ETHICS, TECHNOLOGY, AND PANDEMICS

MARIA JOÃO CABRITA
ÂNGELO MILHANO
/ORG.

COLEÇÃO TA PRAGMATA

PRAXIS

Título: Ethics, Technology, and Pandemics
Organizadores: Maria João Cabrita e Ângelo Milhano

Praxis - Centro de Filosofa, Política e Cultura
www.praxis.ubi.pt

LusoSofia: Press
Coleção: Ta Pragmata
Direção: José António Domingues e Olivier Feron
Design: Cristina Lopes

ISBN
978-989-654-996-1 (papel)
978-989-654-998-5 (pdf)
978-989-654-997-8 (epub)
Depósito Legal
531386/24

Tiragem: Print-on-demand

Universidade da Beira Interior
Rua Marquês D'Ávila e Bolama.
6201-001 Covilhã. Portugal
www.ubi.pt

Covilhã, 2024

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— Disruptive technologies and disaster ethics

Javier Gil (University of Oviedo, Spain)[1]
Beatriz Rayón (University of Oviedo, Spain)[1]

1 — Introduction

We know from historical records that the devastating consequences of so-called natural disasters have been a scourge for humanity at human, environmental and socio-economic levels. Even in modern times, the human inability to anticipate and prevent natural hazards invariably resulted in high casualties, losses and damage to communities around the world. Consequently, the predominant coping strategy during centuries was often largely reactive and resigned. Over time, the evolution and accumulation of knowledge and skills contributed to a better understanding of the different types of hazards and improve strategies to mitigate

1. Javier Gil, University of Oviedo (Spain), javiergil@uniovi.es; Beatriz Rayón, University of Oviedo (Spain), rayonbeatriz@uniovi.es. The preparation of this chapter benefited from the research project "Ethical duties in disaster contexts – DESASTRE", funded by the BBVA Foundation Grants for Scientific Research Projects, and the "Bioética y Éticas y Aplicadas (BIOETICA)" Research Group from the University of Oviedo.

their direct and indirect effects on societies. An enhanced knowledge of the natural and anthropogenic phenomena that trigger disasters as well as of the social conditions that favor them led during the 20th century to the development of more effective prevention measures and to the emergence of increasingly advanced tools, such as simulation models, early warning systems and monitoring devices. As in many other areas of human life in an ever-evolving world, scientific advances and technological innovations have refined societies' abilities to anticipate and manage natural and human-made disasters and are transforming our perception and understanding of them. In short, we are better equipped than in the past to cope with disasters in all their phases (preparedness, response and recovery), largely because we have acquired, built, and strengthened better scientific knowledge and technological power.

Looking at the understanding of disasters, a shift towards a proactive approach has been emerging as a global trend over the last half century. In contrast to the previously hegemonic conception of natural disasters as supervening hazards to be dealt with reactively and above all through technological solutions, the proactive approach has been based on the recognition of social vulnerability and the building of community resilience and it has placed a high value on disaster risk prevention and mitigation. Such approach has been strongly supported and carefully shaped at the international level through the *Sendai Framework for Disaster Risk Reduction 2015-2030* (UNISDR, 2015). This non-binding policy framework represents a consistent evolution from the *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters 2005-2015* and the *Yokohama Strategy and*

Plan of Action for a Safer World (UNISDR 2005 and UNDRR 1994), and it has laid the foundation for disaster risk reduction (DRR) on a global scale. Importantly, the Sendai Framework recovers a high appreciation of the role of technological advancement, innovation, and transfer, especially in view of communities' preparedness to disasters as a kind of pillar in disaster risk reduction.

The applications of information and communication technologies (ICT) and so-called emerging, innovative and disruptive technologies to DRR have gained increasing relevance in contemporary societies over the last decades. Advances in data collection and analysis, artificial intelligence, and global interconnectedness enable rapid and efficient responses to the challenges posed by natural and human-induced hazards. The abundance and availability of both recorded and real-time information, big data processing capabilities, and the media outreach are transforming the decision-making processes in advance to crisis situations (Roberts et al. 2021). In addition to improving our ability to prevent and manage disasters, new technologies influence the public perception and awareness of the nature and dynamics of disasters and reinforce the public attention to risk prevention and mitigation. What is more, these technologies are not simply a set of neutral and more or less efficient tools, but a social reality that incorporates epistemic and practical values and significantly reshapes our fully socialized view of the emergencies and disasters.

