

RESEARCH ARTICLE

Decolonizing technology assessment: Towards a radical transformation of the modern world

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Abstract • This research article makes a conceptual contribution to decolonizing technology assessment (TA) by highlighting the persistence of colonial relations, not only between nations but also between different ways of knowing and being. Beyond the modern, these ways are often categorized as Indigenous, traditional, vernacular, artisanal and local. Against many such ways, the modern world has enacted colonial relations of superiority and supremacy, control and domination, as well as extraction and appropriation. To help transform these globally extensive relations, we call to decolonize TA through radical care for the social-material bases of colonially marginalized ways of being and knowing. This means that TA should enable refusals of modern innovations if they are likely to damage those social-material bases. Furthermore, radical care in TA means practicing solidarity with decolonial movements that directly confront entrenched colonial relations behind modern concentrations of power and privilege. We support our arguments with brief examples from agriculture.

Entkolonialisierung der Technikfolgenabschätzung: Hin zu einer radikalen Umgestaltung der modernen Welt

Zusammenfassung • Dieser Forschungsartikel leistet einen konzeptionellen Beitrag zur Entkolonialisierung der Technikfolgenabschätzung (TA), indem er das Fortbestehen kolonialer Beziehungen nicht nur zwischen Nationen, sondern auch zwischen verschiedenen Wissens- und Existenzweisen hervorhebt. Über Kategorien der Moderne hinaus werden diese oftmals als indigen, traditionell, alltagsbezogen, handwerklich und lokal eingestuft. Vielfach hat die moderne Welt ihnen koloniale Beziehungen der Überlegenheit und Vorherrschaft, der Kontrolle und Beherrschung sowie der Ausbeutung und Aneignung auferlegt. Als Beitrag zur Transformation der globalen Beziehungen rufen wir dazu auf,

die TA durch radikale Fürsorge für die sozial-materiellen Grundlagen kolonial marginalisierter Wissens- und Existenzweisen zu dekolonisieren. Das bedeutet, dass TA die Ablehnung moderner Innovationen ermöglichen sollte, wenn sie diese sozial-materiellen Grundlagen schädigen könnten. Darüber hinaus bedeutet radikale Fürsorge in der TA Solidarität mit Entkolonialisierungsbewegungen zu üben, die sich gegen moderne Konzentration von Macht und Privilegien sowie dahinterstehende etablierte koloniale Beziehungen stellen. Wir unterstützen unsere Argumente mit kurzen Beispielen aus der Landwirtschaft.

Keywords • sustainable development, colonial modernity, radical care, pluriversal flourishing, agricultural sustainability

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Introduction

Technology assessment (TA) has been central in attempts to democratize modern techno-scientific developments (Grunwald 2019). Serving as a bulwark against technocracy, TA has mobilized a range of concepts and methods including participatory techniques, precautionary principle, responsibility (and anticipation) in innovation governance, care ethics, and even anti-colonialism. Despite these major achievements, however, TA approaches neglect that modern technosciences are developed within a world made by colonial relations over five centuries since the first genocides in the Americas (Quijano 2000; Gaonkar 2001). It is this modern world that is now globally hegemonic in its many forms and lies behind the development of industrial agriculture based on technologies such as genetically engineered crops and massive irrigation infrastructures (Arora and Van Dyck 2021). Conceptualizing this world as *colonial modernity* (Arora and Stirling 2023), we argue that TA must help confront and transform modern world-making so that colonially marginalized ways of being and knowing can once again thrive.

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Our times are deeply affected by social-ecological crises of many kinds including wars and biodiversity losses, as well as climate injustices and vast inequalities, which are linked to the widespread use and development of modern techno-sciences. While TA has made crucial contributions to governance of innovation for sustainability, many social-ecological crises have worsened in the last five decades. In this context, it is important for TA to move beyond governance of individual innovations and help pluralize directions in modern progress (Stirling 2008). More critically, TA must help confront historically entrenched patterns of social-material and political-ontological relations that

techno-sciences may be unknown and causal chains may be unpredictable (Wynne 1992). Where uncertainties are not reduced to risk, the precautionary principle (PP) may be foregrounded (Stirling 2014). PP mandates that technology governance must not wait for full scientific certainty, if there are *possibilities of undesirable health and environmental effects* (Harremoës et al. 2001). Precaution thus requires action for protection by regulating or postponing the use of an innovation. It is perhaps for this reason that PP is opposed by political and economic interests behind innovations, and labelled as ‘anti-science’ or ‘anti-innovation’ (Stirling 2014).

