Data-Enabled Sustainability: The Collective Work of Turning Data into Actions for Environmental Care

Chiara Rossitto
Department of Computer and Systems Sciences, Stockholm University
Stockholm, Sweden
chiara@dsv.su.se

Martin Valdemar Anker Lindrup
Department of Computer Science, Aalborg University
Aalborg, Denmark
mval@cs.aau.dk

Rob Comber
Department of Media Technology and Interaction Design, KTH Royal Institute of Technology
Stockholm, Sweden
rcomber@kth.se

Jakob Tholander
Department of Computer and Systems Sciences, Stockholm University
Stockholm, Sweden
jakobth@dsv.su.se

Mattias Jacobsson
Department of Media Technology, Södertörn University
Stockholm, Sweden
mattias.jacobsson@sh.se

Alex Cabral
Department of Computer Science, Harvard University
Boston, USA
acabral@g.harvard.edu

Rikke Hagensby Jensen
Department of Computer Science, Aalborg University
Aalborg, Denmark
rjens@cs.aau.dk

ABSTRACT

This one-day workshop invites discussions on the role of data and data-enabled practices in addressing challenges of environmental sustainability. Fostering acts of care for the environment is a complex endeavor entailing multi-lifespan relations to people and institutions, to the environment and other non-human actors, and to existing infrastructures and processes. The workshop addresses such challenges by exploring the role of data, and the work of making them actionable for the many actors involved in protecting the environment. It will bring together interdisciplinary scholars, representatives of public institutions, activists, environmental collectives, and IT practitioners interested in the design of more sustainable futures. The workshop will discuss analytical and design issues of data-enabled sustainability, along with the practical opportunities of using data to infrastructure acts of care for the environment. The workshop will accommodate up to twenty participants and will be mainly run on-site.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**.

KEYWORDS

Data, Sustainability, Environmental Care, Collaboration

1 INTRODUCTION

An increasing range of technologies – from sensor-based IoT devices to digital platforms and AI-enabled systems– allows local institutions, collectives, and single individuals to generate and analyze environmental data. Domains as diverse as waste management, water and air quality, food systems, biodiversity, energy consumption, traffic and transportation have become areas of relevance for data-centered environmental care. Extracting patterns of behaviors, quantifying environmental harm, or predicting societal and individual changes show the potential of using machine learning and big-data artificial intelligence to develop awareness and support decision-making in contexts of sustainability. The techno-centrism of such approaches, however, overlooks the socio-ecological relations and the collaborative work underpinning both the creation and use of environmental data (see [11] [29]). Moreover, it resists the more-than-human perspectives that can be encompassed in structuring data and caring for the environment. This narrow focus on data fails to capture processes and interactions whereby data can enable sense-making about sustainability concerns, become a capacity to infrastructure partnerships between various actors [38], influence governance, and create specific opportunities for environmental care (see [36]).

This workshop is open to researchers, practitioners, and activists interested in sustainable interactions between humans, digital systems, and the world we inhabit. It targets the many actors (e.g., think tanks, public institutions) concerned with both environmental and social sustainability, participatory forms of data collection (e.g., Citizen Sciences projects), alternative representations of data (e.g., by the inclusion of indigenous perspectives), and explorations of various data-centered sociotechnical advances. We invite participants to investigate the potential benefits and multiple challenges of a data-enabled, multi-stakeholder, action-oriented approach that takes seriously the cooperative work underpinning computer-supported efforts for environmental sustainability.

2 BACKGROUND

Actions aiming at more sustainable futures are bound up in care, and a turn towards action is also a turn toward caring about the environment [36]. This ethical standpoint is framed by the commitments and attachments that different stakeholders develop towards environmentally-concerned actions, and by the partnerships and relations such stakeholders develop with specific socio-ecological contexts, not only with digital technologies.

Data – in the broad sense of information about a certain entity or phenomenon – have the potential to promote and initiate actions toward more sustainable futures. The acquisition, representation, and accessibility of data about our environment (e.g., data on harmful air particles, or global temperature patterns) have, to a large degree, resulted in increased awareness and in-depth understanding of global sustainability issues. Providing awareness about specific pollutants might, for instance, inspire people to change individual behaviors and habits. Societal and infrastructural changes require, however, more ecological understandings of how environmental data become meaningful and actionable.