2 — Technologizing disasters

Disruptive technologies refer to emerging technologies that outperform those prevailing in the market and are expected to have a large socioeconomic impact. They encompass a wide range of innovations, such as social media, cloud computing, the Internet of Things (IoT), artificial intelligence (AI), machine learning (ML), Deep learning (DL) and robotics, including autonomous vehicles and drones. Recent advances in disruptive technologies, often combined with older technologies such as mobile phones, seismometers, and satellite imagery, are seeing successful growth and rapid diffusion because they find – or credibly promise – solutions for disaster risk detection, mitigation and intervention. It goes without saying that the opportunities these technologies offer for improving resilience and risk reduction (as in many other social areas and human activities) represent a profitable field of research and investment due to the substantial benefits expected in relation to disaster preparedness, response, and recovery. In what follows we will briefly comment on a few examples of disruptive technologies currently used in disaster risk prevention and disaster response (for a comprehensive overview, see ITU 2019, Izumi et al., 2020, Vijay Kumar and Sud 2020).

1) AI methods are being widely employed in both research and practical application to natural hazard risk analysis and assessment. They have proven to be effective in estimating the probability of occurrence of natural hazards and their impacts, such as physical damage or loss of functionality of systems in relation to the magnitude of the hazard. Big data analytics and ML approaches can identify patterns and generate insights from disaster-related datasets to be applied in disaster risk management. In short, AI is making a significant contribution to assessing the likelihood of natural hazards (such as landslides, floods, earthquakes, volcanos, and wildfires) turning into disasters.

AI models are being applied, for instance, in the prediction and mapping of wildfire probabilities, based on database of spatial distribution of previous occurrences (Jaafari et al. 2019), and in the prediction of the flooding patterns of rivers with the aim of strengthening resilience in water systems (Saravi et al. 2019, Kaur et al. 2021, Ali et al. 2022). For these and other potential disasters, such as those resulting from landslides and debris or coastal hazards, such anticipatory results serve to refine preventive decision-making and community-coping methods. For instance, anticipating which bank will be affected by flooding and at what speed is key to allocating resources for the evacuation of residents along a river course.

Prominent advances of "AI for good" are taking place in the fields of seismology and vulcanology. AI techniques together with DL and ML mechanisms incorporating high-quality data to anticipate future patterns have been employed for earthquake detection (Banna et al. 2020, Mousavi and Beroza 2022). Although accurate prediction of earthquake magnitude, time, and location is currently not possible, large earthquakes may show a preparedness phase that could be discernible in advance thanks to a catalogue of detections and locations generated by an AI-based workflow. According to a promising body of research, earthquake monitoring together with long-term seismic records can facilitate the earthquake preparedness processes (Beroza 2018, Kwiatek et al. 2023).

A combination of ML with satellite imagery (such as those of various Sentinel launched by the European Space Agency), ground-based sensors and also devices for measuring gases transported by drones are being used by researchers to monitor, track and even predict volcanic activity around the planet (Albino et al. 2019). It is not only that researchers can measure in real time the composition of volcanic gases on the computer and monitor ground deformations thanks to geospatial information. They are creating models to assign probabilities to the chances of specific volcanos erupting in a given time period. While it is an exaggeration to say that we are witnessing a revolution in vulcanology (Parmer 2020), there is no doubt that valuable tools are being assembled to improve monitoring and create preparedness and mitigation of future crises (Cassidy and Mani 2022).

2) The IoT plays a significant role among the technologies reinforcing disaster and risk management. The network of sensors and software can optimize the timely collection and distribution of relevant data, such as temperature measurements, water/humidity levels, smoke, wind strength, images, videos, and so on. This data can be combined in a variety of ways with AI techniques to support informed decision-making by relevant stakeholders. A wide variety of predictive studies analyze IoT-based strategies aimed at enabling early warnings, notifications, data analysis and aggregation, remote monitoring, real-time analytics, and victim location (Ray et al., 2017, Esposito et al 2022).

3) Disaster robots and drones (or unmanned aerial vehicles) are employed for location and circumstance inspection, evaluation of situations, prioritization of assistance, and search and rescue missions (Meier 2015: 82-93, Battistuzzi, Tommaso and Sgorbissa 2021). Good drones and robots minimize human exposure to hazardous environments supervised by humanitarian and civil protection teams, for example by delivering medical supplies or accessing places that animals and relief workers cannot

enter due to space constraints, unstable conditions or potential risks. Many other uses improve the effectiveness of interventions in disaster response and rebuilding. For example, drones help to tell and assess among irreparable damages and fixable buildings and infrastructures. But their outputs and functions are not limited to those of operations in the response and recovery phases. They also contribute to disaster management strategies by collecting imagery, mapping areas, and assisting in data recording and warning systems.

