low-lying areas along the coastline flood more frequently than they used to.

**Narrative 2 | Hotter and increasing rainfall extremes**

It is 2035 and average early summer temperatures are 2C higher than they were back in the late 20th century, while winter temperatures are around 1.5C higher. Heat waves (more than 5 days above 36C combined with warm nights) are twice as common as they used to be in the summer months, which has caused an acute increase in heat-stress-related health problems, particularly for the elderly. Wealthier residents have invested in air conditioning in response, but this, combined with rapid population growth, has contributed to increases in energy demand, particularly during the summer months.

Higher average temperatures mean that the malaria season is now longer in the city and surrounds as mosquitoes and parasites are able to breed more rapidly when temperatures are higher. While average summer rainfall hasn’t changed significantly from the late 20th century, when periodic wet summers do occur, the combination of high temperatures and standing water result in acute rates of malaria infection. Even in dry years, the reduction in standing water does not mitigate the effect of increasing temperatures, and malaria rates remain higher than in the late 20th century.

Rising sea levels and storm surges associated with tropical cyclones and strong tropical storm systems have caused extensive erosion along unprotected sections of the coastline, impacting newer residential and tourism developments along the coastline.

Even though total rainfall has not significantly decreased, increased evaporation rates and the rapidly increasing population growth and urbanization and resultant increase in water demand has forced the city to increase groundwater extraction and investigate alternative waters sources, including pumping water from the Limpopo River 200 km to the northeast.

While average rainfall has not changed significantly, the intensity of rainfall events and the frequency of heavy rainfall events during the main rainy season are higher than they used to be, particularly in wet years. The combination of this with increased area coverage of hard surfaces and poor drainage means that some areas of Maputo experience flooding more often than they used to, resulting in health and economic impacts. This is made worse by higher sea levels, which means that drainage rates have changed and many low-lying areas along the coastline flood far more frequently than they used to.
Figure A1: Shows consistent increase in average temperatures across the year. DJF= December-January-February, MAM = March-April-May, JJA= June-July-August, SON= September-October-November.

North-East
Temporal evolution of seasonal mean of daily maximum temperature
CMIP5 GCM MME (rcp85)

Figure A2: Shows consistent increase in frequency of days above 35°C. DJF= December-January-February, MAM = March-April-May, JJA= June-July-August, SON= September-October-November.
Figure A3: Some model projections show decreasing rainfall in winter (Jul-Aug) and the early rainy season (Sep-Nov) on the order of 25% reduction by the 2030s.

Figure A4: Some model projections show increasing frequency of 95th percentile rainfall events in the core rainy season (Dec-Feb), and some show decreasing frequency, particularly in winter (Jun-Aug) and the early rainy season (Sep-Nov).
Figure A5: Some model projections show increasing average intensity of rainfall in the core rainy season (Dec-Feb), and some show decreasing intensity, particularly in winter (Jun-Aug) and the early rainy season (Sep-Nov).
IT’S THE YEAR 2035 IN MAPUTO

SCENARIO

- **LESS RAIN**
  - Average early summer temperatures are 1.5°C higher
- **WARMER**
  - Average winter temperatures are 1°C higher
- **HEAT WAVES** are more common
- **AVERAGE RAINFALL** has decreased

IMPACTS

**HEALTH**
- When wet summers do occur, high temperatures and standing water lead to acute rates of malaria infection.
- Increase in heat stress-related health problems, particularly for the elderly.

**ELECTRICITY DEMAND**
- Increased use of air conditioning among wealthier residents, particularly in summer, together with increased need for pumping and transferring water, contribute to increased energy demand.

**WATER SCARCITY**
- More farmers are irrigating with groundwater, and the city has increased groundwater extraction to meet growing demand. Groundwater levels are critically low.

**COASTLINE EROSION**
- Rising sea levels and storm surges cause erosion along unprotected sections of the coastline, impacting new residential and tourism developments.

**CROPS**
- Seasonal shifts, decreased rainfall, and higher temperatures have led to changes in types of crops grown, with some previously common crops no longer viable.

