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The Environment and Global Media and Communication Policy

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> We envision a toxic-free future, where each new generation of technical improvements in electronics products includes parallel and proportional advances in social and environmental justice. Our goal is environmental sustainability and clean production, improved health, and democratic decision making for communities and workers most affected by the high-tech revolution. (*Vision Statement*, Silicon Valley Toxics Coalition, quoted in Byster and Smith 2006: 111)

> A major feature of the knowledge-based economy is the impact that ICTs [information and communication technologies] have had on industrial structure, with a rapid growth of services and a relative decline of manufacturing. Services are typically less energy[-]intensive and less polluting, so among those countries with a high and increasing share of services, we often see a declining energy intensity of production … with the emergence of the Knowledge Economy ending the old linear relationship between output and energy use (*i.e.* partially de-coupling growth and energy use). (Houghton 2009: 1)

One of the newest and most valuable areas of communication research to emerge in the twenty-first century focusses on how the media frame global awareness of the transnational risks associated with climate change and other threats to the Earth's well-being. An Environmental Communication Network specializes in such questions and publishes *Environmental Communication: A Journal of Nature and Culture* (http://www.esf.edu/ecn). Most work in this tradition falls in behind the bulk of communications research and public policy. It assumes that the principal role of the media is to inform the public, providing a grand conduit of knowledge and hence consciousness, a universal system of meaning that is now transcending the old broadcast model to make each consumer into a producer. Information has been supplemented, and in some ways supplanted, by participation, and the emerging cacophony is the newest signature of vibrant democratic norms and urges. Communication technologies provide an expanding universe of discourse. In this story of limitless growth, the principal goal of technology is to overcome scarcity and bestow the benefits of plenitude through access on every person, all the time. The planet must be comprehensively wired, every child must have a laptop, cell phones must proliferate, and we must all turn into media producers. Of course, the older media, such as print, film, radio, and television, have long been the object of a similar policy discourse. In each case, there have been dual goals – expanding access and

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use; and ensuring that content behooves the interests of the population. Growth has been the watchword.

We challenge such assumptions. The media – and ICTs and consumer electronics (CEs) more generally – are not only means for exchanging awareness and analysis of environmental issues. Just as importantly, they are participants in climate change, pollution, declining biodiversity, and habitat decimation – four constituents of the global ecological crisis. The production and powering of electronic equipment consumes, despoils, and wastes natural resources at ever-increasing rates; ICTs and CEs contain toxic substances that pervade sites and environs of their manufacture, use, and disposal, poisoning people, soil, air, and water; and rapid cycles of innovation and planned obsolescence accelerate both the production of new electronic hardware and the accumulation of obsolete and junk electronics, known as electronic waste (e-waste). Coming to this recognition, comprehending the historic role of media technologies in the ecological crisis casts into serious doubt the notion of ICTs as saviors of the planet, and poses new and intriguing challenges for global communication policy. As a consequence, this chapter merges questions of global environmental governance with global media and communication policy.

Major public entities and marketers around the world continue to celebrate the growth of ICTs and our cavalier use of electronic equipment. The UK's National Grid (2006), for example, proudly promotes its management of peak electricity usage based on television-audience activity during half-time in football matches, when people race to the kettle. Power use surges by as much as 10 percent in what is known as the "TV pick-up." Is this desirable? What is it telling us? Then there is the relentless marketing of the apparatus itself as a perpetual novelty, simultaneously part of established daily routines and radically upgraded consumption. In 2007, 207.5 million television sets were sold around the globe; 56 percent were old-style, fat-screen analog TVs. The estimated number for 2011 is 245.5 million, with just a third being analog fat screens, and the remainder flat-screen, digital ones. This is very much a problem of the Global North: the Asia-Pacific region continues to buy old-style sets in much greater numbers than consumers elsewhere (Tekrati Inc. 2007). Marketing for flat-screen televisions stresses the pleasures of higher resolution and a slimmer profile, which derive from their intense energy use. And as the cost of the sets drops, their uptake increases, with little regard for electricity consumption (Crosbie 2008). Depending on screen size, flat-screen TVs can use more than three times the electricity required for older cathode-ray tube (CRT) sets. In Britain, it is estimated that flat-screen televisions will add 700,000 tons a year to carbon emissions by 2010, an increase of 70 percent on 2006 levels (Russell 2006; Roth and McKenny 2007; International Telecommunication Union 2008).

When old and obsolete TVs are junked, they become e-waste, which constitutes the fastest-growing part of municipal clean-ups around the First World. E-waste salvage yards have generated serious threats to worker health and safety wherever plastics and wires are burnt, monitors smashed and dismantled, and circuit boards grilled or leached with acid, while the toxic chemicals and heavy metals that flow from such practices have perilous implications for local and downstream residents, soil, and water. Most electronic salvage and recycling are done in the Third World by preteen girls, who work with discarded television sets and computers to find precious metals and dump the remains in landfills. The e-waste ends up there after export and import by "recyclers." They eschew landfills and labor in the First World in order to avoid the higher costs and regulatory oversight of recycling in countries that prohibit such destruction to the environment and workers. And businesses that forbid dumping in local landfills as part of their corporate policies are all too happy to ship their waste elsewhere (Basel Action Network and Silicon Valley Toxics Coalition 2002; Lee 2002; Tong and Wang 2004; Pelta-Heller 2007; Wong *et al.* 2007; Medina 2007).

None of this is news to the world's environmental activists, who have long been aware of both the mundane and the spectacular dangers posed by electronic wizardry, as the opening epigraph to this chapter indicates. But activists like those of the Silicon Valley Toxics Coalition (SVTC) have faced a major political-economic obstacle in their fight to ensure that electronic technology be built on ecologically and sound principles (evident from our second epigraph). Why? Because the microelectronics revolution has been a linchpin of global capitalism for three decades. ICTs allegedly overcame the 1970s economic crisis which was supposedly caused, or at least exacerbated, by two energy crises. Those crises might have brought home the reality of industrial capitalism's unsustainability. Instead, they provided the impetus for capital to reverse the downwards redistribution of wealth in the First World that had come about since 1945 through working-class organization and politics. Neoliberals took the reins of economic restructuring, paying no attention to the environment as they asserted control over the technical capacity and operating materials of ICTs and the New International Division of Cultural Labor (Schiller 1981, 1984; Hamelink 2001; Maxwell 2003: 85–100; Miller *et al*. 2005).

Whatever lethal characteristics SVTC and other environmentalists saw in electronics were also suppressed by a technological sublime. In the 1970s and 1980s, First World pundits, politicians, and academics became entranced by thoughts of a chrome-plated electronic wonderland, built on microchips, digital gadgetry, and planetary networks, that would spark unending prosperity throughout the market system. Business professors, coin-operated think tanks, and management gurus said it was feasible; the *bourgeois* business media concurred; and leaders of the advanced market economies bet their treasuries on it (Maxwell 2003: 88). Knowledge workers were announced as the new core of First World economies, thanks to information-based technologies that promised endless gains in productivity and the purest of competitive markets (Bar with Simard 2006: 351). The supposed by-product would be a brand-new day of green industries, a post-manufacturing utopia for workers, consumers and residents, where the by-products were code, not smoke.

Behind this enchantment with ICTs lie decades of strategic maneuvers by the world's richest countries. The "information economy" was in full swing when Ronald Reagan entered the White House in 1981 and replaced welfare-oriented state control and risk management with a militant anti-governmental governance that would, paradoxically, use state power to intervene in the name of the market economy (Foucault 2008: 132). The United States (US) led the way in dismantling domestic and international regulation of media and telecommunications. Under Reagan, who once said that trees caused pollution, the government eviscerated public policies and programs that promoted alternative energy and protected the air, water, and soil. Intolerance of green policy was (and remains) a powerful rallying point for the political right, as symbolized by Reagan's first act after his reelection in 1984: to order the removal of solar panels from the White House where his predecessor had installed them with equally passionate, though quite divergent, hopes for the planet's future (Shabecoff 1989: 1). The new political economy was shifting smokestack industries to the periphery, both geographically and rhetorically. Polluting industries seemingly no longer represented the dynamic core of industrial capitalism; instead, market dynamism radiated from a networked, intellectual core of creative and informational activities. ICTs catalyzed the new information- and knowledge-based economies that would rescue First World hegemony from an "insurgent world" that lurked within as well as beyond itself (Schiller 1984).

The presumption that ICTs would deliver a cleaner, post-industrial, capitalism has been continually reinforced by the "virtual nature of much of the industry's content" which "tends to obscure their responsibility for a vast proliferation of hardware, all with high levels of built-in obsolescence and decreasing levels of efficiency" (Boyce and Lewis 2009: 5). In the twenty-first century, awareness of climate change made the apparently virtual elements of ICTs even more important; hence, the term "dematerialization" to describe the economic impact of these developments (International Telecommunication Union 2009: 4). The promised "dematerialization of society" (we're still waiting) will see electronic commerce, teleconferencing, telecommuting, and the electronic administration of health and taxes (Bio Intelligence Service *et al*. 2008: 257). No wonder the Australian Council for the Humanities, Arts and Social Sciences' (2006: 1) submission to its national Productivity Commission pleads rather winsomely for a place at the table with corporations and governments to discuss this allegedly new "post-smokestack era of industry."

