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Women, E-Waste, and Technological Solutions to Climate Change

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Abstract

In this paper, we argue that a crossover class of climate change solutions (which we term "technological solutions") may disproportionately and adversely impact some populations over others. We begin by situating our discussion in the wider climate discourse, particularly with regard to the Millennium Development Goals (MDGs) and the Basel Convention. We then suggest that many of the most attractive technological solutions to climate change, such as solar energy and electric car batteries, will likely add to the rapidly growing stream of electronic waste ("e-waste"). This e-waste may have negative downstream effects on otherwise disenfranchised populations. We argue that e-waste burdens women unfairly and disproportionately, affecting their mortality/morbidity and fertility, as well as the development of their children. Building on this, we claim that these injustices are more accurately captured as problems of recognition rather than distribution, since women are often institutionally under-acknowledged both in the workplace and in the home. Without institutional support and representation, women and children are deprived of adequate safety equipment, health precautions, and health insurance. Finally, we return to the question of climate justice in the context of the human right to health and argue for greater inclusion and recognition of women waste workers and other disenfranchised groups in forging future climate agreements.

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Introduction

OF THE MANY reasons to address climate change—economic impacts, habitat loss, ocean acidification, agricultural uncertainty, species disappearance, impacts on vulnerable populations, etc.—justice and rights concerns stand out as some of the more prominent. Such concerns relate primarily to three core areas: the distribution of benefits and burdens regarding impacts from climate change, backward-looking blameworthiness for having caused climate change, and forward-looking responsibility for fixing the problem.

One somewhat less discussed concern, however, relates to the benefits and burdens stemming from whatever management strategies—whether mitigation, adaptation, or remediation—are eventually adopted. In particular, there is reason to be concerned that a crossover class of solutions to climate change (what we here will be calling "technological solutions") may disproportionately and adversely impact some populations over others. In this paper, we address concerns about future gender injustices stemming from technological solutions to climate change.

On one hand, it is clear that the problems presented by climate change must be addressed, due in no small part to the above-mentioned global inequalities and injustices. Among proposed solutions to these climate injustices, policy makers have suggested global agreements, economic interventions, and a variety of technological solutions including alternative energy technologies, adaptation-oriented technology transfers, and even climate remediation in the form of sophisticated geo-engineering proposals. Indeed, technological solutions may be the most politically feasible, economically viable, and institutionally plausible way to address climate change.

On the other hand, however, these technological solutions are likely to generate new distributive imbalances of their own, and so it is not clear that technological solutions alone can suffice to rectify prior injustices. Current and proposed technological solutions may instead actually exacerbate geopolitical imbalances, particularly with regard to waste, gender inequities, and human rights to health. Unless the downside burdens of the waste stream are addressed, many attractive technological solutions may simply compound existing injustices. It would behoove all parties to anticipate and tackle these issues before they become institutionally entrenched.

In the first section of this paper, we situate our "downstream" justice concerns in the context of more traditional "upstream" justice concerns. In the second section, we discuss three key arguments for pursuing technological solutions to climate change. We argue that many of the most attractive technological proposals, such as solar energy and electric car batteries, will likely add to the rapidly growing electronic waste ("e-waste") stream. This, we reason, may have negative downstream effects on otherwise disenfranchised populations.

In the third and fourth sections, we discuss the human dimensions of e-waste and propose that e-waste is both a justice issue and a gender issue. We argue that e-waste unfairly and disproportionately burdens women by affecting their mortality/morbidity, fertility, and the development of their children. Specifically, we claim that these injustices are more accurately captured as problems of recognition rather than distribution, since women are often institutionally under-acknowledged—their rights ignored—in the workplace and in the home. In this instance, we understand recognition as an important mechanism by which we value and respect other persons and, specifically, their rights to equality and health.

Finally, we return to the question of climate justice and argue for greater inclusion and recognition of women waste workers and other disenfranchised groups in forging future climate agreements.