**SERVICE DELIVERY COSTS**
- The local dam (Pequeno Lubombo) is mostly dry and groundwater levels are critically low. The city is investigating alternative sources, including pumping water from the Limpopo river 200km away. Infrastructure and pumping costs are seeing a significant increase.

**FLOODING**
- Frequent heavy rain events make flooding a less frequent problem. However, higher sea levels mean low-lying coastal areas flood more often.
IT'S THE YEAR 2035 IN MAPUTO

SCENARIO

AVERAGE EARLY SUMMER TEMPERATURES ARE 2°C HIGHER
AVERAGE WINTER TEMPERATURES ARE 1.5°C HIGHER
HEAT WAVES ARE 2X AS COMMON
HEAVY RAINFALL EVENTS ARE MORE INTENSE & MORE FREQUENT

IMPACTS

HEALTH

Higher average temperatures have increased the length of the malaria season. Malaria infection rates are generally higher, even during dry years, due to high temperatures.

Increase in heat stress related health problems, particularly for the elderly.

ELECTRICITY DEMAND

Wealthier residents use air conditioning more. This and rapid population growth has contributed to increased energy demand, particularly in summer.

WATER SCARCITY

Rainfall has not significantly decreased but increased evaporation rates and population growth and urbanization have increased water demand. The city is increasing groundwater extraction and exploring alternative water sources.

COASTLINE EROSION

Rising sea levels and storm surges cause extensive erosion along unprotected sections of the coastline, impacting newer residential and tourism developments.

INFRASTRUCTURE COSTS

The local dam (Fremosur-Libombo) is mostly dry and groundwater levels are decreasing. The city is investigating alternative sources, including pumping water from the Limpopo river 200km away. Infrastructure and pumping costs are on the rise.

FLOODING

More intense and more frequent heavy rainfall events, together with increased hard surface area coverage and poor drainage, means that some areas flood more often. Higher sea-levels and changed drainage rates mean low lying coastal areas flood more often.
ANNEX 2: SURVEY QUESTIONS

PHASE 1 SURVEY: SEASONAL HEALTH SCENARIO
This exercise seeks to understand the ways climate information might influence decision-making in the health sector. Please imagine you are a policy-maker for the health sector in Mozambique. Your task is deciding how to allocate the new malaria budget for the coming year.

One of the key diseases that the Mozambican health sector has to manage and control is malaria. Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected mosquitoes. In Mozambique, malaria is a major cause of illness and death, especially among children. According to the historical records, up to 6 million people contract malaria in Mozambique every year. Episodes of increased temperature have been shown to relate to increases in malaria transmission.

**There is a decision that needs to be made:**
[participants are given one of the following four scenarios]

**Scenario 1: High climate probability scenario framed as a gain (-)**
The available seasonal forecast projections indicate a 65% probability that temperatures will be 1 degree higher than average in the coming season, meaning that more people will be at risk of contracting malaria in the country. If the average seasonal temperature in Mozambique is 1 degree above historical average (unusually hotter for the season) and if you choose to invest in further preventative measures in malaria-affected areas, at least 120 000 additional people will be saved from contracting malaria.

**Scenario 2: Low climate probability scenario framed as a gain (-)**
The available seasonal forecast projections indicate a 35% probability that temperatures will be 1 degree higher than average in the coming season, meaning that more people will be at risk of contracting malaria in the country. If the average seasonal temperature in Mozambique is 1 degree above historical average (unusually hotter for the season) and if you choose to invest in further preventative measures in malaria-affected areas, at least 120 000 additional people will be saved from contracting malaria.

**Scenario 3: High climate probability scenario framed as a loss (-)**
The available seasonal forecast projections indicate a 65% probability that temperatures will be 1 degree higher than average in the coming season, meaning that more people will be at risk of contracting malaria in the country. If the average seasonal temperature in Mozambique is 1 degree above historical average (unusually hotter for the season) and if you choose not to invest in further preventative measures in malaria-affected areas, at least 120 000 additional people will contract malaria.
Scenario 4: Low climate probability scenario framed as a loss (-)
The available seasonal forecast projections indicate a 35% probability that temperatures will be 1 degree higher than average in the coming season, meaning that more people will be at risk of contracting malaria in the country. If the average seasonal temperature in Mozambique is 1 degree above historical average (unusually hotter for the season) and if you choose not to invest in further preventative measures in malaria-affected areas, at least 120 000 additional people will contract malaria.

