Improving climate change resilience through risk communication supporting effective private risk reduction

Strategy making in the face of complex communicative options and motivation factors

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Abstract

Climate change driven risks in urban areas increase pre-existing challenges of risk management. Often and for good reasons public risk reduction cannot be offered to all areas due to lacking efficiency or acceptability, because they are hardly compatible with the dense and multifunctional urban fabric (i.e. inundation) or because of the spatially unrestricted or unpredictable pattern of the hazard (i.e. heat, heavy rain). Private action and its effectiveness to reduce risk or damage has been described on several occasions. It is widely agreed, that private risk reduction despite cardinal challenges can play an effective part in reducing risk and improving resilience. However, communication between public authorities and "private risk reducers" lacks a sound basis of reflected communication goals and well-founded communication strategies.

Resilient and social just solution not only protect but also involve the potentially affected stakeholders. We propose, that targeted and well-designed communication strategies offer the potential to leverage the risk reduction potential of private actors affected by climate change induced hazards. On the one hand, strategy design implies that both public authorities and private actors recognize and accept adapted role models to allow for an efficient knowledge transfer and the implementation of effective risk reduction at private level. On the other hand, communication design requires a knowledge basis about communication options and their potential effects taken alone and in combination. However, systematic knowledge about communication options and their motivating or enabling effects remains fragmented and sound knowledge on the potentials of different options rather rare.

We address a part of this gap by systemizing knowledge about potentially effective communication options and their possible effects understood as communication success in motivating private stakeholders to act. The scientifically sound detection of effects of communication is a task addressed by ongoing research the results of which may help to fill the other parts of the knowledge gap described. We present an innovative approach to classify communication measures and provide a first overview of their potential effects. The proposed classification looks at individual and collective effects and on the directionality (mono- to multi-directional) of communication. And we present our approach to strategy design and an exemplary communication strategy designed to address individual and collective motivation factors. Finally, we discuss important design elements for successful communication at the level of strategies and single measures.

Keywords: risk communication, private risk reduction, climate change induced risks, risk management, resilience

1.   Introduction

Climate change driven risks in urban areas increase pre-existing challenges of risk management. Often and for good reasons public risk reduction cannot be offered to all areas due to lacking efficiency or acceptability, because they are hardly compatible with the dense and multifunctional urban fabric (i.e. inundation) or because of the spatially unrestricted or unpredictable pattern of the hazard (i.e. heat, heavy rain). Private action and effectiveness to reduce risk or damage has been described on several occasions (e.g. Schünemann et al., 2020).

Private risk reduction is a significant contribution to the risk management that is usually carried out by the public sector and thus also an important component of resilience at the local level. The importance of communication for awareness raising,

knowledge about options for action and the development of capacities for individual and collective action has long been emphasized, e.g. by IPCC documents (Noble et al., 2014). In 2015, also the 2030 Agenda for Sustainable Development (United Nations, 2015) formulated resilience and adaptive capacity as a central element of Goal 13 and addresses explicitly the need for the education of individuals and institutions to adapt and reduce impacts. However, communication between public authorities and the actors of private risk management still lacks a sound basis of reflected communication goals and well-founded communication strategies.

In practice, the delegation of risk management to the private level usually takes place without any additional involvement or resources (Kuhlicke et al., 2020) and is thus partly interpreted as a rather neoliberal approach (e.g. Coaffee & Lee, 2016). Systematic communication between institutional actors in risk prevention (e.g. municipal specialist administrations or state offices) and affected "non-state actors" ("laypersons" according to Ballantyne, 2016) is not established or is part of a learning process in the ongoing development of risk management (cf. also Demeritt & Nobert, 2014, p. 313). Thaler et al. (2019, p. 1074) speak in this context of an ongoing social transformation with regard to dealing with natural hazards, and underline the need for a "new social contract" in this field, including a readjustment of organization and responsibilities.

Risk communication with private actors has already become important. Risk communication in relation to health risks is well established and already better investigated (Adekola, 2020b; Fitzpatrick-Lewis et al., 2010). In contrast, approaches to risk communication relating to flood risk management, other environmental risks (Kuhlicke et al., 2020; Wachinger et al., 2013), or climate change and climate adaptation (Körfgen et al., 2019; Moser, 2016) are newer, less established and less studied. Knowledge, experience, competencies and capacities among the actors acting as communicators are often not sufficiently developed to date (Körfgen et al., 2019; Moser, 2016). Participatory formats in risk communication are being discussed as particularly effective, but are still rather the exception (Rollason et al., 2018, p. 1670; Wirth et al., 2014, p. 36). Moser (2016, p. 360) even speaks of the need to develop "boundary institutions dedicated to the improved exchange between CC-Communication researchers and communication practitioners ... and ... involving ... the intended audiences".