Justice concerns

Inasmuch as a good portion of the climate justice literature has addressed the distribution of burdens and benefits regarding impacts, culpability, and responsibility, the justice discussion has primarily emphasized "upstream" concerns: identifying anticipated climate injustices and establishing who bears more or less of the burden to do something about climate change.[1] The upstream justice arguments have been the subject of much attention and are not the subject of this paper.[2] There are, however, other "downstream" justice considerations that have received far less attention. These include some proposals for addressing climate change, which may generate further injustices, even if the upstream justice considerations are addressed. One class of solutions in particular—technological solutions—engenders a unique suite of downstream problems that ought not to be overlooked.

Consider first that proposed responses to climate change span an enormous range of recommendations, from individual action to international cooperation, which many times are in tension with one another. Policy makers have proposed and/or implemented local, state, regional, and global agreements, economic interventions with carbon markets and taxes, and technological alternatives to address various aspects of this complex problem.[3] Such solutions include new automotive technologies, alternative energy technologies, and drilling technologies. What is unique about the downstream justice concerns associated with these technological solutions is that they cut across all proposed responses to climate change. They are not limited to mitigation efforts or to adaptation proposals. By way of clarification, we do not intend the term 'technological solutions' to capture all policy or engineering interventions, or even to refer to solutions that deploy more primitive engineering technologies. Rather, we are concerned with technological solutions that engage advanced technologies producing downstream waste, particularly if that downstream waste may place a disproportionate burden on disenfranchised populations.

There are several reasons to focus on these downstream concerns now. First, when it comes to climate change, policy makers tend to emphasize macro, aggregate concerns—such as energy or sea level rise—over intra-national disparities in wealth and health. This aggregate emphasis not only tilts the discussion toward technological solutions, but also masks their role in generating disproportionate impacts.[4] Second, inasmuch as wealthy nations are likely to lead the charge to address climate impacts and injustices, they are likely to choose technological solutions over non-technological solutions. We say more on why below. Finally, inasmuch as least-developed countries (LDCs) generally lack financial or institutional resources, they may only be able to respond to, rather than initiate, technological management strategies themselves. In this respect, any downstream health and environmental costs are effectively foisted upon the citizens of those countries. LDCs could gain greater control by staying ahead of the discussion. The worry according to all of these various reasons is that these crosscutting technological solutions may perpetuate further injustice, remedying one set of injustices while exacerbating others. All things considered, it will be much easier to overcome future injustices and rights abridgements if care is taken to choose appropriate solutions.

The near-universal adoption of the Basel Convention in 1989 placed restrictions on the transboundary movement and disposal of toxic wastes, thus ostensibly addressing equity, health, and environmental issues arising from the transfer of hazardous waste between more-developed countries (MDCs) and LDCs. The US, however, is one of two signatories that has not ratified the Convention, and still exports significant quantities of hazardous waste—including e-waste.

The UN Millennium Development Goals (MDGs)—which include, among other things, (1) promoting gender equality and empowering women, (2) reducing child mortality, (3) improving maternal health, (4) ensuring environmental sustainability and (5) securing global partnerships

for development—ostensibly reinforce the Basel Convention's restrictions on toxic waste transport, though they remain goals and not binding commitments. Both the Basel Convention and the MDGs can be used to address gross injustices and improve respect for human rights, but there is still work to be done. Again, our concern in this essay is only that technological solutions to climate change may further intensify existing injustices that the Basel Convention and the MDGs are seeking to address.

Technological arguments and proposals

Technological solutions are often viewed as the lowest hanging fruit among the plethora of potential options. There are at least three primary reasons for this: economic viability, political feasibility, and institutional plausibility. It does not hurt, of course, that technological solutions tend also to be the most exotic and tantalizing. How much more exciting to pursue a grand technological moonshot than to return to older, more primitive technologies and times? Consider the rationales in turn.

