Emerging Technologies: Sustainability, Gender and the Need for Technology Assessment and Monitoring

Neth Dañ; Kathy Jo Wetter - ETC Group (Philippines, USA)

Unsustainable technology revolution

The past few decades have seen unprecedented technological advances, which are massively transforming the planet and impacting people's daily lives. While the dramatic leaps and bounds in information and communications technology (ICT) development are perhaps the most obvious, there are many other emerging technologies that are also impacting our world and shaping our future, just as significantly but much less visibly — and not necessarily in the direction of sustainable development.

Technological developments in molecular biology in the 1980s have led to a situation in which genetically modified organisms (GMOs) are now ubiquitous on farms and grocery shelves in many countries around the world. However, a more recent but related technology, synthetic biology,[1] has taken biotechnology a step further: it is now possible to shift from transferring single genes from one species to another to build made-to-order stretches of DNA, one base pair at a time. These novel genomes can transform microorganisms into tiny 'biological factories', which can process almost any biomass to make almost any bio-product (eg. grasses to diesel fuel, or maize to plastic). Furthermore, whereas it had taken 13 years and US$3 billion to map the human genome just ten years ago, it is now possible to map a complex genome in 8 days for less than US$10,000 (ETC Group, 2012). A new field known as 'meta-genomics' allows the sequencing of entire communities of organisms in one fell swoop in order to exploit the microbial functioning of ecosystems.

In addition, a suite of techniques to manipulate matter on the scale of atoms and molecules, referred to as nanotechnology, can dramatically transform the material properties of conventional substances by taking advantage of 'quantum effects'. With only a reduction in size (to around 300 nm or smaller in at least one dimension) and no change in substance, materials can exhibit new characteristics – such as electrical conductivity, increased bioavailability, elasticity, greater strength or reactivity – properties that the very same substances may not exhibit at larger scales. But the qualities that make nanomaterials so attractive to industry across a wide range of fields – their mobility and small size, on the same scale as biological processes, and their unusual properties – turn out to be the same qualities that can make them harmful to the environment and to human health. Nanoscale particles can easily enter most cells, often without triggering any kind of immune response. While there is great uncertainty about the toxicity of nanoparticles, hundreds of published studies now exist that show manufactured nanoparticles, currently in widespread commercial use (including zinc, zinc oxide, silver and titanium dioxide) can be toxic.

In tandem with these developments, new hyperspectral imaging[2] technologies — using satellites and airplanes — are making it scientifically and financially possible to map and measure unique biodiversity across the globe. The near-term possibilities include the aerial identification of proprietary crops or livestock with unique genetic traits or DNA markers, which could impinge on farmers' rights to save and/or improve genetic material through breeding. The risk of biopiracy also increases. On the planetary scale, geo-engineering — the deliberate large-scale manipulation of the earth's systems (by injecting sunlight-reflecting particles into the stratosphere, for example) — is

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[1] "Synthetic biology is the engineering of biology: the synthesis of complex, biologically based (or inspired) systems, which display functions that do not exist in nature." http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2174633/

[2] Hyperspectral imaging is a process that maps not just visible light but the entire electromagnetic spectrum.

being pushed as a technological 'quick fix' to the climate crisis and for other ecological crises, such as ocean acidification and water cycle imbalances.

In addition to the potential ecological and health issues that surround these untested technologies and products, there is a concern that they are collectively creating industrial platforms that demand entirely new production and/or processing systems. The most direct impact of new designer materials created using nanotechnology or synthetic biology, for example, is multiple raw-material options for industrial manufacturers, which could mean major disruptions to traditional commodity markets. It is too early to predict with certainty which commodities or workers will be affected and how quickly. However, if a new nano-engineered material or a new bioproduct created using synthetic biology equals or outperforms a conventional commodity and can be produced at a comparable cost, it is likely to replace the conventional commodity. Modern history is replete with examples of new technological products and processes replacing traditional commodities, causing massive displacements in livelihood and employment.[3]

The new technologies thus have the potential to have a profound impact on communities and peoples' livelihoods, including women in rural areas involved in commodity production and those in urban areas engaged in processing and manufacturing. Their suitability in terms of meeting national and local needs is also highly speculative. The global South and marginalized sectors, especially women, are already bearing the brunt of environmental deterioration and climate change and are also likely be the guinea pig for testing these powerful technological packages.