In our paper, we present an innovative approach to classify communication measures and provide a first overview of their potential effects. The proposed classification looks at individual and collective effects and at the directionality (mono- to multi-directional) of communication. And we present our approach to strategy design and an exemplary communication strategy designed to address individual and collective motivation factors. Finally, we discuss important design elements for successful communication at the level of strategies and single measures.

2. Private risk reduction and strategic risk communication on three levels

The term "private risk reducer" is not defined in the literature. It is used here to refer to actors who are responsible for deciding on and implementing measures to privately reduce their own risk. These may include non-state actors such as private individuals, organizations or even companies which, on their own responsibility and in their own interest, implement measures to reduce risks to health, objects, buildings, production facilities, etc. Individuals making their own provisions for risk reduction are typical addressees of risk communication.

The term risk describes the probability of negative consequences triggered by events (e.g. natural hazards influenced by climate change) such as heat, heavy rain or floods. Risk results from the interaction of hazard, exposure and vulnerability. Communication is generally understood as a process of mono- to multi-directional exchange of information and knowledge between actors (Adekola, 2020b; Covello et al., 1986). Risk communication is one of the (external) factors that influence how people understand risks, how they perceive them and how and which decisions they make in dealing with these risks (cf. e.g. Grothmann & Patt, 2005; Vulturius et al., 2019). The aim of risk communication is to support private risk reducers in taking measures to reduce the negative consequences of natural hazards. Risk communication is thus also related to the wider fields of "climate change communication" (Ballantyne, 2016) or "environmental communication" (Cox, 2007; Hansen, 2019).

Risk communication takes place at various levels and involves different communicators and addressees (target groups). Organized actors from politics, administration, associations etc. sometimes have formally defined tasks in the management of climate change risks and are both target groups of communication (e.g. from science) and central actors of risk

communication (Carius & Renn, 2003). This group is the subject of climate change communication science (Moser, 2016). Citizens, business enterprises or associations are often addressees of risk communication (cf. Ballantyne, 2016). In the context of our work, we consider risk communication primarily as communication between actors of state institutions (including local administrations) on the one hand and citizens as private risk reducers on the other. In a "modern" understanding of communication, however, private risk reducers not only passively receive communication, but also shape contents and processes of strategic communication designed to strengthen their willingness and ability to perform in private risk reduction (P. Wiedemann & Schütz, 2010).

Our contribution is based on the working hypothesis that there is an increasing number of studies on risk communication, but that these do not sufficiently address the strategic orientation of such communication. Targeted and well-designed communication strategies offer the potential to leverage a risk reduction potential of private actors affected by climate change induced hazards. Communication strategies can be seen as contributions to the development of climate-sensitive and resilient societies (Körfgen et al., 2019). The targeted design of communication strategies is an important part in a contemporary role definition and role perception of public actors of risk management. Strategies can also make an important contribution to the development of the perception and fulfilment of the role of private actors by addressing influencing factors such as risk perception, sense of responsibility, knowledge, self-efficacy or outcome efficacy (see section 3 and Figure 2).

Ballantyne (2016, p. 340) describes strategic communication as "coordinated effort with a strategic aim, clear objectives, coordinated messages and media tactics, well defined audiences, carefully considered time and resource management". A strategic approach to risk communication thus implies the aim of achieving goals through planned and coordinated communication processes in the sense of better information and exchange and the joint search for solutions, right through to influencing the behavior of addressees (P. Wiedemann & Schütz, 2010). Strategies for risk communication can affect different phases of risk management (Höppner et al., 2012) and may pursue short, medium and long-term communication concerns (Loroño-Leturiondo et al., 2019). For the understanding of the strategic orientation of risk communication in this paper, however, (1) the measure-oriented understanding of strategy and (2) the analytical distinction of three levels of effectiveness of strategies are important.

(1) As a communication strategy we consider bundles of communication measures that are put together with regard to defined communication goals, target groups and natural hazards ("strategy design"). A strategy thus consists of at least two measures ("mix of measures") and is also justified by synergy effects between them. Synergy effects can result from factual, temporal and social dimensions (Howlett & Mukherjee, 2018). This includes two different perspectives when looking at a communication strategy (a) from the perspective of the combination and sequence of applied measures and (b) from the perspective of the individual measures, involving aspects such as timing and "framing" of implementation for selected communication goals, target groups and contexts.

(2) The understanding of effectiveness of risk communication strategies is important on three levels (see Howlett, 2019):

Level 1 "Objective of strategy development as a process": Risk communication can be the more effective the more strategic it is realized under consideration of conditions for the implementation of measures. Strategy development (or design) as a process is thus already a contribution to increasing the effectiveness of risk communication. Communication objectives are only part of the relevant aspects.

