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Preferences on funding humanitarian aid and disaster management under climatic losses and damages: A multinational Delphi panel

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Abstract

Losses and damages from climate change and the frequency of extreme events will burden our global budgetary constraints and adaptive capacities. Scientific and analytical support for allocating public funding in humanitarian aid and disaster management to counter them involves determining the most pertinent criteria to use or where to design forecasting. Their priorities are often assumed, and assumptions can be ill-fitting. Thus, we asked the key users of such information for their preferences.

A two-round anonymous Delphi method utilising global frameworks for a funding allocation simulation was employed to survey the stated preferences of a stratified panel of losses and damages experts (N=36). They were experts from 19 countries of origin representing international organisations (e.g., United Nations, European Union, World Bank), the research sector, the public sector, and civil society (e.g., Save the Children, World Vision). The consensus was analysed with parametric measures.

We find that the near-future preference for magnitude-indicating criteria, such as people-centric and disaster risk-based, outweighs the importance of indicators related to governance, the rule of law, or a socio-economic aspect. Likewise, financing adaptation options to climate change-related risks to food security, human health, and water security are a high near-future priority for minimising losses and damages compared to, for example, risks to living standards or risks to terrestrial and ocean ecosystems. The covariance suggests that these priorities are an emergent preference in the losses and damages sector. Thus, it raises further questions on what we can and should prioritise with scarce resources.

Keywords

climate change; losses and damages; behavioural economics; humanitarian aid; disaster risk management; Delphi

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Declarations

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- Bart van den Hurk, Scientific Director at Deltares and IPCC WG2 co-chair
- Clemens Gros, Consulting Senior Technical Adviser at Red Cross Red Crescent Climate Centre
- Flavia Marà, Livelihoods Technical Advisor at World Vision Deutschland
- Isabelle De Schryver, Team Leader Evidence-Based Policy at European Commission – Directorate-General for European Civil Protection and Humanitarian Aid Operations (ECHO)
- John Schneider, Secretary General at GEM (Global Earthquake Model) Foundation
- Marie Wagner, Information Management Officer at United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) Regional Office for West and Central Africa (ROWCA)
- Nicolas Rost, Head of Programme, Central Emergency Response Fund (CERF) at United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA)
- Thuy-Binh Nguyen, Climate Change Adaptation Specialist at CARE Climate Justice Centre

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Data Availability: The relevant data that supports the findings are available within the article or its supplementary data. The rest of the generated data (e.g., raw freeform answers) is unavailable because it contains sensitive information that could compromise the privacy of research participants. The INFORM suite methodologies (https://drmkc.jrc.ec.europa.eu/inform-index) and data behind IPCC key representative risks (https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-16) are available at respective online sources.

1 Introduction

In September 2023, Storm Daniel wreaked havoc across the Mediterranean – killing at least 4,300 and creating an aid requirement of USD 71 million to support the 250,000 affected people in Libya alone (UN OCHA, 2023). World Weather Attribution assessed that an extreme event comparable to what the Storm caused in Libya "has become up to 50 times more likely and up to 50% more intense compared to a 1.2C cooler climate" (Zachariah et al., 2023, p. 2).

As climate change and the frequency of extreme events will further burden our global budgetary constraints and adaptive capacities via losses and damages (Coronese et al., 2019; Juhola et al., 2022; van der Wijst et al., 2023), two classic questions of the 'fair cake-cutting problem' are prevalent for the humanitarian aid and disaster management mechanism: Where to disperse the limited amount of public funding in the future and based on what objective criteria? This study explores priority preferences for these questions with a Delphi panel gathered from international expertise and using global frameworks from the IPCC Assessment Report 6 (AR6) and the INFORM decision-making indices as our baseline. Both frameworks are transparent and freely accessible, cover multiple types of hazards scientifically robustly, and provide a common language for comparability. Our motivation was a simple premise: It is better to ask than to assume what is essential (Rising et al., 2022; Yan, 2023).

The status of humanitarian and disaster response to losses and damages, such as shelter support or food security early warning, around the globe shows the importance of the study for climate policy: Around USD 18-30 billion has been allocated annually between 2020-2022 to humanitarian and disaster aid globally; compared to the USD 6-10 billion in the early 2010s and a steady rise ever since. We can provide these amounts, while the estimated need has been 1.5-2.0 times higher. The funded envelope comprised 10% of the total USD 213 billion in Official Development Assistance (ODA) in 2022. (OECD ODA, 2023; UN FTS, n.d.) Regarding the need for aid, climate-related disasters almost tripled in the current decade compared to the 1980s per EM-DAT data in the Global Humanitarian Overview 2023 report (UN OCHA, 2022). The IPCC AR6 synthesis states that "[c]limate change [--] is contributing to humanitarian crises where climate hazards interact with high vulnerability (high confidence" (IPCC, 2023).

Foresight research with the INFORM Climate Change Risk tool has assessed future vulnerability and risk of humanitarian crises per the IPCC's scenarios up to 2050 and 2080 (Marzi et al., 2021). A report based on that research by Thow et al. estimates that by 2050, the number of people living in 'very high' crisis risk countries will roughly double from 580 million to 1 billion within the optimistic scenarios for greenhouse gas emissions and socio-economic development (2022, p. 11). In November 2022, the UN climate change conference COP27 agreed to create a new "Loss and Damage" funding arrangement for vulnerable countries.

Distributing scarce public resources now and in the future equitably to people in need facing vastly different circumstances is a monumental task. In addition to working under time pressure, prioritisation is influenced, e.g. by political economy, scientific uncertainty, public pressure, and numerous spatial and temporal variables. (Neumayer et al., 2014; Polasky et al., 2019) Decision-making on which criteria and according to which forecasts funding allotments should be distributed to counter these effects is naturally done routinely in different humanitarian and disaster aid offices, often with discreet or informal rationales. (IPCC WG2, 2022, p. 2575) The human capacity required is significant and needs to be improved in operational agencies (UNDRR, 2021; World Bank, 2021), especially when assessing forecast models with higher effective dimensions or long-run behaviour of complex systems. (Millner & Heyen, 2021; Puy et al., 2022) Among adaptation instruments, economic tools are likely to handle equity challenges, while direct planning and regulation should include more focus on supporting equity (Ulibarri et al., 2022).

At the European Humanitarian Forum of 2023, policymakers emphasised the importance of "principled prioritisation of scarce resources" in addition to proceeding further with comparability of need severity analyses as well as mitigation of climate-driven disasters and anticipatory action to them (EHF, 2023, paras 11–14). Our previous investigation indicated a research gap in transforming climate change-related modelling into forecast-based economic decision-making (Jäpölä & Van Passel, 2023). Financial modelling of climate change is not suitable for analysis of deep uncertainty, extreme risk, or endogenous preferences connected to it (Stern et al., 2022), research on humanitarian forecasting itself is sparse (Altay & Narayanan, 2022), and the amount of climate information available for crisis resource allocation is overabundant (Lentz & Maxwell, 2022). Blankespoor et al. argue that researchers have low incentive to translate results to decision-maker formats – even though a study would be more legitimate if it is tasked and acceptable to the end user (2023).