Different studies have explored ways to use data in sustainability contexts, by focusing on physical data artifacts (e.g., [12, 32, 37]), data-enabled negotiations (e.g., [8, 9, 31]), embodied experiences of data (e.g., [4, 30]), data imaginaries [39–41], or data transparency. Prior HCI research has outlined diverse approaches to collect and visualize environmental data for diverse stakeholder groups. We draw on this scholarship for an initial framing of the workshop's discussions. Data collection can be broadly categorized as follows: *1) Public-private partnerships*, which often include government and technologist stakeholders but lack the expertise of residents [10], which may, thus, leave little room for resident agency [15, 19, 23]; *2) Crowdsourced*, which cedes some power to residents but may exclude minority groups [14] and can make residents feel like data sources rather than collaborators [1]; *3) Community-driven*, which enables local communities to drive design decisions and can increase community engagement [2, 24], but can exclude essential municipal stakeholders [21] and put an excess burden on the communities most affected by environmental harms [17, 42]; *4) Participatory*, which engage residents as collaborators in co-design through activities such as workshops [3, 18, 22, 23], but can lead to projects without feedback from government agents [21] who are essential stakeholders in leading to environmental policy changes [26]. Environmental data visualizations often include mapping platforms, timelines, and dashboards [7, 13, 28], which allow users to compare

the data to other spatially and/or temporally correlated phenomena, but risk simplifying the complex interactions that both drive and provide solutions for environmental issues [34]. Physically situated visualizations have been shown to drive engagement and create community sensemaking and education opportunities [11, 35, 43], yet there is still a need for environmental data visualizations that enable diverse stakeholders to easily manipulate data and work together collaboratively for environmental care [11].

Furthering this scholarship, this workshop will develop conceptual, empirical, and technological investigations showing how the creation and use of environmental data are shaped by sociotechnical practices and by the work performed by various actors to promote, or hinder, acts of care for the environment. Moreover, it sets out to explore the collaborations and partnerships that make the use of environmental data possible, as well as the political, ethical, and economic relations underpinning the creation of such alliances.

2.1 Topics of interest

Authors may wish to address a range of themes including but not limited to:

Making data actionable. Technology is never neutral and neither are the visual and tangible representations and the embedded data structures that characterize environmental data. As specific technological features, such qualities uniquely shape the uptake of concrete actions to responsibly inhabit, protect, or restore the environment. We invite discussions on how and when data become meaningful, the different practices and collaborations that make them meaningful, and on the different values data might have for different actors and stakeholders. Challenges associated with data literacy, transparency, or data ownership are relevant to this theme. We encourage contributions illustrating the partnerships, power relations, and political and economic factors (e.g., relations between technology and governance, business models) that underpin the creation of environmental data, and that shape how data can be used for environmental sustainability.

Entangling data. Scholarship within Sustainable HCI (SHCI) has outlined the need to focus on current circumstances to understand what can be in the future. Eli Blevis' call [5] to 'See What Is and What Can Be' puts emphasis on the production of action (as opposed to the mere action) as relevant to understand how sustainable actions come to be, and how design matters in the ecology of that action. Relatedly, our previous work [33, 36] has emphasized that acts of care for the environment can be seen as interconnected and additive. This practically means considering how the outcomes of specific interventions (e.g., collection of data about urban littering) can activate other acts of environmental care (e.g., from policy-making to developing awareness), and what type of resources (e.g., evidence to enforce policy change, educational material) such outcomes become in that context. We invite authors to discuss case studies that illustrate the mechanisms and processes whereby data become actionable. This can include the participatory production of data, the development of multi-stakeholders collaborations, interactions with governance, policy, and policy-making. Accounts of the political and power dynamics that might actually hinder the

disclosure of environmental data (e.g., air pollution) are particularly relevant to this theme.