Level 2 "Effectiveness of an individual strategy": This level deals with the substantive objectives of a communication strategy as a whole. Several measures are combined to contribute to the realization of a strategic communication objective through mutual complementarity and synergy effects (e.g. synergy effects through "addressing" individual and collective motivational factors, see section 3). Local contexts, previous experience, communication habits, communication obstacles, ongoing communication processes and the implementation of certain communication formats also influence strategy design.

Level 3 "Aim of a single communication measure": A linear causal link between measures and possible desired effects (in the sense of motivation to implement private measures) cannot be assumed (Moser, 2016, p. 351; Steelman & McCaffrey,

2013, p. 695; Wachinger et al., 2013, p. 1063). The impact of measures depends largely on their design and the context of their implementation.

3. Traditional and innovative communication measures for communication strategies

As a means of risk communication, communication measures pursue different (single or multiple) communication goals, address or involve specific (also differing) target groups, make specific use of single to multiple communication methods or communication formats, address selected communication contents and convey intended key messages. Coordinated with each other and aligned with higher-level goals, communication measures can form communication strategies. We have identified different and differently complex communication measures (see Table 1). These range from well-known formats such as brochures and maps to rather new formats such as serious gaming or citizen science. The extremes range from mono-directional forms of information provision to multi-directional communication formats and collaborative physical actions. Occasionally, rather traditional formats such as story-telling or very new formats such as communication through visual or performing arts where identified.

Types of communication measures can be classified according to different aspects such as target groups, methods, contents, the intended effect, etc. A comprehensive systematics of communication measures has not been identified in the literature. Kuhlicke et al. (2016) have presented the potential specific effectiveness of different communication methods with reference to four selected communication objectives of flood risk management. Mast (2008, p. 424) contrasts communication methods from the field of change management in the economy with their potential scope and depth of effect. Körfgen et al. (2019) categorize schematically according to the frequently discussed mono-directional and inter-active communication formats. In line with our action-oriented strategy design, we propose a classification according to two basic dimensions of communication instruments. These two dimensions allow only a rough but innovative and helpful systematization of the variety of measure types with regard to the goals of strategy development:

Dimension 1 "Basic communication approach" - mono- vs. multi-directional. As has been described, there is a discrepancy between the recognition of the particular effectiveness of dialogical, multidirectional communication approaches in addressing numerous motivational factors on the one hand, and the still predominant practice of mono-directional, "under-designed" approaches risk communication on the other.

Dimension 2 "Type of impact of a measure" - individual vs. collective. Both individual and collective effects have their importance and justification as a communication objective. They can complement each other optimally to improve effectiveness. However, collective effects in particular have so far been severely underrepresented both in the orientation of measures and in research (cf. also Kuhlicke et al., 2020) and deserve increased attention.

Table 1. Types of measures in risk communication

Communication measures	Brief description
Hazard maps, risk maps	Hazard and risk maps (printed or web-based) visualize areas of potential hazard or risk related to different land uses and allow a differentiation of hazard levels or damage probabilities.
Planning documents	Plans are documents containing statements on aims and measures authorized by the public authorities with a regulatory character, e.g. in relation to land use or risk management.
Brochures/flyers	Brochures (printed or downloadable) usually provide generalized information, e.g. on local risks or options for private risk management.
Websites	Websites usually offer generalized information, e.g. on local risks or options for private risk management - as an alternative form of preparation to brochures or with the possibility of user-oriented guidance through the contents.
Real-time information (e.g. water levels)	Real-time information provides current values about the status of parameters that can indicate danger or risk - as a basis for behavioral private decisions: e.g. water levels, temperatures, precipitation