The public and private sectors, mainly in rich countries, have poured staggering quantities of research and development funds into these technologies. For example, agribusiness invests at least US$100 million to develop each herbicide-tolerant crop variety that is marketed together with the companies' proprietary chemicals. Global public investment in nanotechnology research has exceeded US$50 billion since 2000, with more than 60 countries now having national nanotechnology initiatives (ETC Group, 2010). The leading global investors and developers of synthetic biology products include six of the ten largest chemical companies, six of the ten largest energy companies, six of the ten largest grain traders, and the world's seven largest pharmaceutical companies (ETC Group, 2012). All the processes and products developed by these companies are protected by intellectual property rights that ensure monopoly control, and profits.

Many governments in developing countries see access to new technologies as vital to their ability to respond to developmental and environmental challenges. They are therefore anxious to ensure that legal and institutional obstacles such as intellectual property rights regimes and licensing arrangements do not impede access. Technology development and transfer, however, do not necessarily involve assessment of the impacts that such technologies may have on human health, environment and livelihoods. Thus, as the tragic history of many technologies has already shown, technology transfer can amount to dumping unwanted and untested technologies from industrialized countries onto developing regions. Not recognizing the importance of technology assessment and mechanisms involves high economic and political costs for proponents and regulators respectively, and can often have irreversible impacts on human health and the environment (ETC Group, March 2012).

This is especially the case with these new technologies, many of which are being allowed to reach the market without long-term safety tests and/or regulations, and often without labels and adequate information about the processes and risks involved being made available to the consumer. Controversies over the adverse effects of GMOs on human health, biodiversity and the environment

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[3] In the face of perennially low and volatile prices for primary export commodities, and the persistent poverty experienced by many workers who produce commodities, few would argue in favour of preserving the status quo; however, preserving the status quo is not the issue. The immediate and most pressing issue is that new technologies are likely to bring huge socio-economic disruptions for which society is not prepared.

have been raging since the mid-1990s for example. Despite that, GM varieties of maize, soybeans and cotton are now cultivated on an estimated 160 million hectares of land in about 25 countries (ISAAA, 2012). Similarly, by 2011, over 1,300 products of nanotechnology had come to market, with virtually no regulation in place despite dozens of scientific studies showing the toxic effects of some nanomaterials (Wilson Center, PEN online inventory). Ironically, low technology-awareness prevails in the age of high-tech.

More worryingly still, the UNEP Foresight Report, “21 Issues for the 21st Century,” notes that the pace of introducing new technologies has increased while the role played by regulatory bodies in protecting the public from the consequences of new technologies has actually diminished (UNEP, 2012: 40). The situation is both ironic and alarming given the rapid introduction of new technology products into ecosystems and the food chain. These lapses in technology governance are happening at precisely the same time that citizen concern over the safety of technologies is growing and the public’s lack of confidence in the ability of governments to protect its interests is increasing. Technology-related disasters, including ‘Mad Cow’ disease and Foot and Mouth disease (mostly in industrialized countries) and, later, the rapid spread of genetically modified crops, have contributed to this distrust (ETC Group, 2012). The meltdowns at three of Fukushima’s reactors in 2011 did nothing to improve the situation. Meanwhile, unlabeled and untested products of nanotechnology have come to market, and products of synthetic biology will arrive soon.