To highlight what can make policymakers cautious of utilising results of global risk indicators for de facto funding allocation, Visser et al. concluded that "the coherence between indicators from different organisations but with identical definitions varies enormously" (2020, p. 1). Thus, Working Group II (WG2) of IPCC AR6 states that "[--] a key research priority is to understand and evaluate methodological strengths and weaknesses in damage estimation and reconcile the differences affecting comparability [--]" (2022, p. 2496) and is echoed by IPCC WG3 (2022, p. 88).

Based on the above problem setting, our study intended to find a scientifically transparent consensus among a humanitarian and disaster aid expert panel on the priority criteria in computing funding and the priority key risks of climate change that are the most critical to finance. We used the widely applied Delphi method for this examination with a relaxed basis of stated preference during a funding allocation simulation. Instead of monetary valuation or discrete choices, our panel assigned priorities on funding criteria from the INFORM decision-making indices and risk options to fund from IPCC AR6 along with their preferred timescale, thus mimicking a real-life economic decision-making mechanism. We hypothesised that the expert panel would predominantly select people-centred indicators of need or risk as the most emergent factor for funding allocation that could encompass all relevant sub-data and be inequity averse at the same time (Dellmuth et al., 2021; Robinson et al., 2017). For example, the hazard is likely an irrelevant sub-indicator by itself if there is no exposure of the hazard to a vulnerable population.

From an economic point of view, the paper investigates the tension between the expected utility theory (EUT) and empirical behaviour. EUT would hold, in the most simplistic sense, that a decision maker or social planner naturally chooses from risky or uncertain futures the one with the most valuable expected utility. On the other hand, a behaviouralist approach determines that she can be a flawed human with limited cognitive capacity or self-interest that is a partial driver of their choice - known as bounded rationality. (Friedman & Savage, 1952; Kahneman, 2003; Thaler, 1980) For example, Taberna et al. found that a rational household agent significantly overestimates adaptation and underestimates damages in flood hazards compared to boundedly rational behaviour (2023). In contrast, the IPCC WG2 generally has low engagement from economics (Noy, 2023), and the chapter on 'Decision-making options for managing risk' discusses these considerations to a limited extent (2022, Chapter 17).

Next, the paper determines the material and methods used. Section 3 displays the quantitative and qualitative results of the preferred priority criteria and options. Section 5 discusses the study's strengths and limitations, the results' importance to the science-policymaking interface, and pertinent conclusions.

2 Material and methods

2.1 Research design

The Delphi method has been successfully and widely used in the past decades to form a unified group opinion on a problem or a forecast. It does not use a representative statistical sample but a human panel of sectoral expertise iteratively until a consensus forms. It is especially suited to resolve decision-making in highly complex and uncertain settings. Anonymity between the panellists during the survey rounds removes usual biases – such as anchoring or halo effect – that could be in a live debate. (Akins et al., 2005; Van Schoubroeck et al., 2022; von der Gracht, 2012)

We used the EUSurvey (European Commission) platform to manage the study via email-invited online surveys). We estimated that two Delphi rounds (R1 and R2) would be sufficient in gathering enough evidence versus exhausting the panellists' time capital and increasing motivation to participate (Beiderbeck et al., 2021). Our main questions (Q1 and Q2) to the panel were according to two factors prevalent in a social planner's resource allocation decision-making: The *criteria* she uses to allocate and the *options* to assign the funding to. Within these two, the objective of our study was to find the most prioritised stated preferences relating to funding humanitarian or disaster aid in a future world under climate change, according to the expert group (Table 1).

Table 1 Main questions subjected to the Delphi panel.

Q1	What are the priority *criteria* in allocating humanitarian or disaster aid funding per future forecasts in view of climate change response or adaptation?
Q2	What are the priority *options* for which to allocate humanitarian or disaster aid funding regarding adaptation to representative key risks of climate change?

In each question, Q1 and Q2, the panellists were introduced to a simulation where to allocate funding for future humanitarian or disaster aid under climate change. They must choose the most prioritised criteria and options suitable for completing the task from their expert viewpoint (i.e., mimicking a real-life economic decision-making process as much as possible). The panellists received guidance to answer according to their role and that effective prioritisation (i.e., all cannot be a high priority) was the expectation. We used a 4-point scale for the survey. Instead of the typical Likert questions of agree or disagree, we chose to use terms indicating priority more explicitly (i.e., from 'low priority' to 'high priority') to mimic a de facto task of resource allocation as well as to introduce equidistance. The survey and its question formulation were pre-tested with three experts in advance for conformity.

To utilise the time capital of the (presumably) busy panellists better and jump more straightforwardly into actual prioritisation, we used the best possible global consensuses as a baseline from the INFORM suite and IPCC AR6 to create both the criteria and option items. Our reasons for using them were that they cover multiple types of hazards globally and scientifically robustly, they are transparent and freely accessible, and they provide a common ground for comparability. Choosing a priority was mandatory in all criterion and option items, as in actual resource allocation. The questionnaires are in Appendices A and B.

For Q1's initial criteria, we amalgamated at first ten different types of criteria groups from the methodologies of the operational INFORM Severity (Lopez et al., 2023; Poljansek et al., 2020, pp. 26–34) and INFORM Climate Change Risk (Marzi et al., 2021; Poljansek et al., 2022, pp. 28–47) indices. As the INFORM suite is developed under the Inter-Agency Standing Committee (IASC) and used by IPCC WG2 (2022, pp. 76, 78), we chose it as a representation of the best possible baseline on which indicators an entity should consider when allocating

resources either in observable short-term or in a projected future. Between R1 and R2, we collated the ten initial items into eight according to the panel responses. (Table 2.)

Table 2 The eight Q1 *criterion* items and their descriptions based on the INFORM Climate Change Risk and INFORM Severity suite for the panel to prioritise from low to high priority (4-point scale) in R2 after amending them based on panel responses in R1. Here, they are alphabetically but randomised during the survey.