Warning services (e.g. app-based)	Warning services (increasingly web-based) provide event-related warning information on the sequence of expected or ongoing events (natural hazards).
Advertising campaigns	Advertising campaigns can communicate public and private messages about risk management solutions. Advertising campaigns convey focused key messages that can provide information or provide the impetus for further work on issues relating to personal provision.
Reporting in traditional media	Widely spread and usually little site- or solution-specific reporting on risks or options and examples of (private) risk management.
Exhibitions	Exhibitions are temporary (e.g. days to weeks) offers of information and interaction on specific topics.
Online forums	Forums are web-based, highly interactive exchange formats between experts and citizens (among themselves or mixed), which are usually managed by an administrator and focus on specific topics.
Blogs	Blogs are web-based, thematically oriented information channels that offer thematically focused information. By offering commentary functions, an exchange with bloggers or between readers may be supported. Blogs tend to be less interactive than online-forums.
Social networks	Communication based on social networks (e.g. Twitter, Instagram, Facebook) enable short-term, thematically oriented notifications to subscribers of the channels or network partners, which can be distributed quickly by forwarding.
Traditional information events	Traditional information events mainly transport mono-directionally thematically focused content from the authorities to the citizens. Participatory or dialogical formats and possibilities are rather limited.
Activating communication events (ACE)	Activating communication events are time-limited (rarely longer than a few hours) events. They serve to activate desired behavior with regard to private risk management. ACEs specifically address the target audience and combine different formats of information, discussion and interaction to address different motivating factors that support and enable behavior modification. Wherever possible, ACEs work with concrete information and respond to the information needs of the addressed citizens in order to enable them to adapt their behavior to their personal situation.
Participatory workshops	Participatory workshops are short-term (usually shorter than one day) content-related and/or spatially focused events for the development of solution options with regard to issues related to risk and risk management.
Citizen dialogues	Citizen dialogues are communicative events, usually organized by the local or regional level (specialist administrations), in which citizens are both addressees and actors. Citizens' dialogues are intended to engage in intensive discussions with citizens, e.g. about current or future planning and implementation. Citizens' dialogues differ from information events in that they are actively designed to promote exchange and are supported by suitable settings and event formats.
Planning games / scenario workshops	Planning games serve a creative exploration of possible shapeable futures, e.g. with regard to the development of risks and/or the realization of risk management options.
Consultation	Consulting supports the search for solutions by citizens* for private risk management in a targeted, technically sound and context-related manner.
Explanatory video clips	Video clips are used to illustrate explanations, making them easier to understand and more responsive to specific situations.
Computer-based simulation	By means of 2D or 3D reproductions of processes in space (e.g. flooding, heat distribution, etc.), simulations are suitable for the representation and transfer of complex, e.g. spatial relationships between natural events and their effects. For example, variants of measures and their impact on the affected area or potential damage can be simulated. In simulations, there is usually no personal interaction between the providers and recipients of the information. However, the technology and programming of a simulation offers a high degree of bi-directional communication. Simulations are also suitable for offering participatory elements/participation elements such as different adaptation options. Simulations can thus be part of Serious Games (adapted from STZ, 2019).
Serious Gaming	Serious games are a form of technology-based communication. They are used to communicate complex e.g. spatial relationships between natural events and their effects in a playful way (e.g. risk perception) and to strengthen them through visual recognition and repetition (adapted from 2av & STZ, 2019).
Virtual reality applications	Virtual Reality applications enable a particularly life-like representation of interrelationships and thus potentially enable a higher degree of understanding and identification between users and content.
Education and training	Education contents may integrate issues of risk management into the curricula of educational institutions such as universities, colleges or schools.

Citizen Science	Citizen Science serves a rather project-like integration of citizens into knowledge-creating processes.
Competitions	Competitions motivate citizens to participate in the development of ideas and solutions or the documentation of solutions.
(Protection) exercises	Community exercises related to the management of natural hazards organized by competent authorities, private sector operators or other organizations such as fire or water brigades.
Reconstruction workshops	Joint, partly guided reconstruction activities after damaging events.
Neighborhood help	Mutual support of (potentially) affected persons in exposed areas in the preparation and management of natural events.
Financial support instruments	Financial support instruments to promote "desired" (in the sense of risk-adapted) behavior, e.g. from local, regional or state level.
Legal regulations	Legal regulations on the framework and obligations in connection with, for example, personal provision.
Performances (arts, theatre, installations)	Artistic, performative examinations of the content of risk and risk management.
Story-telling	Traditional form of communication for the transmission of knowledge, experiences, rules, social norms etc.