We are writing in the midst of the greatest global economic crisis for seven decades, one that exceeds the 1970s version in its reach and impact. The dual discourse of virtue – that ICTs will save the two ecos (the economy and ecology) – is, if anything, more pervasive than it was in the 1970s and 1980s.

But there is now a contradictory understanding of ICTs in the technocratic cloisters of diplomacy. For example, the intergovernmental International Telecommunication Union (ITU) has recognized that the proliferation of electronic gadgets for productivity and pleasure also generates some negative externalities in the form of environmental problems (International Telecommunication Union 2008: 67–84, 2009: 2, 5). Hamadoun Touré, Secretary-General of the ITU, tells us that ICTs will connect the 6.5 billion residents of the Earth by 2015. In the near future, then, "everyone can access information, create information, use information and share information" and "the ICT sector will take the world out of financial crisis, because it's the only industry that's still growing," thanks to developing markets (Hibberd 2009: 1). But at the same time, Touré presses for "climate neutrality" and greater efficiency in energy use, and such venues as the 2008 World Telecommunication Standardization Assembly in Johannesburg encouraged members to reduce the carbon footprint of communications, in accord with the UN Framework Convention on Climate Change (United Nations 1992; Touré 2008). In a similar vein, the Organization for Economic Cooperation and Development (OECD) says that ICTs will play a pivotal role in developing service-based, low-polluting economies in the Global South (offering energy efficiency, adaptation to climate change, mitigation of diminished biodiversity, and decreased pollution), but is quick to caution that such technological advances can produce negative outcomes, such as remote sensing of marine fisheries that enables unsustainable levels of fishing (Houghton 2009).

What had engendered this contradictory discourse on ICTs and leavened the cybertarian utopics of ICT boosters was the growth of environmentalism's influence in policy circles since the 1980s. Prior to the first United Nations (UN) conference on the environment in 1972, only Britain, France, and Canada had cabinet-level environment ministries. By the second UN conference in 1992, there were more than one hundred environment ministries. By 2009, global environmental governance involved at least 198 environmental ministries, agencies, or directorates plus many intergovernmental organizations, as well as such international nongovernmental organizations as Greenpeace, the Basel Action Network, and SVTC. SVTC's campaign against toxic electronics marked a signal moment in the coming struggle to challenge the ICT "clean-industry myth." Activists, public health advocates, workers, and policy-makers have organized to expose the environmental impact of the electronics, electrical, and energy industries in Silicon Valley and elsewhere (Byster and Smith 2006: 109). More and more research on environmental hazards associated with ICTs and CEs has emerged over the last twenty years, along with a significant rise in green citizenship. Between 1980 and 2000, there was a threefold increase in the reported membership of US environmental groups. During the same twenty-year period, membership in environmental groups worldwide had more than doubled. "Today, membership in environmental groups rivals that of political parties, and exceeds the membership levels of other important civil society sectors" (Dalton 2005: 453–454; Maxwell and Miller 2009). These were hopeful signs that the neoliberal era would be a brief, if traumatic and destructive, moment of mismanaging the Earth during a half-century that otherwise had seen an ever-stronger environmentalism (Hopgood 1998: 2; Frank *et al*. 2000; United Nations Environment Programme 2007).

Along with this expansion of environmental activities has come a deepening of green citizenship and governance, expressed in claims for public rights to clean air, soil, and water that supersede the private rights of industry; a responsibility for the environment that transcends national boundaries and state interests; and the espousal of intergenerational caring rather than policies that discount the health and value of future generations (Dobson 2003; Commission of the European Communities 2008: 31). Green governance presses these capabilities into international, intergovernmental, and nongovernmental organizations with an ethico-political commitment to the Earth and its inhabitants. An ideal expression of this is embodied in Articles 71–74 of the 2008 Ecuadorian Constitution, which guarantees the rights of nature, or *Pacha Mama*, and the rights of citizens to demand that public authorities protect nature's rights (www.presidencia.gov.ec). As green governance introduces aspirations into the global public sphere to counter the environmental despoliation that threatens human life, it also confronts risks to non-human nature posed by the mounting ecological crisis. This allows mainstream environmentalism to embrace the diversity of environmental politics – from left eco-centrism and eco-feminism to technocratic, anthropocentric forms (Groves 1995; Pepper 2000; Maxwell and Miller 2008).

Mainstream approaches to green governance of environmental protections are mostly human-centered, in that they focus on saving lives, infrastructure, and heritage from environmental risks. This was the framework for sustainable development established by the 1987 World Commission on Environment and Development (the Brundtland Commission). It accords relatively equal value to economic growth, social progress, ecological health, and, in more recent interpretations, cultural and informational sustainability. This is a difficult balancing act for policy-making. Whereas the interpretation of economic, social, and cultural needs is fraught with conflict and requires negotiations at multiple scales of global governance, the "scientific prerequisites for ecological sustainability" are not a matter of political agreement or "individual values": "nature does not conduct consensus talks" (Schauer 2003: 3–6). At the beginning of the twenty-first century, the science was conclusive: "warming of the climate system is unequivocal" (Intergovernmental Panel on Climate Change 2007: 72), yet the twenty leading economic powers continued to treat climate change and other ecological hazards as one variable of international relations, ignoring decades-old warnings about the fast-closing circle of remedies for environmental ills (for which see Commoner 1971).

Environmental sustainability rests on "non-negotiable planetary preconditions" (Rockstrom *et al.* 2009: 4) that set limits on how much the Earth can give to and absorb from economic, social, and cultural activities. Human transgression of these limits has led to our ecological crisis, which consists of four interrelated environmental problems:

- climate change (global warming) caused by overproduction of greenhouse-gas emissions (carbon dioxide, methane, and nitrous oxide);
- pollution in the over-developed world, including industrial dumping from the Global North to the South, with rising levels of poisons disrupting biological development and immunological, endocrinal, neurological and hormonal systems of "virtually all organisms";
- radically reduced biodiversity – the Earth's "sixth great extinction," unique for being caused by one species; and
- disappearing habitat – 50 percent of the Earth's forests are gone, as are 25 percent of sea habitats (Curry 2006: 10–13; Rockstrom *et al.* 2009).

In the remainder of this chapter, we examine how different media, at different points in their life cycles, have contributed to this ecological crisis. We illustrate some of the environmental consequences that flow from basic technology, energy, and natural-resource consumption, and the corporate ownership of media. To the extent that we can identify an ecological context for media governance, we suggest ways that ecologically sound media policy might set sustainable boundaries on media production, consumption, and technological end-of-life management. While our main focus will be on ICTs and CEs, we begin with the print media as our point of departure for an ecological approach to media and communication policy.

Print Media

Paper-based media contribute massively to climate change and pollution. Pulp and paper manufacturers are "the single largest consumer of water used in industrial activities in the wealthy democracies"; "the second largest consumer of energy" in the US; and "the third largest greenhouse gas emitter, after the chemical and steel industries" in OECD countries (Independent Press Association *et al.* 2001: 6; OECD 2001: 218; Burke 1979: 180–181). Greenhouse gases from paper- and pulp-makers have included carbon monoxide, nitrogen dioxide, particulate matter, sulfur dioxide, and volatile organic compounds at significantly higher levels than electronics and computer manufacturing, and in some categories higher than mining and petroleum (Environmental Protection Agency 1995).

Contemporary paper-mill effluents have introduced large quantities of sulfite salts, sulfur dioxide, caustic soda, sodium sulfate, and bleaching chemicals into the environment. Each refinement in chemical pulping has deepened the environmental impact of paper by amplifying the tree species that can be cut down for paper-making and multiplying the "waste liquor" emitted into waterways. Modern chemical processes have produced synthetic by-products, including dioxin, a carcinogen that settles without decaying in the ground, waterways, and the human food supply (making it bio-accumulative). Dioxin is the most dangerous human-made substance that is emitted through pollution. Print-shop working conditions also pose environmental risks. Early-twenty-first-century pressrooms expose workers and environs to toxic smog, heavy metals, solvents (containing toluene, methyl ethyl ketone, xylene, and trichloroethane), silver (film development), film and paper scraps, and wastewater (Tripsas 1997: 124, 142). And as printing has become an everyday part of household and office work, the implications for pollution through domestic, bureaucratic, and scholastic plastics, ink dust, and flame retardants have grown serious: each year, 575 million printer cartridges are thrown away in North America alone (Pelta-Heller 2007).

Along with toxic pollution, deforestation to make paper has posed grave risks to animal and plant diversity and habitat. Since 2000, high-end magazine publishing has been eating up forests at a higher rate than any other print medium – the glossier the magazine, the more new or virgin wood is needed. In the US, 18,000 magazine titles comprise an estimated annual print run of 12 billion copies, cutting down 35 million trees and emitting tons of waste and greenhouse gas emissions. Two-thirds of all magazines remain unsold, leaving 90 percent to be trashed within a year of publication, creating waste – only 19 percent of which is recycled. The rest (about two million tons) ends up in landfills or is incinerated (Independent Press Association *et al.* 2001: 5–10).