4) Among the most common uses of augmented – virtual or mixed – reality in risk and disaster management are training systems for first responders, support responders or the general public. Many of these systems are simulations that attempt to achieve training close to real or hypothetical situations with lower costs and risks involved. They include, for instance, training focused on CBRN disaster preparedness, training with evacuation simulations (e.g., a flooded subway, a building collapse due to earthquakes) or training games on drill evacuation with realistic situational and audio-visual recreations of emergency scenarios.

5) Mobile devices and applications, frequently integrated with one or more of the technologies aforementioned, furnish supportive information for disaster preparedness guidance, disaster training, weather warnings, data collection and tracking of different types of hazards. Many governments and organizations already provide mobile apps offering disaster-related tools and information, including alerts and resources such as the location of emergency shelters and recovery centers.

We have commented on some cases of disruptive technologies designed and deployed as "tech for good interventions in disasters". These designs and deployments incorporate ethical values and intersect with moral norms and commitments, while prioritizing a systematic consequentialist rationale. In the following section we aim to broaden the perspective to talk about a wide ethical framework for these designs and deployments.

3 — Disaster ethics meeting new technologies: a bird's eye view

Disaster ethics is an applied field that converges or overlaps with other applied ethics (humanitarian ethics, public health ethics, ethics of technology, and various professional ethics among them) and therefore covers a large number of issues. Far from pretending to give a complete picture of disaster ethics and its aims, we will comment on some general points concerning an ethical framework for the challenges of disruptive technologies applied to disasters.

To begin with, the ethical view of disasters considers the entire disaster management cycle and the accompanying cycle of protection of victims and professionals. Relevant ethical obligations and corresponding responsibilities arise in any of the continuous and often overlapping phases of the disaster cycle. Having said that, whether or not obligations and responsibilities relating to disaster preparedness are met largely predetermines the course of expectations and responses in subsequent phases (Gil, 2022). As mentioned above, the normative traction towards preparedness is evident in technological innovations applied to disasters. It is true that very often the ethical assessment focuses on normative analyses of technological changes after the fact. Likewise, it evaluates retrospectively thorny questions of those technological and CBRN disasters that could have been avoided. However, the normative exploration of emerging technologies prioritizes the analysis of the implications of current and future technology-related goods and developments in case of disasters. That implies, among other things, weighing both the societal benefits and risks that these new technologies will bring.

Ethical assessments of technology applications to disasters drop some assumptions of traditional ethics such as that (responsible) agents are mostly individuals and that the consequences of their actions are both directly causally traceable and verifiably certain (Doorn and van de Poel 2012). First, technological advances take place in collective contexts, where multiple actors contribute to shaping these technologies and their social consequences. Not only the production, but also the intervention of new technologies in disaster contexts requires the activity of diverse groups of people such as different professionals, humanitarian teams, volunteers, managers, researchers, and other stakeholders. Secondly, technological advances are complex processes involving long causal chains from the initial inputs, such as the actions of engineers and scientists, to the final effects, such as possible empowerment in the recovery of communities. Moreover, disaster contexts are typically multi-causal scenarios in which there are often technological products and processes operating as intervening factors. Third, disasters and their social consequences are often difficult to predict in advance, let alone foresee with certainty. In such contexts, innovative technologies cannot but embody fallibilist values, taking risks and even renouncing to have full control on the consequences of their applications. These features of technological activity – collectivity, indirect causality, and uncertainty – call for an ethical perspective more focused than traditional individual-centered approaches on the role that collective and shared responsibilities have to play.

The way disaster ethics examines disruptive technologies is also characterized by being multilevel and cross-sectoral, in line with DRR measures. Arguably, many technologies could cross borders, accessing wherever disasters exist or may occur. The responsibilities for specific applications can occur at the most basic local and community level, through the regional level, reaching the national level and even further the regional and global level. The aforementioned *Sendai Framework for Disaster Risk Reduction 2015-2030* highlights this multilevel structure. Trying to adjust to the existing political, economic, social and legal structures, this framework details for each of the priorities a series of recommendations according to the scale of governance, establishing subdivisions according to the "national and local" and "global and regional" levels (UNISDR, 2015). Moreover, it considers that DRR is a common problem of all states and that the capacity of developing countries to effectively implement DRR measures can be further improved through sustainable international cooperation. Interestingly, the Sendai Framework emphasizes the importance of the promotion of technological advancement, innovation, and transfer in this regard. In a sense, DRR has turn into an increasingly technological ecosystem and, since 2015, emerging technologies have implemented in many countries the Sendai Framework recommendations on risk-informed sustainable development (Shaw and Kanbara 2022).