Figure 1 illustrates the assumption that the majority of communicative measures (such as brochures, risk maps or warning media) tend to be mono-directional and address rather individual factors. Types of measures with a stronger potential for multi-directional communication and collective effects include, for example, citizen dialogues and participatory workshops of actors from different areas of society such as politics, administration, economy, civil society, etc. Such measures are also considered to be more effective in terms of motivating social and emotional factors (Höppner et al., 2012). Figure 1 shows a preliminary and approximate classification as an insight into a process of "work in progress". For many measures, the classification is not clear-cut due to the wide scope for designing options: both the communication approach (mono- vs. multidirectional) and the more individual or collective impact of the measures are strongly linked to the design and implementation of a communication measure. The placement near the axes indicates a greater flexibility in this sense. The types of measures that have been selected as elements of an exemplary strategy (see section 4 below) to strengthen private provision are highlighted in red.
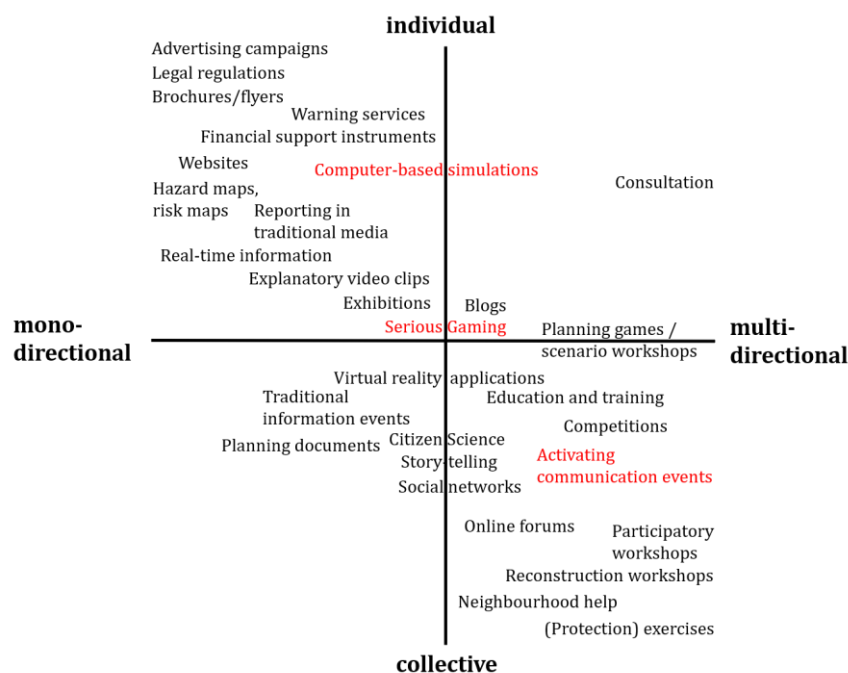

Figure 1. Classification of communication measures according to the characteristics individual vs. collective and mono-directional vs. multi-directional.

Effects that can be achieved by communication are measure specific. "Effects" are represented by motivational factors that have been identified and described in environmental psychological research as relevant for influencing human behavior. These motivation factors are central elements for understanding a communication measure and thus for steering the design of strategies and individual measures towards specific effects with regard to intended protection and adaptation behavior. Motivational factors can be divided into individual and collective factors. Figure 2 gives an overview of motivation factors considered. Factors particularly regarded in our work are highlighted bold.
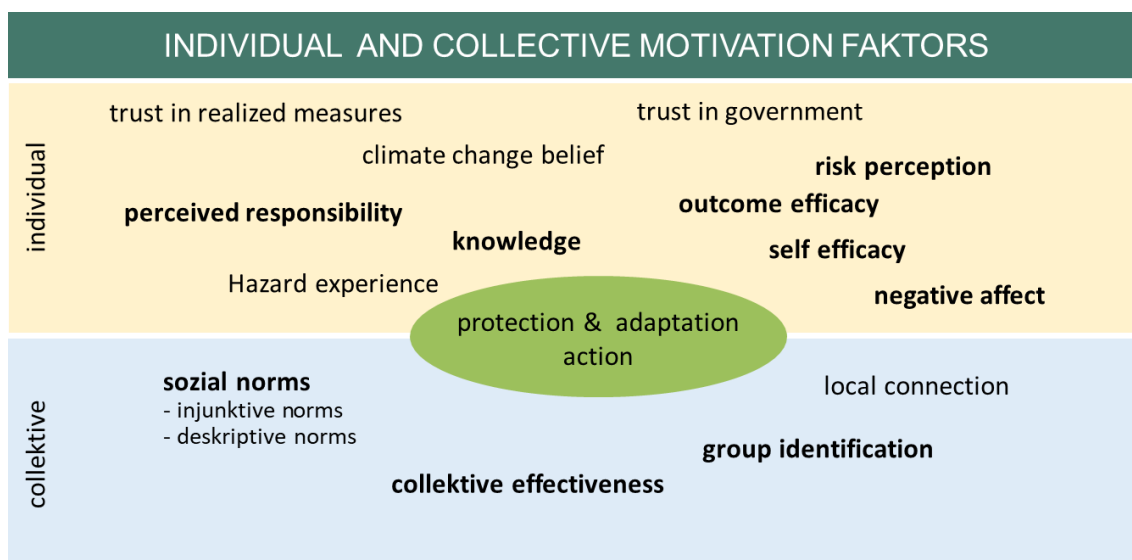

Figure 2. Individual and collective motivation factors (following Köhler & Masson, 2020; van Valkengoed & Steg, 2019).