Media policy has not directly addressed the environmental impact of paper-based texts. Nevertheless, omnibus and specific industrial agreements, laws, and court decisions related to climate change, biodiversity, and the protection of air and soil, as well as national and regional legislation, pressure pulp, paper, and print businesses to clean up their acts. The US Environmental Protection Agency (EPA) formed a "pulp and paper cluster group" in the 1980s, and has enforced Clean Water Act and Clean Air Act updates since the 1990s to address toxic effluents. Recycling regulations impose limits on the way the industry collects, produces, and markets recycled paper. Meanwhile, per capita paper consumption has declined, especially in the European Union (EU), causing some boosters to predict the passing of paper-based media, a vision that discounts the rapid growth of paper consumption in China and other developing countries, and ignores new risks associated with digital technologies replacing paper (Fairfield 2008).

One area where policy might intervene would be to connect environmental protection more closely to the expansion of non-commercial, ecologically friendly print media. This could include a deforestation tax on advertisers similar to one proposed in the US in 1920 by a Republican congressman who sought (unsuccessfully) to stem deforestation by taxing advertisers 10 percent of the cost of column inches they purchased in periodicals, thereby encouraging them to "tell their stories in less space and thus conserve the use of paper and curtail enormous waste now quite evident and admitted" (quoted in Burke 1979: 194). Such a tax could be used to fund non-commercial periodicals printed on recycled toxin-free paper or made from alternative fibers.

Electronic Media

By 2008, global ICTs were contributing between 2.0 and 2.5 percent of greenhouse gas emissions. This is about the same as aviation, if the indirect energy used in manufacturing communications technologies is combined with the energy consumed by personal computers, data monitors, printers, fixed and mobile telecommunications devices, local-area networks, and server farms (data centers with servers, storage machines, network gadgetry, power supplies, and cooling technology), but excludes energy used in transporting ICTs (Corbett and Turco 2006; Gartner, Inc. 2007; International Telecommunication Union 2009: 4). Again, this is one of the few sectors of the world economy that is growing everywhere.

The manufacturing of ICT and CE is a major source of toxic waste and pollution. The most important component of electronic equipment is the microchip. According to SVTC, the semiconductor industry uses over a thousand hazardous substances to make chips. A single semiconductor facility may require 832 million cubic feet of bulk gases, 5.72 million cubic feet of hazardous gases, 591 million gallons of deionized water, 5.2 million pounds of chemicals, including acids and solvents, and 8.8 million kilowatt hours of electrical power (Silicon Valley Toxics Coalition nd). Plastic is a standard component of circuit boards, wiring, and casing that poses environmental risks in its production. Workers in the electronics industry are exposed to skin irritants, dangerous solvents and acids that harm mucous and pulmonary tissue, and chemicals that can cause cancer, reproductive complications, and debilitating illnesses. Workers and consumers alike face risks of radiation exposure from TVs, computer monitors, cell phones, laptops, telecommunication and electrical towers, electronic games, and power lines (Brigden *et al.* 2008; Lean 2008; Environmental Working Group 2009).

Between 2004 and 2009, small electrical and electronic devices increased their global consumption of residential electricity faster than other household appliances. According to the International Energy Agency (IEA), ownership of ICTs and CEs accounted for about 15 percent of global residential electricity consumption in 2009. Over 5.5 billion devices need external power supplies, including two billion TV sets and a billion personal computers, in addition to mobile phone services, which are utilized by half the world's population (up from 145 million in 1996 to around four billion in 2009, with 3G phones necessitating higher frequencies and greater power use than their predecessors). About 40 percent of US homes had video-gaming consoles, leading to electricity consumption at the same annual rate as the city of San Diego, the ninth largest in the country (International Telecommunication Union 2009: 5; Mouawad and Galbraith 2009: 1). Residential energy consumption by electronic equipment in non-OECD countries is growing at twice the rate of consumption inside the OECD. If these trends continue without governments and manufacturers taking action to improve ICT and CE energy efficiency, the IEA estimates that electricity consumption by electronic equipment will rise to 30 percent of global demand by 2022, and 45 percent by 2030 (International Energy Agency 2009: 21; cf. The Climate Group 2008: 18–23).

Global electricity consumption by commercial server farms doubled between 2000 and 2005. By 2006, servers consumed 1.5 percent of the US electrical supply, about US$4.5 billion worth. Google's server farm in Oregon uses the same amount of power as a city of 200,000 people. If server farms and their power usage continue to grow in line with these trends, their electricity consumption in the US and the EU will double every five years (Koomey 2007: i; Wald 2007; Schäppi *et al.* 2007: 9; Bio Intelligence Service *et al.* 2008; International Telecommunication Union 2009: 10).

The ICT and CE industries' business strategy of planned obsolescence is directly responsible for the volume and pace of e-waste dumped into the environment. For example, the short lifespan deliberately constructed for computer systems (drives, interfaces, operating systems, and so on) by making tiny improvements that are designed to be incompatible with existing hardware has fostered high levels of electronic garbage and energy usage, with related waste, pollution, and hazardous working conditions (Science and Technology Council of the American Academy of Motion Picture Arts and Sciences 2007: 33–50; Boyce and Lewis 2009).

Greenpeace estimates that annually between twenty and fifty million tons of discarded electronic and electrical equipment is generated globally, 75 percent of which is "disappeared" via inadequate or illegal salvage. The EU is expected to generate upwards of 12 million tons annually by 2020 (Commission of the European Communities 2008a: 17). While refrigerators account for the bulk of EU e-waste by weight and dangerous refrigerants, about 44 percent of the most toxic e-waste measured in 2005 came from medium-to-small ICTs and CEs: liquid crystal display (LCD) and CRT computer monitors, fat- and flat-screen TVs, telecommunications equipment, toys, tools, and anything with a circuit board (Commission of the European Communities 2008a: 31–34). In the US, the EPA estimates that in 2007: "of the 2.25 million tons of TVs, cell phones and computer products ready for end-of-life management, 18% (414,000 tons) was collected for recycling and 82% (1.84 million tons) was disposed of, primarily in landfills" (Environmental Protection Agency 2008: 1).

The EPA (2007) acknowledges that twenty million computers fell obsolete across the US in 1998, and the rate was 130,000 a day by 2005. SVTC estimates that the 500 million personal computers discarded in the US between 1997 and 2007 contained 6.32 billion pounds of plastics, 1.58 billion pounds of lead, 3 million pounds of cadmium, 1.9 million pounds of chromium, and 632,000 pounds of mercury (Basel Action Network and Silicon Valley Toxics Coalition 2002: 6).

US consumers trash between 130 and 140 million cell phones each year and purchase replacements in cycles of 12 months and counting down (Mooallem 2008: 40–41; Environmental Protection Agency 2008). Like most microelectronic devices, cell phones contain lead, mercury, and other heavy metals through circuit boards; their chemical chip production needs toxic detergents and etchants; they use tantalum, the mining of which has caused social and environmental harm in Africa; most have flame retardants made of polybrominated diphenyl ethers (bioaccumulative synthetic chemical compounds thought to cause neurological problems); and all require batteries (Grossman 2006). The compounds in storage batteries are toxic (among the substances they house are nickel-cadmium, lead-acid, nickel metal-hydride, and lithium-ion and lithium-polymer components) (Rydh 2003).

E-waste salvage yards have generated serious concerns with regard to worker health and safety risks, including bone disease, brain damage, headaches, vertigo, nausea, birth defects, diseases of the stomach, lungs, and vital organs, and disrupted biological development in children because of exposure to heavy metals (lead, cadmium, and mercury, among others). Poisonous fumes, including deadly dioxin, are emitted during the melting of electronic parts for precious metals such as copper and gold, and also while burning wires insulated with polyvinylchloride and cooking circuit boards and plastic casings containing polychlorinated biphenyls or newer brominated compounds (Ray *et al.* 2004; Wong *et al.* 2007; Leung *et al.* 2008). It is no surprise, then, that corporations and governments in the Global North want to dispatch these hazards to other countries, globalizing a problem that is already transterritorial given the impact on air, water, and land that transcends the origins of despoliation.

There are international protocols to govern these matters. The 1992 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (United Nations Environment Programme 1992) prohibits the transport of hazardous material from non-Members of the accord (like the US) to Members (like Mexico and South Korea), though the latter make side deals to exempt US shipments. Several powerful polluters, such as Japan, Canada, and the US, seek to undermine the 1995 Basel Ban Amendment, which prohibits such exports. They engage in "venue shopping," seeking out dumping grounds wherever feasible and justifying such actions on a neoliberal basis, even as they exploit extremely poor countries by invoking the doctrines of comparative advantage and the notion that every nation has a certain amount of e-waste that they can bear. California alone shipped about twenty million pounds of e-waste in 2006 to Malaysia, Brazil, South Korea, China, Mexico, Vietnam, and India (Lee 2007: A1). Some of this trade is legitimized through the dogma of comparative advantage. Other parts are regarded as beyond the pale: Canada's Criminal Intelligence Service (2008) is seeking to control a thriving illegal trade disposing of e-waste alongside the country's other global organized crime.

There are many willing recipients of e-waste detritus. Consumers International and its partners (2008: 2) have conducted research that indicates "around half a million second-hand computers are dumped on Nigeria every month," of which three-quarters are unusable and land in toxic waste dumps. Ghana reports similar numbers and proportions (also see Schluep *et al.* 2008).[1] Thousands of small firms clustered along the Chinese coast specialize in this illegal trade, notably in the deltas of the Pearl and Yangtze rivers. The latter imported perhaps 700,000 tons of e-waste in 2001, hidden as scrap metal and other like items. As with so many environmental problems that are still emergent and not characterized by spectacular incidents, it features only infrequently in the news headlines. One incident that did attract media attention occurred in the République de Côte d'Ivoire in 2006. A toxic waste spill cost ten people their lives and made another 70,000 ill, at the very time that Kenya was hosting a meeting to address e-waste elements of the Basel Convention at which the UN Environment Programme estimated that 50 million tons of e-waste was being created each year (Basel Action Network and Silicon Valley Toxics Coalition 2002; Tong and Wang 2004; BBC News 2006, 2006a; Pynn 2006; Basel Action Network 2007).

