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Elgar Encyclopedia of Environmental Sociology

Bush, Simon R.; Spaargaren, Gert

https://doi.org/10.4337/9781803921044.ch33

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Introduction

Ecological modernization theory (EMT) emerged in the 1990s as an alternative means of thinking about environmental reform that was centred around "de-growth" and "small is beautiful" environmental activism. This de-growth movement focused on the perceived need for radical changes to societies emerging from capitalist industrial modes of production and the failure of nation-states to avert the environmental crisis as the environmental design fault of modernity (Jänicke 1990). EMT proposed analysing alternative conditions and pathways to environmental reform in which the dynamics of modernity, including capitalism and the nation-state, can be made to work towards sustainable production and consumption (Mol 1996; Spaargaren 2000). EMT frames the solution to the environmental crisis not in terms of short-term technology-driven transitions, but instead as a transition process in which ecological knowledges and interests gain crucial importance in the reproduction of societies (Mol 2002; Spaargaren 1997). Underpinning such a transformation, and positioning ecological modernization as a general theory of societal change (Spaargaren 2000), is the strong assumption that societies are able to reflexively undertake rational and self-critical processes of continued environmental reform.

The following outlines the five core areas of conceptual development that underpin EMT. This is followed by a discussion on the global relevance of EMT as a sociological perspective of environmental reform around the world and new frontiers of EMT research.

Five core features of EMT

EMT contributes to a sociological understanding of environmental reform by developing five core features that can be used to study environmentally led societal transformations from local to global scales. First, and arguably most fundamentally, EMT highlights the embedding of an emerging "ecological rationality" (Dryzek 1987) and its connected environmental discursive practices and ideologies. The assumed "parity" of an ecological rationality with both economic and socio-political rationalities underpins an EMT worldview and, with it, an ontological positioning of environmental goals and arguments as an indispensable part of decision-making practices by any set of societal actors – from states to corporations and civil society actors (Spaargaren 2000). The inclusion of this ecological rationality and its increasing importance in justifying practices and institutional designs underpin the longer-term, reflexive processes of environmental reform. To what extent and in what kind of ways ecological rationality becomes actually embedded in the practices and institutions of modernity depends on a range of factors, including prevailing modes and (power) relations of production and consumption, and the combined set of rules, norms and incentives set by state and non-state actors. The overall "emancipation of ecology" is dependent on the kinds of ecological realities of different stakeholders that – as Hajer (2020) has argued – are mediated by images, understandings, priorities and discursive framings in different locations of the global network society. These framings enable or close off environmental identities, practices and institutions that make future environmental outcomes thinkable and more (or less) likely. Based on such analysis, EMT scholars focus on the ways "strong" ecological rationalities can shape the reproduction of modern institutions and practices worldwide.

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Second, given this strategic importance of science and technology for sustainability, EMT interrogates the role of science and technology in processes of environmental reform around the world. In doing so, EMT accepts environmental problems as inherent side-effects of early industrial modernization processes, but also emphasizes the crucial role of science and technology as a means of progressing cleaner forms of production and consumption (Mol 2001). In early scholarship, the broadening of the concepts of "clean technology" and the "greening of industry" was argued for in order to arrive at a more preventive, more encompassing, and also more social science–informed approach to environmental transitions. To avoid a restricted techno-optimism (e.g., Szarka 2012), EMT scholars emphasized the need to focus on *socio*-technical systems of production and consumption while not restricting technological innovation to only one site or element of value chains and networks. Inspired by Ulrich Beck's (1992) risk society and Ulrich Beck and Anthony Giddens' notion of reflexive modernization (Beck, Giddens, and Lash 1994), EMT argues that environmental reform can emerge from the reinvention of modern institutions – evidence of which includes environmental networks in industry, environmental institutes in academia and global networks of environmental non-government organizations.