Which of the effects are ultimately achieved by an implemented communication measure depends on design and numerous other factors (see section 5). The impact spectra are a basis for two considerations that are central to the development of a strategy. First: Which measures are basically suitable for achieving certain impact objectives? Second: Which measures can be sensibly combined to achieve the strategic objectives as a whole? Table 2 attempts to describe a potential spectrum of effects for the communication measures chosen for the communication strategy. The information is taken from the authors' assessments based on literature and their own experience. A broader empirical basis and validation of the impact spectrum for all identified communication measures (cf. Table 1) is part of the ongoing research work. The listing of the spectrum of effects does not imply an evaluation of the possible effectiveness. Nor is it likely that any individual measure is generally suitable for addressing all relevant motivational factors (Loroño-Leturiondo et al., 2019).

Table 2. Design-dependent impact potentials of communication measures (preliminary results).

Communication measures	Trust in implemented measures	Trust in the government	(Event) Experience	Knowledge	Risk perception	Belief in the reality of climate change	Perceived responsibility	Self-efficacy	Outcome efficacy	(Action) Experience	Negative affect	Local connection	Social norms (injunctive und descriptive)	Group identification	Collective effectiveness
Activating communication events (ACE)	■	■		■	■	■	■		■		■		■		■
Computer-based simulation					■			■	■	■					
Serious Gaming					■			■	■	■					

4. Design of an exemplary communication strategy

The clarifications of strategy design (section 2), the portfolio of measures and the potential spectrum of effectiveness of individual measures (section 3) form the basis for the development of an exemplary communication strategy within the framework of an ongoing research project. The strategy will be implemented at various locations in cooperation with local stakeholders wherever possible integrated into existing communication processes. The effectiveness of this strategy will be examined. We want to trace the stages of strategy development in relation to the three levels of strategy development discussed in section 2.

Level 1: Objective of strategy development

The background to the undertaken strategy design is a research project (Private Risk Reduction, German Federal Environment Agency, FKZ 3718 48 101 0), which is intended to enable reliable statements about the effects of risk communication by implementing and measuring the impact of strategically developed communication measures. We were looking for a generic communication strategy to strengthen private risk reduction in the context of climate adaptation for different target groups and several natural hazards influenced by climate change. Work on risk communication shows that a communication strategy can generally be applied to different natural hazards (Höppner et al., 2012). Indications of limited transferability are discussed for environmental impacts with highly different dynamics such as for flooding and air pollution (Loroño-Leturiondo et al., 2019).

The strategy is also intended to specifically address gaps in previous risk communication in order to strengthen the intentions (motivation) and ability to act of private risk reducers. By combining methods and content in multi-directional and mono-directional formats, we want to ensure that different groups can be reached by the communication strategy and that multiple of the selected motivational factors can be addressed. In the case of the developed strategy, the project consortium selected a number of individual and collective motivational factors considered to be of particular importance in motivating individuals (cf. Figure 2): Knowledge, risk perception, perceived responsibility, self-efficacy, outcome efficacy, negative affect, social norms, group identification and collective effectiveness.

The orientation towards communication measures with a high impact potential suggests a concentration primarily on measures that combine multi-directional forms of communication and innovative communication concepts. Three criteria are particularly important for the selection of measures:

- Expectation of effectiveness. *Is the type of measure basically suitable for addressing the desired motivational factors?* (level 2, below)

- Strategy orientation: *Can the type of measure support the effectiveness of other measures in the strategy?* (level 2, below)

- Feasibility: *Can the measure be implemented in high quality within the existing time, financial limits and partner constellation?* This question only sounds project-specific at first. Also in the real world, risk communication is subject to temporal and financial restrictions and must be implemented within defined partnerships (level 3, below).

Other project-specific "test criteria" also played a role: the project-internal interests in knowledge generation, innovative measures and the suitability of a communication measures for methodologically rigorous impact measurement. Neither of these criteria was found to be significant for strategy processes or was selective for the constellation of measures. They are omitted in the following discussion.

Level 2: Effectiveness of an individual strategy

The relationship between knowledge or perception and action is complex, not linearly predictable. It has been repeatedly stated that the traditional linear and mono-directional approach to communication by providing information does not

necessarily lead to action (Moser, 2016, p. 351; Steelman & McCaffrey, 2013, p. 695; Wachinger et al., 2013, p. 1063). Numerous factors influence the extent to which a risk is perceived as such and the extent to which it translates into an intention to take action. In order to achieve communication goals, the motivational factors to be addressed must be clarified before designing strategies or measures.