Situating data. Studies within SHCI have been criticized for abstracting and simplifying sustainable actions, by merely focusing on individual behaviors, attitudes, and cognition [6, 16, 20, 27]. We welcome theoretical and analytical frameworks, as well as design interventions and examples of existing technologies that highlight the ecology of relations that exist between environmental data, environmentally sustainable practices, and broader social contexts – e.g., physical infrastructures, governance, the law and other regulations. While the "good" of data is often associated with the idea that data can easily grow and globally scale up, we invite authors to reflect on the locally bound qualities of environmental care, the global relevance of data collected at specific localities, and the extent to which aggregated data sets can mobilize actions across contexts.

2.2 Workshop goals

The workshop aims at developing visions and possible scenarios to use data from within an action-oriented perspective to sustainability. The workshop's goals can be summarized as follows:

(1) Identify data sources and structures that can better address urging environmental actions;
(2) Identify conceptual, empirical, and technological examples that unpack how data can become resources to structure collective acts of care for the environment;
(3) Account for power structures embedded in data sources, the interfaces and affordances that enable their creation and representation, as well as in the narratives that promote the use of such data;
(4) Account for the political, ethical, and power relations that underpin the creation of partnerships, collaborative projects, or design interventions whereby environmental data are made available and become contextually meaningful and instrumental to environmental protection.
(5) Brainstorm ideas for future studies that can contribute better understandings of data-enabled sustainability and the work to infrastructure action-oriented sustainability;
(6) Synthesize ideas into future plans for research collaborations and dissemination beyond the time frame of the workshop
(7) Develop strategies to encourage collaborations and partnerships between researchers, practitioners, public and private institutions, and other actors for whom data can be a means to structure and sustain environmental care over time.

3 PRE-WORKSHOP PLAN

The call for participation and other workshop-related information will be made available at the following link: **http://www.sustws.medieteknik.info**.

We will circulate the workshop call through the organizers' professional networks (e.g., EUSSET), relevant mailing lists, and social media groups (e.g., CHI Meta, CSCW Meta, Researchers of the socio-technical, personal social media accounts).

Authors are invited to submit a 2-4 page position paper following the ACM single-column format – either by using the Word or LaTeX template. To promote broader participation (including

but not limited to activists, representatives of the public sector, collectives, or industry practitioners), we offer the option to submit other research and design materials, such as design portfolios, short manifestos, pictorials, and design fictions. We encourage authors to explicitly address their interest in the workshop themes. We welcome reports of design cases, data sets, empirical results, theoretical pieces, or short calls for future research. Submissions will be reviewed by the workshop organizers and selected based on their quality, novelty, relevance to the workshop's topics, and potential to spark discussion. In selecting the contributions, we will aim for a good balance of perspectives and cases. Given the authors' consent, the submitted papers will be made available at the above-mentioned website before the workshop, to give participants the time to familiarize themselves with each contribution.

We will do our best to accommodate specific *accessibility needs*. Authors will be invited to specify any particular requirement in their position papers, or to directly contact the organizers.

3.1 Key dates

The workshop's planned key dates are:

- July 6st, 2023: the workshop call is advertised
- August 31st, 2023: submission deadline for authors.
- September 10th, 2023: notification of acceptance.
- Saturday, October 15th, 2023: Workshop at CSCW 2023

4 WORKSHOP STRUCTURE

The workshop is organized as a one-day event with presentations, design explorations, and discussions (see table for an overview of the day). To jointly develop visions and identify challenges connected to the ways environmental actions can be infrastructured through data, we will limit the time spent on presentations of position papers. By situating parts of the workshop in the outdoor setting of the city of Minneapolis, we aim to gather real-life examples that can serve as inspiration for the conversations and activities that will follow. We believe this setup will contribute to creating an open-minded and playful atmosphere to engage with the workshop topics.

5 POST-WORKSHOP PLAN

The workshop aims at building community between researchers and practitioners with an interest in environmental sustainability, particularly in how collective acts of care for the environment can be infrastructured and enabled through data. The workshop will act as an initial step for fostering long-term collaborations, including the organization of future events (e.g., organizing research workshops or other joint research activities). We aim to write a piece for ACM Interactions to outline the most challenging and inspirational outcomes of the workshop and point to future opportunities for joint research. Participants' suggestions on possible future actions will also be discussed at the workshop. Given the participants' consent, the position papers will remain available at the workshop's website.