The situation in the conventional chemicals sector is relevant and revealing. According to an OECD study cited in the UNEP Foresight Report, very few of the 1,500 most commonly used chemical substances in industrialized countries have been adequately assessed for their health risks; 10% have not been examined at all; and virtually none have been examined for their environmental effects (UNEP, 2012: 40). Yet, global chemical markets, including agrochemicals/pesticides, are growing and becoming increasingly concentrated (ETC Group, 2011). The ten biggest agrochemical companies control more than 90% of the global market, for example. A disturbing trend cited in the “OECD Environmental Outlook to 2030” is the shift of chemicals production from traditional hubs in industrialized countries to emerging economies in developing countries, where regulatory regimes are even less stringent and oversight capacity is much lower (OECD, 2008).

These developments and trends have understandably contributed to a widespread view that risks and unintended side effects multiply in parallel to scientific-technical progress and as a result of that progress (Maasen and Merz, 2006:10). As the recent history of global controversies over technologies involved in nuclear power, GMOs and industrial food production shows, different experts can hold different, often contradictory views while claiming a grounding in ‘sound science,’ leaving the public confused, feeling powerless and distrustful of the experts relaying the information. As a result, science is no longer regarded as a producer of unambiguous knowledge (Grunwald, 2002 in Maasen and Merz, 2006).

The invisible dimension: gender and technology

Gender concerns in technology are often overlooked. As one feminist scholar has observed, the “technology question in feminism is generally neglected” (Faulkner, 2000). Gender being a ‘non-issue’ in technological discourses is largely due to the pervasiveness of the concept of ‘technology neutrality.’

As the minority in ‘hard technology’ fields such as engineering, women are generally regarded as recipients of technology rather than creators of technology, while, conversely, they are regarded as nurturers of nature and the environment (McIlwee and Robinson, 1992 and Edwards, 1996 in Faulkner, 2000). As a result, women’s power with regards to technology is relegated to exercising ‘consumer choice’ over products that are made commercially available to them (Faulkner, 2000:15). But as consumers, women are being exposed to the risks involved in food and consumer products of genetic engineering, nanotechnology and synthetic biology, often with no or little information being provided to them by technology owners/sellers. Indeed, it is often the case that the adverse consequences of these new technologies are not known, and by the time unexpected consequences become apparent, the technology is already well-entrenched (referred to as the 'Collingridge Dilemma'), often with irreversible impacts. This quandary is evident in the case of GM crops and foods whose risks to human health and the environment came to global attention only after the products had been introduced into the human food and animal feed supply systems (UCS, 2004). The same story is echoed in products of nanotechnology, which are prematurely designated as 'clean' even though credible institutions have barely begun to look into the safety of the technology.

The new manufacturing methods involved in technology platforms such as nanotechnology and synthetic biology will also impact women in other ways as well, including through commodity replacement or displacement, as described above; choice of employment and manufacturing locations; and impacts on global markets for natural resources ranging from copper to cotton and from natural fibers to vegetable oils, on which the livelihoods of millions of rural women depend. In particular, as synthetic biology aims to produce high-value compounds through new bio-fermentation methods and nanotechnology aims to alter substances to exhibit new properties, the impacts of these technologies on the exporters of natural commodities (mainly produced in developing countries) could be profound, while the products themselves could end up being hazardous. The risk of livelihood displacement is especially relevant for women in developing countries: on average, women make up 43% of the total agricultural labour force in developing countries (although only 20% of landholders are women) (UN, 2012; FAO, 2010).

Muted right: women and technology

As the principal international legal instrument on women's rights, the Convention on the Elimination of Discrimination against Women (CEDAW) enshrines the right of women in rural areas to access appropriate technology (along with access to credit and loans, marketing facilities, and equal treatment in land and agrarian reform and in land resettlement schemes). However, CEDAW is silent on the right of women in urban and peri-urban areas to appropriate technology and completely fails to acknowledge gender concerns in technology. With its silence on the relationship between technology and women, CEDAW implicitly perpetuates the prevailing condition of women being passive recipients of new technologies with no active role in decision-making with respect to the technology development process.