The result of the strategy development in our study is a combination of measures that is suitable for supporting the goals formulated for the strategy development (see Figure 2 and Table 2) in a promising way. As a result, the developed strategy comprises three types of communicative individual measures framed by a fourth communication path being the embedding of the measures by accompanying locally specific communication concepts:

- Activating communication event

- Computer-based simulation

- Serious Gaming

- accompanying on site communication concept (framing)

The combination of measures offers a variety of methods and formats and is found to be appropriate to address the motivation factors identified as particularly relevant. The types of measures jointly form a generic strategy that addresses different natural hazards and target groups. In accordance with the classification (Figure 1) and description (Table 1) of the communicative measures outlined above, our strategy combines (a) multi- with mono-directional communication formats, (b) individual and collective factors, (c) "factual" with more "playful" formats and (d) familiar methods (e.g. established event formats) and comparatively new approaches such as simulation or serious gaming.

Level 3 „Aim of a single communication measure"

The selected types of measures have already been defined in previous sections and characterized in relation to a) communication approaches "mono-directional vs. multi-directional" and b) expectations of effectiveness "individual vs. collective". In combination, the measures meet the requirements of the selection criteria introduced above:

Expectation of effectiveness: All three types of measures address important individual and partly collective motivation factors (Table 2). The decisive factor in determining which motivation factors can be addressed and to what extent is the individual and coordinated design of the individual measures.

Strategy orientation: We expect that synergies can be achieved in the implementation of the measures both for the content and the effectiveness of communication. While computer-based simulations and serious gaming can deploy explicit strengths with regard to risk perception, self-efficacy and outcome efficacy, activating communication events are able to address these and complementary motivational factors accompanying or preparatory manner.

Feasibility: For the selected types of measures, considerable organizational and partly technological (in particular for computer-based simulation and gaming applications) effort is to be expected, especially when they are implemented for the first time. The implementing consortium combines the necessary know-how and experience to realize the coordinated design of measures in high quality, to develop local cooperation and to implement the measures in a synergetic way in terms of organization, content and methodology.

For the target levels of strategy development and the selection criteria, it is the design of the measures that determines whether the objective of strategy development has actually been implemented (level 1), whether the objectives of the individual strategy can be consistently addressed (level 2) and whether individual measures can be successfully implemented and develop the desired effects and synergies both individually and in combination (level 3). Section 5 summarizes some central aspects that may are useful for guiding the development of strategy and measure design.

5.   Design of communication measures – interface to the implementation of the communication strategy

Communication design is more than the translation of content into a language that can be understood by the addressee, an understanding often used by conventional approaches to transfer or dissemination. The challenges of risk communication directed at citizens are not trivial. The first major communication hurdle already exists between science and the main communicators, including actors in politics, administration, interest groups or the media (Moser, 2016, p. 356f). Impact-oriented design of communication measures serves the high claim to achieve the defined communication intentions through communication. Good strategy and implementation design shape communication processes in such a way that the communication reaches the addressees, involves them wherever appropriate and can be understood, accepted and transformed into action patterns.

Numerous studies deal with the question of how best to communicate in order to achieve the desired enabling or empowering of private actors (Moser, 2016, p. 351). Wirth et al. (2014, p. 33) name 18 success factors for good communication mainly with reference to content, target groups, motivational elements. Adekola (2020a) summarizes a range of requirements for good communication. Many other authors emphasize single or several of these requirements. In the following, significant challenges for the strategic design of strategies and measures are condensed. Only few of these can be addressed at the strategic level (Table 3). The definition of communication goals were already discussed in section 3.

***Table 3.** Design challenges of strategy development on three target levels.*

Strategic target level / Challenge	Level 1 „Goal of strategy development "	Level 2 „Goal of the individual strategy"	Level 3 „Goal of an individual communication measure"
Communication goals	X	X	X
Continuity of the communication process		X	X
Local context		(X)	X
Obstacles to communication			X
Communication content			X
Communication formats			X
Confidential persons			X
Product and media design			X

Continuity of the communication process

Project-like (predefined start and end) interventions carry the risk that they may reduce the reach, acceptance and also the learning and motivation effects among the addressees. In addition to changes in contexts, knowledge or personal decision-making phases (Bryan et al., 2019), the memory of knowledge and experience - e.g. from previous events - is also subject to the gradual loss over time (e.g. Sutton et al., 2020). Risk communication is therefore an ongoing task, both in general and specifically through the various phases of risk management before, during and after events (based on Steelman & McCaffrey, 2013, p. 690).

Local context

Individual action is always embedded in social structures and power relations that originate from the past, but are also shaped by daily interactions. Understanding the local context, such as the need for knowledge or discussion, special sensitivities towards issues or actors, and communication experiences, is important in order to frame communication appropriately at the local level, to formulate messages sensitively (acceptability) and thus to enable an effective local discussion (based on Steelman & McCaffrey, 2013, p. 689).