Third, ecological modernization theory explores transformations of the "environmental state" (see Mol 2010) to enable non-state actors to drive environmental reform. Linked closely to political modernization, EMT explores how the politics of left and right, which emerged largely in the context of the welfare state, are mismatched with the institutional requirements for safeguarding the environment (Arts and Van Tatenhoven 2006). Under such conditions, the environmental state has been shown to shift away from bureaucratic, reactive and command-and-control public institutions towards more flexible and decentralized institutions (Mol 2010). These shifts entail the involvement of non-state actors taking over service provision (e.g., Scheinberg and Mol 2010); forms of rule-making and enforcement (Oosterveer et al. 2014); and private partnerships and ambition setting (Howes 2018). It also involves the emergence of supranational institutions and governance arrangements that offer the state a new platform for environmental politics around transboundary issues once limited to water and air pollution and now linked to food, mobility, biodiversity and more (e.g., Boas et al. 2018; Cortes et al. 2022). As argued by Mol (2000), these shifts enable the emergence of "preventative institutions" based on networks of states supporting "sub-polities" of market and civil society actors. By building new alliances between economic (business) and environmental (NGO) interests, it is possible for these actors and institutions to dis-embed themselves from standard oppositional categories while moving beyond an exclusive emphasis on industrial, capitalist drivers of environmental decline.

Fourth, ecological modernization theory interrogates the role of economic and market actors and institutions in environmental reform. In doing so, EMT has moved beyond a productionist bias to emphasize how everyday consumption practices are not only influenced by decisions of individuals but by a range of green lifestyle groups acting under different conditions of access and use (Spaargaren and Cohen 2020). Next to this emphasis on the emerging power of the consumer, EMT scholars have investigated the role of market institutions extending beyond national production and consumption to a global web of chains and networks. Global markets are, as such, not only sites of exchange and accumulation, but also social institutions that enable "flows" of non-monetary values, information, and materials and services that contribute to the coordination of "eco-modernized" forms of production, trade and consumption through environmental certification, roundtables and state interventions such as the EU Farm to Fork Strategy (Bush et al. 2015). Furthermore, the greening of these markets is shaped by a range of extra-transactional actors, including financiers, insurance companies, business associations and infrastructure or utility companies, setting conditions for environmental conduct and performance. "Environmental states" also continue to play a central role in articulating environmental goals and reform processes through, for instance, monetary policy and public lending.

Fifth, EMT emphasizes the changing position, role and ideology of civil society towards advocating and performing processes of environmental reform under con-

ditions of globalization. Similar to market actors, this global environmental civil society has shifted from the periphery of global environmental institutions to a more central role in globalized political and economic decision-making (Spaargaren 2000). Under conditions of globalization, these civil society actors have taken on new functions that affect multiple institutions and sites of power that shape environmental reform. Following the wider logic of cosmopolitanism, these include market and political institutions, but also extend to changes in moral and cultural rules and norms that underpin environmental change (Held 2009). In doing so, EMT emphasizes how different sites of power combine to create hybrid forms of rule-making, as seen with non-state or private principles for "entrepreneurial" forms of conservation (Bottema and Bush 2012); environmental health and tourism (Atmodjo, Lamers, and Mol 2017); forestry and agricultural landscapes (Kotilainen et al. 2008); and a wide range of food sectors (Bush and Oosterveer 2019). Following Boström, Micheletti, and Oosterveer (2019), this re-embedding of civil society actors into new and often hybrid advocacy, regulation and partnership roles draws on a new rationality for steering rather than opposing societal actors towards positive environmental outcomes.

From Western to global relevance

The initial development of EMT in the 1980s and 1990s reflected in large part the rise of globalization and environmental reform in liberal Western democracies. Subsequently, however, evidence grew of different forms and modes of ecological modernization in a variety of political contexts – reflecting "real world" variation in environmental reform (as earlier argued by Buttel 2000). For example, China's incorporation of environmental reform, which has evolved into a policy programme of "ecological civilization", reflects processes of state-controlled transitions of private sector-led reform, market reform and (planned) public participation (Mol 2006; Zhou 2015). In Southeast Asia, and to a more limited extent in Africa, various patterns of environmental reform have been observed by ecological modernization scholars, noting variation in terms of modes of provision of environmental services of energy, water and waste (Van Vliet, Spaargaren, and Oosterveer 2010), in terms of small and medium-sized enterprises (e.g., Wattanapinyo and Mol 2013), different forms of advocacy for civil society actors and variation in the degree to which command-and-control regulation have been increasingly linked to new developmentalist agendas of the state (Dent 2018).

