This forum showcases emerging approaches, new ideas, and promising pathways that draw attention to the diverse, interdisciplinary, and impactful work of global scholars to advance dialogue in the field on how we can best contribute to climate action. **— Robert Soden, Vishal Sharma, Matthew Louis Mauriello, and Nicola J. Bidwell, Editors**

Mountains Under Pressure:

HCI Facing Environmental and Social Transformations

Eleonora Mencarini, Chiara Leonardi, and **Paolo Massa,** Fondazione Bruno Kessler

The sudden collapse of the Marmolada glacier in the Italian Alps in the summer of 2022 shocked the Trentino region and the world. Beyond the tragic loss of lives, the event drew attention to the rapid retreat of Alpine glaciers and the consequences for the safety of tourists and local communities. Marmolada's collapse, however, was not the only striking event of 2022 in that region. That year, tourism reached an unprecedented high, driven by the post-pandemic travel recovery and renewed appreciation of the outdoors, a trend that has continued ever since. Later, in 2023, graffiti reading "Tourists go home" defaced some of the most iconic rocks in the Dolomites, a UNESCO World Heritage site. The message echoed sentiments already present in several European cities, including Barcelona, Venice, and Lisbon, where residents have protested the pressures of mass tourism. These events mark the culmination of ongoing developments that require local authorities to balance economic, environmental, and social interests while responding to the escalating impacts of the climate crisis.

CONTROVERSIES AROUND WATER MANAGEMENT

Mountain regions are hot spots of climate impacts, characterized by high levels of socioecological vulnerability. This vulnerability stems from the narrow ecological constraints within which mountain communities operate, making it challenging to predict fluctuations in the availability of natural resources. Additionally, the limited infrastructure, compared to that of large urban systems, complicates the management of these resources. Water, in particular, in its different forms—from snow to rivers—plays a central role in local economies. Beyond domestic use, agriculture, and energy production, water is essential for tourism, as main attractions in mountain areas include skiing in the winter and lush green landscapes in the summer. The rise of temperatures, shifts in precipitation patterns, and increasingly frequent extreme weather events, however, are placing mountain landscapes, communities, and economies under growing pressure.

Tourists are increasingly concentrating at higher altitudes in search of more-pleasant conditions, contributing to overcrowding and a decline in the overall quality of their experience. Policymakers are adopting measures to safeguard the economic benefits of tourism, such as maintaining sufficient water reserves for artificial snowmaking. These interventions, however, create tensions over competing water uses in other sectors (e.g., agriculture) and raise concerns about landscape and biodiversity conservation, illustrating how climate change and overtourism interact across sectors and levels and produce cascading challenges and controversies.

We had the opportunity to reflect on the connections between climate change, tourism, and water management in the region through Nevermore. This EU-funded project aims to model, simulate, and assess the impacts of mitigation and adaptation policies on climate change. Our discussions with public bodies in Trentino and other local actors revealed that both top-down and bottom-up approaches are necessary. It is crucial to foster new tourism models, such as *de-seasonalization*, to promote visits outside high-peak seasons; enact policies that relieve pressure from the most-visited places; and repurpose certain areas and infrastructures, such as using ski lifts and slopes for mountain biking. It is also important to raise awareness and change visitors' attitudes about the fragility of mountain ecosystems, particularly water scarcity. Policymakers don't want to dissuade tourists from visiting, but rather to provide them with tools to envision alternatives and ways to mitigate their negative impact.

Insights

- → HCI can provide careful curation and communication of transdisciplinary data to translate the complex and intertwined dynamics of overtourism and climate change.
- → HCI work should focus on creating interactive systems that support reflection and dialogue on trade-offs and limits of adaptation to climate change, rather than enforcing them.

TWO DATA-DRIVEN INTERVENTIONS TO FOSTER CRITICAL REFLECTION

We developed two data-driven interventions that utilize storytelling and physicalization to raise awareness about the challenges climate change poses to the mountain environment. Both create meaningful representations by integrating diverse sources of data, including scientific knowledge on climate and tourism, qualitative accounts, and local knowledge from stakeholders directly affected by changes.

Stories from the Peaks is an interactive storytelling prototype that encourages users to experience data about the impacts of climate change and overtourism from the perspectives of different actors in Trentino [1]. Informed by data humanism and feminist data approaches, the prototype integrates scientific data into storytelling and leverages it to raise awareness and foster sustainable actions [2]. The stories draw on data from public datasets and on interviews with local stakeholders and a scientific specialist in mountain flora and fauna. To represent the socioeconomic sectors and natural environment affected, there are four human personas—a resident, a mountain hut manager, a mountain guide, a tourist—and a nonhuman persona, an alpine bird that inhabits the Dolomites. These stories highlight sometimes conflicting interests and priorities, and each concludes with practical suggestions for being a responsible tourist.

Framing Water is a data-physicalization game intended for visitors to find at remote mountain huts—hosting facilities that require careful management of resources such as water, energy, and food. It offers a playful experience by inviting visitors to explore limits on water availability and reflect on what they're willing to sacrifice to ensure the huts continue operating and others can enjoy them [3]. During gameplay, visitors first select puzzle pieces that represent the amount of water they'll consume daily during their stay at the hut, for eating, drinking, and using the toilet. Once they choose the amount, they must try to fit it within the maximum water consumption allowed for each person for their entire stay. It's a challenging task because visitors have to anticipate their needs and carefully consider the number and arrangement of pieces within the constrained space. This interaction is designed to offer a tangible metaphor of the limits, provoke reflection, and foster dialogue on the possibility of staying within those limits in different ways.

Graffiti expressing anti-tourist sentiments in the Dolomites.

Ecological, economic, and social tensions generated by climate change are deeply interconnected and cannot be understood in isolation.