6 CALL FOR PARTICIPATION

'The Collective Work of Turning Data into Actions for Environmental Care' workshop explores the intersections between data, diverse

Time	Activity
9.00-9.20	Welcome and brief introduction to the workshop
9.20-10.20	Short presentation of each contribution. Each author will be given two/three minutes to introduce the main statements in their position papers.
10.20-11.00	Coffee break
11.00-12.00	Outdoor activity: We will adopt a 'Learning by Walking' approach [25] to examine various urban sustainability practices and explore how data can play a role in such practices. This group activity will be documented through different means, such as pictures, notes, videos, or other relevant artifacts.
12.00-13.00	Lunch
13.00-14.30	Reporting back and discussing the previous group activity.
14.30-15.00	Coffee break
15.00-16.30	Group activity: Design explorations of the environmental actions that data can infrastructure.
16.30-17.00	This last half hour is intended to allow participants to relax and socialize while discussing future plans and actions.

Table 1: Proposed overview of the workshop schedule

practices of sustainability, digital technologies, and the work of making data meaningful and actionable for diverse stakeholders.

Data, in the broad sense of information about a certain entity or phenomenon, have the potential to promote and initiate actions towards more sustainable futures. The acquisition, representation, and accessibility of environmental data (e.g., information about harmful air particles, global temperature patterns, biodiversity) have, to a large degree, resulted in increased awareness and in-depth understanding of global sustainability issues. Providing awareness about specific pollutants might, for instance, inspire people to change their individual behaviors and habits. Societal and infrastructural changes, stemming from the use of environmental data, require however a more ecological understanding of how data are made meaningful and actionable.

This workshop seeks to develop conceptual, empirical, and technological understandings showing how the use of environmental data is shaped by broader sociotechnical practices and by the work performed by various actors to promote, or hinder, acts of care for the environment. Moreover, it sets out to explore the collaborations and partnerships that make the use of environmental data possible, as well as the political, ethical, and economic relations underpinning the creation of such alliances.

We welcome researchers, practitioners, designers, and other actors who find this call relevant to their work and/or life practices. This one-day workshop will include short presentations, and outdoor explorations of urban data practices for which sustainability is key. It will entail group and plenary discussions on how data

can become valuable resources for actions aiming at environmental care.

We encourage participants to submit a 2-4 page position paper (references excluded) in the ACM single-column format, either by using the Word or Latex template. The workshop organizers will review the submissions which will be selected based on their quality and relevance to the workshop themes. At least one author of each accepted paper must attend the workshop' and register for it. We will do our best to accommodate specific *accessibility needs* participants might have. Authors are invited to specify any particular requirement in their position papers, or by directly contacting the organizers.

- Position papers can be sent to: **chiara@dsv.su.se**.
- Submission deadline: **August 31st, 2023**.
- Notification of Acceptance: **September 10th, 2023**.

More information about the workshop can be found at: **http://www.sustws.medieteknik.info**.

7 ORGANIZERS

The organizers constitute an international team of CSCW and HCI researchers, whose work spans multiple areas including sustainable interaction design, digital civics, community-led initiatives, and data studies. The organizers' previous experience will be valuable to facilitate discussions on novel ways to think about the role of data and design in collectively supporting environmental care.

Chiara Rossitto is Associate Professor of HCI at Stockholm University, Sweden, and visiting Professor at the Centre on Sustainable and Digital Transformation, Aalborg University, Denmark. Her work explores questions related to more sustainable futures, social change, community-led initiatives, and the politics of design. She is the principal investigator of a project that explores relational perspectives within Sustainable HCI, and how care for the environment in waste management practices can be enabled through digital technologies and multi-stakeholders engagement.

Martin Lindrup is a PhD Student at the Department of Computer Science at Aalborg University, Denmark. Through his work, Martin explores and designs for the various roles of environmental data in everyday interactions with food and technology.

Rob Comber is an Associate Professor at the KTH Royal Institute of Technology in Stockholm, Sweden. He is part of the Sustainable Futures research team and works across issues of social and environmental sustainability from a critical feminist perspective. He has run workshops at CHI, DIS, and UbiComp and was the subcommittee chair for the CHI Subcommittee on Critical and Sustainable Computing.