The ethical evaluation of disruptive technologies should sometimes adopt a cross-sectional view since there are many agents and sectors involved in emergencies and disasters and they should operate in an interconnected manner. That is again in tune with the Sendai Framework, where the guiding principles and, above all, the priorities for action concerning DRR address a differentiated and intersectoral structure of disaster preparedness and cooperation. Ultimately, as other tasks and measures in DDR, specific technological practices throughout the disaster cycle involve collective responsibilities that can be institutionally mediated and applied in cross-sectoral contexts. So, although people may be individually obliged as end-users, responsibilities for the use of technologies in disasters concern states and governments and can also be found in all sorts of organizations (local, national, international, nongovernmental, private sector and so on) and other relevant agents of civil society.

Considering disruptive technologies in connection to DRR also leads us to reflect on the positive duties that require actions aimed at protecting from the damage caused by disasters. These obligations can be general moral duties or, more than that, duties of justice in each particular case. People, organizations and states are obliged to provide assistance in case of emergency or need. In certain circumstances, there are duties related to the fair distribution of resources, including technological ones, as well as access, inclusion, and recognition of those affected by present and future disasters. These duties require substantial commitments to aid and compensate those who are most in need or excluded and underrepresented, commitments that extend over time beyond (that is, before and after) emergency responses. To the extent that the innovative technologies are designed and deployed to reduce risks and minimize direct and indirect negative impacts on groups and communities, they should conform to this demanding view of justice. However, that is not the case when profits and vested interests determine the processes of their production, application and consumption. Importantly, vulnerability to disasters is decisively influenced by social, economic, cultural and environmental conditions of the affected communities. Along with other man-made factors, technologies have the potential to build resilience and promote distributive justice or, rather, to create vulnerabilities and widen pre-existing disparities and disadvantages. Specific disruptive technologies can make a powerful instrumental value available to large populations or make social functions accessible to people who were previously excluded from them or compensate for preexisting differences in living conditions (Hansson, 2017). But their uses often ignore hierarchies, reproduce and stabilize social divisions, and amplify inequality and exploitation. In short, value-insensitive disruptive technologies not only lack a solution for the justice implications of their uses but can also contribute to maintaining injustices and aggravating existing structural inequalities. It could therefore be said that technologies have played, are playing and will continue to play an increasingly crucial role in both reducing and creating disaster risk.

4 — A note on disaster justice and responsibilities

Disasters are characterized by the scarcity of available resources. As part of the limited resources, technologies should be distributed fairly. The stubborn reality is that access to them is scarce in remote and precarious areas around the world and their availability to disadvantaged countries and by certain social groups in developed nations is unevenly distributed. The question of how to allocate these technologies appropriately, given their social utility and the major public good they serve, is a concern of social justice. According to this, technological services and resources for disasters should benefit the affected communities, especially when they are burdened by scarcity, the access to them should not depend on arbitrary features such as social class or ethnicity, and barriers to access resulting from the lack of organization and knowledge should be removed or corrected as far as possible.

Consider the digital divide in disaster contexts. Digital divide is defined as the inequitable use and access to ICT and is related to the lack of the infrastructures to connect devices to the network. There is nowadays a worldwide unequal distribution of both infrastructure and connectivity. One third of humanity does not have access to the Internet and large populations around the world are mostly isolated in terms of ICT. This divide rides on a widened disparity between countries and communities and corresponds to a global imbalance between the northern and southern hemispheres. Digital inequality and cyberspace failure have been listed among the prominent future risks of the world (Global Risk Report 2022). The digital and virtual divides have an impact on DRR. Populations that are unable to participate, access or mobilize resources and connections through ICT *before, during, and after a disaster* show greater social vulnerability and face increasing risk. For instance, pre-existing inequalities are reflected in data management initiatives aimed at prevention, while disaster-related data projections have potential long-term consequences. Likewise, assuming that information is available at the right time, differences in timely disaster response depend to a large extent on people's unequal access to technological resources. Finally, the availability of useful technologies widens the gap in opportunities and capabilities in the recovery phases, entrenching inequalities between nations as well as within countries.