First, technological solutions may be the best option for pursuing change without disrupting the economy. Stephen Pacala and Robert Socolow have argued that "humanity already possesses the fundamental scientific, technological and industrial know-how to solve the carbon and climate problem for the next half-century."[5] Their "wedges" approach breaks the complexity of the climate problem into a suite of manageable options that each serve to minimize a portion of the climate damage. Attractively, they assess the impact of present day technologies. Their wedges include everything from renewable energy to carbon sequestration to economic policies, all of which can work in concert to stabilize emissions in a practical and feasible manner. In this respect, their strategy of offering a "portfolio of responses" is economically appealing, as each alternative can be applied where it is most cost-effective, and economic development can continue unabated. As Socolow puts it: the wedges approach "decomposes a heroic challenge into a limited set of monumental tasks".[6] Seen in this light, technological solutions also redirect the discourse of climate change from "monsters behind the door" to the language of engineering, facts, and figures: that is, from the cognitively abstract to the practical.[7]

Second, technological solutions are more politically feasible than other solutions since they can be implemented without much disruption to existing social and economic systems. Roger Pielke Jr. argues as much with his "Iron Law of Climate Policy," which he puts as the position that "when policies on emissions reductions collide with policies focused on economic growth, economic growth will win out every time."[8] On this view, policy essentially plays second fiddle to economics, and if the economic viability arguments above hold, then so too do the political feasibility arguments. Michael Shellenberger and Ted Nordhaus make a somewhat more direct argument for the political feasibility of technological solutions in their 2007 book *Break Through*.[9] Technological solutions, they reason, especially those regarding energy efficiency, can promote rapid deceleration of CO_2 emissions, and thus appear to be the only feasible options, since policies that limit economic growth will not realistically succeed in a world driven by political motivations. Their stance is perhaps even more pertinent to countries like India or China, whose emissions are growing alongside their development and will continue to do so as more people gain access to electricity and motorized transportation.

Technological solutions, of course, span a wide spectrum of proposed technologies, any of which involve both rethinking our existing technologies but also innovating with new types of materials. No comprehensive account or taxonomy of technological proposals can easily be given. Nevertheless, it is reasonable to make a few generalizations about some of the more prominent technological solutions on the table. On the mitigation front, many advocate for alternative energy sources, such as photovoltaic, nuclear, or wind energy.[10] On the adaptation front, many advocate for technology transfers and thereby aim to bring existing domestic, agricultural, and industrial

infrastructure up to 21st Century standards. On the remediation front, some engineers are returning to earlier weather modification proposals to see if it may be possible to control the climate, which some propose to do by creating advanced air capture technologies.[11] The IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN) nicely catalogues the diversity of technological solutions available to combat climate change, including, for instance, bioenergy, direct solar energy, geothermal energy, hydropower, ocean energy, and wind energy.[12]

Any of the above-mentioned technological solutions have potential downstream effects that, despite real and potentially significant contributions toward curbing CO2 emissions, may adversely impact or burden vulnerable populations. In some prominent cases, the downstream effects of alternative technologies are well-acknowledged. Nuclear power, for instance, is one such contested alternative energy source in which the upside carbon-free energy benefits are counterbalanced by downside nuclear waste concerns. In these cases, the downstream impacts and risks are mostly local.

In the cases that concern us, the downstream impacts and risks are mostly distributed and geographically distant. Here, we focus on some of the more widely discussed technological solutions to climate change (specifically solar power, photovoltaics, and electric car batteries) because of their prominence in the discussion and because of their likely disproportionate impact on vulnerable populations. As we will demonstrate below, women and children in LDCs have for years borne the disproportionate burden of disposing of toxic waste from multiple industries.[13] As such, these technological solutions threaten to compound injustices that at-risk populations are already experiencing due to a changing climate.

Unfortunately, it will likely always be cheaper for businesses and states to dispose of their toxic waste in developing countries. The challenge will be to move forward in a way that is respectful of the over-burdened populations.