Jakob Tholander is an Associate Professor in Human-Computer Interaction at the Department of Computer and Systems Science at Stockholm University. Jakob has been involved in a number of research projects, including tangible and embodied interaction and sustainable interaction, which currently includes work on how to design for digital stewardship.

Mattias Jacobsson is Assistant Professor at the Department of Media Technology at Södertörn University. Mattias is doing research within the field of HCI and interaction design around topics related to change by means of design – e.g., social aspects, health, lifestyle, and care for the environment.

Alex Cabral is a PhD Candidate in Computer Science at Harvard University. Her research is focused on designing large-scale, wireless sensor networks for urban environmental sensing, with an emphasis on real-world deployments and the usage of open data.

Rikke Hagensby Jensen is Assistant Professor at Aalborg University, Denmark. Rikke's research lies at the intersection of sustainability and design. She currently works with interaction design, environmental data, and alternative, sustainable futures with an emphasis on how digital technology may shape everyday social practices in a more caring, collective, and sustainable way.

ACKNOWLEDGMENTS

REFERENCES

[1] Paul Aoki, Allison Woodruff, Baladitya Yellapragada, and Wesley Willett. 2017. Environmental protection and agency: Motivations, capacity, and goals in participatory sensing. In *Proceedings of the 2017 CHI conference on human factors in computing systems*. 3138–3150.

[2] Carolina L Balazs and Rachel Morello-Frosch. 2013. The three Rs: How community-based participatory research strengthens the rigor, relevance, and reach of science. *Environmental justice* 6, 1 (2013), 9–16.

[3] Mara Balestrini, Yvonne Rogers, Carolyn Hassan, Javi Creus, Martha King, and Paul Marshall. 2017. A city in common: a framework to orchestrate large-scale citizen engagement around urban issues. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. 2282–2294.

[4] Heidi R. Biggs and Audrey Desjardins. 2020. High Water Pants: Designing Embodied Environmental Speculation. In *Conference on Human Factors in Computing Systems - Proceedings*. Association for Computing Machinery, Honolulu, HI, US, 1–13. https://doi.org/10.1145/3313831.3376429

[5] Eli Blevis. 2018. Seeing What Is and What Can Be: On sustainability, respect for work, and design for respect. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–14.

[6] Hrönn Brynjarsdóttir, Maria Håkansson, James Pierce, Eric P.S. Baumer, Carl DiSalvo, and Phoebe Sengers. 2012. Sustainably unpersuaded: How persuasion narrows our vision of sustainability. In *Conference on Human Factors in Computing Systems - Proceedings*. ACM Press, New York, New York, USA, 947–956. https://doi.org/10.1145/2207676.2208539

[7] Ling-Jyh Chen, Yao-Hua Ho, Hu-Cheng Lee, Hsuan-Cho Wu, Hao-Min Liu, Hsin-Hung Hsieh, Yu-Te Huang, and Shih-Chun Candice Lung. 2017. An open framework for participatory PM2. 5 monitoring in smart cities. *Ieee Access* 5 (2017), 14441–14454.

[8] Adrian K Clear, Sam Mitchell Finnigan, Patrick Olivier, and Rob Comber. 2017. "I'd Want to Burn the Data or at Least Nobble the Numbers": Towards Data-mediated Building Management for Comfort and Energy Use. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*. ACM, Portland, OR, USA, 2448–2461. https://doi.org/10.1145/2998181.2998184

[9] Adrian K Clear, Samantha Mitchell Finnigan, Patrick Olivier, and Rob Comber. 2018. ThermoKiosk: Investigating Roles for Digital Surveys of Thermal Experience in Workplace Comfort Management. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. ACM, Montréal, QC, Canada. https://doi.org/10.1145/3173574.3173956

[10] Jason Corburn. 2005. Street science: Community knowledge and environmental health justice. (2005).