The digital divide in disaster scenarios highlights the relevance of technological skills and education. Merely possessing the tools (e.g., the devices or apps that provide real-time information about disasters) proves insufficient if people lack the skills and knowledge needed to use and understand them. On the other hand, improving digital literacy (e.g., to employ fact-checking techniques) is a necessary, but not sufficient condition for ensuring the reliability and quality of information transmitted by ICT and social media. The responsibilities for reliable sources and trusted informants are distributed throughout the processes of developing, deploying, and allocating information, rather than lying merely with the end-users and affected populations. That is of paramount importance for DRR, because old and new technologies serve as the mediating infrastructure for communication and collaboration among stakeholders at all levels and stages of disaster management – whether it be assessing risks, issuing early warnings, tracking hazards, coordinating recovery efforts, etc. It is therefore operationally necessary and morally imperative to ensure timely and transparent dissemination of information on potential and actual disasters, to filter and prioritize relevant information through sources and platforms that provide truthful data, and to guard against the proliferation of false information on social media. As a general rule, it is mandatory to seek information backed by scientific evidence and relevant justifications and to rely on national and international institutions and agencies that have proven to be reliable sources of information and are ready to be held accountable.

As with digital ICT, the increasing use and reliance on disruptive technologies in disaster management poses numerous ethical and political challenges. As is well known, data protection has become a highly sensitive issue. The collection and use of large datasets – especially in the name of prevention and preparedness – increases confidentiality and privacy concerns, such as the guarantee of the anonymization and de-identification of data and the ethical issues related to data governance and the rights of individuals and groups affected by disasters. For instance, individual privacy can be compromised by groups categorizations, even when these sometimes turn into a means to enhance the protection to individuals.

Ethical concerns of trustworthiness and privacy reflect a dual-pronged perspective shared more broadly in the application of technologies to disaster scenarios. DRR adopts this two-track perspective and ethics has to judge in both directions, retrospective and forward-looking (Fahlquist 2018). On the one hand, what went wrong and could have exacerbated the damage should be assessed, as well as what did work and could have minimized the negative effects and what needs to be corrected in order to avoid or reduce loss and damage in the future. Retrospective responsibility is the ability of the parties involved to be accountable and provide an explanation for its actions and omissions, and at times gives rise to sanctioning liability. Many ethical judgments on technological interventions after a disaster has occurred look for responsibilities in this sense. On the other hand, it should also be established the collaboration of a plurality of agents to the generation of social and institutional disaster resilience as well as the operability and effectiveness of a division of labor thereof. Particularly those responsible for preparedness and planning must consider sound risk analysis, adapt to the resources and vulnerabilities of the affected communities, and equip them with technology development and implementation. Prospective responsibilities are the expectation that certain actors who are properly trained or authorized will effectively contribute to the pursuit of a state of affairs to which the community aspires, such as avoiding, remedying, or mitigating future harms as disasters are.

Technological responsibilities can be assigned both in the light of what has happened and with a view to what might happen. Certainly, the uses of innovative technologies lean more towards the prospective orientation and fit well with a consequentialist perspective in line with it. The emphasis is usually placed on leveraging technological advances to anticipate potential risks. Some disruptive technologies help in predicting hazards, others play a role in forecasting, preventing, and mitigating the impacts of disasters. Most importantly, other applications serve to improve the infrastructure for addressing future events and enhancing the resilience capabilities of communities at risk.

5 — Flight from the Earth as a prospective *Zeitgeist*

Prospective responsibilities are claimed by two current positions that look to the future in quite opposite directions. Proponents of the first view provide, mostly in a defeatist way, a foresight for an inevitable systemic closure after a series of cumulative clashes supposedly predicted by solid social sciences research.

Advocates of the other view envisage an indefinite opening to countless coming populations with the support of an optimistic confidence in technological improvements.

