Sustainable HCI and efforts toward environmental justice

Hasan Mahmud Prottoy
University of Maryland, Baltimore county, hmprottoy@umbc.edu

It is urgent to step up HCI's efforts toward sustainability and environmental justice in light of growing worries about global environmental catastrophes like global warming and climate change. In this paper, I have reviewed 20 papers published in major HCI venues which are related to sustainable HCI and environmental justice to analyze the current state of sustainable HCI (SHCI) and what remains underexplored. From a careful exploration of these publications, it is evident that SHCI scholarship has played a self-conscious role in establishing its vision, priorities, and future orientations to emphasize environmental justice. What it needs right now is to produce empirical accounts of how that goal of ensuring justice can be achieved through SHCI approaches.

CCS CONCEPTS • Sustainable HCI • Environmental justice

1 Introduction and motivation

Sustainable Human-Computer Interaction (SHCI) is a field in HCI that focuses on both - designing devices, artifacts, and systems that are sustainable and designing persuasive systems to influence users to behave and live more sustainably or in other words, influencing users to adopt more sustainable lifestyles or decision-making [2]. Advocating for environmental justice is generally defined as the efforts toward eradicating unequal distribution of environmental resources, unfair exposure to environmental pollution, hazards, and destruction to communities [21]. Amidst the rising concerns of a global environmental catastrophe like global warming and climate change [22], and the unavoidable injustice on various communities associated with it [23], it is high time to strengthen HCI efforts toward sustainability and environmental justice. On that point I try to find out what is the current state of HCI's efforts toward sustainability and environmental justice, what has been done and where it is heading in this literature review.

2 Literature review

2.1 Methods

I have reviewed 20 papers including full papers, extended abstracts, poster papers on the topic of sustainable HCI and efforts towards environmental justice through its approaches. I have searched for these papers using keywords like 'sustainable HCI', 'environmental justice', 'sustainable computing' among others in google

scholar and ACM digital library. I have only incorporated publications from major ACM venues (CHI, CSCW, DIS) for this review. After selecting adequate papers on the vision, and systematic reviews of the area, I have chosen to include some examples of representational areas within sustainable HCI that have been covered in HCI so far. I have categorized the papers that I have reviewed in Table 1.

Table 1: Categorizing the reviewed papers

Paper title	Assigned category	Year of publication	Type
Sustainable Interaction Design: Invention & Disposal, Renewal & Reuse [1]	Setting SHCI's vision	2007	Full paper
HCI and Environmental Sustainability: The Politics of Design and the Design of Politics [3]	Setting SHCI's vision	2010	Full paper
Environmental Sustainability and Interaction [2]	Setting SHCI's vision	2007	Extended Abstract
This Changes Sustainable HCI [4]	Setting SHCI's vision	2018	Full paper
Mapping the Landscape of Sustainable HCI [5]	Systematic Reviews	2010	Full paper
Three Environmental Discourses in Human-Computer Interaction [6]	Systematic Reviews	2009	Extended Abstract
A Decade of Sustainable HCI Connecting SHCI to the Sustainable Development Goals [7]	Systematic Reviews	2021	Full paper
Hitting the Triple Bottom Line Widening the HCI Approach to Sustainability [8]	Systematic Reviews	2022	Full paper
Food Democracy in the Making: Designing with Local Food Networks [9]	SHCI at Food and agriculture	2018	Full paper
Symbiotic Encounters: HCI and Sustainable Agriculture [10]	SHCI at Food and agriculture	2019	Full paper
Nourishing the Ground for Sustainable HCI: Considerations from Ecologically Engaged Art [11]	Incorporating art as an approach	2009	Full paper
Beyond Boundaries: Towards Symbiotic Relationship Between Ecological Arts and Computational Thinking for Sustainability [12]	Incorporating art as an approach	2020	Poster presentation
Towards Digital Environmental Stewardship: the Work of Caring for the Environment in Waste Management [13]	Waste management and recycling practices	2022	Full paper