The human dimensions of e-waste

Technologically speaking, e-waste is the byproduct of components that make all electronic and electrical products function. Almost all of these components contain heavy metals and persistent toxic substances (PTSs). Solar cells contain silicon tetrachloride, cadmium, and selenium, among other substances. The batteries that power hybrid electric vehicles, plug-in vehicles, and fuel-cell vehicles vary in toxicity according to the type of battery in use, but include everything from lead-acid to zinc-bromine.[14] Beryllium, cadmium, chromium hexavalent, lead, mercury, brominated flame-retardants (BFRs), polyvinyl chloride (PVC), and phthalates are just a few of the most hazardous toxins found in e-products, and each toxin comes with a long list of health implications. Many are classified by the International Agency for Research on Cancer as known human carcinogens, such as beryllium, cadmium, and chromium hexavalent.[15] These chemicals are also non-biodegradable, which increases the length of exposure risk. Epidemiological studies suggest that particulate matter stemming from these toxic chemicals increases cardiovascular morbidity and mortality.[16] In short, these toxins can cause serious and irreversible damage to human organs and body systems.[17] The list of toxic components is extensive, and it will likely grow as new technologies proliferate.

The current and next generation of e-waste, which includes toxic fluids and hazardous chemicals used for nuclear energy production, solar thermal generation, solar electricity storage, carbon capture, and so on, is expected to grow and include as-yet undiscovered substances.[18] Solar panel use has already increased dramatically. The IPCC estimates that by 2040 all solar panels currently in use will be entering the waste stream.[19] Further, by the early 2020s, over 500,000 electric car batteries are estimated to enter the waste stream, presenting a huge recycling challenge.[20] Whether such waste flows into the informal sectors of LDCs is uncertain but likely given the historic and current direction of similarly hazardous waste.

Almost all distributed energy generation technologies—localized solar and wind energy, for instance—will produce more e-waste than centralized energy generation. Even perhaps the cleanest of renewable energy such as wind power or hydropower involves converters and generators that will most likely need to be processed once they expire. Some proposed nanotech solutions heavily depend on electronic components that may also enter the e-waste stream.

E-waste disposal and LDCs

When not disposed of locally, approximately 50-80% of e-waste is shipped to LDCs such as China and India.[21] Sometimes this disposal is legal, though often it is illegal or disguised as 'donations.' Since MDCs like the European Union (EU) and the US produce an estimated 12 million tons of e-waste annually, this constitutes a substantial burden shifting.[22] There can be little doubt that MDCs either legally or illegally shift the disposal burden to LDCs primarily for economic reasons. Disposal is cheaper in LDCs for a number of reasons, including cheaper local labor markets, relaxed enforcement of existing regulations, and because costs such as the health of workers and the environment, which can be severe, are externalized.[23]

The hazardous properties of e-waste become all the more pronounced because of the dangerous working conditions and strenuous hours endured under the insecure conditions in many of these LDCs. As Lars Järup and Agneta Åkesson note, "Poverty compounds the risk of exposure and impending health effects since it is clearly associated with inadequate housing, poor nutrition, and inadequate access to healthcare."[24]

Nor are families safe in the home. The open burning of e-waste releases toxic metals, such as lead, as well as persistent organic pollutants (POPs), like dioxins, and flame retardants (PBDEs) into the environment, creating air, soil, and water pollution.[25] Through air dispersal, these hazardous and non-biodegradable particles enter soil and water systems, also known as soil-crop-food pathways, which is one of the most significant routes for human exposure to heavy metals.[26] According to the World Health Organization:

> Human exposure to toxic chemicals and nutritional imbalances are currently known or suspected to be responsible for range of human health problems, including promoting or causing cancer, kidney and liver dysfunction, hormonal imbalance, immune system suppression, musculoskeletal disease, birth defects, premature births, impeded nervous and sensory system development, reproductive disorders, mental health problems, cardiovascular diseases, genitor-urinary disease, old-age dementia, and learning disabilities. These conditions are prevalent in all countries, and, to some extent, most can be attributed to past and current exposure to chemicals in the foods we eat.[27]