In addition to the Basel Convention, two EU policies provide a framework for eliminating e-waste: the Directive on Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) and the Directive on Waste Electrical and Electronic Equipment (WEEE) (European Parliament 2003, 2003a). The WEEE Directive is meant to eliminate e-waste, or at least ensure that whatever cannot be eliminated is recycled in a manner that reduces environmental harm. RoHS limits the use of carcinogenic metals and compounds (lead, mercury, cadmium, and hexavalent chromium), and fire retardants that endanger humans and wildlife (polybrominated byphenyls and polybrominated diphenyl ethers). While some costs of e-waste collection are paid by municipalities, e-waste management under WEEE is largely financed by electric and electronic equipment producers, including EU-based manufacturers and resellers of imported and own-brand equipment (Commission of the European Communities 2008a: 18). This is an aspect of "extended producer responsibility" (EPR) that requires producers to take responsibility for end-of-life management of their products, thus internalizing the environmental costs of inefficient and wasteful design that were once treated as "negative externalities" in the electronics sector. Although costs paid by producers are initially transferred to consumers in the price of electronic equipment, EPR encourages new designs that cost less to collect, treat, and recycle (Raphael and Smith 2006: 247–259). The WEEE directive involves national and local authorities; producers, and distributors; consumers; treatment operators, recyclers, and collectors; the transport sector; and "producer responsibility organizations" that make sure producers meet their obligations (Commission of the European Communities 2008a: 26).

It is also important to note how electronic media networks affect the environment. In addition to chemical and heavy metal pollution from electronics production and disposal, communication infrastructures pose risks to wildlife and humans. Artificially created electro-magnetic fields (EMF) introduced by electronics into the Earth's natural EMF create radiation exposure that has "no counterpart in man's evolutionary background" (Massey 1979: 149). The electromagnetic spectrum comprises ionizing radiation (ultraviolet rays, X-rays, and gamma rays) and non-ionizing radiation (extra-low and very-low frequencies (electrical power lines), radio waves, and microwaves). Non-ionizing radiation occurs at the atomic level, when sufficient energy excites electrons and molecules without knocking the electrons loose as ionizing radiation does (Massey 1979: 109–111). By 1980, research led to policies that set parameters of exposure, including the energy level of signal generation, proximity to signal source, radio wave frequency resonance with affected bodies (EMF absorption rates vary among species and body sizes and ages), pulsed versus continuous wave forms, and duration of exposure. The consensus was that transmission towers and signal generators (and some CEs) posed biothermal risks to media workers continuously exposed to radio, TV, and telecommunication equipment, as well as office workers on the top floors of buildings within range of high-power transmission antennae (Massey 1979: 121–125; National Research Council 2005: 133–137).

By 2009, radiation from CEs became the focus of increasing concern, in particular EMFs emitted by cell phones and other wireless electronic equipment. Scientific studies of long-term exposure to cell-phone radiation have been linked to two types of brain cancer (glioma and acoustic neuroma), salivary gland tumors, migraines, and vertigo, and to behavioral problems in children. This research has led health agencies throughout Europe to issue warnings about cell-phone radiation exposure, and has prompted EU law-makers to discuss new legislation that would require lower radiation limits for cell phones. Regulators in a number of European countries have recommended caution to adult users and, in most cases, extreme caution for children while they await results from ongoing research. Taking this precautionary principle further, the French Senate has proposed legislation to ban cell-phone use by children under six as well as related advertising directed to kids under the age of 12 (Sénat français 2009). In 2009, the European Parliament adopted a resolution on "Health concerns associated with electromagnetic fields" (INI/2008/2211), which affirmed potential risks of EMFs from a range of wireless electronic devices (Wi-Fi/WiMAX, Bluetooth and landline cordless phones). This resolution also called for government oversight of scientific research and campaigns to educate citizens on precautions, including safe techniques for using electronics and how to avoid exposure to EMFs (e.g., using maps to avoid transmission towers and high-voltage power lines). The International Commission on Non-Ionizing Radiation Protection has appealed for public policy to set limits on the "simultaneous exposure" from multiple EMF-emitting devices (Environmental Working Group 2009: 18–22, 28). Meanwhile, in the US, the Federal Communications Commission (FCC) has "all but ignored evidence that long term cell phone use may be risky" (Environmental Working Group 2009: 3–4).

Communication towers and wires also contribute to environmental damage, affecting biodiversity and habitat. These structures kill an estimated forty to fifty million birds annually in North America, affecting over two hundred species (the data are old because the FCC no longer requires annual reports on this problem) (Ornithological Council 1999; Federal Communications Commission 2004). There are national guidelines regulating placement and size of communication structures, many of which overlap with zoning rules that prohibit communication towers from being built in protected habitats, wildlife refuges, historic or heritage locations, or near where children play or attend school. Such ecologically sound policy rarely arises from a green consensus where broadcasters and cell-phone operators willingly embrace the principle of a bird's right to exist (which is guaranteed by a number of international agreements that protect migratory birds and endangered species). When they want to erect communication towers with connecting cables (guy wires) and aerial power and communication lines, experienced media companies know the criteria set out in national environmental policy and routinely press ahead with little friction from regulatory agencies.

The problem for the birds is that these agencies may not be on their side. For example, the US Telecommunications Act of 1996 mandated the acceleration of tower construction as part of its communication infrastructure expansion. That Act's free market framework embodied all the theoretical gullibility matched with corporate duplicity that we have come to expect from neoliberalism. It barred "states and local governments, explicitly or effectively, from imposing unreasonable" regulation on the growth of cellular and other mobile services (Krasnow and Solomon 2008: 50). Between 1990 and 2000, the number of cell towers and antennae in the US grew to 130,000; 40,000 towers were 200 feet tall and many reached a thousand feet (Ornithological Council 1999; US Fish and Wildlife Service 1999; Wikle 2002: 46). The American Bird Conservancy and the Forest Conservation Council took the Commission to court over the way it authorized these communication towers. The DC Court of Appeals found that the FCC had failed to abide by key environmental laws. The decision enhanced the capacity to challenge the FCC on the basis of environmental law and procedure (Krasnow and Solomon 2008: 62–63). This may look like a domestic US matter, until one realizes that birds are the most experienced and determined of globalizers, with boundaries set by geography rather than sovereignty.

Limits of Eco-Policy in the Global Political Economy

Since the 1930s there have been more than a hundred global and 145 regional environmental agreements. Many of these modify earlier accords. They protect workers, waterways, plant and animal life, fisheries, archeological and other cultural-environmental heritage, and atmospheric and ground air quality; they regulate waste management, transborder flows of heavy metals, airborne and waterborne pollutants, forests, nuclear energy; and they ban exports of hazardous waste. Scores of these global policies intersect with the ecological context of media and communication technology in the areas of climate change, pollution, biodiversity and habitat, outlined here. For instance, in the case of storage batteries that power electronics, both large and small, hundreds of national and regional laws regulate production, contents, disposal, and transportation. Many overlap with court decisions and international agreements, notably the previously mentioned Basel Convention (1992) and RoHS and WEEE Directives (2003), the Stockholm Convention on Persistent Organic Pollutants (United Nations 2001) and the Kyoto Protocol to the United Nations Framework Convention on Climate Change (United Nations 1997). In this section, we focus on the problems of implementing such policies, using the examples of the WEEE and RoHS protocols to illustrate how political-economic structures limit their effectiveness.

The WEEE and RoHS directives promise to reshape e-waste management within the EU and in countries where manufacturers are producing electronic equipment for the European market. They envision implementation benefiting the EU as a whole, as well as non-residents affected by e-waste flowing illegally from the Union. A number of practical problems emerged during the initial years of the WEEE directive. One difficulty has been how to measure waste that disappeared because it was either tossed into bins with the garbage, or resold illegally in the growing global e-waste salvage market. Raising consumer awareness might improve e-waste recycling at home. But to confront the rising pollution levels caused by the global e-waste business, major changes in the political-economic system would be needed to make the illegal global e-waste trade unprofitable, starting with the biggest source of revenue. The United States Government Accountability Office (GAO) notes that the US does virtually nothing to impede illegal and harmful exports. The US has few relevant regulations apart from bans on exporting CRTs, and lax enforcement of those that exist. In 2008, GAO operatives "posed as foreign buyers" in search of CRTs. Forty-three US corporations offered to sell them, and just one bothered to submit the forms required of such recyclers. The Office monitored two e-commerce trading sites for three months and found 1.3 million CRTs exchanged between the US and the rest of the world. Experts say that a vastly bigger trade is enacted in secret (United States Government Accountability Office 2008: 23–27, 24 n. 22).