Paper title	Assigned category	Year of publication	Type
The Breaking Hand: Skills, Care, and Sufferings of the Hands of an Electronic Waste Worker in Bangladesh [14]	Waste management and recycling practices	2019	Full paper
UbiGreen: investigating a mobile tool for tracking and supporting green transportation habits [15]	Persuading behaviors and participatory sensing	2009	Full paper
Environmental Protection and Agency: Motivations, Capacity, and Goals in Participatory Sensing [16]	Persuading behaviors and participatory sensing	2017	Full paper
Religion and Sustainability: Lessons of Sustainable Computing from Islamic Religious Communities [17]	Religion and sustainability	2020	Full paper
Who Are We Listening to? The Inclusion of Other-than-human Participants in Design [18]	Incorporating non-human participants	2021	Full paper
Social Justice-Oriented Interaction Design: Outlining Key Design Strategies and Commitments [19]	Incorporating justice	2016	Full paper
The future of HCI and Sustainability: Championing Environmental and Social Justice. [20]	Incorporating justice	2018	Extended Abstract

2.2 Setting SHCI's vision

As a relatively new field of HCI, sustainable HCI (SHCI) has seen a number of efforts to define its vision thus far. It all started with Eli Blevis's argument that sustainability can and should be the focus of interaction design in his landmark paper 'Sustainable interaction design' in CHI 2007 [1]. There he articulated that, while designing a mode or means of interaction, equal attention should be given about the future of that and emphasizes on disposal, reuse, and recycling. He framed two principles- invention & disposal and renewal & reuse. Invention & disposal talks about making chic innovations to upgrade, remodel and own heirloom devices instead of owning the latest gadget available and disposing of the previous one altogether. And, the renewal and reuse principle hints at innovations of new modules that can upgrade a product and reduce the need for buying a new model altogether. This paper defines the term 'sustainable interaction design' and makes sustainability really important in HCI for the first time. In the same conference (CHI 2007), Mankoff et al wrote an extended abstract where they take Eli Blevis's idea of "sustainability can and should be a central focus of interaction" as the central tenet in their special interest group [2]. They acknowledge that, CHI community was facing an unanswered challenge in the creation of interactive systems, which is environmental sustainability. They offer a categorization for the efforts towards environmental sustainability in design: sustainability in design (mitigating material effects of software/hardware) and sustainability through design (influencing sustainable lifestyles or decision-making). This categorization later became widely accepted in the sustainable HCI area. Paul Dourish, in CHI 2010 writes an argument piece where he argued

that the dominant approaches to environmental research in HCI are inherently self-limiting and overlook important areas for potential action [3]. In his opinion, effective engagement with environmental problems necessitates a careful and critical examination of the conceptual foundations on which our systems and reasoning are built. He invited the HCI community to pay attention to how problems and solutions are articulated. He proposed that “thinking about scale - the scales of action and the scales of effects” - could provide a useful new entry point for design practice by taking the political, cultural, institutional, and spatial aspects of environmental activism seriously [3]. Knowles et al, presents a paper [4] at CHI 2018 titled ‘This changes sustainable HCI’ echoing the title and arguments of the book by Naumi Klein, This Changes Everything: Capitalism vs the Climate. This paper emphasizes the fact that sustainable HCI was still struggling to reach a common understanding of sustainability and HCI's role in addressing it. As a result, they make an attempt to articulate a vision around which the HCI community can productively unite. They noticed two dominant views in the SHCI discussion. One is the perspective that incremental reductions in energy consumption would be enough and another one is that significant changes are needed to our current way of life to really address the related environmental issues. Knowles et al. argued that in order to have a greater and longer-lasting impact, the SHCI community should unite around the latter notion which tells about significant changes in our current way of life. Looking at the recent works at SHCI, they argue that the community has already arrived at an understanding that aligns with that vision. They draw from Naumi Klein’s book for articulating the vision in detail in the paper. They also highlighted some implications for adopting Naumi Klein’s vision in SHCI which includes orienting around climate change rather than sustainability, developing a new model for the digital economy, helping to build and support a mass movement, fighting injustice and inequality on all fronts, fostering values-based debate, and bracing for impact.