Given this information on the probability of the seasonal projection and the associated risk of contracting malaria, you need to decide whether you will invest in further preventative measures by allocating 20% of your funds from the malaria treatment budget into the malaria prevention budget.

Would you take 20% from the treatment budget to invest the additional 20% in prevention? Yes/No

Part 2
Socio-economic Questions
Please tick one box only or fill in the answer where appropriate

1. Please explain your main reason for making the decision you made regarding the budget __________

2. Have you or any of your immediate family members ever had malaria? Yes/No

3. Which of the following three statements do you personally believe?
   a. Climate change (global warming) is happening, caused mainly by human activities.
   b. Climate change (global warming) is happening, but caused mainly by natural forces.
   c. Climate change (global warming) is NOT happening.
   d. None of the above

4. Do you believe that an increase in temperature has an influence on malaria? Yes / no / don’t know

5. Gender:
   a. Female
   b. Male

6. Age: 18-24 years old / 25-34 years old / 35-44 years old / 45-54 years old / 55-64 years old / 65-74 years old / 75 years or older

7. What is your first language?

8. Is your profession in, or directly related to, the health field? Yes/No

9. Is your profession in, or directly related to, climate science? Yes/No
PHASE 2 SURVEY: HEALTH AND WASH SCENARIOS

Health

Please imagine you are a policy-maker in the health sector. Your task is deciding how to allocate the health budget. You will be presented with a pair of scenarios (this page and the next page). Please answer both. These scenarios do not represent the complexity of real life and may seem unfeasible and/or unrealistic; however, please take them as hypothetical and answer them based on the information you are given.

Please imagine you are a policy-maker for the national health sector. Your task is deciding how to allocate the health budget for the coming year.

[participants are given one of the following four pairs of scenarios]

Scenario 1

*There is a decision that needs to be made:*

The available seasonal forecast projections indicate a 65% (high) probability that the summer season will be associated with extended and severe heat waves leading to an increased number of deaths due to heatstroke, respiratory disease and cardiovascular disease.

In order to have the time to set up the required response programs, you would need to set up a heatwave planning and response unit now. If there are extended and severe heatwaves in the coming season and you choose not to establish the planning and response unit now, then at least 20% additional people will die from heat-related illnesses in the next summer season.

Given this information on the probability of the seasonal projection and the associated risk of heat-related illness, you need to make a decision. Will you invest in a heatwave planning and response unit now by allocating 10% of your funds from the rest of your health budget into development of the unit? This would mean that you have 10% less funds to address other pressing health concerns.

Would you take 10% from the rest of your health budget and invest this into a heatwave planning and response unit?

Yes/No

*There is another decision that needs to be made:*

The available climate projections indicate a 65% (high) probability that severe heatwaves will occur at least once a year from 2030 onwards, leading to an increased number of deaths due to heatstroke, respiratory disease and cardiovascular disease.
If this scenario occurs and you choose not to invest now in a long-term process for integrating heat-related illness response measures into standard operating procedures, it will mean that at least 20% additional people each year will die from heat related illnesses from 2030 onwards.

Given this information on the probability of the climate projection and the associated risk of heat-related illness, you need to make a decision. Will you invest now in establishing a process that enables the national health service to integrate heat-related illness response measures into standard operating procedures? This would mean allocating 10% of the funds from the rest of your health budget into the program, meaning that you have 10% less funds to address other pressing health concerns.

Would you take 10% from the rest of your health budget and invest this into a heatwave preparedness process?

Yes/No

Scenario 2

There is a decision that needs to be made:

The available seasonal forecast projections indicate a 35% (low) probability that the summer season will be associated with extended and severe heat waves leading to an increased number of deaths due to heatstroke, respiratory disease and cardiovascular disease. In order to have the time to set up the required response programs you would need to set up a heatwave planning and response unit now. If there are extended and severe heat waves in the coming season and you choose not to establish the planning and response unit now, then at least 20% additional people will die from heat-related illnesses in the next summer season.