Other problems have occurred as ironic results of the very success of the RoHS Directive. Consider batteries again. RoHS bars the use of cadmium in battery production, and prohibits the transport of cadmium outside the EU. These policies caused a rise in production of other battery types, provoking a shift of most nickel-cadmium battery production to China. In Wuxi, Jiangsu province in 2007, twenty battery workers were diagnosed with cadmium poisoning in a factory contracted by a US company to make nickel-cadmium batteries for the Japanese multinational Panasonic. The manufacturer had used the New International Division of Cultural Labor because "no one in the United States wanted to deal with the waste from cadmium," which Japan also prohibits (cited in Juan 2008: 1; Basel Action Network 2007). As this example demonstrates, important advances in environmental protection can be hindered by failures to address inequities in the existing arrangements in the global political economy and the international division of labor that supports it. In such cases, policies must embrace principles of environmental justice and human rights on a global scale in order to transform the structural conditions of battery manufacture and other electronics production.

While workplace and environmental hazards abound in electronic equipment production, the need for a global media policy based on principles of environmental justice is most evident in e-waste. The experience of China, a major player in the entire life cycle of electronic technologies, is illustrative. A typical trajectory is for computers made in China to be sold, used, and discarded in Australia; disassembled in the Philippines; sent back to China for partial reassembly; then returned to Australia for the extraction of valuable metals (Tong and Wang 2004). Because imports of e-waste have been illegal in China since 1996, there are no official figures on the amount being smuggled into the country's "informal" e-waste recycling economy, but estimates range from one to fifteen million tons annually (Manhart 2007: 18; Human Rights Advocates 2008: 5). The number of people involved in e-waste recycling is also hard to pin down. There may be over 700,000 people collecting and disassembling e-waste, with an estimated 98 percent working in the informal sector. The nation's two major recycling centers are at Luquiao in Zhejiang Province and Guiyu in Guangdong Province. Guiyu was once a farming town. That changed in the 1990s with the arrival of e-waste from the "creative industries" of the West. E-waste has transformed Guiyu in three ways: 80 percent of local families have left farming for recycling jobs, soil and water contaminants from recycling saturate the human food chain, and the pollution of land and water with persistent organic pollutants has prohibited the safe return of affected agricultural lands to future generations (Manhart 2007; Wong *et al.* 2007). Dioxin has been found at levels 56 times higher than World Health Organization standards (Human Rights Advocates 2008: 5). Approximately 20 percent of recycling workers are estimated to have no basic protection against toxic metals, and exposure to fifty times the "safe" level of lead has been reported, while many others carry toxic dust residue on their clothing and into their homes. Contaminants from incineration and landfill of residual waste saturate local dust, soil, river sediment, surface and ground water, and air (Manhart 2007; Leung *et al.* 2008). Banning the illegal e-waste salvage business will require multilateral policy and enforcement, with costs for administration, enforcement, healthcare, and other forms of remediation paid by the responsible corporations. No single nation can ensure effective ripostes to this trade in disease.

Private Sector Policy and Innovation

Of course, not all policy is made by governmental and intergovernmental organizations. Civil society, too, adopts and adapts policies, and the business sector has pursued strategies and design innovations in response to the crisis we have outlined, rather than denying its existence. Britain's BT plc has diminished carbon emissions by 58 percent in the decade since it began measuring such things. Telefónica, the dominant telecommunications force across much of Latin America, Africa, and Europe, has a Climate Change Office charged with reducing workplace electricity use by 10 percent, and network use by 30 percent, by 2015. NTT in Japan and Britain's Vodafone have similar goals (International Telecommunication Union 2009: 10–11).

And consider film and television drama production. News Corporation is vigorously re-examining its disastrous environmental record, thanks to an unlikely source of progressive thought Rupert Murdoch. In 2007, Murdoch convened a meeting of his entire global workforce. The sole agenda item was his goal of making the company carbon-neutral by 2010, despite its annual usage of almost 650,000 tons of such fuels. Murdoch told his employees that "if we are to connect with our audiences on this issue, we must first get our own house in order," and "climate change poses clear, catastrophic threats" (News Corporation 2007). Even Fox's far-right vigilante television show *24* got involved. It became the first carbon-neutral US TV drama in 2009, with offsets calculated against the impact of car chases, air travel, and coal-generated electricity, and the use of wind and solar power from India where feasible (Glaister 2009; Kaufman 2009). For its part, Time Warner's (2008) *Corporate Social Responsibility Report* proclaimed "Energy Efficiency at the Studio Lot Since 2002," announcing that it had saved "over 8 million kilowatt-hours of energy and approximately $1 million annually" via efficient lighting, heating, and air-conditioning, occupancy sensors and timers, and so on. The corporation even undertook a carbon-footprint analysis in 2007 to determine the greenhouse gas impacts of DVD manufacture and distribution (Warner Brothers Studio 2007).

Other major studios have initiated programs that include: installing low-energy light-emitting diodes to illuminate buildings and outdoor signage; reducing paper utilization; composting organic waste; retrofitting buildings with computer-controlled air and heating systems and environmentally friendly materials; paying for reforestation out of production budgets to account for a film's overall pollution; teleconferencing; recycling wood, paper, recording media, metals, film stock, electronics, and printer and toner cartridges; managing chemical use and disposal; reducing or eliminating hazardous materials; eliminating and recycling wastewater; installing solar and other renewable energy sources; and networking with green suppliers and organizations like the Greencode Project (funded by the National Film Board of Canada) (Gardner 2007). Many corporations have joined founders Google and Intel in climatesaverscomputing.org.

Various governmental and professional trade initiatives support such private sector activities. For instance, the UK Film Council has created an "Environmental Strategy" to help "trade bodies and individual companies" reduce the environmental impact of the UK film industry, where so many nominally Hollywood products are made (Gardner 2007; UKfilmcouncil.org nd: 1). Similar film-commission initiatives exist in Canada, New Zealand/Aotearoa, and the US.[2] And the Science and Technology Council of the US Academy of Motion Picture Arts and Sciences is pressing for industry-wide models to deal with aspects of the digital transition that could alter Hollywood's relation to the environment in positive ways. Though their recommendations do not explicitly mention the environment, they are indirectly linked to environmental risks posed by Hollywood. They reject the current "store and ignore" and "save everything" attitudes of producers and studio managers and plan to reduce wasteful practices through better-organized responses to technical obsolescence (for instance, standardization and non-proprietary technical collaborations, using open-source systems to extend the utility of digital platforms) (Science and Technology Council of the American Academy of Motion Pictures Arts and Sciences 2007).

At the same time, there are various greenwashing, AstroTurf initiatives such as the "Global Sustainability Initiative Supply Chain Working Group" and the "Electronic Industry Code of Conduct" that seek to ward off international legislation and enforcement by proclaiming the industry's capacity to regulate itself through the "good governance" mantra that proved so successful as a business rhetoric until the recent financial crisis. The limiting factor to these business strategies is their proponents' profit motive and desire to avoid the democratic controls of public policy and regulation, plus the fact that national legislation is difficult to coordinate across jurisdictions. We expressed our concerns with TV sets earlier in this chapter: in 2009, Sony announced new liquid-display sets that would require much less power than others, in part by going to sleep when they were not being watched, thanks to motion-sensor surveillance of viewers. The plan was to play environmental politics against economies of scale – to charge a premium for green consumers and hence counter the tendency for high-definition TV prices to fall (Jiji Press 2009). This is simultaneously a business plan, an element of the company's environmental policy as part of marketing its sense of corporate responsibility, and an attempt to elude democratic regulation.

Innovation in the ICT world is shifting to integrated networks that combine telephony, data, mobility, and media into unified systems that will have important implications for energy use. We are normally told about this in terms of our role as customers who will be using one device anywhere and everywhere to record and watch movies, sports, child-care centers, and "happy-family" snap shots. The new era should see fewer switching centers, without the need for air conditioning, and with low-power and sleep functions. But Very High-Speed Digital Subscriber Lines and Gigabit Passive Optical Networks will massively increase the capacity for transmission – and associated power consumption. And as more and more corporations and governments draw on cloud computing, data centers will become even bigger emitters of pollutants. At the same time, that may also result in office buildings with smaller footprints. We are also seeing a switch from desktop to laptop computers, which means 40 percent less electricity used per appliance; the proliferation of multi-core processors, which diminish energy use; increased power-saving applications; the emergence of light-emitting diode monitors over CRT monitors; and the popularity of flash drives versus hard disks. Some of these developments (the bad ones) are driven by rapidly rising energy consumption; some (the good) by regulations in the wealthiest world market – the EU – via mandated eco-policies (Bio Intelligence Service *et al.* 2008; International Telecommunication Union 2009: 9–11).

Policy studies must also identify and analyze the ecological bona fides of ICT innovations aimed at "helping" the environment, such as gadgets that are promoted as the key solution to global warming in the *Smart2020 Report*. Produced by a front organization for corporations like Deutsche Telekom, Cisco, T-Mobile, Intel, Vodafone, and other firms keen to influence and create international policy, the seemingly ubiquitous *Smart2020 Report* has been endorsed by Infosys, the California Environmental Protection Agency, the UN Environment Programme, the China Development Research Foundation, and the China Mobile Communications Corporation. Travel, work, electricity, all will diminish their carbon activity, thanks to the benign businesses that paid for and backed the report (The Climate Group 2008: 3). Further to the left, the Institute for Sustainable Development outlines strategies for using ICTs to create sustainable development and ameliorate poverty levels in South Africa, Kenya, Costa Rica, Brazil, and Egypt (Willard and Andjelkovic 2005). Since 1994, the ITU has also called for an "increasing role" in environmental protection by ICTs monitoring climate change and natural disasters, communicating information to those affected via collaboration with the World Meteorological Organization's World Weather Watch, and reducing business travel through teleconferencing (International Telecommunication Union 2009: 1, 5–6).