The gradual evolution in the vision of sustainable HCI that we see in these literatures assures us that it is emphasizing to address environmental justice, climate change more and more. This also works as one of the motivations for this project.

2.3 Systematic Reviews

Since its emergence, there have been several systematic reviews that looked into the landscape of sustainable HCI. I would highlight a few of them. DiSalvo et al created a map of sustainable HCI in 2010 by reviewing 83 HCI papers and programmatic statements [5]. They classified SHCI works into five genres based on how they formulate problems and approach solutions. The five genres that they formulate are persuasive technology, ambient awareness, sustainable interaction design, formative user studies, and pervasive and participatory sensing. Following that, the paper focused on the major differences that often exist in the works of the same genre which they call the axes of difference. Some of the examples of these differences that they highlighted are sustainability as research focus vs. application area, improving vs. fundamentally changing lifestyles, users as problems vs. solving users’ problems- among others. Another review [6] was done by Elizabeth Goodman in 2009 where she ran discourse analysis on 120 documents on the subject of human-computer interaction related to “nature,” “the environment,” or “sustainability.” The analysis resulted in identification of three separate discourses: sustainable interaction design, re-visioning consumption, and citizen sensing. She also noticed two under-explored areas that had promise in her views, which are: participatory design and moving beyond human-centered computing. We can see that the promising areas that Goodman highlighted in this earlier review came out as genres at DiSalvo et al’s mapping.

2.3.1 Use of development frameworks for reviewing SHCI works

Some reviews tried to use frameworks from sustainable development areas like Sustainable development goals (SDG) and Triple Bottom Line (TLP) for reviewing SHCI literature. Hansson et al., for example, used the United Nations' Sustainable Development Goals (SDGs) to identify high-level goals that SHCI researchers worked toward since the inception of SHCI [7]. In doing so, they analyzed 71 peer-reviewed papers and came to the thinking that the SDGs and the SDG targets can be used generatively, for example as a checklist, to come up with areas and problems where SHCI research could but has not yet contributed to any larger extent. Another systematic review by Scuri et al used the framework of Triple Bottom Line (TLP) consisting of three dimensions: environment, economy, and society to classify SHCI works [8]. They analyzed 77 articles from the SHCI literature and found that 44 of them targeted environmental sustainability as a central issue, 15 of them were concerned with social sustainability, and 18 of them had components of more than one dimension. They identified that there is a gap in addressing the economic angle in SHCI literature if we take TBL as a framework. They proposed that by taking a sociology perspective on the economic angle of the TBL, HCI can advance the discussion and understanding of economic concepts surrounding sustainability.

These systematic reviews give us the overview of the already covered areas within SHCI and different ways of looking at it. Especially the gap of addressing the economic dimension identified by Scuri et al presents us with an opportunity to think about the role HCI can play in redefining the established foundations of the current economic system which goes with the SHCI's vision which I discussed in the earlier section.

In the next sections I would highlight some specific areas where the works of SHCI focused that we can consider as examples.

2.4 SHCI at Food and agriculture

There are a number of works within SHCI which have dealt with SHCI approaches in the subject of food and agriculture. I would talk about two of them in this section.

Prost et al, in their CHI 2018 paper adopted an action research approach in two deprived neighborhoods in the North East of the UK [9]. In doing so, they introduced 'food democracy' as a theoretical framework for HCI to engage in human-food interaction. Through informal conversation and observations with community centers, producers, food waste charities, and other stakeholders, they identified tensions around environmental, social, and economic goals; challenges of local food businesses operating within the existing economic paradigm; and differing perspectives on ownership and governance in the network. They argued that their proposed theoretical lens would broaden HCI's engagement with food beyond health and environmental sustainability and would help to engage with questions of social and economic justice and democratic governance of our food system.