Communication design is therefore oriented towards numerous questions which, in addition to communication intentions, also deal intensively with the possible realities and perspectives of the addressees in order to integrate them as effectively as possible into the communication process. Such questions can be: What previous knowledge and experience do the addressees have as actors in dealing with e.g. heat, floods or heavy rain? With which other, possibly "more important" topics do these questions compete? How do the addressees see their own role in dealing with these hazards (also in contrast to the role of the state)? What communication habits do the addressees have?

Obstacles to communication

Measure design must take into account communication obstacles, which can vary greatly from case to case and can weaken or completely counteract the effectiveness of communication. These include, for example, the emotions triggered by a topic (Chapman et al., 2017; Rakow et al., 2015; Roeser, 2012; Wirth et al., 2014) or fears (P. M. Wiedemann et al., 1991), social norms and values prevailing locally or in society (Kuhlicke et al., 2020), a possibly developed passivity ("learned helplessness" (Paton & Johnston, 2001) or the simple lack of willingness of the addressees to absorb knowledge ("knowledge-ability", cf. Adekola, 2020b, p. 4). Such communication barriers are often deeply rooted in society and cannot necessarily be addressed or removed by means of risk communication (Ballantyne, 2016). Nevertheless, taking them into account can help to facilitate effective communication.

Adequacy, relevance and comprehensibility of the communication content

It is not the information itself that determines its effect, but rather the way in which people interpret and process it in the context of their experiences, convictions and expectations (following Paton, 2008, p. 4). Different addressees - e.g. men, women, representatives of different milieus - have different communication needs and experiences (cf. e.g. Bryan et al., 2019; West & Orr, 2007). Therefore, both the relevance and appropriateness of the selected contents (Steelman & McCaffrey, 2013) and their preparation are central, so that they can be understood and " integrated " into the body of knowledge and experience (e.g. Slovic, 1986). Also important are factors such as the closest possible connection of information to one's own living environment (e.g. the own property Rollason et al., 2018, p. 1672), the integration of local knowledge and the interweaving of local knowledge with external expert knowledge, reliability (Steelman & McCaffrey, 2013, p. 690) as well as the timeliness and transparency with regard to uncertainties and knowledge gaps (Adekola, 2020a; cf. also Rollason et al., 2018).

Communication formats

The choice of communication formats should be closely aligned with the communication objectives, addressees and their contexts. Even if individual communication formats are never equally suitable for all population groups (Loroño-Leturiondo et al., 2019), the view has become accepted that the mere provision or dissemination of information according to the transmission-reception paradigm (Rollason et al., 2018, p. 1666) to serve a supposed "knowledge deficit" (transmission paradigm) is not promising to motivate people to act (Ballantyne, 2016). Interactive formats are generally regarded as the more suitable approaches to risk communication (Adekola, 2020a, p. 121). In CC communication, a shift towards dialogical formats has only intensified in the decade after 2010 (Pearce et al., 2015). Research has also shown that private actors are prepared to become involved in natural hazard management processes if their concerns are heard and taken into account (Thaler et al., 2019, p. 1079).

Confidential persons, suitable communicators

Decisions relating to natural hazards are made in the context of uncertainty (Paton, 2008, p. 4). People tend to trust rather related parties than government agencies, and they are often organized in groups to which access must first be established (Tyler & Sadiq, 2018). The involvement of accepted actors, who enjoy a high degree of trust among the addressees, is of utmost importance for the acceptance of the communication content and the success of the communication process as a whole (Grothmann et al., 2013; vgl. Paton, 2008; Steelman & McCaffrey, 2013, p. 685). Trust helps to reduce the perceived uncertainty and complexity of risk (Siegrist & Cvetkovich, 2000). This effect is even larger the less knowledge is available and is therefore of great importance when decisions have to be made despite uncertainties (Paton, 2008, p. 4f). The involvement of trusted third parties can be an important "door opener" when it comes to reaching local people. At the

same time, opinion leaders can also have a markedly contrary influence on an intended process (Thaler et al., 2019, p. 1079).

Product and media design

In addition to other factors, computer-aided simulations and serious games are subject to specific technical and optical quality requirements from the field of classical product and media design.

6. Conclusions

The targeted design of risk communication strategies and measures is important to increase the resilience of people and locations to climate-influenced natural hazards. We present a "look into the workshop" of an ongoing strategy and measure development. The effectiveness of the communication strategy not only depends on the chosen types of communication measures, but especially on the specific design and implementation of the chosen measures in local context conditions. Strategy design and measure design go hand in hand. Strategy design defines the goals and target groups of communication and coordinates the selection and combination of communication measures. The design on the level of communication measures implements the strategic goals through the targeted development of communication measures. At the same time, the specific spectrum of possible effects of communication measures also determines the combination of measures within a communication strategy.

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