CAPACITY OF LOCAL ACTORS AND ON-GOING PROGRAMMING TO RESPOND/ADAPT For example, analyses and projections of the local actors' (e.g., government, NGO presence, on-going programming) capacity to respond and adapt, such as 1) capability to take anticipatory or early action vis-à-vis forecasted hazard or 2) efficiency of preparedness to reduce/prevent humanitarian impact and risk in the future
HUMANITARIAN ACCESS INDICATORS For example, indicators of impediments to entry into country, restriction of movement, interference into the implementation of humanitarian activities, on-going insecurity/hostilities affecting humanitarian assistance, presence of mines and improvised explosive devices, etc. and their possible extrapolation into the future
INDICATORS ON VULNERABLE GROUPS OR DIVERSITY OF GROUPS AFFECTED For example, indicating the following either pre-existing or forecasted vulnerability: uprooted people, estimated number of people living with HIV, child mortality or children underweight, prevalence of undernourishment, Domestic Food Price Index, count of different types of affected population groups from IASC humanitarian profile common operational dataset
LACK OF INFRASTRUCTURAL COPING CAPACITY For example, indicators on communication capacity measured via access to electricity (World Bank) or adult literacy rate (UNESCO), physical infrastructure quality via roads density (OpenStreetMap) or access to improved water source (WHO /UNICEF), or access to health systems via physician density, health expenditure per capita or proportion of population with access to vaccines (WHO)
PEOPLE IN NEED (PIN) PER SEVERITY LEVEL OF THEIR HUMANITARIAN CONDITIONS (INCL. AFFECTED AND DISPLACED) The estimated distribution of affected people in severity categories according to their conditions and humanitarian needs, such as from level 1 (minimal needs) to level 5 (extreme needs), based on e.g., projections from Humanitarian Data Exchange (HDX), local disaster relief or civil protection authorities, UN OCHA Humanitarian Needs Overviews (HNOs), or Integrated Phase Classification (IPC, incl. Acute Food Insecurity AFI classification)/FEWS NET for food security - including displaced people generated by the crisis and their forecast, such as refugees or internally displaced persons (IDPs), from UNHCR, IOM, national statistics or similar
RISK OF HAZARD AND EXPOSURE TO DISASTERS Regarding *human disasters*, for example: conflict intensity via the HIIK conflict barometer or Global Conflict Risk Index (GCRI), total people killed from Armed Conflict Location & Event Data Project (ACLED), or other suitable source for future projection Regarding *natural disasters*, for example: future risks of earthquake, tsunami, river flood, coastal flood, cyclone, drought, epidemics, etc. from e.g., Aqueduct Global Flood Maps, Standardised Precipitation Evapotranspiration Index (SPEI), European Drought Observatory (EDO), models of vector-borne diseases, Global Earthquake Model (GEM), or cyclone wind intensity maps with Saffir-Simpson Hurricane Scale
RULE OF LAW INDICATORS AND LACK OF INSTITUTIONAL COPING CAPACITY For example, country self-assessments in disaster risk reduction from the Sendai Framework, government effectiveness index from the World Bank, Corruption Perception Index (CPI), rule of law from Bertelsmann Stiftung's Transformation Index (BTI) or World Governance Indicators (WGI) via the World Bank, Freedom in the World report from Freedom House, etc. or similar sources for projection
SOCIAL COHESION INDICATORS AND SOCIO-ECONOMIC VULNERABILITY For example, indicators on development and deprivation via HDI or MPI, inequality via GINI, aid dependence via public aid per capita or net ODA received, empowerment from the CIRI Human Rights Dataset, BTI – democracy status, ethnic fractionalisation from the Ethnic Power Relations (EPR) dataset, size of excluded ethnic groups, Gender Inequality Index (GII), etc. and their possible extrapolation

For the initial options in Q2, we took the eight representative key risks (RKR) from IPCC's WG2 contribution to AR6 as a thematic baseline (Table 3). The logic of choosing RKRs as the options to fund was that humanitarian aid and disaster management would likely focus their resource allocation on risk-based themes. IPCC defines the RKRs as a clustered synthesis of 127 regional and sectoral key risks that could enter a severe phase by the end of the century under a distinct set of climate hazard, exposure, and vulnerability. (IPCC WG2, 2022, p. 113)

Table 3 The eight Q2 *option* items and their descriptions based on IPCC WG2 AR6 key representative risks for the panel to prioritise from low to high priority (4-point scale) in R1 and R2. Here, they are alphabetically but randomised during the survey.

RISK TO FOOD SECURITY Food insecurity and the breakdown of food systems due to climate change effects on land or ocean resources
RISK TO HUMAN HEALTH Human mortality and morbidity, including heat-related impacts and vector-borne and water-borne diseases
RISK TO LIVING STANDARDS Economic impacts across scales, including impacts on GDP, poverty and livelihoods, as well as the exacerbating effects of impacts on socio-economic inequality between and within countries
RISK TO LOW-LYING COASTAL SOCIOECOLOGICAL SYSTEMS Risks to ecosystem services, people, livelihoods and key infrastructure in low-lying coastal areas and associated with a wide range of hazards, including sea level change, ocean warming and acidification, weather extremes (storms, cyclones) and sea ice loss, for example
RISK TO TERRESTRIAL AND OCEAN ECOSYSTEMS Transformation of terrestrial and ocean/coastal ecosystems, including change in structure and/or functioning and/or loss of biodiversity
RISK TO WATER SECURITY Risk from water-related hazards (floods and droughts) and water quality deterioration; focus on water scarcity, water-related disasters and risk to Indigenous and traditional cultures and ways of life
RISKS ASSOCIATED WITH CRITICAL PHYSICAL INFRASTRUCTURE, NETWORKS AND SERVICES Systemic risks due to extreme events leading to the breakdown of physical infrastructure and networks providing critical goods and services
RISKS TO PEACE AND TO HUMAN MOBILITY Risks to peace within and among societies from armed conflict as well as risks to low-agency human mobility within and across state borders, including the potential for involuntarily immobile populations

Our motivation in combining indicators from the short-term/micro INFORM Severity index with the long-term/macro INFORM Climate Change Risk as well as the high-level and century-encompassing RKRs of IPCC AR6 was to explore the forward-looking criteria and options that are priorities in humanitarian or disaster aid funding in general and regardless of organisation, policy background/job function, region of focus, discrete time horizon, or similar factors (i.e., an attempt to find covariant variables in continuous time).

2.2 Data collection and processing

Recruitment for R1 was opened on 7 March 2023 by email to the initial pool and closed on 5 May (Fig. 1.) The authors prepared an analysis of R1 (Appendix C) for the panellists to fuel their further deliberation as well as to document the R1 results. There are studies indicating that this could lead to the minority moving towards the assessment of the majority (Makkonen et al., 2016; Meijering & Tobi, 2018), but we favoured transparency in a complex problem as well as to appreciate the time and effort that the panel put into the research (Beiderbeck et al., 2021). Based on the panellists' comments or suggestions and the intermediate analysis, we made minor amendments to question titles and descriptions, merged equivalent question items, and formed one new criterion (Appendix C, pp. 11-12).