Liu et al produced three ethnographic accounts in which researchers can learn to notice, respond, and engage in symbiotic encounters with companion species and the living soil of the earth [10]. They conducted an ethnographic study in two farming villages in rural Taiwan which resulted in those ethnographic accounts. Although they didn't offer specific answers to how technology might address issues in both environmental sustainability and food crisis, they provide a lens to understand emerging sustainable farming practices, and also provide accounts for looking into non-human users and the interactions between human and other species which opens discussion about a space of possibility for technological interventions.

2.5 Incorporating art as an approach

DiSalvo et al, in their argument paper in CHI 2009 [11] explored the question of “How might HCI researchers working on sustainability productively understand the discourses and practices of ecologically engaged art as a means of enriching their own activities?” In doing so, they go through the frameworks of art and eco-art practices and come up with alternative suggestions for design and assessment of sustainable HCI. They argued that developing a more critically aware sustainable HCI can be facilitated by having a good foundation in the history of ecologically involved art as well as the art-historical and critical discourses that have surrounded it.

Snehalkumar 'Neil' S. Gaikwad in his poster presentation [12] at CSCW 2020, presented a framework named ‘beyond boundaries’ which includes ecological arts, remote sensing Landsat satellite time-series datasets, and civic engagement and discourse facilitated through a public exhibition, to increase shared consciousness on climate-and-human induced threats to sustainability. This project intended to curate the symbiotic relationship between arts and science. The paper suggested that the concourse of practices at the intersection of arts and sciences could yield key innovations and participatory civic engagements for sustainability.

2.6 Waste management and recycling practices

Rossitto et al introduced a framework for sustainable HCI called ‘digital environmental stewardship’ in their CHI 2022 paper [13]. They also applied this framework to three cases concerned with waste management in Sweden which are plogga (a movement combining jogging with litter picking-up activities), Litterati (a data-centered digital platform that supports the crowd-sourced documentation of litter collection), and Samfällighe (a housing community association who manage waste in multi-apartment buildings). They found that stewardship actions are emerging configurations of interconnected actors, multiple capacities to act, and varying motivations. They argued that their framework for digital environmental stewardship can help unravel how actions come to be, rather than merely evaluate them and their consequences. In their view, the digital environmental stewardship framework re-centers technology's relevance for the environment and can help reframe design and design towards ethical concerns for the environment.

Through an eight month long ethnography with the e-waste recycling community (Bhangari community) at Dhaka, Bangladesh, Rifat et al contextualized three characteristics of the use of hands of the e-waste workers- knowledge, care, and skills & collaboration [14]. They also bring out the pain and sufferings involved in this e-waste recycling profession especially in the global south. This study brings attention to the tactile experiences of the bhangaris while interacting with the broken electronics.

2.7 Persuading behaviors and participatory sensing

Froehlich et al in their CHI 2009 paper talked about the process of developing a mobile phone based system named ‘UbiGreen’ which encourages users to adopt green transportation habits [15]. This system provides feedback on a mobile ambient display and is capable of engaging users to change their transportation behaviors. They ran two formative studies consisting of an online survey and experience sampling study to figure out the key requirements of designing a system for encouraging users. Then they developed ‘UbiGreen’ and did a qualitative study of three weeks deployment of the system. They recruited 14 participants from Pittsburgh and Seattle from Craigslist posting who used the system for an average of 21 days. They collected

data from the system, through questionnaires and interviews with each participant to evaluate their system. The system was able to persuade users to adopt sustainable transportation habits in an overall sense and produced insights for increased social interaction, engagement and motivation through deployment of digital tools.

Aoki et al examined the citizen science experience from the perspective of citizen participants in their CHI 2017 paper [16]. They discussed the results of four connected qualitative investigations and technological interventions of community air quality monitoring initiatives, looking at the motivations and skills of citizen participants and describing how they fit with various forms of citizen science. By doing this they discovered a variety of ways in which citizen motivations, capabilities, and ambitions are not well matched with scientific agendas. They noted that data collection requires intricate trade-offs across multiple dimensions and that the widely held belief that citizen science platforms benefit both the public and science may be overstated.