While some of the innovations we have discussed aid environmental monitoring and research, all of them contribute to environmental decline in their current form – sometimes these are one and the same technologies. For instance, satellites monitor environmental changes (deforestation, desertification, earthquakes, volcanoes and climate modeling, and so on), help fisheries and species migrations research, and inform marine ecosystem protections. But space junk from satellites is a growing problem, with over 330 million pieces orbiting the

Earth, potentially discharging toxic chemicals and compounds and nuclear waste, and threatening damage to operational satellites (Broad 2007). Other technologies that require careful study include so-called smart technologies that use radio controls and Internet protocols to reduce consumption of natural resources and shrink greenhouse-gas emission and conventional pollutants: examples of these communication systems now operate irrigation systems and smart electricity grids.

Conclusion

The ecological context of electronic and electrical equipment, networks, and systems poses unique challenges to global media and communication policy. In this chapter we have identified specific policies that help to limit harms, improve designs, and raise awareness of the environmental impact of ICTs and CEs. While important, these efforts are only part of a much broader policy strategy that will be needed if we want to advance global governance aimed at eliminating the negative environmental impact of media technologies while also increasing the contributions that these technologies make to ending the ecological crisis. In the most general sense, we need to determine how much media technology can be developed and used within the fixed limits of environmental sustainability. In setting these parameters we would also need to ask whether existing media and communication institutions should be sustained in their present size and reach or shrunk to ecologically sound dimensions.

In order to address these general questions, green global governance must develop a set of strategies to match the scale and variation of environmental problems caused by media technologies within and across the ecosystems that make up the Earth's biosphere. At the global scale, for example, this will entail the greening of the old tripartite model wherein peak councils of capital, labor, and states set policy. A green model must involve advocates for our fellow animals and other life forms that have significance in people's lives, and make room for environmental scientists, leaders of disenfranchised minorities and indigenous communities fighting for environmental justice, and representatives of workers whose expertise resides outside the rule of law (from worldwide assembly and recycling lines which are especially important given the low density of unionization in the global factory). Without this transterritorial concern for the biosphere and the participation of those conventionally excluded from the policy calculus of media and communication, we shall simply burn one more page in an unsustainable playbook. At this scale of governance, policies such as EPR become truly global, rather than being applied spottily and only within the Global North (Babu *et al.* 2007; Nnorom and Osibanjo 2008).

To succeed, this global effort depends on nation-states continuing to adopt omnibus and specialized laws to ban harmful practices of the ICT and CE sectors within their nationally bound ecosystems. The interdependence of supra-state, inter-state, and state governance over environmental matters can already be found in numerous policies, laws, and agreements; the EU represents the most evolved instance in which states successfully move to harmonize governance to meet transterritorial aspirations.

But the state has a further role to play. It must create conditions for green governance to be decentralized so that small-scale institutions can autonomously design and monitor sustainable practices, in particular where government oversight and management is unfeasible and/or inefficient. For example, a national government could lay out a legal framework that funds the establishment of local recycling associations that are self-organized to monitor best practices and sanction violations by their members as they pursue both efficiency and livelihood now lacking in large-scale recycling programs; and this could result in greater compliance with national and international laws. Such self-organized enterprises could be developed in almost all the lower tiers of the supply chain (from mining and transport to low-value, high-volume component production) where national regulation is difficult to implement and where green compliance audits by manufacturers like Apple, Dell, and Hewlett-Packard, have little influence. There would be a number of benefits for government and ICT and CE businesses if they supported and financed enterprises at this scale of governance, at least in locales where such enterprises could flourish.[3]

As a complement to the transterritorial and state levels of green governance, this model of autonomous, self-organized resource management moves away from the spaceless, subject-free fantasies of universalist policy and draws on the principle of a common cause of solidarity in place of monadic selfishness envisioned in such defining works as Hardin's *The Tragedy of the Commons* (1968; cf. Ostrom 2000). Ostrom (2000) shows that well-organized local institutions have a higher rate of success in resource management if external laws provide for their autonomy ("involving users in their choice of regulations so that these are perceived to be legitimate") and if political and economic arrangements encourage organizational relationships between such enterprises and communities sharing an ecosystem. Relationships focussed on ecologically sound resource management could be extended up the ladder of a supply chain to involve resource users across many ecosystems to monitor what works and fails, to eliminate harmful waste, to modify methods of resource acquisition, and to share information that increases "the benefit flow to be derived from a sustainable use of local resources" (Ostrom 2000: 47). Research by Karpowitz *et al.* (2009) on "enclave deliberation among the disempowered" provides further evidence that decentralized, participatory governance can play a vital role in policy-making, in particular by generating wide agreement on key policy recommendations by means of a "consensus conference" involving community members, resource users, experts, and elites (Karpowitz *et al.* 2009: 584). Such models transcend the now-discredited Anglo-Saxon policy framework that has dominated for three decades, favoring instead the recognition that rational outcomes may derive from a stakeholder approach to managing the commons.

Any attempt to generate new media policies to advance green governance has to be mindful of the ethical dilemma that accompanies environmental sustainability. Fifty years ago, Stuart Hall wrote about the spread of CEs among the poor as part of "a legitimate materialism, born out of centuries of physical deprivation and want" (1958: 26). Yet the value and significance that these technologies hold for many crash headlong into the material limits imposed on their production and consumption by the ecological crisis. The latter challenges precious doctrines of liberal democracy that valorize a voice for all at all times and promote the growth of cultural and communication technologies as ever-expanding universes of tolerance and merriment. The watchword must be sustainability, not growth. To get there, a new policy calculus must derive from the most careful popular and expert contributions in epidemiological, environmental, and biological research working with regulators of ICT and CE sectors, but also an ethnographic evaluation of the formal and informal sectors, from Delhi rag-pickers to Bangalore magnates, from US Federal Prison inmates to DC mavens, in order to establish the dimensions of the problems we face and to counter the untrammeled information society ideology that we and the public otherwise receive.

Notes

1 Some facilities in the First World recycle safely, but they are expensive. So in addition to sending the problem overseas, the US uses cheap, indentured labor in unsafe conditions in the form of its Federal Prisons population.

2 See, for example, http://www.bcfilmcommission.com/community/reel_green_bc.htm; www.greeningthescreen.co.nz; http://www.filminflorida.com/prl/gpp.asp; http://www.nmfilm.com/filming/green-filming; and http://www. oregonfilm.org/resources/greenproduction.

3 Many factors determine the viability of this model, peace being a precondition, as is evident in eastern Congo where armed conflict and despotism are funded by "conflict minerals" mined to feed the rapid expansion of electronics manufacturing (Global Witness 2009).

References

Babu, B. R., Parande, A. K., and Basha, C. A. (2007) "Electrical and electronic waste: A global environmental problem," *Waste Management & Research*, 25(4): 307–318.

Bar, F., with Simard, C. (2006) "From hierarchies to network firms," in L. Lievrouw and S. Livingstone (eds) *The Handbook of New Media: Updated Students Edition*. Thousand Oaks, CA: Sage Publications, pp. 350–363.

Basel Action Network (2007) *JPEPA* [Japan–Philippines Economic Partnership Agreement] *as a Step in Japan's Greater Plan to Liberalize Hazardous Waste Trade in Asia*. Seattle: BAN.

Basel Action Network and Silicon Valley Toxics Coalition (2002) *Exporting Harm: The High-Tech Trashing of Asia* (February 25). Seattle: BAN.

BBC News (2006) "Help urged for Ivory Coast waste" (November 24), London: British Broadcasting

Corporation, http://news.bbc.co.uk/2/hi/science/nature/6180604.stm (accessed 01/12/2006).

BBC News (2006a) "UN warning on e-waste 'mountain'" (27 November), London: British Broadcasting Corporation, http://news.bbc.co.uk/2/hi/technology/6187358.stm (accessed 01/12/2006).

Bio Intelligence Service with European Business Council for Sustainable Energy and Fraunhofer Institut Zuverlässigkeit und Mikrointegration (2008) *European Commission DG INFSO: Impacts of Information and Communication Technologies and Energy Efficiency [Tender No. CPP 16A-2007/2007/S 68-082361] Final Report*. Ivry sur Seine: Bio Intelligence Service S.A.S.

Boyce, T., and Lewis, J. (eds) (2009) *Climate Change and the Media*. New York: Peter Lang.

Brigden, K., Santillo, D., and Johnston, P. (2008) *Playing Dirty: Analysis of Hazardous Chemicals and Materials in Games Console Components*. Amsterdam: Greenpeace International.

Broad, W. J. (2007) "NASA forced to steer clear of junk in cluttered space" (July 31), New York: The New York Times, F4.

Burke, J. G. (1979) "Wood pulp, water pollution, and advertising," *Technology and Culture,* 20(1): 175–195.

Byster, L., and Smith, T. (2006) "From grassroots to global," in T. Smith, D. A. Sonnenfeld, and D. N. Pellow (eds) *Challenging the Chip: Labor Rights and Environmental Justice in the Global Electronics Industry*. Philadelphia, PA: Temple University Press, pp. 111–19.