Just like all other intergovernmental agreements and processes that involve years of negotiations and compromises, CEDAW has greatly underestimated the speed of technological change and the impact some key technologies may have on the global environment, climate change, and the South's economy. Even more so in fact, given that this agreement was negotiated and adopted by states in the 1970s when the impacts and influence of technological innovations were not as dramatic as they are now. The massive influence of new technologies in shaping today's world economy and socio-political relations merits a review of CEDAW and other international legal instruments on the protection of the rights of women, taking the gender dimension of new technologies into account.

Facing a blank wall: where's gender in technology governance?

There is a consensus view among global institutions and experts that there is little substantive effort to assess, let alone try and control the introduction of new technologies to minimize harmful effects (UNEP, 2012; ETC Group, 2011; Unger, 2002). Technology governance is virtually absent in today's real world where the products of high technology dominate many peoples' lives.

Conducting a literature search on the gender dimension of technology governance can be likened to searching for the proverbial needle in a haystack. Scholarly writing or documentation of actual experiences and reflections on this topic is virtually non-existent – beyond the sparse literature on the gender question in technology in general and the more recent focus on gender and governance in the information and communication technology (ICT) sector.

Women are at the forefront of dealing with the unintended and unpredictable consequences of new technologies, but are not yet empowered to assess their relevance, alternatives and potential impacts. Gender concerns cannot be dismissed and women's rights as active actors cannot remain muted if technology is to become a tool to attain sustainable development.

Making technology work for sustainable development

Many civil society organizations, including women's organizations and health movements, have called for a ban on GMOs and a moratorium on nanotechnology until the socio-economic and health and environmental implications are understood. Despite these calls, this new Industrial Revolution is marching ahead almost entirely unmonitored and unregulated.

It would be unforgivable for any post-2015 agenda to ignore, remain silent on or underestimate the importance of addressing technology issues. A relevant and forward-looking post-2015 agenda must include the following key strategies to ensure that technology will contribute to the attainment of sustainable development.

Firstly, strategies must be developed to integrate grassroots participation and gender concerns in decision-making in technology development, including in the design of technologies as well as in the context of their use. However, the increased and active participation of local people and women in decision-making about new technologies will lead to sustainable development only if it is linked to a radical vision and agenda for the transformation of technology into "a practice that is more democratic and respectful of diversity, and with products which are safer, friendlier and more useful" (Faulkner, 2000: 18).

Second, technology assessment must be made an integral component of technology governance; and gender perspectives on technology must be integral to any such technology assessment framework. Women must be key actors in technology assessment at different levels and stages of the technology development process. To this end democratic mechanisms for assessing new technologies must provide meaningful opportunities for recipients and users of the technology, including women, to participate in the design, decision-making and assessment of the potential impacts that these new technologies might have on health, economy, livelihood, culture and the environment. These processes must be put in place at the local, national and regional levels.

Third, at the intergovernmental level, the logical prerequisite to technology development and transfer is the creation, by the United Nations, of a technology evaluation and information mechanism that is based on the precautionary principle and supports national sovereignty and technology policy choices. As reaffirmed in the Rio+20 outcome document, governments must go beyond rhetoric and operationalize the commitment to strengthen "international, regional and national capacities in research and technology assessment, especially in view of the rapid development and possible deployment of new technologies that may also have unintended negative impacts, in particular on biodiversity and health, or other unforeseen consequences." (UNCSD, 2012: para. 275)

The UNEP Foresight Report itself urges policy makers to "consider…organizing a new international governance system which would produce, and potentially oversee, new international procedures to identify dangerous side effects of technologies and chemicals before they are produced" (UNEP, 2012). It suggests that such a governance system would be anticipatory, impartial, aware of the need to deal with the risks arising from interactions among multiple technologies developed for different purposes, and universal. It must also ensure that individual countries and their corporate interests do not make decisions that can have global impacts unilaterally (UNEP, 2012). The report urges policymakers to work together with the scientific, environmental and other stakeholder communities to determine what a new governance system should look like.