Addressing social justice and ecological integrity, care-based approaches usefully extend earlier work on uncertainties and precaution.

16

make and receive modern techno-sciences (Quijano 2007; Arora et al. 2020). These underlying relations that constitute colonial modernity in its different forms, resist change even as they make all kinds of novel techno-sciences promoted as inevitable or sustainable (Arora and Stirling 2023). We discuss six such relations that are tangled up with each other in modern technological developments and call to re-imagine and re-enact TA concepts and methods for transforming colonial modernity.

These six relations are: assuming comprehensive superiority, extending imagined control, enforcing gendered domination, appropriating cultural privileges, asserting military supremacy and expanding toxic extraction (Arora and Stirling 2023). They exist not just between nations and racialized groups, but also *between different worlds* that underpin many ways of doing knowing (beyond colonial modernity’s sciences and technologies). We argue that decolonial TA foregrounds radical care for social-material bases of Indigenous and other colonially marginalized ways of knowing and being. This means that TA efforts must enable refusals of modern innovations where they are appraised as carrying possibilities of exploiting colonially marginalized worlds, no matter how uncertain or ambiguous such appraisals might be. Further, decolonizing TA means solidarity with social movements and struggles to dismantle colonial relations that underpin modern concentrations of power and privilege.

Assessing modern technology

Since the 1970s, TA approaches have developed valuable insights into the precautionary principle; participatory decision-making processes; and contested values in society to underscore responsible research and innovation (RRI).

Uncertainties inherent to techno-sciences can be reduced to probabilistic risk of well-defined possible occurrences (Callon et al. 2009). This reduction overlooks that futures afforded by new

Such labelling, however, neglects that precaution in TA aims to empower social choice. PP may mean the rejection of toxic innovations such as synthetic pyrethroids and neonicotinoids (Maderson 2023), but it also means the steering of innovation along many alternative possible pathways. Precaution therefore is about enabling techno-scientific pluralism (Stirling 2014).

Beyond precaution, to deal with uncertainties and mobilize robust evidence from diverse actors including the most marginalized, TA has embraced participation at all stages of innovation (e.g., constructive technology assessment: Schot and Rip 1997). Participatory TA is considered crucial for gaining greater legitimacy of governance decisions (Grunwald 2019). Participation can improve social learning and collaboration among ‘lay citizens’ and ‘expert practitioners’. However, in settings saturated with asymmetric power and privilege such as the promotion of ‘smart’ agricultural technologies among smallholders, participatory processes can be easily instrumentalized. For instance, some participants’ perspectives may be cherry-picked to suit entrenched interests. Thus, participation can be enacted to put “democracy at the service of technocracy.” (Ghosh and Arora 2022, p. 320)

Arguably to address such issues (van Lente et al. 2017), the last two decades have seen the rise of RRI (Stilgoe et al. 2013). Central here are ethical concerns about emerging technologies, including genome editing techniques like CRISPR/Cas9 and newer insecticides, herbicides, fungicides and nematicides for ‘crop protection’ (Maienfisch and Koerber 2024). However, using academic discourses of anticipation, reflexivity, inclusion and responsiveness (Stilgoe et al. 2013), RRI can inadvertently end up legitimizing highly controversial innovations through their ostensible embedding “in ethical principles accepted by society” (Gremmen 2023, p. 201). Thus, RRI can jeopardize hard-fought gains made for democratizing innovation through TA’s institutionalized precautionary and participatory processes (Delvenne 2017). Playing limited role in enabling social choice over diverse

possible directions of innovation, RRI also neglects how entrenched political formations of colonial modernity close down alternatives (Stirling 2024).