The ingestion of certain PTSs, such as persistent organic pollutants (POPs), can explain more than 90% of exposures, and high cancer rates can be traced back to e-waste recycling sites.[28] In Guiyu, China, for instance, most of the crops are grown around the large e-waste open-burning sites, or placed on river banks, where the food is also cleaned.[29]

For the most part, the international community recognized the growing health and environmental dimensions of the transnational movement of e-waste in the early 1980s, and responded by negotiating the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. The Convention specifically addresses the vulnerability of LDCs due to the increasing likelihood of businesses from industrialized states disposing of their hazardous waste in cheaper as well as less environmentally regulated countries.[30] Yet the US, the single largest exporter of hazardous waste, has not ratified the Basel Convention and continues to export hazardous waste, and in particular e-waste, to LDCs. In this respect, the people most severely affected by e-waste are effectively unrecognized by those who are most responsible for generating the waste.

To underscore the significance of this point, consider that one-quarter of India's population lives below the international poverty line of $1.25 a day. Informal recyclers in India can earn between $2-5/day by selling collected and sorted waste through

middlemen up the recycling chain.[31] Thus, the poverty of hundreds of millions of their citizens, in addition to their ever-increasing need for raw materials, as well as the immediate monetary benefit of importing hazardous waste, forces LDCs to view e-waste as a commodity first, and a health and environmental issue second. Additionally, trade agreements, loan conditions, and aid agreements with the international community influence the economic decisions of LDCs. In order to benefit from significant monetary packages, governments may feel pressure to ignore international hazardous waste standards. When they do, the poor and the politically voiceless have little recourse. It would be easy to characterize these negative outcomes as "externalities," but we hope to have shown that these are not mere externalities. They are more aptly characterized as a consequence of failed recognition, the impact of which leads to the violations of the human rights of people living in poverty.

E-waste work and its impact on women's health

Unfortunately, even among those that are often socially under-acknowledged there are some populations that have it worse than others. As might be expected, there is a widespread stigma associated with doing waste work. Women in India's Dalit caste for example, are at the bottom of the e-waste recycling hierarchy. Typically, Dalit families live close to waste sites and make their living by scavenging for waste, which they take to others to process and sell. In many of these groups, women and girls are accorded a lower social status than men and boys.[32] Women are thus disproportionately affected by the e-waste sector, since it is they who often assume the lowest-tier jobs. They are, as it were, the "lowest of the low."

As the lowest of the low, women waste workers operate not only under the radar of many policy makers and politicians, but also in the shadows of the household.[33] They work in an unregulated and informal economy. They may live and toil in inscrutably hostile home environments. They are thus not only poorly outfitted to do their jobs, forced to use low-tech tools to extract the precious metals and reusable components of e-waste, but also saddled with the most undesirable and dangerous tasks, including using acid baths to reclaim precious metals.[34]

Compounding the concerns about the gendered distribution of labor, which themselves are a matter of justice, fairness, and rights, are women-specific health concerns stemming directly from these dangerous tasks. E-waste specifically affects women's morbidity/mortality, and fertility, as well as the health of any children. Of the 14 general types of hazardous chemicals commonly found in e-waste, more than half affect women's general reproductive and endocrine functions.[35] Women exposed to environmental toxins such as heavy metals, flame retardants, PCBs, and phthalates may suffer from anemia, fetal toxicity, hormonal effects, menstrual cycle irregularities, endometriosis, autoimmune disorders, and cancers of the reproductive system.[36]

E-waste work may also be tied to fertility problems. Lead and mercury exposure within the first trimester of pregnancy may affect fetal development, resulting in potential neurobehavioral development problems, low birth weight, or spontaneous abortion and birth defects.[37] Ambient air pollution, a consequence of burning e-waste in open-air pits, is also linked to reduced fertility.[38] The damage to reproductive function after several years of exposure to this pollution is irreversible.[39] For many women, this damage has occurred before they even reach reproductive age.