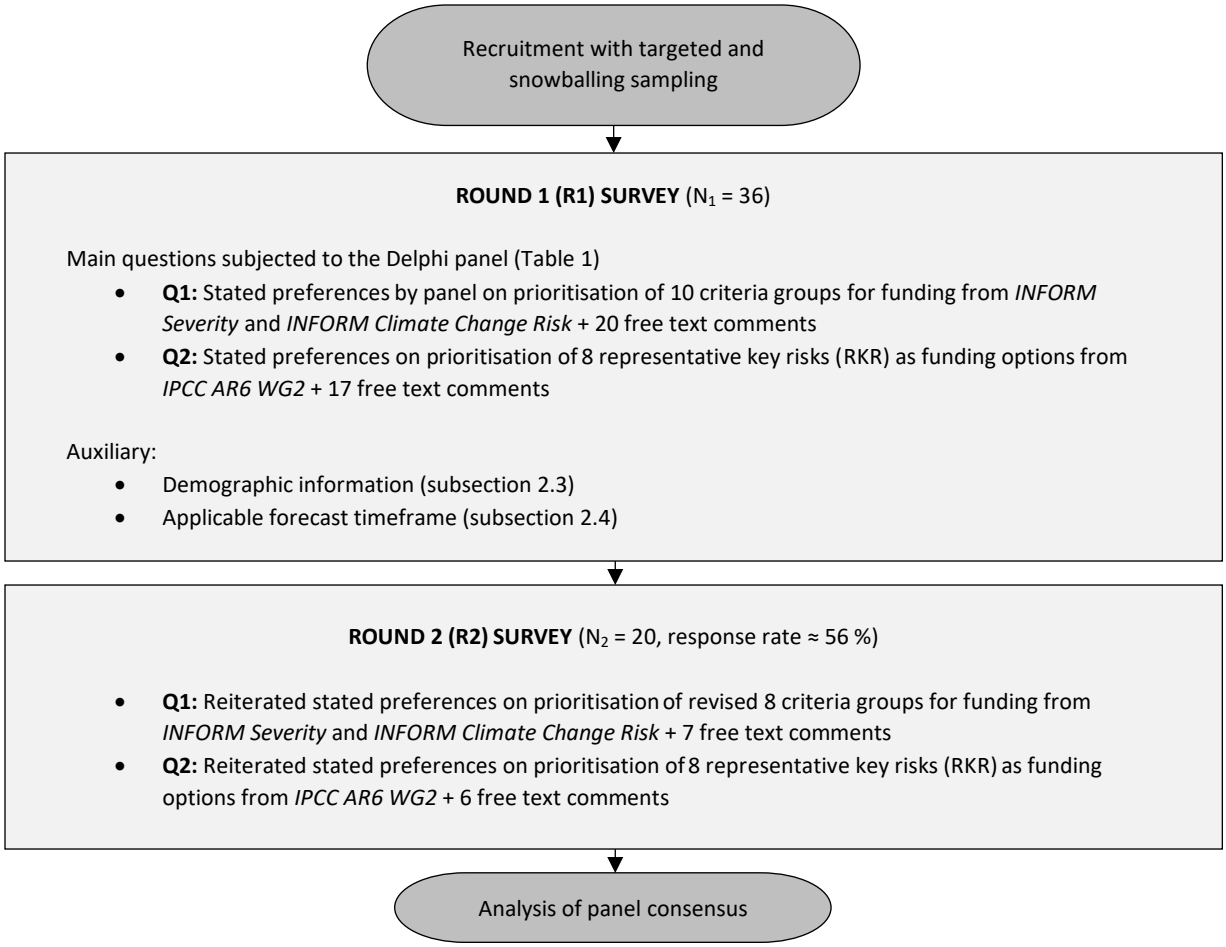

Fig. 1 Flowchart of Delphi data collection and processing

R2 was opened to the panel of R1 on 12 June 2023 and closed on 31 July. During the opening, the panellists received the intermediate analysis via email and as an attachment within the new survey form. The panel's responses to the substantive questions Q1 and Q2 are in the respective subsections on results.

2.3 Panel recruitment and composition

We started formal recruitment of the Delphi panel when R1 opened—our initial pool of invitations comprised over two hundred email addresses. The pool included government units or officials, international experts, or civil society employees working on, among others, combinations of humanitarian aid operations, forecast-based financing (or early action, FbF or FbA), anticipatory action (AA), disaster risk management, risk reduction or preparedness (DRM, DRR, or DP), climate resilience, or climate change adaptation (CCA) as well as academics who had published in the mentioned fields or private sector entities working on them (e.g., disaster risk insurance firms).

During R1, we requested basic demographic information from the panel members. Panellists could select "Prefer not to say" at any question, but none used it. The panel comprised, in general, the following target groups: 1) UN system (incl. OCHA, UNICEF, WFP, WMO), European Commission (DG ECHO), Red Cross Red Crescent, and World Bank staff; 2) universities & research institutions; 3) government and public sector officials; and 4) civil

society/INGOs/NGOs (e.g., ACAPS, Action Against Hunger, CARE, GEM, REACH, OXFAM, Save the Children, World Vision). It included personnel serving both in headquarters and in field operations.

Out of 36, the panel included 18 identifying as females and 18 identifying as males (the possibility to select 'other' gender was available) and 19 different countries of origin spread globally. Regarding the primary employment sector, 13 represented civil society, and 13 represented international or intergovernmental organisations; 4 were from research institutes, and 6 were from the national government or public sector. The primary field represented analysis and research the most, with 10 panellists. Next were desk/policy/project officers and the category 'other' with both 7. In descending order, the remaining were from coordination/stakeholder relations, operations/logistics, leadership, and financing/budgeting. (Appendix C, pp. 9-10.)

In general, we concluded that the panel was diverse and well stratified for this expert Delphi research and corresponding to the amount of personnel available (e.g., compared to vacancies on ReliefWeb) with expertise in the three distinct sectors of climate change, funding, and humanitarian or disaster aid. There were no panel members from the private sector and the countries of origin are more oriented toward the Global North (mainly Europe). Still, these were both expected, considering the nature of the topic and the direction of the flow of funding.

2.4 Applicable forecast timeframe

The future timeframe that the social planner or expert is most likely to allocate funding for and to use for foresight plays a significant part in the priority preference for Q1 and Q2. Thus, we requested the panellists to determine during R1 the forecast timeframe(s) most suitable for their role and to use this as their anchor when responding to Q1 and Q2. The choices available ranged from a lead time of hour(s) or year(s) forward until the IPCC long-term scenarios and panel members could choose multiple. (Fig. 2.)