Given this information on the probability of the seasonal projection and the associated risk of heat-related illness, you need to make a decision. Will you invest in a heatwave planning and response unit now by allocating 10% of your funds from the rest of your health budget into development of the unit? This would mean that you have 10% less funds to address other pressing health concerns.

Would you take 10% from the rest of your health budget and invest this into a heatwave planning and response unit?

Yes/No

There is another decision that needs to be made:

The available climate projections indicate a 35% (low) probability that severe heat waves will occur at least once a year from 2030 onwards, leading to an increased number of deaths due to heatstroke, respiratory disease and cardiovascular disease.
If this scenario occurs and you choose not to invest now in a long-term process for integrating heat-related illness response measures into standard operating procedures, it will mean that at least 20% additional people each year will die from heat-related illnesses from 2030 onwards.

Given this information on the probability of the climate projection and the associated risk of heat-related illness, you need to make a decision. Will you invest now in establishing a process that enables the national health service to integrate heat-related illness response measures into standard operating procedures? This would mean allocating 10% of the funds from the rest of your health budget into the program, meaning that you have 10% less funds to address other pressing health concerns.

Would you take 10% from the rest of your health budget and invest this into a heatwave preparedness process?

Yes/No

Scenario 3:

There is a decision that needs to be made:

The available seasonal forecast projections indicate a 65% (high) probability that the summer season will be associated with extended and severe heatwaves leading to an increased number of deaths due to heatstroke, respiratory disease and cardiovascular disease.

In order to have the time to set up the required response programs, you would need to set up a heatwave planning and response unit now. If there are extended and severe heatwaves in the coming seasons and you choose to establish the planning and response unit now, then at least 20% additional people will be saved from heat-related illnesses in the next summer season.

Given this information on the probability of the seasonal projection and the associated risk of heat-related illness, you need to make a decision. Will you invest in a heatwave planning and response unit now by allocating 10% of your funds from the rest of your health budget into development of the unit? This would mean that you have 10% less funds to address other pressing health concerns.

Would you take 10% from the rest of your health budget and invest this into the heatwave planning and response unit?

Yes/No

There is another decision that needs to be made:

The available climate projections indicate a 65% (high) probability that severe heat waves will occur at least once a year from 2030 onwards, leading to an increased number of deaths due to heatstroke, respiratory disease and cardiovascular disease.
If this scenario occurs and you choose to invest now in a long-term process for integrating heat-related illness response measures into standard operating procedures, it will mean that at least 20% additional people each year will be saved from heat related illnesses from 2030 onwards.

Given this information on the probability of the climate projection and the associated risk of heat-related illness, you need to make a decision. Will you invest now in establishing a process that enables the national health service to integrate heat-related illness response measures into standard operating procedures? This would mean allocating 10% of the funds from the rest of your health budget into the program, meaning that you have 10% less funds to address other pressing health concerns.

Would you take 10% from the rest of your health budget and invest this into a heatwave preparedness process?

Yes/No

Scenario 4:

There is a decision that needs to be made:

The available seasonal forecast projections indicate a 35% (low) probability that the summer season will be associated with extended and severe heatwaves leading to an increased number of deaths due to heatstroke, respiratory disease and cardiovascular disease.

In order to have the time to set up the required response programs, you would need to set up a heatwave planning and response unit now. If there are extended and severe heat waves in the coming seasons and you choose to establish the planning and response unit now, then at least 20% additional people will be saved from heat-related illnesses in the next summer season.

Given this information on the probability of the seasonal projection and the associated risk of heat-related illness, you need to make a decision. Will you invest in a heatwave planning and response unit now by allocating 10% of your funds from the rest of your health budget into development of the unit. This would mean that you have 10% less funds to address other pressing health concerns.

Would you take 10% from the rest of your health budget and invest this into the heatwave planning and response unit?

Yes/No

There is another decision that needs to be made:

The available climate projections indicate a 35% (low) probability that severe heatwaves will occur at least once a year from 2030 onwards, leading to an increased number of deaths due to heatstroke, respiratory disease and cardiovascular disease.
If this scenario occurs and you choose to invest now in a long-term process for integrating heat-related illness response measures into standard operating procedures, it will mean that at least 20% additional people each year will be saved from heat related illnesses from 2030 onwards.