RRI and other TA debates have nevertheless engaged with the concept of modernity, particularly following Beck's (1992) argument of *reflexive modernization*. Due to its focus on governance of risks associated with industrialization, TA is seen by some proponents as directly attuned to reflexive modernization (Hennen 1999; Grunwald 2019). Modernity is also prominent in TA debates on globalization (Hennen et al. 2023). Approached mainly as the extension of the 'West' into 'developing' countries, globalizing modernity is seen as posing significant challenges to TA approaches focused on wealthy nation-states. In this context, the usefulness of a diversified 'global TA' is appreciated but seen as a distant reality (Grunwald 2019). Such engagements with modernity, however, neglect its colonial constitution.

Extractive relations are underpinned by colonial fantasies of control.

Feminist perspectives

Feminist TA approaches go beyond "inclusion in existing unequal systems and structures of knowledge production", to question "the underlying discursive and material power relations that enable exclusion" (Hackfort and Saave 2024, p. 2). Feminist approaches foreground *politics of care* around modern techno-sciences (Martin et al. 2015), which includes deliberating gendered divisions of labour and resisting the externalisation of technologies' socio-ecological consequences (Hackfort et al. 2024). Addressing social justice and ecological integrity, care-based approaches usefully extend earlier work on uncertainties and precaution (Whittingham and Wynberg 2021).

Feminists caution against an "intentionally *feminized* ethic of care" (MacGregor 2004, p. 61, italics in original), which can essentialize women's subjectivities. Grounded instead in everyday practices and diverse relations, politics of care go beyond presumably stable identities and abstract conceptions of rights and justice (Martin et al. 2015). In particular, affect is articulated to center care in TA. Affect recognizes multiple rationalities and emotions – including gut reactions and moral doubts – in people's relations with technologies. Care also means attending to shifts or ruptures in relations afforded by new technologies (Wickson et al. 2017).

Examining biotechnology regulation in South Africa, Whittingham and Wynberg (2021, p. 8) note that care can help reimagine and redesign relationships to move beyond "values of a patriarchal-technological culture that stems from colonial and developmental ideologies of yield, productivity and efficiency". Care-based approaches to TA thus need to be situated against the wider (post)colonial context of modernisation (Arora et al. 2020).

Indigenous perspectives

Indigenous studies scholars highlight how colonialism is omitted from sustainability claims of modern technologies and from Eurocentric studies of their governance. For example, scrutinising settler-colonial genetic engineering of salmon in the USA, Schneider (2022) shows how modern TA overlooks Indigenous knowledges developed over thousands of years of observing and experiencing salmon. By ignoring historically accumulated knowledges and Indigenous ways of knowing, TA exercises may conclude that an industry is "safe" for wild salmon, while it is nothing of the sort. Contrasting forms of Indigenous TA not only take plural values seriously but also appraise how technologies can play a "restorative role in the continual rebalancing of the world" (Schneider 2022, p. 246).

Examining corn seeds in Hawaii's industrial food system that relies on privatisation of Indigenous lands and germplasms (and TA that neglects Indigenous alternatives based on care for

the land and on connections between communities' and lands' health), Gupta (2015) frames activism against genetically modified corn as part of the Kanako Maoli' struggles to foreground *Aloha 'Āina* or love for the land. Similarly, Maori scholar Baker (2012) calls for collectivist views in assessments to undo hierarchies between 'experts' and 'lay' people, supporting calls for TA frameworks that rely on Indigenous values.

Anticolonial proposals made from settler contexts in the Global South include: a) situating the regulation of genetically modified seeds in modernist ontologies that marginalize alternative ways of knowing (Whittingham et al. 2024); b) countering neoliberal claims of individual ownership over seeds by accounting for modern agriculture's displacement of Indigenous seeds and associated agricultural practices (Jimenez et al. 2022). Resulting deskilling and loss of knowledges are challenged through struggles for on-farm restoration of genetic and epistemological diversity, led by Indigenous and other smallholders (Montenegro de Wit 2016).