Technology Assessment at the core of Technology Governance

Technology assessment (TA) is a concept that originated in the early 1970s reflecting attempts to analyze and evaluate the impacts of applications of scientific-technical knowledge in modern society (Maarsen and Merz, 2006: 11). TA aims to address concerns about the unpredictability of technology impacts, and to address the lack of public trust that results from controversies over technologies. TA is regarded as a response to the Collingridge Dilemma mentioned above, which posits that by the time unintended and/or undesirable consequences are discovered, the technology is already well-entrenched meaning that control is extremely difficult and change is expensive and time-consuming (Collingridge, 1980 in Nordman, 2010:5).

In order to be effective, technology assessment needs to be anticipatory, comprehensive, inclusive and oriented towards decision-making. Recent experiences and methodologies developed in some countries in Europe demonstrate that TA is not limited to considering the potential consequences of an emerging technology but also includes its social and cultural context and determinants of its emergence, acceptance and application (Maarsen and Merz, 2006: 11).

Interest in TA increased in the 1970s and through the 1980s, with the creation of assessment institutions in the United States and across Europe, but the trend reversed in the 1990s and interest declined throughout the decade (Unger, 2002). Ironically, in the years after the Rio Earth Summit in 1992, the capacity of governments and the international community to undertake technology assessment and evaluation diminished. Immediately following the Earth Summit, the UN Center on Science and Technology for Development (UNCSTD), first established in 1979, was drastically cut back from its significant New York offices to a small secretariat housed within UNCTAD in Geneva. Simultaneously, the UN Centre on Transnational Corporations (UNCTC), which monitored the major industries developing new technologies, was eliminated altogether. Some national technology assessment facilities – existing mainly in industrialized countries – were also diminished or eliminated. In the mid-1990s, for example, the US Congress's Office of Technology Assessment (OTA) was shut down. The collapse in the ability of governments to assess new technologies took place at exactly the point in time when it was most needed – as the world moved to liberalize trade and financial systems in pursuit of economic growth and, as indispensable to that strategy, unleashed the most rapid, and broadest, expansion of new technologies in history (EEA, 2011) .

Beginning in the new century, however, at least a dozen industrialized countries have moved to resuscitate or strengthen their technology assessment capacity. Within the European Union, for example, the Science and Technology Options Assessment (STOA) organ of the European Parliament, which was established in 1987, was updated, in 2004 and in 2009. Assessment mechanisms in at least nine European countries — including Germany, Switzerland, Denmark, the United Kingdom, Finland, France, Greece, Italy, and the Netherlands — have been strengthened and upgraded to respond to the rapid advance of technological innovations and growing concerns among their citizenry about the consequences of emerging technologies (ETC Group, 2012). It should be noted, however, that over the same period, other government bodies directly and indirectly involved in assessing technology impacts experienced diminished capacity or were eliminated altogether. In 2010, for example, the UK abolished its Sustainable Development Commission as well as the Royal Commission on Environmental Pollution [RCEP]. A 2008 investigation by the Union of Concerned Scientists also revealed that more than half of the 1,600 scientists at the US Environmental Protection Agency reported political interference in their work during the previous five years (UCS, 2008: 2).

Opposition to technology evaluation can be expected from some industries and governments. Arguments against undertaking technology assessments historically revolve around protestations that the assessments are premature – or, alternatively, too late – are too costly, or are not worth the potential delay in commercial deployment or risk to competitive advantage (ETC Group, 2012). However, there is reluctant recognition from many parties, and within the UN, that 'business as usual' is not working. In the absence of any technology assessment mechanism to deal with intergovernmental concerns and transboundary issues, the UN has had no structural alternative but to adopt three moratoria related to new technologies since the beginning of the 21st century, namely, on GURTs (genetic use restriction technologies, or Terminator seeds) in 2000; on ocean fertilization in 2008; and a general moratorium on climate-related geoengineering in 2010, which was reaffirmed in 2012 – all under the aegis of the Convention on Biological Diversity (CBD).