Given this information on the probability of the climate projection and the associated risk of heat-related illness, you need to make a decision. Will you invest now in establishing a process that enables the national health service to integrate heat-related illness response measures into standard operating procedures? This would mean allocating 10% of the funds from the rest of your health budget into the program, meaning that you have 10% less funds to address other pressing health concerns.

Would you take 10% from the rest of your health budget and invest this into a heatwave preparedness process?

Yes/No

WASH
Please imagine you are a policy-maker in the water sector. Your task is deciding how to allocate the water budget. You will be presented with two different scenarios (this page and the next page). Please answer both. These scenarios do not represent the complexity of real life and may seem unfeasible and/or unrealistic; however, please take them as hypothetical and answer them based on the information you are given.

[participants are given one of the following four pairs of scenarios]

Scenario 1:
There is a decision that needs to be made:

Your city relies solely on dam storage for water supply. The available seasonal forecast projects a 65% (high) probability that rainfall in the coming rainy season will be lower than average, meaning that the recharge of the dams would not be sufficient by a significant margin to meet the demand for water in the coming dry season.

If this scenario occurs and you decide not to institute water restrictions for the coming year, then demand for water will exceed supply.

Given this information on the probability of the seasonal forecast, you need to decide whether you will institute water restrictions. This would mean you would receive 15% less income from water usage tariffs in the coming year, and you would have 15% less funds to address other pressing water management concerns.

Would you institute water restrictions?

Yes/No
There is another decision that needs to be made:

Your city relies solely on dam storage for water supply. The available climate projections indicate a 65% (high) probability that rainfall will decrease by 10% or more by 2030, meaning that there will be insufficient water available from dam storage by as early as 2025. Corresponding projections of demand show that demand will remain stable up to 2030.

If this scenario occurs and you decide not to start investing in permanent alternative water production this year, then demand for water will start exceeding supply in the foreseeable future.

Given this information on the probability of the climate projection, you need to decide whether you will start investing in alternative water sources now, in order to be ready. To do this, you would need to allocate 8% of each year’s water supply budget over the next 7 years into permanent alternative water production technology. This would mean that you have 8% less funds to address other pressing water management concerns.

Would you allocate 8% of your overall annual budget, each year for the next 7 years, to investing in alternative water sources?

Yes/No

Scenario 2:
Please imagine you are a policy-maker in the water sector. Your task is deciding how to allocate the water budget for the coming year.

There is a decision that needs to be made:

Your city relies solely on dam storage for water supply. The available seasonal forecast projects a 35% (low) probability that rainfall in the coming rainy season will be lower than average, meaning that the recharge of the dams would not be sufficient by a significant margin to meet the demand for water in the coming dry season.

If this scenario occurs and you decide not to institute water restrictions for the coming year, then demand for water will exceed supply.

Given this information on the probability of the seasonal forecast, you need to decide whether you will institute water restrictions. This would mean you would receive 15% less income from water usage tariffs in the coming year, and you would have 15% less funds to address other pressing water management concerns.

Would you institute water restrictions?

Yes/No
There is another decision that needs to be made:
Your city relies solely on dam storage for water supply. The available climate projections indicate a 35% (low) probability that rainfall will decrease by 10% or more by 2030, meaning that there will be insufficient water available from dam storage by as early as 2025. Corresponding projections of demand show that demand will remain stable up to 2030.

If this scenario occurs and you decide not to start investing in permanent alternative water production this year, then demand for water will start exceeding supply in the foreseeable future.

Given this information on the probability of the climate projection, you need to decide whether you will start investing in alternative water sources now, in order to be ready. To do this, you would need to allocate 8% of each year’s water supply budget over the next 7 years into permanent alternative water production technology. This would mean that you have 8% less funds to address other pressing water management concerns.

Would you allocate 8% of your overall annual budget, each year for the next 7 years, to investing in alternative water sources?

Yes/No

Scenario 3:
Please imagine you are a policy-maker in the water sector. Your task is deciding how to allocate the water budget for the coming year.