To complicate the picture considerably, there are many adverse developmental outcomes associated with exposure to toxins as well. A recent study at a large e-waste recycling site in Taizhou, China, showed that the estimated daily intake of PTSs in 6-month-old breastfed infants was twice that of infant intake from a non-e-waste area.[40] Other studies indicate a connection with congenital anomalies, low birth weight, developmental delays, and childhood cancers.[41] Children may also be exposed to toxins by working directly with e-waste, playing near a processing area, or even through interacting with parents who work with e-waste outside the home. For example, "e-waste processing workers may unintentionally carry hazardous materials home on their skin and clothing,

subjecting their families to unintended exposure."[42]

The irony here is that many women choose waste work precisely because it is stable, offers enough pay to support a family, and has flexible hours that permit women to care for their children.[43] Thus, health justice concerns span multiple generations, while holding in common their impact on populations with low status and little control over the occupational hazards of their daily lives. Therefore, e-waste work results in women and their offspring sharing a high probability of being adversely affected by chemical exposure pathways that are often unavoidable, far-reaching, and long term.

The case for inclusion

There are many justice questions embedded in the climate discourse, some of which are mentioned above, and any of which can be approached by the broad spectrum of justice theories that dot the theoretical landscape. In our discussion we obviously cannot address them all. We will instead focus on contractarian theories of justice, and particularly on the matter of recognition and exploitation. (Roughly speaking, contractarian and contractualist theories of justice propose that morality and law derive their legitimacy from some kind of mutually endorsed contract, whether explicit or tacit, between affected parties.) While we believe that our concerns could be accommodated by many of the variant theories of justice, the contractarian literature provides a particularly fruitful starting point since the current state of international climate discourse involves, essentially, the sorting out of interests, burdens, and benefits through contract negotiations. Our claim here is that as we pursue some of these technological solutions to climate change, it will be critical that such solutions are also accompanied by attempts to integrate the voice and rights, particularly to equity and health, of vulnerable populations.

First, it is important to note the ways in which justice theory has taken up matters not just of distribution, but also recognition. Nancy Fraser, for instance, has argued that concerns over recognition stand in contrast with concerns about burdens and benefits, which tend to dominate the justice discussion.[44] Certainly within the broad climate ethics community that has been true. Consider for instance the authors we cite above: most center on benefit and burden questions while giving little attention to recognition issues. In simplified terms, Fraser's position is that recognition is ultimately a question of social status, and that justice cannot be adequately addressed without attention to the social status of women. As Iris Young puts it: "Struggles about environmental justice cannot simply be about the placement of hazardous sites, a distributive issue, but must more importantly be about the processes through which such placements are decided."[45] Many others have pointed out the recognition dimensions of environmental justice struggles as well. In this vein, Fatma Denton argues that women in particular are left voiceless in the climate struggle.[46] These problems of voicelessness and the related violation of rights are all the more amplified when we consider hazardous waste issues associated with proposed technological solutions to climate change.

So how are we to approach the problem of recognition in the context of e-waste? Consider again that so many international agreements are built on the model of the contract. Almost all variants of contractarianism and/or contractualism are grounded, among other concepts, in either rationality or reason, variously construed. Contractarianism is typically distinguished from contractualism by its more limited reliance upon rational self-interest. Where contractarian theories tend to lean more heavily on appeals to Hobbesian self-interest, contractualist theories tend to construe reason more broadly, with Kantian contours. Nowhere in the feminist literature is this contract position more persuasively advanced than in the work of Jean Hampton, who suggests that contractarianism can provide a critical test against exploitation.[47] Like Young and Fraser, Hampton is concerned with overcoming exploitation arising from structural disenfranchisement, particularly with regard to gender inequity. Heavy emphasis on self-interest might be thought to be anathema to the feminist, but Hampton points out that this need not be so.

Hampton pursues her contractarianism by

suggesting that the metaphor of the contract be extended quite widely, into family and friendships. "A woman whose devotion to her family causes her to serve them despite the fact that they do little in return is an exploitative relationship."[48] What makes Hampton's position particularly enticing is that it situates a remedy for injustice in the respect accorded to others but still acknowledges that problems of injustice are also distributive.