From the UN to states: building technology assessment capacity

Rio+20's outcome document, "The Future We Want," reaffirmed the commitment of the international community in 1992 to strengthen the capacity of countries to pursue national and regional technology assessment initiatives (as embodied in Chapters 34 and 35 of Agenda 21). Nevertheless, the UN system has no credible capacity to evaluate technologies or to advise governments. Furthermore, the use and application of technologies will vary from country to country because of the extraordinarily different health, environmental and socioeconomic conditions that might apply. Thus there is an urgent need for both a global and national-level monitoring and information-sharing capacity that includes the full participation of civil society – especially the indigenous and local communities that will be affected, with a particular effort to include the views of women.

There are several ways to operationalize this commitment to move toward a technology assessment and information mechanism, which has remained unimplemented since 1992. One is through the establishment of a Technology Assessment Service under the strengthened UNEP, which could establish a dedicated secretariat to service the needs of governments. Another is by reinvigorating UNCSTD with more staff, resources and an expanded mandate to monitor technologies and share information under the guidance of an intergovernmental committee. A reinvigorated UNCSTD should serve as the key UN body that provides up-to-date information and capacity to regional and national institutions in terms of conducting technology assessments, and it should be adequately supported to operationalize its mandate.

It is important to note that the multilateral system's technology assessment capacity does not need to reside within an environmental network or institution *per se*. A more strategic approach would be the creation of an International Convention for the Evaluation of New Technologies (ICENT) under the UN General Assembly, which would have the advantage of being able to address the socio-economic as well as the environmental aspects of new technologies. ICENT should aim to create a socio-political and scientific environment for the sound and timely evaluation of new technologies in a participatory and transparent process that supports societal understanding, encourages scientific discovery and facilitates equitable benefit-sharing (ETC Group, March 2012).

Institutional capacity to identify and monitor significant technologies must include an evaluation of their social, economic, cultural, health and environmental implications. UN monitoring and assessment of new technologies must be based on the Precautionary Principle and assessments must be completed before a new technology is released.

In order to minimize waste and risk, the monitoring process should accompany the development of the technology from science to shelf. Any technology assessment body established (or reinvigorated) at the UN must have 'teeth' to assert the integrity of the multilateral community and to counter unilateral or 'coalition of the willing' impositions of dangerous or untested technologies with global impacts. This should include the establishment of a legally-binding prohibition on all forms non-UN-sanctioned deployments that have the potential to cause harm to the planet, such as geo-engineering technologies (ETC Group, 2012).

At the regional, national and local levels, governments, civil society, social movements and communities must be encouraged and supported to establish technology assessment platforms or mechanisms that will allow key sectors and potentially affected communities to directly participate in the evaluation of emerging technologies. Gender perspectives must be integrated in the framework and approach of any technology assessment model.

A first promising mark on the current blank wall of gender and technology assessment is the proposal for a critical feminist technology assessment that seeks to extend existing technology assessment procedures to give full voice to the range of interested groups in technological design and to begin assessments with a critical debate about which technologies are needed and whose needs will be met by them, rather than focusing only on technologies already in use (Morgall, 1993, cited in Faulkner, 2000:17).

A recent report submitted by the UN Secretary-General to the UNGA, in response to the request made by member-states in the Rio+20 outcome document, recommended the establishment of an international network of technology assessment centres and/or national and global advisory groups on technology assessment and ethics as important elements of a global technology facilitation mechanism (UNGA, 2012: 16). Any such technology assessment platforms must be democratic, participatory, inclusive, comprehensive and proactive. Women, as key users and consumers of products of most emerging technologies, must be actively involved in technology assessment processes, as well as indigenous and local communities, which are generally the least prepared to deal with the unforeseen consequences of technologies and are virtually never consulted in the technology development process.

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