2.8 Religion and sustainability

Rifat et al in their paper at CSCW 2020 [17] drawn from a very underexplored source for a lesson for sustainable computing which is, religion. They pointed out that persuasion, while considered an important tool for adopting sustainable behavior, persuasion components which are embedded in religious practices are not explored or considered in the existing discussion. Through a six-month long ethnography with the Islamic communities at a Bangladeshi city, they describe how the basic components of persuasion like motivation and habit are built in their practice which can reflect the vision of sustainable living. Then they argue that a deeper understanding of religious values can help designing for sustainable living and broaden the scope of sustainable computing.

2.9 Incorporating non-human participants

In the argument piece [18] by Santos et al emphasized the significance of identifying, referring to, and including "pervasive peripheral participants"—a phrase they used to describe non-human participants—in research and design processes. The paper intends to be a “remembering” of the other-than-human entities that are already involved in the design process, affecting and being influenced by human-driven actions both directly and indirectly. It prompts the query, "Why on earth would we want to break ground, anyway?" Liu et al in their paper on symbiotic encounters also highlights the perspective of including non-human users [10].

2.10 Incorporating justice

In their DIS 2016 paper [19], Dombrowski et al offered a method for fostering a social justice emphasis in design. They demonstrated how a social justice viewpoint offers an answer to current open problems and also creates significant new difficulties for HCI research by using cases from sustainability, ICTD, and community informatics. They also emphasized practical methods for implementing interaction design that is aimed toward achieving social justice along six dimensions: transformation, recognition, reciprocity, enablement, distribution, and responsibility. CHI 2018 hosted a special interest group workshop on the future of HCI and sustainability where they set the vision for championing environmental and social justice [20]. They recognized that it was their responsibility as a sustainability-focused SIGCHI community to continue promoting environmental and

social justice—a commitment that is especially necessary in light of the numerous globally mediated digital events that have challenged those intertwined notions of justice.

3 Discussion

From the reviewed vision papers on sustainable HCI, it is evident that SHCI has reached the point where it takes the position to make significant changes in our current way of life rather than making incremental reductions in energy consumption. Knowles et al finally articulated this position for SHCI [4] but coming to this notion was really a gradual cumulative journey by SHCI scholarship which includes Eli Blevis's introduction of the concept of sustainable interaction design [1] and Paul Dourish's call for critical examination of the conceptual foundations of our existing systems and reasoning- among others. So, the question of improving vs. fundamentally changing lifestyles which DiSalvo et al presented as a major axe of difference [5] in their mapping of SHCI, seems to be settled within the community due to the significance and urgency of the matter. Scuri et al's exploration of SHCI literature using the Triple Bottom Line framework revealed the gap of addressing the economic angle in SHCI's efforts so far. This lack of work in addressing and redefining the established foundations of the current economic system by SHCI is a major drawback towards its vision for changing lifestyles. Going back to Knowles et al's recommendations for making a meaningful impact toward that direction, their suggestions for orienting around climate change rather than sustainability, developing a new model for the digital economy, helping to build and support a mass movement, fighting injustice and inequality on all fronts, fostering values-based debate, and bracing for impact- all seems comprehensive at this moment. The example literature presented in this paper shows a glimpse of how SHCI is incorporating those implications. The framework of food democracy presented by Prost et al [9] can be considered as a significant effort for incorporating the economic angle. Liu et al's exploration of symbiotic encounters in agriculture [10] and Snehalkumar 'Neil' S. Gaikwad's work on establishing symbiotic relationships between ecological art and computational thinking [12] can work as inspiration for taking this aspect of symbiotic encounters or relationships in SHCI's approach. This also relates to incorporating non-human participants highlighted by Santos et al [18]. SHCI related works on waste management [13] and recycling practices as the after use phase of technology [14] all are positive steps. Rifat et al's argument for understanding religious values for sustainable living seems sound in terms of working towards fundamentally changing the current way of life but it needs a careful consideration of its consequences as this area is still very underexplored from SHCI's perspective. Finally, Dombrowski et al's offered methods for fostering a social justice emphasis in design [19] and Bates et al's argued future of SHCI which is championing environmental and social justice are the strong indication that SHCI community should responsibly incorporate the perspective of justice for materializing it's vision. So, going through the list of reviewed systematic reviews, developed theoretical frameworks, suggested approaches and examples of different efforts showcase that there is a need for more empirical works on how this incorporation of justice would happen in SHCI. SHCI is almost clear about its direction and responsibility in the context of the current situation of the earth but for getting answers on how to address this social and environmental injustice, more empirical works are needed to explore the perspective of affected communities, engaged artists, activists and practitioners in this area in any sense. Currency SHCI doesn't seem to have that answer definitively.