Commission of the European Communities (2008) *The Economics of Ecosystems & Biodiversity: An Interim Report*. Brussels: European Communities.

Commission of the European Communities (2008a) *"Impact assessment" (3 December): Commission Staff Working Paper accompanying the Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment (WEEE) (recast)*. COM (2008) 810 Final. Brussels: Commission of the European Communities.

Commoner, B. (1971) *The Closing Circle*. New York: Knopf.

Consumers International, DanWatch, and the Danish Consumer Council (2008) *The Real Deal: Exposing Unethical Behavior*. London: Consumers International, http://www.consumersinternational.org/shared_asp_files/GFSR.asp?NodeID=97576 (accessed 25/01/2010).

Corbett, C. J., and Turco, R. P. (2006) *Sustainability in the Motion Picture Industry*. Report prepared for the Integrated Waste Management Board of the State of California. Sacramento, CA: Integrated Waste Management Board of the State of California, http://personal.anderson.ucla.edu/charles.corbett/papers/mpis_report.pdf (accessed 23/01/2007).

Council for the Humanities, Arts and Social Sciences (Australia) (2006) *CHASS Submission: Productivity Commission Study on Science and Innovation*. Canberra: CHASS.

Criminal Intelligence Service Canada (2008) *08 Report on Organized Crime*. Ottawa: Criminal Intelligence Service Canada.

Crosbie, T. (2008) "Household energy consumption and consumer electronics: The case of television," *Energy Policy*, 36(6): 2191–2199.

Curry, P. (2006) *Ecological Ethics: An Introduction*. Cambridge: Polity Press.

Dalton, R. J. (2005) "The greening of the globe? Crossnational levels of environmental group membership," *Environmental Politics*, 14(4): 441–459.

Dobson, A. (2003) *Citizenship and the Environment*. Oxford: Oxford University Press.

Environmental Protection Agency (1995) *Profile of the Printing and Publishing Industry*. Washington, DC: EPA.

Environmental Protection Agency (2007) *Management of Electronic Waste in the United States*. Washington, DC: EPA.

Environmental Protection Agency (2008) *Statistics on the Management of Used and End-of-Life Electronics*. Washington, DC: EPA, http://www.epa.gov/epawaste/conserve/materials/ecycling/manage.htm (accessed 09/08/2008).

Environmental Working Group (2009) *Cell Phone Radiation: Science Review on Cancer Risks and Children's Health*. Washington, DC: Environmental Working Group, http://www.ewg.org/cellphoneradiation/fullreport (accessed 09/09/2009).

European Parliament (2003) *Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS)*. Luxembourg: EU Publications Office.

European Parliament (2003) *Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on Waste Electrical and Electronic Equipment (WEEE)*. Luxembourg: EU Publications Office.

Fairfield, H. (2008) "Pushing paper out the door," (February 10), New York: The New York Times, Sunday Business Section 1.

Federal Communications Commission (2004) *Avian/Communication Tower Collisions* prepared by the Avatar Environmental, LLC; EDM International Inc.; and Pandion Systems Inc. Washington, DC: Federal Communications Commission.

Foucault, M. (2008) *The Birth of Biopolitics: Lectures at the Collège de France, 1978–79*, ed. M. Senellart, trans. G. Burchell. Basingstoke: Palgrave Macmillan.

Frank, D. J., Hironaka, A., and Schofer, E. (2000) "The nation-state and the natural environment over the twentieth century," *American Sociological Review*, 65(1): 96–116.

Gardner, E. (2007) *Developing an Environmental Strategy for UK Film*. London: UK Film Council.

Gartner, Inc. (2007) "Gartner estimates ICT industry accounts for 2 percent of global CO2 emissions" (April 26), Stamford: Gartner, Inc., http://www.gartner.com/technology/about.jsp (accessed 30/03/2008).

Glaister, D. (2009) "Jack Bauer saves the world again: *24* goes carbon neutral" (March 3), *Guardian News and Media Limited*, guardian.co.uk.

Global Witness (2009) *"Faced with a Gun, What Can You Do?" War and the Militarisation of Mining in Eastern Congo*. London: Global Witness Ltd.

Grossman, E. (2006) *High Tech Trash: Digital Devices, Hidden Toxics, and Human Health*. Washington, DC: Island Press.

Groves, R. H. (1995) *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism 1600–1860*. Cambridge: Cambridge University Press.

Hall, S. (1958) "A sense of classlessness," *Universities & Left Review*, 5: 26–31.

Hamelink, C. (2001) "Remembering Herbert Schiller: Our common efforts," *Television & New Media* 2(1): 11–16.

Hardin, G. (1968) "The tragedy of the commons," *Science*, 162(3859): 1243–1248.

Hibberd, M. (2009) "Public private partnership" (September 15), *Telecoms.com*, http://www.telecoms.com/14505/public-private-partnership (accessed 15/09/2009).

Hopgood, S. (1998) *American Foreign Environmental Policy and the Power of the State*. New York: Oxford University Press.

Houghton, J. (2009) *ICT and the Environment in Developing Countries: Opportunities and Developments*. Paper prepared for the Organization for Economic Cooperation and Development, Paris: OECD.

Human Rights Advocates (2008) *The Human Rights Impact of the Illicit Transfer and Dumping of Toxic Wastes and Dangerous Substances: E-Waste, Sham Recycling, and the Need for Effective Regulation* (report to the United Nations Human Rights Council, 7th Session). Berkeley, CA: Human Rights Advocates, http://www.humanrightsadvocates.org/UN%20interventions%20list1.htm (accessed 02/06/2009).

Independent Press Association, Conservatree, and Co-op America (2001) *Turning the Page: Environmental Impacts of the Magazine Industry and Recommendations for Improvement*. Washington, DC: The Paper Project.

Intergovernmental Panel on Climate Change (2007) *Climate Change 2007: Synthesis Report Summary for Policymakers*. Geneva: World Meteorological Organization.

International Energy Agency (2009) *Gadgets and Gigawatts: Policies for Energy Efficient Electronics. Executive Summary*. Paris: Organization for Economic Cooperation and Development.

International Telecommunication Union (2008) *ICTs for e-Environment: Guidelines for Developing Countries, with a Focus on Climate Change*. Geneva: ICT Applications and Cybersecurity Division, Policies and Strategies Department, ITU Telecommunication Development Sector.

International Telecommunication Union (2009) *ITU Symposium on ICTs and Climate Change Hosted by CTIC, Quito, Ecuador, 8–10 July 2009: ITU Background Report*. Geneva: ITU.

Jiji Press (2009) "Sony to launch power-saving TVs" (January 19), *Jiji Press*. Tokyo: Jiji Press.

Juan, S. (2008) "Bearing the brunt of globalization" (July 3), *China Daily*, http://www.chinadaily.com.cn/china/2008-07/03/content_6815829.htm (accessed 09/08/2009).

Karpowitz, C. F., Raphael, C., and Hammond, IV, A. S. (2009) "Deliberative democracy and inequality: Two cheers for enclave deliberation among the disempowered," *Politics & Society* 37(4): 576–615.

Kaufman, L. (2009) "Car crashes to please Mother Nature" (March 2), *The New York Times*, New York: The New York Times, http://www.nytimes.com/2009/03/02/arts/television/02twen.html (accessed 02/03/2009).

Koomey, J. G. (2007) *Estimating Total Power Consumption by Servers in the US and the World*. Oakland, CA: Analytics Press.

Krasnow, E. G., and Solomon, H. A. (2008) "Communication towers: Increased demand coupled with increased regulation," *Media Law & Policy*, 18(1): 45–68.

Lean, G. (2008) "Mobile phones 'more dangerous than smoking'" (March 30), *The Independent*, independent.co.uk, http://www.independent.co.uk/life-style/health-and-wellbeing/health-news (accessed 30/03/2008).

Lee, M. (2007) "Our electronic waste is piling up overseas" (June 19), *San Diego Union-Tribune*, San Diego, CA: San Diego Union-Tribune, A1.

Lee, S. (2002) "Ghosts in the machines" (May 12), *South China Morning Post Magazine*. Hong Kong: SCMP Group.

Leung, A. O. W., Duzgoren-Aydin, N. S., Cheung, K. C., and Wong, M. H. (2008) "Heavy metals concentrations of surface dust from e-waste recycling and its human health implications in Southeast

China," *Environmental Science and Technology*, 42(7): 2674–2680.

Manhart, A. (2007) *Key Social Impacts of Electronics Production and WEEE-Recycling in China*. Freiburg: Institute for Applied Ecology (Öko-Institut e.V.).

Massey, K. A. (1979) "The challenge of nonionizing radiation: A proposal for legislation," *Duke Law Journal* (Tenth Annual Administrative Law Issue) (February): 105–189.

Maxwell, R. (2003) *Herbert Schiller*. Lanham, MD: Rowman & Littlefield Publishers.

Maxwell, R., and Miller, T. (2008) "Ecological ethics and media technology," *International Journal of Communication*, 2: 331–353.

Maxwell, R., and Miller, T. (2009) "Talking rubbish: Green citizenship, media, and the environment," in T. Boyce and J. Lewis (eds) *Climate Change and the Media*. New York: Peter Lang, pp. 17–27.

Medina, M. (2007) *The World's Scavengers: Salvaging for Sustainable Consumption and Production*. Lanham, MD: AltaMira Press.