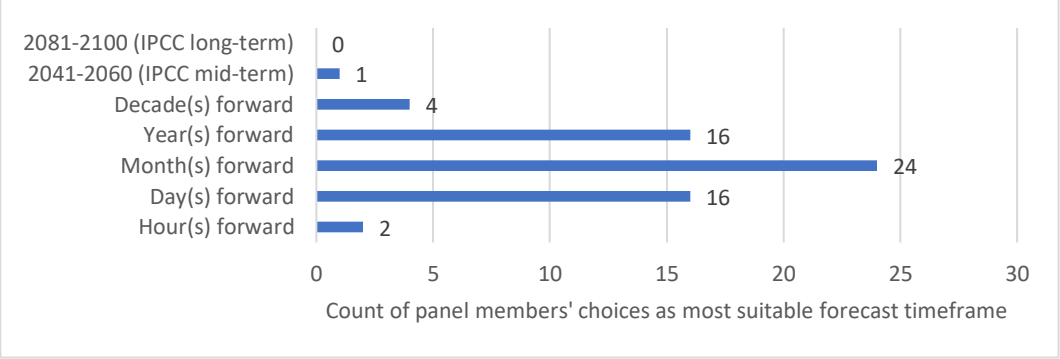

Fig. 2 Count of panel members' choice for the timeframe(s) most suitable for their role (N_T=63) from R1 arranged in descending order from farthest to earliest. The panel members (N_1=36) could choose multiple with the caveat, "Try to stay consistent, i.e., that you choose timeframes close to each other and not, for example, that you only choose hour(s) forward and 2041-2060."

The distribution of the preferred timeframes resembles a bell curve-type shape with 'month(s) forward' as the most preferred - followed by both 'year(s) forward' and 'day(s) forward' in second place. Most timeframe groups had positive Pearson correlation coefficients of either moderate or strong between them when compared within question sets Q1 and Q2. Still, there was a weak correlation between the earliest and farthest timeframes on the priority criteria in Q1 - whereby, in essence, the most distant-looking panel members favoured risk-based indicators over people-centred criteria. (Appendix C, p. 8.) This interplay can be noticed in qualitative answers to Q1 as well. On priority options in Q2, all cohorts answered similarly with strong positive correlations.

We do not draw a quantitative conclusion because the sample sizes of the earliest and farthest timeframe groups are small. We could, for example, posit that at some point around 'year(s) forward' the uncertainty of a projection could start turning intolerable to decision-making and risk-based indicators would become a more dominant preference.

3 Results

To compare the Delphi panel's stated preferences for each sub-question, we transformed their choices per category into numerical values for quantitative analysis (4-point linear scale, 1 = low priority and 4 = high priority). Mean and standard deviation (SD) were used as the primary parametric methods to determine the rank and consensus of each item. They are intuitive, straightforward, and naturally readable; similarly, SD and mean show a negligible risk of a false position or consensus in a corresponding field of disaster medicine. (Franc et al., 2023) In Appendix D, the disaggregated results and more descriptive statistics are available.

3.1 Q1 - Priority criteria in allocating humanitarian or disaster aid funding per future forecasts in view of climate change response or adaptation

The quantitative results of R1 and R2 for Q1 are displayed in descending order of priority (Tables 3 and 4). Between the rounds, we merged categories Q1.1-3 on people-centred criteria and Q1.4-5 on disaster risk-based criteria into single items due to their similarity and proximity in both quantitative and qualitative results as well as adding a new criterion Q1.X per panel suggestions (Appendix C, pp. 11-12).

Table 4 Stated preferences for R1 by panel (N_1=36) on priority criteria in allocating humanitarian or disaster aid funding per future forecasts in view of climate change response or adaptation (Q1). Scale and colouring for median and mean: 1 = low priority (white), 4 = high priority (green); the closest point assigns priority. Colouring for standard deviation (SD): 0 = blue, 1 ≤ white. Order was randomised for each panel member but is now in descending order per mean. Item coding is with this order.

Priority ↑	Item	Mean ↑	SD	Median	Range	Mode
HIGH PRIORITY (4)	Q1.1 PEOPLE IN NEED (PIN) PER SEVERITY LEVEL OF THEIR HUMANITARIAN CONDITIONS	3,64	0,67	4,00	3,00	4,00
SOMEWHAT HIGH PRIORITY (3)	Q1.2 PEOPLE AFFECTED BY THE CRISIS	3,42	0,72	4,00	2,00	4,00
	Q1.3 PEOPLE DISPLACED BY THE CRISIS	3,33	0,82	4,00	3,00	4,00
	Q1.4 RISK OF HAZARD AND EXPOSURE TO NATURAL DISASTERS	3,31	0,78	3,50	2,00	4,00
	Q1.5 RISK OF HAZARD AND EXPOSURE TO HUMAN DISASTERS	3,28	0,73	3,00	3,00	3,00
	Q1.6 INDICATORS ON VULNERABLE GROUPS OR DIVERSITY OF GROUPS AFFECTED	3,17	0,93	3,00	3,00	4,00
	Q1.7 HUMANITARIAN ACCESS INDICATORS	2,53	0,76	3,00	3,00	3,00
SOMEWHAT LOW PRIORITY (2)	Q1.8 SOCIAL COHESION INDICATORS AND SOCIO-ECONOMIC VULNERABILITY	2,44	0,96	2,00	3,00	2,00
	Q1.9 LACK OF INFRASTRUCTURAL COPING CAPACITY	2,28	0,90	2,00	3,00	2,00
	Q1.10 RULE OF LAW INDICATORS AND LACK OF INSTITUTIONAL COPING CAPACITY	2,14	0,95	2,00	3,00	2,00
LOW PRIORITY (1)	-	-	-	-	-	-

Table 5 Same as above but for R2 (N_2=20). Item coding, scale, colouring, and order logic are from Table 4, excluding merging of equivalent items Q1.1-3 and Q1.4-5 to single items and creating new item Q1.X.

Priority ↑	Item	Mean ↑	SD	Median	Range	Mode
HIGH PRIORITY (4)	Q1.1-3 PEOPLE IN NEED (PIN) PER SEVERITY LEVEL OF THEIR HUMANITARIAN CONDITIONS (INCL. AFFECTED AND DISPLACED)	3,80	0,51	4,00	2,00	4,00
	Q1.4-5 RISK OF HAZARD AND EXPOSURE TO DISASTERS	3,55	0,59	4,00	2,00	4,00
SOMEWHAT HIGH PRIORITY (3)	Q1.6 INDICATORS ON VULNERABLE GROUPS OR DIVERSITY OF GROUPS AFFECTED	3,20	0,93	3,00	3,00	4,00
	Q1.9 LACK OF INFRASTRUCTURAL COPING CAPACITY	2,65	1,06	2,50	3,00	2,00
	Q1.X CAPACITY OF LOCAL ACTORS AND ON-GOING PROGRAMMING TO RESPOND/ADAPT	2,60	0,86	3,00	3,00	3,00
SOMEWHAT LOW PRIORITY (2)	Q1.8 SOCIAL COHESION INDICATORS AND SOCIO-ECONOMIC VULNERABILITY	2,35	0,79	2,00	3,00	3,00
	Q1.7 HUMANITARIAN ACCESS INDICATORS	2,21	0,69	2,00	3,00	2,00
	Q1.10 RULE OF LAW INDICATORS AND LACK OF INSTITUTIONAL COPING CAPACITY	2,10	0,83	2,00	3,00	2,00
LOW PRIORITY (1)	-	-	-	-	-	-