There is a decision that needs to be made:
Your city relies solely on dam storage for water supply. The available seasonal forecast projects a 65% (high) probability that rainfall in the coming rainy season will be lower than average, meaning that the recharge of the dams would not be sufficient by a significant margin to meet the demand for water in the coming dry season.

If this scenario occurs and you decide to institute water restrictions for the coming year, then demand for water will not exceed supply.

Given this information on the probability of the seasonal forecast, you need to decide whether you will institute water restrictions. This would mean you would receive 15% less income from water usage tariffs in the coming year, and you would have 15% less funds to address other pressing water management concerns.

Would you institute water restrictions?

Yes/No
There is another decision that needs to be made:

Your city relies solely on dam storage for water supply. The available climate projections indicate a 65% (high) probability that rainfall will decrease by 10% or more by 2030, meaning that there will be insufficient water available from dam storage by as early as 2025. Corresponding projections of demand show that demand will remain stable up to 2030.

If this scenario occurs and you decide to start investing in permanent alternative water production this year, then demand for water will not start exceeding supply in the foreseeable future.

Given this information on the probability of the climate projection, you need to decide whether you will start investing in alternative water sources now, in order to be ready. To do this, you would need to allocate 8% of each year’s water supply budget over the next 7 years into permanent alternative water production technology. This would mean that you have 8% less funds to address other pressing water management concerns.

Would you allocate 8% of your overall annual budget, each year for the next 7 years, to investing in alternative water sources?

Yes/No

Scenario 4:
Please imagine you are a policy-maker in the water sector. Your task is deciding how to allocate the water budget for the coming year.

There is a decision that needs to be made:

Your city relies solely on dam storage for water supply. The available seasonal forecast projects a 35% (low) probability that rainfall in the coming rainy season will be lower than average, meaning that the recharge of the dams would not be sufficient by a significant margin to meet the demand for water in the coming dry season.

If this scenario occurs and you decide to institute water restrictions for the coming year, then demand for water will not exceed supply.

Given this information on the probability of the seasonal forecast, you need to decide whether you will institute water restrictions. This would mean you would receive 15% less income from water usage tariffs in the coming year, and you would have 15% less funds to address other pressing water management concerns.

Would you institute water restrictions?
Yes/No
There is another decision that needs to be made:

Your city relies solely on dam storage for water supply. The available climate projections indicate a 35% (low) probability that rainfall will decrease by 10% or more by 2030, meaning that there will be insufficient water available from dam storage by as early as 2025. Corresponding projections of demand show demand will remain stable up to 2030.

If this scenario occurs and you decide to start investing in permanent alternative water production this year, then demand for water will not start exceeding supply in the foreseeable future.

Given this information on the probability of the climate projection, you need to decide whether you will start investing in alternative water sources now, in order to be ready. To do this, you would need to allocate 8% of each year’s water supply budget over the next 7 years into permanent alternative water production technology. This would mean that you have 8% less funds to address other pressing water management concerns.

Would you allocate 8% of your overall annual budget, each year for the next 7 years, to investing in alternative water sources?
Yes/No
[Follow-on Questions]

1. Please explain your main reason for your decision on the budget.

2. Which of the following three statements do you personally believe?
   a. Climate change (global warming) is happening, caused mainly by human activities.
   b. Climate change (global warming) is happening, but caused mainly by natural forces.
   c. Climate change (global warming) is NOT happening.
   d. None of the above

3. Do you believe that heatwaves have health implications?
   [ ] Yes  [ ] No  [ ] Don’t know

4. Gender you identify as
   a. Male
   b. Female
   c. Transgender
   d. Non-binary
   e. None of these

5. Your age
   a. 18-24 years old
   b. 25-34 years old
   c. 35-44 years old
   d. 45-54 years old
   e. 55-64 years old
   f. 65-74 years old
   g. 75 years or older