Decolonizing technology assessments?

Struggles for epistemic diversities, may entail the refusal of modern innovations that harm the same diversities. This refusal is more than just resistance to specific modern technologies, it is also a political choice to embrace alternative techniques (Van Dyck et al. 2022). Refusal is thus simultaneously "a movement of exit and a process of invention" (Weeks 2011, p. 100). Refusals of biotechnological, digital, chemical and aerial technologies in modern agriculture may seek to sustain alternatives: 'traditional' seeds, animal manures, smallholders' land rights and cultivation practices, and Indigenous, artisanal and agroecological ways of

knowing (Arora and Van Dyck 2021). Refusals may therefore be acts of radical care towards other worlds providing social-material bases to diverse ways of knowing and practices of living with lands, seeds, water and more.

The notion of radical care builds on feminist and Indigenous struggles that center life, while resisting and healing from violent predations of modern ‘resource’ extraction (Sultana 2022). Radical care is thus not only about countering (eco)modernisation that damages colonially marginalized worlds (Hobart and Kneese 2020), but also about practicing solidarity with alternative ways of knowing. It is by using these alternative ways that colonized peoples have historically made many worlds of life-sustaining practices (Portocarrero Lacayo 2024). Moving beyond colonial relations between nations and cultures, radical care challenges modernity’s colonial encounters with other worlds across the Global South and North (de la Cadena and Blaser 2018).

re-legitimized as responsible and just innovations (Ludwig and Macnaghten 2020).

Modernity’s integrative and assimilative tendencies must be situated in pasts and present of colonial appropriation of artisanal, ecological, economic, epistemological and spiritual privileges from colonized worlds (Arora and Stirling 2023). Without confronting and dismantling modernities’ constituting appropriations, calls for integration (of Indigenous knowledges for example) and even for epistemic diversity in sustainability transitions (Balanzó-Guzman and Ramos-Mejia 2023), can further concentrate power and privilege in the modern world at the expense of other worlds.

Similar to appropriations, colonial relations enact modern powers’ extraction from other worlds. Objects of this toxic extraction are all kinds of materialities associated with land (above and below the ground), labour, water, knowledges and cultural

In dismantling of colonial relations thrives the hope that many worlds can undergo reparations to flourish together in divergence.

Being more than just nations and cultures, social-material worlds involve deeper ontological foundations of ways of knowing (de la Cadena and Blaser 2018). Thus, Indigenous, artisanal, agroecological and industrial ways of knowing are not simply different epistemological cultures approaching the same ‘nature’ and grasping the same reality, but rather they help make many realities. In some ontologies underpinning such ways of knowing, the modern category of ‘nature’ divided from cultures might not even exist. A diversity of such ontologies is associated with Indigenous peoples and other artisanal and agroecological communities. It is the making of many worlds through such ontologies, that is obscured by colonial relations that privilege modern categorial divides of nature vs. culture and subjects vs. objects (Escobar 2020). Thus, many worlds as variously entangled ‘culture-natures’ – based on diverse ontologies – are either marginalized or assimilated by colonial modernity.

Allying with Indigenous, artisanal and peasant struggles to stop damage and exploitation of their land and ‘resources’, we articulate radical care as challenging colonial modernity’s six constituting relations (Arora and Stirling 2023). We propose that this six-fold challenge be made central in TA, to help imagine and enact reparations for colonially marginalized and damaged worlds.

Modernity firstly works through assumptions of its technosciences’ superiority – often based on its claims to singular objectivity – over artisanal and agroecological ways of knowing based in indigenous and other colonized worlds (Arora and Stirling 2023; Ajwang et al. 2023). Where such ways of knowing are acknowledged as valuable, focus can be on their integration into modern technosciences. Grounds for such assimilation may be strengthened if modern technosciences are re-framed or

symbols (Gómez-Barris 2017). These may then be translated into modernity as resources for monocultural plantations and wider industrial agricultures (Kröger 2021). At the same time, modernity’s material messes such as toxic wastes, trails of industrial agriculture and cheapened products are dumped on marginalized communities and worlds (Patel and Moore 2017). Without confronting such relations, participation of plural perspectives in TA can serve to hide and inadvertently legitimize colonial modernity’s toxic-extractive relations.