We asked the panel to justify their assessments, measure their confidence, and suggest amendments to the survey. R1 had 20 free-text comments and R2 had 7. A synthesis of common topics that the panellists discussed follows. **First, people-centred criteria were predominantly the top criteria.** While it is true that many criteria items overlap and have a complex interplay between them, most focus on people-centred criteria, especially emphasising the magnitude and severity of the need (e.g., the number of people affected by the disaster). Other key human-related terms mentioned were a lifesaving, humanitarian mandate, or saving livelihoods (ID12, ID2, ID6, ID9, ID33, ID14, ID11, ID16.) One panellist stated fittingly that "experience tells me that at the end of the day, the most relevant are people-centred criteria reflecting those in need of humanitarian assistance" while emphasising that other elements (e.g., resilience, coping capacity) are also essential (ID6).

Second, the nuanced interplay between people-centred criteria, risk, and vulnerability is crucial. For example, people-centred needs often interconnect with other elements, such as pre-existing vulnerability (ID9), assessing how some of the indicators are more directly or indirectly linked to saving lives and livelihoods (e.g., humanitarian access and pre-existing assets) (ID33), or conducting an analysis of current severity and magnitude of the need for pre-existing vulnerability before layering risk of shocks (ID14). ID12 condensed the assessment on this interplay by noting that while risks are crucial to know about, it is more important to be aware of the population at risk and their capacity to cope: “A disaster does not trigger humanitarian need if there is no one living in its area of impact.”

During R2, the focus on interplay continued. For example, the risk-based criteria should capture all the vulnerabilities mentioned as is commonly defined (ID41). Similarly, ID52 set the risk-based criteria in ‘somewhat low priority’ as more well-off countries will likely be able to cope with a high risk.

Third, the most essential criteria could depend on the expected timewise sequence of interventions and disasters. The further the panellists looked to the future, the more emphasis there was on elements of risk – which we noticed in the timeframe analysis as well (subsection 2.4). For example, ID1 stated that “high priority on risk assessments to determine physical and socio-economic impacts of disasters (including both rapid and slow onset hazard)”, which we can then invest today to build resilience and coping capacity to reduce risk in the future. This interplay between magnitudes of people in need, existing vulnerabilities/coping capacities, and risk of future hazard and exposure depends on the forecast timeframe and the expected intervention time. Risk is naturally irrelevant if the disaster has already happened (excluding residual risk) or the impact projection is reliable (ID8, ID9). The answers reflected the timewise sequence of policy-wise terminology and overlaps of different nexuses (ID7, ID8, ID1, ID14, ID35), such as forecast-based funding or anticipatory action, early action funding or post-

hazard humanitarian response, build back better and mitigating residual risk, and humanitarian-development nexus programming (building resilience, climate change adaptation, disaster risk reduction).

Fourth, there were differences in confidence in answering, but it improved in R2. Two panellists reflected that they were confident or quite confident in their answers or assessments - particularly pointing to the use of humanitarian or people-based needs and the magnitude and extent of the need (ID28, ID10). Two noted that the priority of criteria would also depend on context, such as whether it is a particular forecast or in general, as well as dependent on whether data sources allow for a sufficiently local visual of potential humanitarian impact (ID4, ID15). Two found disentangling and separating the criteria for prioritisation challenging. Regardless, even in these cases, there was a verge of leaning on the people-centred criteria or more all-encompassing categories, i.e., where multiple characteristics come together (ID11, ID16). During R2, three panellists reflected that they were more confident or somewhat more confident because of the intermediate analysis and the refining of the categories (ID42, ID46, ID50).

Fifth, during R2, panellists also reflected that we should consider the practicality of funding in the end. For example, despite the focus on people-centred and humanitarian indicators being the most pertinent, we must recognise the level of humanitarian access, institutional coping capacity, and capacity of local actors to either act, absorb, or utilise funding. (ID42, ID43.) One member chose the priorities based on what is likely the most effective or meaningful use of resource supply, e.g., where needs are highest and the capability to respond is at a good level versus a complex situation where successful aid programming is difficult (ID45).

3.2 Q2 - Priority options for which to allocate humanitarian or disaster aid funding regarding adaptation to representative key risks of climate change

The panel's quantitative stated preferences in Q2 are below (Tables 5 and 6) in the same layout as in Q1.

Table 6 Stated preferences for R1 by panel (N_1=36) on priority options for which to allocate humanitarian or disaster aid funding regarding adaptation to representative key risks of climate change (Q2). Scale and colouring for median and mean: 1 = low priority (white), 4 = high priority (green); the closest point assigns priority. Colouring for standard deviation (SD): 0 = blue, 1 ≤ white. Order was randomised for each panel member but is now in descending order per mean. Item coding is on this order.

Priority ↑	Item	Mean ↑	SD	Median	Range	Mode
HIGH PRIORITY (4)	Q2.1 RISK TO FOOD SECURITY	3,75	0,43	4,00	1,00	4,00
	Q2.2 RISK TO HUMAN HEALTH	3,69	0,62	4,00	2,00	4,00
	Q2.3 RISK TO WATER SECURITY	3,67	0,67	4,00	3,00	4,00
SOMEWHAT HIGH PRIORITY (3)	Q2.4 RISKS TO PEACE AND TO HUMAN MOBILITY	2,94	0,88	3,00	3,00	3,00
	Q2.5 RISKS ASSOCIATED WITH CRITICAL PHYSICAL INFRASTRUCTURE, NETWORKS AND SERVICES	2,61	0,92	3,00	3,00	3,00
	Q2.6 RISK TO LIVING STANDARDS	2,50	0,93	2,00	3,00	2,00
SOMEWHAT LOW PRIORITY (2)	Q2.7 RISK TO LOW-LYING COASTAL SOCIOECOLOGICAL SYSTEMS	2,42	0,95	2,00	3,00	3,00
	Q2.8 RISK TO TERRESTRIAL AND OCEAN ECOSYSTEMS	2,14	0,95	2,00	3,00	2,00
LOW PRIORITY (1)	-	-	-	-	-	-

Table 7 Same as above but for R2 (N_2=20). Item coding, scale, colouring, and order logic are from Table 6.