Knowingly shipping e-waste to a place where it will be recycled in an unsafe manner, without also ensuring that those who will be handling the waste play a participatory role in the formation of such arrangements, amounts to a failure to respect not only the basic human rights of other persons but also to adhere to principles of fairness and equity. The principles of a fair contract, as suggested by Hampton, offer a helpful test for environmental and social injustices, since they enable a comparison between parties that can balance competing concerns according to their moral relevance instead of their aggregation.[49]

When subjected to this test, the US refusal to ratify the Basel Convention clearly stands out as not just a political mess, but also a moral failure. Nonetheless, it is unlikely that the US will ever ratify the Convention. Doing so would make current waste disposal practices illegal and upset many well-resourced industries. US-based manufacturers and suppliers would be restricted from disposing of e-waste in LDCs, thereby increasing supplier costs. The political feasibility calculation, coming at a time of relatively high unemployment and economic weakness, takes a heavy toll on ethical action.

This is unfortunate. For the past 25 years, the US has been unable to participate in further shaping or directing the Basel Convention, forgoing any benefits the country might have received by becoming a party to the Convention in 1989. For instance, the Convention's major decisions, including the Ban Amendment and the Protocol on Liability and Compensation, have already been determined and implemented.[50]

Ratifying the Basel Convention, of course, would have involved significant changes to US laws as well. Currently, state handling and processing of toxic waste is regulated only by voluntary compliance within the US.[51] Focusing more on domestic political considerations, the cross-border transportation of hazardous waste is not currently a ranking issue on the US agenda, and public sentiment is thus unlikely to move laws.

The US failure to ratify the Convention is not the only problem for hazardous waste and human rights. Even if LDCs are given a voice in settling matters of e-waste, there are few state-level systems in place to ensure that the most vulnerable citizens—women and children, primarily—of these countries are empowered to ensure that human rights are protected. The infrastructure for safely handling and disposing of toxic materials in LDCs is typically fairly poor, and high rates of poverty and unemployment exacerbate safety concerns. For example, just 3% of e-waste is repurposed and recycled in India through formal channels.[52] In New Delhi alone, roughly 25,000 people process and dispose of 50,000 tons of toxic e-waste through informal channels each year.[53] Though dismantling e-waste may on one hand provide a significant livelihood improvement opportunity for millions of workers, in the absence of basic protective measures and access to formal disposal channels, the rights of these workers go unacknowledged.

This combination of differential bargaining power, weak infrastructure, and lack of institutional acknowledgement makes the trade of toxic waste between the MDCs and LDCs highly suspect. Developing countries are often placed in an impossible position: deciding between alleviation of poverty on the one hand and quite dangerous health hazards on the other hand. The immediacy of poverty alleviation in LDCs serves functionally to stamp out debate regarding these hazardous wastes and their impact on the population.

Generally, the argument of comparative advantage has been deployed in the service of justifying asymmetrical international relationships between e-waste handlers. We think instead that the principles of feminist contractarianism offer an alternative to top down technological solutions because they can avoid perpetuating the cycle of uneven exchanges between the developed and the

developing world. The rights of the vulnerable citizens of LDCs might better be protected by including e-waste concerns in UN Monitoring Committees' agendas. Such monitoring bodies, particularly if focused on the voice of the most vulnerable, can go a significant distance in promoting the rights of the disenfranchised.

Objections and concerns

Some may protest that technological solutions are at least partially necessary to solving the "climate problem" and that, given the urgency of climate change, technological solutions may buy the world more time for future inclusive processes. Our aim is not to undermine the need for technological solutions. Rather, it is to point out that technological solutions—as currently conceived—may increase the burdens on disadvantaged groups, not necessarily to alleviate them. Focusing on technological solutions without considering and including those groups who will likely be most affected, and least able to advance their own interests, threatens to intensify existing injustices. More importantly, developing inclusive, deliberative processes is the fastest, most effective way to address climate change, because it draws on local, place-based knowledge and identifies the needs of people most affected, thereby reducing inefficiencies that might result from top-down approaches.