These interventions share the same approach. They are not intended to provide solutions, but rather to raise awareness, prompt critical thinking, and encourage conversations about the ecological limits of mountain ecosystems, the relationship between tourism and natural resources, patterns of

IMAGE BY KORIS SOMMAVILLA

individual and collective resource use, and the trade-offs these dynamics entail. *Stories from the Peaks* presents different voices to promote a comprehensive understanding of the impacts of climate change and overtourism, as well as reflection on the trade-offs generated by environmental, social, and economic interests that complicate decision making. Conversely, *Framing Water* uses data physicalization to foster dialogue about the limits of natural resources. Both projects connect scientific data with local experiences, encouraging reflection on local conditions, ecological resource limits, and the trade-offs that should be addressed.

REFLECTING ON LIMITS

"We need to meet [tourists'] expectations, but not too much.... Where is the limit? We don't know, and it's not easy to establish," said a mountain hut manager we interviewed. This quote summarizes the paradox that underpins the issue of limits. Ecological, economic, and social tensions generated by climate change are deeply interconnected and cannot be understood in isolation; instead, they require questioning the competing interests at play and making trade-offs [4,5]. All interests can't be achieved simultaneously. Therefore, decisions emerge from ongoing negotiations between economic, environmental, and social interests present in each context. How far we go in protecting the interests of one or more groups is a social, value-based, and political question. There is, however, an underlying limit. While the limits of choices are guided by values and political will, *the limits of natural resources are given*. The tangible horizon is the limit of our planet's natural resources whose availability, despite oscillating and being intermittent, is in evident decline.

Overtourism intensifies competition over shared resources, such as space, mobility, water, and energy.

Engaging with the problem of climate change in a popular mountain region of the Italian Alps made us realize that its intersection with other social issues, such as overtourism, affects not only major European capitals but also natural areas. Overtourism intensifies competition over shared resources, such as space, mobility, water, and energy. Although

IMAGES COURTESY OF THE AUTHORS

our interventions focused on natural mountain areas, several of our considerations extend beyond these contexts. In particular, we argue that approaches aimed at fostering critical reflection on the impact of tourism and the limits of natural resources can be relevant for other settings experiencing overtourism.

We believe that HCI can play a fundamental role in critically analyzing the conditions under which limits are established, accepted, or ignored. Our design interventions promote reflection on trade-offs, make resource limits visible, and support situated sensemaking around collective responsibility. Adopting this perspective, we argue that sustainable HCI can contribute to more sustainable forms of tourism and resource governance in different territorial contexts by moving beyond a techno-solutionist approach in which technology seeks to provide a solution to the problem of limits, and instead offer means of interrogating how, why, and for whom these limits are negotiated in specific ways.

This approach calls for a critical rethinking of what it means to design at the intersection of environmental and social transformations, recognizing us as participants in the very systems we are studying. As HCI researchers engaging with these topics, we also believe that critical reflection on trade-offs and limits, as well as the responsibility of choices, extends beyond the design of technologies to include the broader practices through which our community produces knowledge and meets as a community. The ways we work, travel, and gather position us as participants in the systems we study; by attending conferences or engaging in research-related travel, we naturally become tourists, implicated in the environmental and social dynamics we seek to examine. At a moment when climate impacts increasingly intersect with how, where, and why we travel, collaborate, and conduct research, we invite the CHI community to reflect not only on technical design choices but also on conferencing models, work-related travel, and research and development practices we adopt as a research community. Treating our own practices as sites of design and inquiry can help us reflect on our choices and open a space for more equitable and climate-attentive forms of HCI practice.

ACKNOWLEDGMENTS

This article was supported by the Horizon Europe program through the Nevermore project (grant agreement 101056858).

REFERENCES

1. Mencarini, E., Leonardi, C., Massa, P., and D'Errico, F. Stories from the Peaks: An interactive data storytelling to narrate climate change impacts through a pluralism of voices. *Proc. of the 16th Biannual Conference of the Italian SIGCHI Chapter*. ACM, 2025, Article 11, 1–8; https://bit.ly/4qVkl9f
2. Ferreira, M., Nunes, N., Ferreira, P., Pereira, H., and Nisi, V. Connecting audiences with climate change: Towards humanised and action-focused data interactions. *International Journal of Human-Computer Studies 192*, C (2024); https://bit.ly/4kXdBXa
3. Mencarini E., Kruger A. L., Leonardi C., and Massa, P. Framing Water: Exploring tensions between social norms and environmental sustainability through a data physicalization game. *Proc. of the 2026 CHI Conference on Human Factors in Computing Systems*.
4. Irwin, T. and Kossoff, G. Transition design: Wicked problem resolution as a strategy for catalyzing positive, systems-level change. In *Routledge Handbook of Sustainable Design*. R. B. Eigenhoefer, ed., 472–492, Routledge, 2024.
5. Scuri, S., Ferreira, M., Jardim Nunes, N., Nisi, V., and Mulligan, C. Hitting the triple bottom line: Widening the HCI approach to sustainability. *Proc. of the 2022 CHI conference on Human Factors in Computing Systems*. ACM, 2022, Article 332, 1–19; https://bit.ly/4qOvcSp

Eleonora Mencarini is an HCI researcher at the Fondazione Bruno Kessler in Italy. She is interested in understanding ecological relations and fostering resilience in communities affected by climate change.
→ mencarini@fbk.eu

Chiara Leonardi is an HCI researcher at Fondazione Bruno Kessler who applies participatory design methods to understand people's practices and values, with a focus on developing digital solutions that address sustainability challenges.
→ cleonardi@fbk.eu

Paolo Massa is a researcher at the Fondazione Bruno Kessler. His research interests include artificial intelligence, HCI, and recommender systems.
→ massa@fbk.eu