[11] Madeleine IG Daepp, Alex Cabral, Tiffany M Werner, Raed Mansour, Charlie Catlett, Asta Roseway, Chuck Needham, Nneka Udeagbala, and Scott Counts. 2023. The "Three-Legged Stool": Designing for Equitable City, Community, and Research Partnerships in Urban Environmental Sensing. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. 1–19.

[12] Teis De Greve, Steven Malliet, Niels Hendriks, and Bieke Zaman. 2022. The Air Quality Lens: Ambiguity as Opportunity to Reactivate Environmental Data. In *Designing Interactive Systems Conference*. ACM, Virtual Event, Australia, 335–348. https://doi.org/10.1145/3532106.3533530

[13] Zikun Deng, Di Weng, Jiahui Chen, Ren Liu, Zhibin Wang, Jie Bao, Yu Zheng, and Yingcai Wu. 2019. AirVis: Visual analytics of air pollution propagation. *IEEE transactions on visualization and computer graphics* 26, 1 (2019), 800–810.

[14] Priyanka deSouza and Patrick L Kinney. 2021. On the distribution of low-cost PM2. 5 sensors in the US: demographic and air quality associations. *Journal of exposure science & environmental epidemiology* 31, 3 (2021), 514–524.

[15] Paul Dourish. 2010. HCI and environmental sustainability: the politics of design and the design of politics. In *Proceedings of the 8th ACM conference on designing interactive systems*. 1–10.

[16] Paul Dourish. 2010. HCI and Environmental Sustainability: The Politics of Design and the Design of Politics. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems*. Association for Computing Machinery, Aarhus, 10.

[17] Andy Dow, Rob Comber, and John Vines. 2018. Between grassroots and the hierarchy: Lessons learned from the design of a public services directory. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–13.

[18] Joel Fredericks, Glenda Amayo Caldwell, and Martin Tomitsch. 2016. Middle-out design: collaborative community engagement in urban HCI. In *Proceedings of the 28th Australian Conference on Computer-Human Interaction*. 200–204.

[19] Ben Green. 2019. *The smart enough city: putting technology in its place to reclaim our urban future*. MIT Press.

[20] Lon Åke Erni Johannes Hansson, Teresa Cerratto Pargman, and Daniel Sapiens Pargman. 2021. A Decade of Sustainable HCI. Association for Computing Machinery (ACM), 1–19. https://doi.org/10.1145/3411764.3445069

[21] Mike Harding, Bran Knowles, Nigel Davies, and Mark Rouncefield. 2015. HCI, civic engagement & trust. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. 2833–2842.

[22] Christina Harrington, Sheena Erete, and Anne Marie Piper. 2019. Deconstructing community-based collaborative design: Towards more equitable participatory design engagements. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (2019), 1–25.

[23] Sara Heitlinger, Nick Bryan-Kinns, and Rob Comber. 2019. The right to the sustainable smart city. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–13.

[24] Yen-Chia Hsu, Paul Dille, Jennifer Cross, Beatrice Dias, Randy Sargent, and Illah Nourbakhsh. 2017. Community-empowered air quality monitoring system. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. 1607–1619.

[25] Tim Ingold and Jo Lee Vergunst. 2008. *Ways of Walking: Ethnography and Practice on Foot*. Ashgate Publishing, Ltd.

[26] MRSC Insight. 2022. Knowing Your Roles: City and Town Governments. https://mrsc.org/Home/Stay-Informed/MRSC-Insight/February-2022/Knowing-Your-Roles-City-Town-Government.aspx

[27] Bran Knowles, Oliver Bates, and Maria Håkansson. 2018. This Changes Sustainable HCI. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. Association for Computing Machinery, New York, NY, USA, 1–12. https://doi.org/10.1145/3173574.3174045

[28] Stacey Kuznetsov, George Davis, Jian Cheung, and Eric Paulos. 2011. Ceci n'est pas une pipe bombe: authoring urban landscapes with air quality sensors. In *Proceedings of the sigchi conference on human factors in computing systems*. 2375–2384.

[29] Ann Light, Chiara Rossitto, Airi Lampinen, and Andrea Botero. 2023. The Ecological Underpinnings and Future Contributions of (E)CSCW. In *Proceedings of 21st European Conference on Computer-Supported Cooperative Work*. European Society for Socially Embedded Technologies (EUSSET).