4 Conclusion

Sustainable HCI has evolved through gradually reorienting its vision towards making a meaningful impact by adopting the view of justice, addressing inequality, and increasingly incorporating alternative perspectives like involving non-human participants or considering after-use phases of technology among others. SHCI scholarship has played a self conscious role in setting its vision, priorities and future directions for emphasizing environmental justice. To achieve that goal successfully, SHCI scholarship needs to produce more empirical works to better understand how to achieve justice by engaging with affected communities, artists, activists, and practitioners in the related area.

REFERENCES

[1] Eli Blevis. 2007. Sustainable interaction design: invention & disposal, renewal & reuse. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '07). Association for Computing Machinery, New York, NY, USA, 503–512. https://doi.org/10.1145/1240624.1240705

[2] Jennifer C. Mankoff, Eli Blevis, Alan Borning, Batya Friedman, Susan R. Fussell, Jay Hasbrouck, Allison Woodruff, and Phoebe Sengers. 2007. Environmental sustainability and interaction. In CHI '07 Extended Abstracts on Human Factors in Computing Systems (CHI EA '07). Association for Computing Machinery, New York, NY, USA, 2121–2124. https://doi.org/10.1145/1240866.1240963

[3] 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 (DIS '10). Association for Computing Machinery, New York, NY, USA, 1–10. https://doi.org/10.1145/1858171.1858173

[4] 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, Paper 471, 1–12. https://doi.org/10.1145/3173574.3174045

[5] Carl DiSalvo, Phoebe Sengers, and Hrönn Brynjarsdóttir. 2010. Mapping the landscape of sustainable HCI. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10). Association for Computing Machinery, New York, NY, USA, 1975–1984. https://doi.org/10.1145/1753326.1753625

[6] Elizabeth Goodman. 2009. Three environmental discourses in human-computer interaction. In CHI '09 Extended Abstracts on Human Factors in Computing Systems (CHI EA '09). Association for Computing Machinery, New York, NY, USA, 2535–2544. https://doi.org/10.1145/1520340.1520358

[7] Lon Åke Erni Johannes Hansson, Teresa Cerratto Pargman, and Daniel Sapiens Pargman. 2021. A Decade of Sustainable HCI: Connecting SHCI to the Sustainable Development Goals. In Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21). Association for Computing Machinery, New York, NY, USA, Article 300, 1–19. https://doi.org/10.1145/3411764.3445069

[8] Sabrina Scuri, Marta Ferreira, Nuno Jardim Nunes, Valentina Nisi, and Cathy Mulligan. 2022. Hitting the Triple Bottom Line: Widening the HCI Approach to Sustainability. In Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22). Association for Computing Machinery, New York, NY, USA, Article 332, 1–19. https://doi.org/10.1145/3491102.3517518

[9] Sebastian Prost, Clara Crivellaro, Andy Haddon, and Rob Comber. 2018. Food Democracy in the Making: Designing with Local Food Networks. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18). Association for Computing Machinery, New York, NY, USA, Paper 333, 1–14. https://doi.org/10.1145/3173574.3173907