Extractive relations are underpinned by colonial fantasies of control. These are enacted not only on categorically divided modern ‘nature’ and racialized people othered by national and cultural borders (Arora et al. 2020). They are also enacted on entire worlds. Such relations may involve the deployment of surveillance and enumeration technologies, to fence and survey Indigenous and colonized worlds as ‘reservations’ or ‘protected territories’ (West et al. 2006; Mamdani 2020). Socio-material change in these worlds may also be controlled and managed by modern (agricultural) development and conservation experts.

Border zones between worlds may be technologically militarized, also in order to facilitate the appropriation of plants, trees and extraction of land (e.g., in Amazonia: Domingues and Sauer 2023). It is through technologies of extreme violence that moderns assert military supremacy over other worlds (Arora and Stirling 2023, pp. 7). By neglecting colonial violence of military supremacy, mainstream TA fails to check the damage and destruction wrought on other worlds by modern societies.

Crucially, colonial relations mean that modern definitions of genders (including associated roles) are imposed on other

worlds (Oyewumi 1997; Lugones 2007). Such imposition may involve the definition of binary categories of men and women as ‘universally’ applicable roles in any society, thereby promoting and enforcing modern forms of gendered domination. This can include attempts to assimilate colonially marginalized ways of living into modern ones using promises of gender equality, while modernity itself remains replete with intersectional oppressions of racism, Islamophobia, classism and sexism (Ahmed 2024).

Attending to this coloniality of gender in TA efforts may entail the recognition of *infra-sectionality* (Arora and Stirling 2023), in which race, religion and class are not approached as separate ‘sections’ that exist *a priori* and then intersect with categories of gender. Instead, each gendered ‘section’ is constituted from within by a heterogeneous tangle of colonial relations (such as those discussed above). The same recognition then highlights a commitment to deep relational egalitarianism to be made central in TA concepts and methods of all kinds, also through solidarity with wider movements and struggles for confronting and transforming colonial modernities. Such solidarity might involve making central in TA processes, decolonial movements’ critical appraisals of innovations like artificial intelligence and genome editing (including their uses in agriculture), especially as those innovations are hyped up by modern powers as ‘the future’.

Conclusions

Ongoing colonial relations amidst widespread socio-ecological crises mean that TA efforts must help foreground *radical care* for indigenous and other colonially marginalized ways of knowing and being. Firstly, this entails supporting *refusals* of modern innovations through TA, where they are appraised as carrying possibilities of damaging colonized worlds that provide social-material bases of marginalized ways of knowing. More concertedly, making radical care central in TA methods and concepts means practicing solidarity with decolonial movements that directly challenge deeply entrenched colonial relations. Such relations can otherwise remain largely the same while making a whole range of modern innovations and the wider modern world.

None of the six colonial relations discussed above, is a discrete entity that works on its own. Because these relations are entangled with each other in different ways across the Global South and North, directing attention to just one relation (e.g., to counter assumed techno-scientific superiority in support of epistemic diversity, or oppose imagined control to promote technosciences based on values of care) can fail to check the unabated continuation of other colonial relations. The relations that remain unfaced and untransformed can weave back into the focal relation that is confronted, thereby thwarting the singular decolonial transformation that is attempted. Confronting any focal colonial relation must therefore address other relations that are directly entangled with it.

Decolonial transformations of TA thus go far beyond embracing epistemic diversity or techno-scientific pluralism (through precaution and participation), because diverse epistemologies and plural techno-scientific directions can still be encompassed by colonial modernity. Such transformations are about dismantling the web of entrenched relations that continue to make colonial modernity more and more globally hegemonic. In such dismantling of colonial relations thrives the hope that many worlds can undergo reparations to flourish together in divergence. Without contributing to this pluriversal flourishing, TA risks remaining a civilizing instrument of colonial modernity.

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