[30] Martin Lindrup, EunJeong Cheon, Mikael B. Skov, Dimitrios Raptis, and Rob Comber. 2022. Sustainable Foodtures: Exploring Roles of Future Technology in Sustainable Food Shopping. In *NordiCHI'22 - Proceedings of the 12th Nordic Conference on Human-Computer Interaction*. Association of Computing Machinery, Aarhus, Denmark. https://doi.org/10.1145/3546155.3546641

[31] Martin Lindrup, Mikael B. Skov, and Dimitrios Raptis. 2022. Between Egoism and Altruism: A Mixed-Methods Study of Reflections about Energy Use in the Life Cycle of High Preference Grocery Products. In *NordiCHI'22 - Proceedings of the 12th Nordic Conference on Human-Computer Interaction*. Association for Computing Machinery, Aarhus, Denmark. https://doi.org/10.1145/3546155.3546686

[32] Martin V A Lindrup, Arjun R Menon, and Aksel Biørn-Hansen. 2023. Carbon Scales: Collective sense-making of carbon emissions from food production through physical data representation. In *DIS 2023 - Proceedings of the 2023 ACM Designing Interactive Systems Conference*. ACM, Pittsburgh, USA.

[33] Martin V A Lindrup, Jakob Tholander, Chiara Rossitto, Rob Comber, and Mattias Jacobsson. 2023. Designing for Digital Environmental Stewardship in Waste Management. In *DIS 2023 - Proceedings of the 2023 ACM Designing Interactive Systems Conference*. ACM, Pittsburgh, USA.

[34] Shannon Mattern. 2021. *A city is not a computer: Other urban intelligences*. Vol. 2. Princeton University Press.

[35] Andrew Vande Moere and Dan Hill. 2012. Designing for the situated and public visualization of urban data. *Journal of Urban Technology* 19, 2 (2012), 25–46.

[36] Chiara Rossitto, Rob Comber, Jakob Tholander, and Mattias Jacobsson. 2022. Towards Digital Environmental Stewardship: the Work of Caring for the Environment in Waste Management. In *CHI Conference on Human Factors in Computing Systems*. 1–16.

[37] Kim Sauvé, Saskia Bakker, and Steven Houben. 2020. Econundrum: Visualizing the climate impact of dietary choice through a shared data sculpture. In *DIS 2020 - Proceedings of the 2020 ACM Designing Interactive Systems Conference*. Association for Computing Machinery, Inc, 1287–1300. https://doi.org/10.1145/3357236.3395509

[38] Katie Seaborn, Johanna Mähönen, and Yvonne Rogers. 2020. Scaling Up to Tackle Low Levels of Urban Food Waste Recycling. In *DIS 2020 - Proceedings of the 2020 ACM Designing Interactive Systems Conference*. Association for Computing Machinery (ACM), Eindhoven, Netherlands, 1327–1340. https://doi.org/10.1145/3357236.3395524

[39] Robert Soden. 2022. Reimagining environmental data. *Interactions* 29, 1 (jan 2022), 45–47. https://doi.org/10.1145/3501302

[40] Robert Soden, Perrine Hamel, David Lallemant, and James Pierce. 2020. The disaster and climate change artathon: Staging art/science collaborations in crisis informatics. In *DIS 2020 - Proceedings of the 2020 ACM Designing Interactive Systems Conference*. ACM, Eindhoven, Netherlands, 1273–1286. https://doi.org/10.1145/3357236.3395461

[41] Robert Soden and Nate Kauffman. 2019. Infrastructuring the imaginary how sea-level rise comes to matter in the San Francisco Bay area. In *Conference on Human Factors in Computing Systems - Proceedings*. ACM, Glasgow, Scotland, UK, 1–11. https://doi.org/10.1145/3290605.3300516

[42] Olúfémi O Táíwò. 2022. *Elite capture: How the powerful took over identity politics (and everything else)*. Haymarket Books.

[43] Wesley Willett, Yvonne Jansen, and Pierre Dragicevic. 2016. Embedded data representations. *IEEE transactions on visualization and computer graphics* 23, 1 (2016), 461–470.