Priority ↑	Item	Mean ↑	SD	Median	Range	Mode
HIGH PRIORITY (4)	Q2.3 RISK TO WATER SECURITY	3,95	0,22	4,00	1,00	4,00
	Q2.1 RISK TO FOOD SECURITY	3,85	0,36	4,00	1,00	4,00
	Q2.2 RISK TO HUMAN HEALTH	3,80	0,68	4,00	3,00	4,00
SOMEWHAT HIGH PRIORITY (3)	Q2.4 RISKS TO PEACE AND TO HUMAN MOBILITY	2,95	0,86	3,00	3,00	3,00
SOMEWHAT LOW PRIORITY (2)	Q2.6 RISK TO LIVING STANDARDS	2,45	0,74	2,50	3,00	3,00
	Q2.5 RISKS ASSOCIATED WITH CRITICAL PHYSICAL INFRASTRUCTURE, NETWORKS AND SERVICES	2,45	0,80	2,00	3,00	2,00
	Q2.7 RISK TO LOW-LYING COASTAL SOCIOECOLOGICAL SYSTEMS	2,30	0,84	2,00	3,00	3,00
	Q2.8 RISK TO TERRESTRIAL AND OCEAN ECOSYSTEMS	2,20	0,93	2,00	3,00	2,00
LOW PRIORITY (1)	-	-	-	-	-	-

As in Q1, we provide a qualitative synthesis per topic of the optional free-text comments (17 for R1, 6 for R2) the panellists wrote. **First, risks to water security, food security, and human health are the most essential options for allocating funding.** The free-text answers reflect the quantitative results to a large degree. Like in Q1, IPCC's key representative risks of climate change are interlinked and not separable (e.g., ecosystem risks can cascade into food security risks), but even then, the highest priorities were already stable in R1 among the panel.

Like in Q1, the panel indicated that a focus on the human and lifesaving elements is the most critical (ID6, ID2, ID9, ID10, ID12, ID14, ID33). While other options are relevant as well, they likely are secondary when people's lives are at risk (ID6), and the funding should prioritise the worst outcomes (loss of human life and rising mortality) versus other risk trends (ID14). ID12 wrote that even with climate change effects, the primary driver of humanitarian aid is probable caseload within the short term (the successive funding cycles, typically a year) – deriving back to the people-centred criteria. During R2, ID45 summarised that "water and food are essential resources that will destabilise the society at large and, thus, deserve the highest priority".

Second, the panel members prioritised imminent versus underlying and cascading risks (e.g., risks to ecological systems). Three panellists noted that even though the top options are the most critical imminently, the underlying risks, such as protecting ecological systems and minimising risks to peace and human mobility, will inevitably come after the initial priority (ID6, ID33, ID7). R2 echoed similar sentiments that the lower priorities could cascade into the higher stresses, e.g., lack of essential water and food destabilising a society (ID52). Those forecasting furthest into the future determine that "the environment and clean water are the most important to assure the viability of life, health, and livelihood" (ID1). ID25 commented that "ecosystems are directly linked to the top priorities; thus, protecting them is instrumental."

As in Q1, the intervention time matters. Four panellists selected the priorities based on what is viable to be amended or could realistically make a difference in the short or medium term (ID15, ID11, ID36, ID12). For example, water and food security are more prominent on seasonal timescales than ecosystem quality or conflict. Still, on a longer timescale, these could switch places (ID11), or the priority should be on imminent suffering as there might not be enough time for longer-term type intervention – although we should implement this in parallel to resilience building and coherent with humanitarian anticipation and development intervention in the face of the subsequent disasters (ID36).

Third, prioritising which climate change risks to focus on is naturally challenging. For example, ID7 remarked, "would want to put everything in high priority", or ID19 noted, "I find all categories as a high priority, while few are outcomes of the others and hence a higher priority". At the same time, ID28 stated being "rather confident" by assessing them out of long-term sustainable adaptation design. Quantitatively, the panel seemed confident and

like-minded in the prioritisation. Thus, it is more likely that a seasoned expert will admit the difficulty but can perform it, nonetheless. During R2, panel members were more confident (ID50) or equally sure – although unpacking each risk category further would be beneficial (ID42). One would favour everything in high priority but chose to deprioritise those that are more underlying or potentially cascading (ID52), and another still had difficulty due to all the themes deserving priority but focused on the actions that are most viable in building resilience to climatic pressure (ID45).

4 Discussion

4.1 Strengths and limitations

A Delphi panel can give evidence of the most likely result embedded among global expertise and the best way forward for a complex problem – especially with a well-stratified panel (subsection 2.3) and by measuring its consensus. If the panellists have a similar expert understanding and knowledge of the field, even a small sample of 20 can provide a reliable outcome, e.g. compared to augmented sampling. (Akins et al., 2005; Beiderbeck et al., 2021; Diamond et al., 2014)

We used standard deviation (SD) as our leading consensus indicator among the panel members, where SD ≤ 1.00 is a standard cut-off for good consensus. At the same time, SD ≤ 0.50 could be considered a high consensus (Franc et al., 2023). In the whole dataset, the only item that had SD > 1.00 was Q1.9 during R2 with 1.09. Average SD also improved (i.e., decreased) by 0.10 and 0.11 in both item sets from R1 to R2. In general, the high priorities were more consensual and reached SDs ranging between 0.22–0.62 during R2, while items in somewhat high or somewhat low priority were more contested with SDs of 0.74–1.09. (Tables 4–7.) Interquartile ranges, coefficients of variation and other measures in Appendix D provide similar support to the validity of the results (Beiderbeck et al., 2021; Diamond et al., 2014).

In the qualitative parts, many whole sentences indicate good engagement by the panellists (Beiderbeck et al., 2021). All 50 free-text comments (total for Q1 and Q2 in R1 and R2) were complete sentences (ranging from 1219 words and 62 sentences in Q1 of R1 to 207 words and 13 sentences in Q2 of R2). Correlation can also provide information on how stable or similar the panel's answers were between rounds (von der Gracht, 2012). Pearson correlation coefficient (Pearson's r) between the means of the items indicated a strong positive correlation for Q1 (r=0.95) and Q2 (r=0.99) between the panel's answers in R1 and R2.

Thus, based on these parametric measures, this exact panel had a strong consensus on the ranking of the priorities. Nevertheless, our research has significant limitations. The Delphi method does not necessarily represent the actual global consensus or the true answer to the research question. Furthermore, it cannot naturally speak of other sectors' priorities, such as environmental or ecosystem protection. To alleviate this, we intend to make our results more robust and test their sensitivity vis-à-vis real-world data and budgeting in the next phase with, e.g., Monte Carlo and multi-criteria decision-making (MCDA) analyses.

4.2 Discussion

We did what many (Lentz & Maxwell, 2022; Rising et al., 2022; Stern et al., 2022) call for in better informing decision-makers of humanitarian and disaster response as well as climate change adaptation and deciphering their endogenous preferences: Ask the key users what criteria and options they consider priorities when allocating scarce public resources to adapt and to counter losses and damages. The problem of cutting the global budgetary

cake fairly and equitably is not trivial – especially when discussions on the COP27-agreed "Loss and Damage" funding arrangement are ongoing, and climate change exacerbates crises.