Miller, T., Govil, N., McMurria, J., Maxwell, R., and Wang, T. (2005) *Global Hollywood 2*. London: British Film Institute.

Mooallem, J. (2008) "The afterlife of cellphones" (January 13), *The New York Times*, New York: The New York Times, 38–43.

Mouawad, J., and Galbraith, K. (2009) "Plugged in age feeds hunger for electricity" (September 20), *The New York Times*, New York: The New York Times, A1.

National Grid (2006) *The Power Behind the World Cup!* London: National Grid plc.

National Research Council (2005) *An Assessment of Potential Health Effects from Exposure to PAVE PAWS Low-Level Phased Array Radiofrequency Energy*. Washington, DC: The National Academies Press.

News Corporation (2007) *0 by 2010*, http://www.newscorp.com/energy/index.html (accessed 15/04/2007).

Nnorom, I. C., and Osibanjo, O. (2008) "Overview of electronic waste (e-waste) management practices and legislations, and their poor applications in the developing countries," *Resources Conservation & Recycling*, 52(6): 843–858.

OECD (2001) *Environmental Outlook*. Paris: OECD.

Ornithological Council (1999) "Deadly spires in the night: The impact of communications towers on migratory birds," *Issue Brief*, 1(8): np.

Ostrom, E. (2000) "Reformulating the commons," *Swiss Political Science Review*, 6(1): 29–52.

Pelta-Heller, Z. (2007) "HP's printer cartridges are an e-waste disaster: Does the company really care?" (October 29), *AlterNet.org*, Independent Media Institute, http://www.alternet.org/environment/65945 (accessed 30/03/2008).

Pepper, D. (2000) "Environmentalism," in G. Browning, A. Halci, and F. Webster (eds) *Understanding Contemporary Society: Theories of the Present*. London: Sage Publications, pp. 445–462.

Pynn, L. (2006) "Dangerous waste bound for China is intercepted" (December 22), *Vancouver Sun*. CanWest MediaWorks Publications Inc.

Raphael, C., and Smith, T. (2006) "Importing extended producer responsibility for electronic equipment into the United States," in T. Smith, D. A. Sonnenfeld, and D. N. Pellow (eds) *Challenging the Chip: Labor Rights and Environmental Justice in the Global Electronics Industry*. Philadelphia, PA: Temple University Press.

Ray, M. R., Mukherjee, G., Roychowdhury, S., and Lahiri, T. (2004) "Respiratory and general health impairments of ragpickers in India: A study in Delhi," *International Archives of Occupational and Environmental Health*, 77: 595–598.

Rockstrom, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D. Richardson, K., Crutzen, P., and Foley, J. A. (2009) "Planetary boundaries: Exploring the safe operating space for humanity," *Ecology and Society*, 14(2), http://www.ecologyandsociety.org/vol14/iss2/art32 (accessed 09/10/2009).

Roth, K. W., and McKenny, K. (2007) *Energy Consumption by Consumer Electronics in US Residences*. Final Report to the Consumer Electronics Association. Cambridge: Tiaxx LLC.

Russell, B. (2006) "Flat screen televisions 'will add to global warming'" (1 November), *The Independent*, independent.co.uk, http://www.independent.co.uk/environment/climate-change/flat-screen-televisions-will-add-to-global-warming-422424.html (accessed 01/11/2006).

Rydh, C. J. (2003) *Environmental Assessment of Battery Systems: Critical Issues for Established and Emerging Technologies*. Thesis: Department of Environmental Systems Analysis, Chalmers University of Technology, Göteborg.

Schäppi, B., Bellosa, F., Przywara, B., Bogner, T., Weeren, S., and Anglade, A. (2007) *Energy Efficient Servers in Europe: Energy Consumption, Saving Potentials, Market Barriers and Measures. Part I: Energy Consumption and Saving Potentials*. Vienna: Austrian Energy Agency, The Efficient Servers Consortium.

Schauer, T. (2003) *The Sustainable Information Society: Vision and Risks*. Vienna: European Support Centre of the Club of Rome, http://clubofrome.at/archive/sustainable-information-society.html (accessed 02/08/2009).

Schiller, H. I. (1981) *Who Knows: Information in the Age of the Fortune 500*. Norwood, NJ: Ablex Publishing.

Schiller, H. I. (1984) *Information and the Crisis Economy*. Norwood, NJ: Ablex Publishing.

Schluep, M., Rochat, D., Munyua, A. W., Laissaoui, S. E., Wone, S., Kane, C., and Hieronym, K. (2008) "Assessing the e-waste situation in Africa," *Electronics Goes Green 2008+*, Berlin, pp. 1–6.

Science and Technology Council of the American Academy of Motion Picture Arts and Sciences (2007) *The Digital Dilemma: Strategic Issues in Archiving and Accessing Digital Motion Picture Materials*. Los Angeles, CA: Academy Imprints.

Sénat français (2009) *Projet de Loi Portant Engagement National pour L'Environnement*. Paris: Sénat français, http://www.senat.fr/dossierleg/pjl08-155.html (accessed 02/11/2009).

Shabecoff, P. (1989) "Reagan and environment: To many, a stalemate" (January 2), *The New York Times*, New York: The New York Times, p. 1.

Silicon Valley Toxics Coalition (nd) *Electronic Industry Overview*. San Jose: SVTC, http://www.svtc.org/site/PageServer?pagename=svtc_electronic_industry_overview (accessed 25/10/2009).

Smith, T., Sonnenfeld, D. A., and Pellow, D. N. (eds) (2006) *Challenging the Chip: Labor Rights and Environmental Justice in the Global Electronics Industry*. Philadelphia, PA: Temple University Press.

Tekrati Inc. (2007) "Samsung holds lead in global television market in Q2 2007, says iSuppli" (25 September), *Tekrati.com*, http://ce.tekrati.com/research/9371 (accessed 24/09/2009).

The Climate Group (2008) *Smart2020: Enabling the Low Carbon Economy in the Information Age*. London: Global Sustainability Initiative.

Time Warner (2008) *Corporate Social Responsibility Report*. New York: Time Warner Inc., http://www.timewarner.com/corp/citizenship/index.page/tw_csr_report08.pdf (accessed 09/11/2008).

Tong, X., and Wang, J. (2004) "Transnational flows of e-waste and spatial patterns of recycling in China," *Eurasian Geography and Economics*, 45(8): 608–621.

Touré, H. I. (2008) *ITU Secretary-General's Declaration on Cybersecurity and Climate Change* (November 12–13), High-Level Segment of Council, Geneva: ITU, http://www.itu.int/council/C2008/hls/statements/closing/sg-declaration.html (accessed 24/09/2009).

Tripsas, M. (1997) "Unraveling the process of creative destruction: Complementary assets and incumbent survival in the typesetter industry," *Strategic Management Journal*, 18: 119–142.

UKfilmcouncil.org.uk (nd) *Environmental Strategy*. London: UK Film Council, http://www.ukfilmcouncil.org.uk/environmental (accessed 24/07/2009).

United Nations (1992) *United Nations Framework Convention on Climate Change*. Bonn: UN Climate Change Secretariat, http://unfccc.int/resource/docs/convkp/conveng.pdf (accessed 25/01/2010).

United Nations (1997) *Kyoto Protocol to the United Nations Framework Convention on Climate Change*. Bonn: UN Climate Change Secretariat, http://unfccc.int/resource/docs/convkp/kpeng.pdf (accessed 25/01/2010).

United Nations (2001) *Stockholm Convention on Persistent Organic Pollutants*. Geneva: Secretariat of the Stockholm Convention, http://chm.pops.int/Portals/0/download.aspx?d=UNEP-POPS-COP-CONVTEXT.English.pdf (accessed 25/01/2010).

United Nations Environment Programme (1992) *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal*. Geneva: The Secretariat of the Basel Convention, http://www.basel.int/text/con-e-rev.pdf (accessed 25/01/2010).

United Nations Environment Programme (2007) *UNEP 2006 Annual Report*. Nairobi: UNEP.

United States (US) Fish and Wildlife Service (1999) *Bird Kills at Towers and Other Human-Made Structures: An Annotated Partial Bibliography (1960–1998)*. Washington, DC: Office of Migratory Bird Management.

United States Government Accountability Office (2008) *Electronic Waste: EPA Needs to Better Control Harmful US Exports Through Stronger Enforcement and More Comprehensive Regulation*. Report to the Chairman, Committee on Foreign Affairs, House of Representatives. GAO-08-1044. Washington, DC: GAO.

Wald, M. L. (2007) "Taming the guzzlers that power the world wide web" (November 7), *The New York Times*, New York: The New York Times, H7.

Warner Brothers Studio (2007) *Warner Home Video Product Packaging to Go Green*, Warner Brothers Studio, http://www.wbenvironmental.warnerbros.com (accessed 24/09/2009).

Wikle, T. A. (2002) "Cellular tower proliferation in the United States," *Geographical Review*, (92)1: 45–62.

Willard, T., and Andjelkovic, M. (eds) (2005) *A Developing Connection: Bridging the Policy Gap Between the Information Society and Sustainable Development*. Winnipeg: Institute for Sustainable Development.

Wong, C. S. C., Wu, S. C., Duzgoren-Aydin, N. S., Aydin, A., and Wong, M. H. (2007) "Trace metal contamination of sediments in an e-waste processing village in China," *Environmental Pollution*, 145(2): 434–442.