On the one hand, some approaches argue that factors such as overexploitation of natural resources, economic instability, climate change, and other systemic dysfunctions will inevitably precipitate a global collapse or a significant decline of civilization as we know it. This view can drag into a negative activism that renounces the search for improvements within the dominant parameters of current Western societies, or that nudges to accelerate the end of the economic and social structures behind the prevailing consumerist and predatory development model and to adopt radically alternative ways of life. In contrast, some longtermist approaches emphasize the importance of taking an open-ended time perspective when making decisions and planning for the far future. This view encourages individuals, organizations, and societies to weigh the potential consequences of their actions and policies over extended periods, often spanning centuries and millennia. Some long-term advocates consistently tend to neglect the immediate humanitarian impacts of discrete, here-and-now disasters or to minimize the ethical responsibilities for other contemporary crisis. So, at the end of the day, effective altruism and enlightened catastrophism discount current concerns and urgencies on behalf of the demands from an alienating future, be this time coming or distant and be those demands posed for the sake of beneficence or as triggers of anti-systemic agonism.

In a sense, some advocates of effective altruism practice a kind of evasion from the world of human affairs, which is where disaster risks must be managed and value-sensitive technologies enabled to deal with them. No doubt, present generations are obligated to deploy and implement the best innovative technologies. However, in the search for effective responses to future challenges, there are technocratic visionaries who propose solutions that would opt for escaping our planet (Coeckelbergh 2020, 195-196). In some cases, technology-induced vistas of the future even fuel classist fantasies of exile to distant worlds as an alternative to the harms that threaten to wipe out the human species. As humanity settles other places in the cosmos, the risks of existential threats on Earth will likely diminish. It is confidence in outward-looking technological innovations that allows to confront current and coming catastrophic crises in the hope of fleeing from the havoc they wreak. There are also technological proposals in the field of disaster management that seek safety in outer space away from imminent and probable dangers: key tasks of monitoring and addressing disasters and calamities would fall on systems and technologies located outside the destructive reach of said disasters. An example of this is the projection that a network of satellites, shielded from the threats of natural disasters, would play a crucial role in managing disasters from a remote and secure location.

Technological solutionism is an influential way of addressing complex problems and challenges in different spheres of society. It holds that technology can and will successfully solve multifaceted social problems, including pressing problems as those resulting from disasters. Against these high expectations about technology as the main source of problem-solving, it could be argued that proactive disaster preparedness will inevitably remain an incomplete task, and even if we now know more and act better accordingly, we cannot avoid our here-and-now technological parochialism. More importantly, technological solutionism does tend to overlook social, cultural, and political issues and typically neglect structural dimensions of both social vulnerability and communitarian resilience. The duties and responsibilities associated with planning, anticipating, and preparing for potential threats to health, safety and wellbeing involve knowledge of the strengths and weaknesses of affected communities, a deep understanding of local needs and exposure to hazards, a recognition of their vulnerability in view of potential risks and the empowerment of those communities to respond and recover. Indeed, local communities should collaborate with other stakeholders in co-designing solutions and should therefore take an active role in managing available technologies to build genuine resilience to adapt and withstand environmental threats. In contrast to the attempts to externalize the responsibility for dealing with disasters by deferring it to distant technology systems, an effective responsibility sharing depends on the active participation of local communities and other actors directly involved in the employment of good disaster technologies.

Conclusion

Nowadays, cutting-edge technological innovations are playing a key role in DRR while bringing a range of (individual, collective and shared) responsibilities into play. That multiplies the ethical challenges, starting with the issue of how these tools should be distributed in resource-constrained situations. The prevailing consequentialist perspective on the desirable effects of emerging technologies should be balanced with approaches that consider both the dignity and vulnerability of people, as well as their individual and collective judgment capacities and the solidaristic build of resilience. Likewise, a comprehensive ethical approach to the application of technology in disaster-affected areas navigate between the dominant prospective orientation guiding the development and deployment of technology for disaster management and the retrospective scrutiny of the consequences of technological applications on past events, which demands accountability and adherence to moral standards. Such a search of balance warns against certain popular perspectives prioritizing events and processes that will either occur suddenly or be long anticipated to the detriment of current concerns and urgencies. It is equally contrary to doubtful phantasies of escaping the earthly condition of mankind by exploring technological solutions from outer space. Disaster ethics looks instead at the communities that develop the capacity for innovation, prevention, and resilience at the local level, bringing resources and care from the grassroots up. Rather than blindly relying on disruptive technologies to offer simplified solutions to dilemmas that are actually intricate and multifaceted, communities that understand their specific needs and challenges seek to implement those technological solutions that better respond to their vulnerability to hazards. At the end, a genuine resilience to disasters cannot merely be dependent on profit-seeking technologies that take distance (even geographically) from the social reproduction of everyday life but takes root in the interaction between singular communities and their environments.

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