Here, we contribute to behavioural climate economics by providing prioritised expert preferences on the above questions. As IPCC AR6 WG2 states, the current literature "largely does not consider the increased difficulty of adapting to climate extremes and general higher variability in climate that is projected to occur in the future" (2022, p. 2489).

The forecast time preference that the panel members work primarily on is the near future: Thus, predominantly days(s), month(s) or year(s) forward (subsection 2.4). The results could be different if we aimed the Delphi method at purely developmental or investment actors looking strictly at decades ahead. Notwithstanding that, for example, the World Bank's corporate scorecard or the Asian Development Bank's results framework heavily depend on people-centric indicators, such as 'people with strengthened climate and disaster resilience'. This would indicate that the panel's results are covariant, at least on the criteria, for those looking at a longer investment horizon. An explanation could be that public institutions are bound via constitutions to be equity-driven in resource allocation.

For the timeframe, this paper raises at least one issue to examine further on the 'tyranny of the present' problem of losses and damages: How much will our adaptive capacity and its funding envelope in the future pathway contain simply responding more and more effectively to crises and disasters (e.g., using diverse financial instruments or insurance mechanisms, involving private actors) instead of preventing them decades ahead? Especially with scarce resources to distribute timewise between response and prevention among already rising amounts of climate change-attributable extreme events. In other words, in an era of losses and damages.

Our objective was to explore the forward-looking criteria and options that would be prioritised in humanitarian aid and disaster risk management funding allocations regardless of organisation, policy background or job function, region of focus, definitive terminology, exact time horizon, or similar factors. In other words, it attempts to find covariant variables in continuous time for general use. Thus, it seems remarkable how similarly the very diverse panel answered when put in front of an ensemble of composite criteria or complexly interlinked risks – where, in both cases, they often overlap. This consensus suggests that the results of this paper are an emergent preference for the losses and damages sector. Thus, it raises further questions on what we can and should prioritise with scarce resources. In other words, what is the time value of a human life according to behavioural preference? Should we first extinguish the imminent "house is on fire" issues or focus on adapting and reducing the residual of the cascading collapses possible in the longer timeframe? Future research could expand on these scopes and settings and examine our societal preferences.

4.3 Conclusions

In Table 8, we have summarised the results of the two Delphi rounds (subsections 3.1 and 3.2). Instead of the numerical values assigned for analysis, focusing on the qualitative importance of the priority choices available to the panel during the funding simulations is likely better. Effectively, a criterion or option labelled as "somewhat low priority" would probably not be considered important enough in an actual prioritisation exercise to be included in the final cut, whereas a "high priority" would be examined much more carefully.

This panel's preference for people in need-centric and disaster risk-based criteria outweighs the importance of indicators related to governance, the rule of law, or a socio-economic aspect in humanitarian aid and disaster management (Table 8, col. Q1). The experts on the issue prefer those criteria that are inherently equity-driven and likely forecast the severity and magnitude of disasters and humanitarian crises most effectively and in an all-encompassing umbrella manner. Logically, these would estimate the final required funding per capita in need of aid – as likewise discussed in the qualitative comments. The notion corresponds with humanitarian principles and

operational needs assessments of, for example, UN OCHA and the Integrated Food Security Phase Classification (IPC). In other words, that action should be based on need alone, prioritising the most urgent cases of distress.

The other indicators are by no means unimportant. Although focusing on people is often labelled as most relevant, there is a complex and crucial interplay between the magnitude and severity of the people-centred criteria vis-à-vis risk assessments and vulnerability, especially when moving farther in the forecast and intervention time. Principally, when closing in on the conceptual borders between responding and adapting to climate change or nexuses between humanitarian and development work. As discussed, hazard and exposure do not create people in need without vulnerability. The various versions of what encompasses 'risk' across different frameworks likely also contribute to the divergence (Visser et al., 2020). Similarly, the other criteria could have, for example, practical effects (e.g., logistical issues in delivering aid due to low humanitarian access) or development effects (an unstable rule of law causing permacrisis in conjunction with frequent disasters).

Table 8 Summary of panel preferences based on Tables 4–7. Colouring matches the mentioned tables so that high priority = green, low priority = white. Within priority boxes, the categories are alphabetically. See Tables 2–3 for descriptions of each item's metrics and scopes during the Delphi panel.

Priority ↑	**Q1: *Criteria* in allocating humanitarian or disaster aid funding per future forecasts in view of climate change response or adaptation**	**Q2: *Options* for which to allocate humanitarian or disaster aid funding regarding adaptation to representative key risks of climate change**
HIGH PRIORITY	• PEOPLE IN NEED (PIN) PER SEVERITY LEVEL OF THEIR HUMANITARIAN CONDITIONS (INCL. AFFECTED AND DISPLACED) • RISK OF HAZARD AND EXPOSURE TO DISASTERS	• RISK TO FOOD SECURITY • RISK TO HUMAN HEALTH • RISK TO WATER SECURITY
SOMEWHAT HIGH PRIORITY	• CAPACITY OF LOCAL ACTORS AND ON-GOING PROGRAMMING TO RESPOND/ADAPT • INDICATORS ON VULNERABLE GROUPS OR DIVERSITY OF GROUPS AFFECTED	• RISKS TO PEACE AND TO HUMAN MOBILITY
(in between)	• HUMANITARIAN ACCESS INDICATORS • LACK OF INFRASTRUCTURAL COPING CAPACITY	• RISK TO LIVING STANDARDS • RISKS ASSOCIATED WITH CRITICAL PHYSICAL INFRASTRUCTURE, NETWORKS AND SERVICES
SOMEWHAT LOW PRIORITY	• RULE OF LAW INDICATORS AND LACK OF INSTITUTIONAL COPING CAPACITY • SOCIAL COHESION INDICATORS AND SOCIO-ECONOMIC VULNERABILITY	• RISK TO LOW-LYING COASTAL SOCIOECOLOGICAL SYSTEMS • RISK TO TERRESTRIAL AND OCEAN ECOSYSTEMS

Likewise, focusing funding on adapting to climate change-related risks to food security, human health, and water security is a high near-future priority compared to, for example, risk to living standards or risk to terrestrial and ocean ecosystems (Table 8, col. Q2). As with the priority criteria, the results propose a clear prioritisation of where our counter-risk funding should go in the basket of options, but we should consider nuances. The panel noted in the qualitative comments that their choices reflected a timewise priority of the most urgent and life-threatening risks versus fundamental risks that can cascade in the long run. For example, risks to ecosystems and socioecological systems can become threat multipliers for the more imminent risks. Indeed, the IPCC defines that the representative key risks are not separable and that some are already occurring while others will occur before mid-century or before the end of the century (IPCC WG2, 2022, pp. 114, 117).

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