6. What is your first language?

7. Which country do you currently live in?

8. Is your profession in, or directly related to, the [health/WASH] field?
   a. Yes/no

9. Is your profession in, or directly related to, climate science?
   a. Yes/no
ANNEX 3: SURVEY STATISTICS

RESULTS OF THE FOUR SURVEY VARIATIONS

Phase 1: Seasonal health survey
Contingency table of GAIN responses

<table>
<thead>
<tr>
<th></th>
<th>Gain Frame</th>
<th>Loss Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>Low</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

The Fisher test results are: p-value = 1.0 (not significant at any level)
The chi^2 test: chi^2 = 0.009 and a p-value of 0.924 (not significant at any level)

Phase 2: Health seasonal and climate change scenario

Seasonal scenario
Contingency table of GAIN responses

<table>
<thead>
<tr>
<th></th>
<th>Gain Frame</th>
<th>Loss Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>Low</td>
<td>9</td>
<td>16</td>
</tr>
</tbody>
</table>

The Fisher test results are: p-value = 1.0 (not significant at any level)
The chi^2 test: chi^2 = 0.0048 and a p-value of 1.0 (not significant at any level)

Climate change (long-term) scenario
Contingency table of GAIN responses

<table>
<thead>
<tr>
<th></th>
<th>Gain Frame</th>
<th>Loss Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>Low</td>
<td>13</td>
<td>18</td>
</tr>
</tbody>
</table>

The Fisher test results are: p-value = 0.6 (not significant at 90%)
The chi^2 test: chi^2 = 0.128 and a p-value of 0.72 (not significant at 90%)

Phase 2: WASH: Seasonal and climate change scenario

Seasonal scenario
Contingency table of GAIN responses

<table>
<thead>
<tr>
<th></th>
<th>Gain Frame</th>
<th>Loss Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Low</td>
<td>6</td>
<td>25</td>
</tr>
</tbody>
</table>

The Fisher test results are: p-value = 0.04 (significant at > 95%)*
The chi^2 test: chi^2 = 0.0048 and a p-value of 0.039 (significant at > 95%)*
Climate change (long-term) scenario

Contingency table of GAIN responses

<table>
<thead>
<tr>
<th></th>
<th>Gain Frame</th>
<th>Loss Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Low</td>
<td>7</td>
<td>32</td>
</tr>
</tbody>
</table>

The Fisher test results are: p-value = 0.014 (significant at > 95%)*
The chi² test: \( \chi^2 = 0.128 \) and a p-value of 0.022 (significant at > 95%)*

*Note that the significance is an artefact of the skewed sample.

TOTAL YES’S AND NO’S ACROSS ALL FOUR SCENARIOS

Phase 1: Seasonal health survey

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Sector Seasonal Scenario</td>
<td>91</td>
<td>28</td>
</tr>
</tbody>
</table>

p-value < 0.001 (significant at >99%)

Phase 2: Health seasonal and climate change scenario

<table>
<thead>
<tr>
<th>Phase 2</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Sector Seasonal Scenario</td>
<td>56</td>
<td>34</td>
</tr>
<tr>
<td>Health Sector Climate Change (Long-Term) Scenario</td>
<td>63</td>
<td>27</td>
</tr>
</tbody>
</table>

p-value = 0.02 (significant at 95%)
p-value < 0.002 (significant at 99%)

Phase 2: WASH: Seasonal and climate change scenario

<table>
<thead>
<tr>
<th>Phase 2</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASH Seasonal Scenario</td>
<td>41</td>
<td>17</td>
</tr>
<tr>
<td>WASH Climate Change (Long-Term) Scenario</td>
<td>49</td>
<td>9</td>
</tr>
</tbody>
</table>

p-value = 0.0016 (significant at 95%)
p-value < 0.002 (significant at 99%)
TOTAL YES’S AND NO’S ACROSS THE PROBABILITY AND FRAMING SCENARIOS

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL 35% scenarios</td>
<td>174</td>
<td>69</td>
</tr>
<tr>
<td>ALL 65% scenarios</td>
<td>126</td>
<td>43</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 0.3 \text{ and } p\text{-value } 0.58 \]

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL gain scenarios</td>
<td>115</td>
<td>52</td>
</tr>
<tr>
<td>ALL loss scenarios</td>
<td>184</td>
<td>60</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 1.83 \text{ and } p\text{-value } 0.17 \]