[10] Szu-Yu (Cyn) Liu, Shaowen Bardzell, and Jeffrey Bardzell. 2019. Symbiotic Encounters: HCI and Sustainable Agriculture. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19). Association for Computing Machinery, New York, NY, USA, Paper 317, 1–13. https://doi.org/10.1145/3290605.3300547

[11] Carl DiSalvo, Kirsten Boehner, Nicholas A. Knouf, and Phoebe Sengers. 2009. Nourishing the ground for sustainable HCI: considerations from ecologically engaged art. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '09). Association for Computing Machinery, New York, NY, USA, 385–394. https://doi.org/10.1145/1518701.1518763

[12] Snehalkumar 'Neil' S. Gaikwad. 2020. Beyond Boundaries: Towards Symbiotic Relationship Between Ecological Arts and Computational Thinking for Sustainability. In Conference Companion Publication of the 2020 on Computer Supported Cooperative Work and Social Computing (CSCW '20 Companion). Association for Computing Machinery, New York, NY, USA, 257–262. https://doi.org/10.1145/3406865.3418336

[13] 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 Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22). Association for Computing Machinery, New York, NY, USA, Article 335, 1–16. https://doi.org/10.1145/3491102.3517679

[14] Mohammad Rashidujjaman Rifat, Hasan Mahmud Prottoy, and Syed Ishtiaque Ahmed. 2019. The Breaking Hand: Skills, Care, and Sufferings of the Hands of an Electronic Waste Worker in Bangladesh. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19). Association for Computing Machinery, New York, NY, USA, Paper 23, 1–14. https://doi.org/10.1145/3290605.3300253

[15] Jon Froehlich, Tawanna Dillahunt, PredragKlasnja, Jennifer Manko, Sunny Consolvo, BeverlyHarrison, and James A. Landay. 2009. UbiGreen: investigating a mobile tool for tracking and supporting green transportation habits. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems(CHI '09). Association for Computing Machinery, New York, NY, USA, 1043–1052.https://doi.org/10.1145/1518701.1518861

[16] 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 (CHI '17). Association for Computing Machinery, New York, NY, USA, 3138–3150. https://doi.org/10.1145/3025453.3025667

[17] Mohammad Rashidujjaman Rifat, Toha Toriq, and Syed Ishtiaque Ahmed. 2020. Religion and Sustainability: Lessons of Sustainable Computing from Islamic Religious Communities. Proc. ACM Hum.-Comput. Interact. 4, CSCW2, Article 128 (October 2020), 32 pages. https://doi.org/10.1145/3415199

[18] Rodrigo dos Santos, Michelle Kaczmarek, Saguna Shankar, and Lisa P. Nathan. 2021. Who Are We Listening to? The Inclusion of Other-than-human Participants in Design. In LIMITS '21: Workshop on Computing within Limits, June 14–15, 2021.

[19] Lynn Dombrowski, Ellie Harmon, and Sarah Fox. 2016. Social Justice-Oriented Interaction Design: Outlining Key Design Strategies and Commitments. In Proceedings of the 2016 ACM Conference on Designing Interactive Systems (DIS '16). Association for Computing Machinery, New York, NY, USA, 656–671. https://doi.org/10.1145/2901790.2901861

[20] Oliver Bates, Vanessa Thomas, Christian Remy, Lisa P. Nathan, Samuel Mann, and Adrian Friday. 2018. The Future of HCI and Sustainability: Championing Environmental and Social Justice. In Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (CHI EA '18). Association for Computing Machinery, New York, NY, USA, Paper SIG01, 1–4. https://doi.org/10.1145/3170427.3185365

[21] David Schlosberg. 2007. Defining environmental justice: Theories, movements, and nature. OUP Oxford.

[22] S. George Philander. 2008. Encyclopedia of global warming and climate change: AE. Vol. 1. Sage.

[23] Kyle Powys Whyte. 2016. "Is it colonial déjà vu? Indigenous peoples and climate injustice." In Humanities for the Environment, pp. 102-119. Routledge.