The variation of environmental reform around the world demonstrates the ongoing relevance of EMT as a social scientific framework of analysis that is aimed at theoretically specifying and empirically substantiating different routes for reflexive ecological modernization that are taken around the world. Different patterns of transitions between the US and EU, for instance, show different interpretations of risk, responsibility and liability for market reform, and public participation within similar "New Deal" programmes (see, e.g., Damiens, Porter, and Gordon 2021; Machin 2019). The ongoing aim of EMT is, as such, to enable sociologists to specify, learn about and help design long-term trajectories of social change under conditions of global modernity that involve embedding ecological rationalities in practices of production and consumption with the help of socio-technical and political innovations.

New frontiers of EMT research

EMT will remain a relevant and at the same time widely debated field of research within the environmental social sciences in the 21st century. Here we reflect on three areas where EMT can continue to shape debates on environmental reform: (1) the embedding of digital technologies in environmental governance; (2) the changing position of environmental reform in the new geo-politics of resource access; and (3) the renewed emphasis on inequality and identity and their effect on (the primacy of) ecological rationality.

First, EMT enables sociologists to focus on the role of digital technologies as social-technological infrastructures that are fundamentally shaping environmental reform across global space. Reflecting the work of Manuel Castells (1996), the design of these technologies and control over the flow of information through them constitute a new site for environmental decision-making (see also Mol 2008). The digital revolution is also a new site of politics in terms of how – and in whose ways -–design, access and accountability of environmental problems

can be digitally seen, known and managed (Kloppenburg et al. 2022). What effect digital technologies will have on improving environmental performance will likely depend on the degree to which they are able to legitimately embed ecological rationalities into their design. EMT-informed research can generate insights into the ways in which digital technologies can be made to realize their potential for enabling more (even artificial intelligence assisted) automated environmental surveillance systems next to "empowering" consumers and civil society actors in their roles as co-decision-makers of environmental social change.

Second, EMT scholars continue to explore the consequences of ongoing shifts in global geo-political power on environmental reform. An increased "politization" of markets and emerging new geo-politics of globalized resource competition have deep implications for environmental reform. Instead of a retreat of the state, and the gradual decoupling of state sovereignty with global environmental problems (Mol and Spaargaren 2000), the "contemporary" environmental state seems to be characterized by a strong "nationalistic reflex" (Beck, Bonss, and Lau 2003) in dealing with global environmental problems. For example, new resource frontiers are brought into transitions to low-carbon economies in the form of rare – "strategic"– earth minerals for renewable energy production (Vakulchuk, Overland, and Scholten 2020). Under these conditions, states, including the EU, US and China, are revising decisions on both devolving power to the market and extending state control to international environmental governance. Furthermore access to technologies needed for energy, mobility and food production are reshaping international relations with outcomes ranging from a fully cooperative "big New Green Deal" to a form of "dirty nationalism" by ringfencing technologies (Leonard et al. 2021). These trends raise fundamental questions for EMT on how environmental reform through market and normative power will be shaped into the future. The New Green Deal–related policies extending from the European Union and the extension of Chinese ecological civilization through the Belt and Road initiatives are just two illustrative cases.

Third, EMT will have to more deeply engage with the effects of social inequalities and the polarization emerging around issues of identity in order to specify and perhaps reconsider what is meant by the primacy of ecological rationality. To date, inequality, justice and polarization have not been theorized as processes of environmental reform. They have rather been looked at as either potential side-effects or broadly defined conditioning factors for environmental reform. As environmental reforms are put in place, and even "mainstreamed" in practices and institutions, questions of equity will remain relevant in terms of whose practices, institutions, and more fundamentally, visions for what type of environment will be central. Nevertheless, more attention is needed on how inequality can be emancipated from economic and political debates and embedded within the ecological rationality of environmental transitions – especially through the rise of digital technologies and the "new" frontiers of environmental geo-politics.

In spite of its relevance to understanding environmental reform under conditions of global modernity, EMT has in some ways gone out of academic fashion. This is in large part because of its association with the normatively oriented US school of ecomodernism that reduces modernity to technology-driven capitalism. Ecological modernization *theory* as discussed here can be said to offer a more agnostic framework for understanding processes of change towards society-wide environmental reform. Technology continues to play a role, as well as markets as a key global institution. In the same vein, there is not a singular focus on capitalism. Instead, capitalism is one of many modes of production and accumulation that can be subject to a process of reflexivity, modernization and, as such, environmental reform. Linking digitalization, the shift in balance back to state sovereignty and the inherent challenges of inequality offer opportunities for renewed debate on how ecological modernization theory can inform societal responses to the multitude of environmental challenges we face globally.

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