Still others may contest that accounting for the full "life-cycle" of technologies in the market may avoid any concern about e-waste. The implication here is that the justice problem can be overcome by internalizing external costs, and this is precisely the problem. Life-cycle approaches treat the justice problem as primarily an externality of inefficiently structured industries. Our concern is that even if such costs are internalized, this alone cannot be sufficient to overcome the serious justice concerns that we have raised above. While life-cycle approaches certainly are an important step toward alleviating burdens, they do not remove the need to address recognition concerns.

Third, some may point to a different set of justice-related conclusions, such as those of Martha Nussbaum and Amartya Sen.[54] Nussbaum and Sen's "capabilities approach" aims to identify substantive freedoms instead of more formal freedoms familiar to liberal theory. The idea is to emphasize not how many resources a woman may be able to command, but rather "what is she actually able to do and to be."[55] In addition, combined capabilities describe the necessity for both an individual's internal ability as well as favorable environmental conditions for the expression of capabilities.

Under this approach, women's "unequal failure in capability is a problem of justice" and "human abilities exert a moral claim that they be developed."[56] Many of Nussbaum's own criteria for what "makes a life go well" include comprehensive presumptions that may themselves be stuck in a Western context.[57] In response to these types of claims to justice, consider again Hampton's as well as more recently, Serene Khader's work, which avoids the type of paternalism on which Nussbaum's constructed list of capabilities may verge.[58] In this context, what is critical is to ensure respect and create the conditions for autonomy.

Finally, some feminists may disagree that this problem can be adequately addressed by contractarian conceptions of justice, citing a need to return to principles of caring. We think instead that the problem of e-waste pickers fundamentally illustrates the tension between care ethics and justice ethics, since women typically take these jobs because they seek to improve the lives and well-being of their families.

Hampton's contractualist test for exploitation can identify injustices while also leaving space for relationships of care. The challenge: how do you create a fair and just arrangement for a population that is often socially under-acknowledged? The way to address this is with an exploitation test that runs all the way through the injustice hierarchy: both in the workplace and in the family. It will not do to have women appeal to the principle of care, since they are choosing these jobs precisely because they care.

Conclusion

Many authors have addressed the disproportionate burden women will bear from the effects of climate change.[59] Fewer, however, have explored in detail the downstream implications of various strategies for dealing with climate change. In this paper, we have argued that technological solutions threaten to compound old and new injustices. Though the Basel Convention and the MDGs represent efforts on behalf of the international community to address health and equity injustices, there is still a need for a deeper recognition of and respect for those most impacted by current and future technological hazards. Technological solutions to climate change, if they are pursued, must also be accompanied by the formation of deliberative processes that include those affected throughout the lifecycle of the proposed technologies.

We have argued our case by proposing first that e-waste is a concern fundamentally of recognition, where the poorest workers fly under the radar of regulatory regimes. We have further suggested that within the household, women are the lowest of the low, leaving them to toil in dire conditions. Often, we noted, they do so with their families in mind, as the working conditions at waste sites are flexible enough that they can care for their families while still earning a meager living. Altogether these conditions then may generate the triple whammy of morbidity/mortality, fertility, and developmental complications that disproportionately burden women. We have further introduced Hampton's contractualist test for exploitation, which we think can assess exploitation both in the workplace and in the home.

Indeed, in a 2009 report, the UNFPA noted that "the most effective solutions to climate change, however, will be those that come from the bottom up, that are based on communities' knowledge of their immediate environment, that empower—not victimize or overburden—those who must adapt to a new world, and that do not create a new dependency relationship between developed and developing countries."[60] By highlighting the future burdens technological solutions can create, and the ways in which women are disproportionately burdened by these solutions, we hope to convey the need for more than just a quick fix.

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