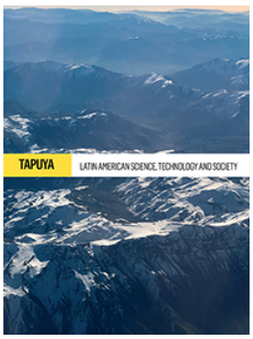

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Baroque tools for climate action. What do we learn from a catalogue of local technologies?

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ABSTRACT

This article presents some key aspects related to the development of the "local technologies catalog for climate action," a platform aimed at making visible different artifacts, strategies, and practices developed and/or adapted to mitigate a specific socio-environmental problem by communities in different territories of Chile. Relying on a long scholarly tradition on the emancipatory and transformative role of grassroot technologies, we reflect on the process of creating a catalog of local technologies and the nature and role of these technologies as tools for climate action. Together with discussing the main methodological challenges involved in the process of cataloging, we develop three theoretical aspects that emerge from the technologies that were mapped: how local technologies involve communities taking a central role in defining what is problematic in specific environmental problems; the different forms in which these technologies are valued; and the logics of combination, adaptation, and variation that underlie these technologies. Based on this, we propose approaching local technologies as a form of baroque tools that result from the situated assemblage and mixture of different logics, values, knowledge, and materialities. We finish discussing whether local technologies and the catalogue constitute a productive space to deploy more radical forms of climate action.

KEYWORDS
Local technologies; climate action; grassroot innovation; conviviality; sustainable transitions

PALAVRAS-CHAVE
Tecnologias locais; ações climáticas; inovação de base; convivência; transições sustentáveis

PALABRAS CLAVE
Tecnologías locales; acción climática; innovación de base; convivialidad; transiciones sustentables

Ferramentas barrocas para a acção climática: ¿O que podemos aprender com um catálogo de tecnologias locais?

RESUMO

Este artigo apresenta alguns aspectos teóricos e metodológicos fundamentais relacionados ao desenvolvimento do "catálogo de tecnologias locais para a ação climática," uma plataforma destinada a circular diferentes artefatos, estratégias e práticas desenvolvidas e/ou adaptadas para mitigar problemas socioambiental és em Chile. Ao fazer isso – e confiando em uma longa tradição acadêmica sobre o papel emancipatório das tecnologias de base – refletimos sobre a natureza e o papel das

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tecnologias locais como ferramentas para a ação climática. O artigo aborda quatro aspectos centrais. Primeiro, discutimos as principais características metodológicas e desafios envolvidos no processo de catalogação. Em seguida, desenvolvemos ainda três aspectos teóricos. Primeiro descrevemos como as tecnologias locais envolvem as comunidades assumindo um papel central na definição do que é problemático em problemas ambientais. Em segundo lugar, desembalamos as diferentes formas em que estas tecnologias são valorizadas em termos de seu valor de uso: elas estão enredadas na reprodução da vida comum em meio à crescente degradação ambiental. Em terceiro lugar, descrevemos as lógicas de combinação, adaptação e variação que estão na base de muitas das tecnologias que catalogamos. Com base nesta descrição, propomos abordar as tecnologias locais, como uma forma de ferramentas barrocas, que resulta da ensamblagem, combinação, e mistura de diferentes lógicas, valores, conhecimentos e materialidades. O artigo termina discutindo se as tecnologias locais constituem um espaço produtivo para implantar formas mais radicais de ação climática.

Herramientas barrocas para la acción climática: ¿Qué podemos aprender de un catálogo de tecnologías locales?

RESUMEN

Este artículo discute los aspectos teóricos y metodológicos asociados al desarrollo del "catálogo de tecnologías locales para la acción climática," plataforma destinada a circular artefactos, estrategias y prácticas desarrolladas y/o adaptadas para mitigar problemas socioambientales en Chile. Para ello -y con base en la tradición académica centrada en el papel emancipador y transformador de tecnologías de base – reflexionamos sobre la naturaleza y rol de las tecnologías locales como herramientas para la acción climática. Junto con analizar los principales aspectos y desafíos metodológicos del proceso de catalogación, desarrollamos posteriormente tres aspectos teóricos que surgen de las tecnologías cartografiadas. Primero, describimos cómo las tecnologías locales implican el control de las comunidades sobre la definición de los problemas medioambientales y caminos de solución. Segundo, exploramos las diferentes formas en que estas tecnologías son valoradas por las comunidades. Tercero, describimos las lógicas de combinación y adaptación que subyacen a estas tecnologías. Con base en este análisis, proponemos entender estas tecnológicas como herramientas de carácter barroco, las cuales resultan del ensamblaje, combinación y mezcla de distintas lógicas, modos de valoración y materialidades. El artículo termina discutiendo como las tecnologías locales y el catálogo como herramienta de circulación pueden constituir un espacio productivo para desplegar formas más radicales de acción climática.

1. Introduction

The need to find technological "solutions" in the face of the ongoing socio-environmental crisis dominates many of the public debates regarding climate action (An Ecomodernism

Manifiesto 2015; Gates 2021). This is particularly visible at the government and international institutional levels, where technology development and transfer appear as one of the main tools to improve mitigation and adaptation strategies, and solutions (IPCC 2022; Üzelgün and Pereira 2020; World Commission on Environment and Development 1987).[1] Here, the creation and transfer of technologies to ease the causes and effects of the climate crisis work also as one of the main links that connect the climate crisis with the expansion of markets and new forms of green capitalism: the promise is that climate crisis and economic gain can go hand in hand (Ariztía 2022; Goldstein 2018).

Various authors and environmental movements have criticized this dominant imaginary of technology as a lifeline in the face of the climate crisis (Isenhour 2016). This criticism points to the urgent need to transcend technological determinism, or what is called *technofixing*, and instead approach the socio-environmental crisis as a challenge that is expressed mainly in the normative and political sphere (Schumacher 2011). According to these critics, the alliance between "big" technology and climate action lacks a proper problematization of the normative, ontological, and political assumptions that underlie technological deployment as a tool for environmental change.

In this article, we adhere to this interest to critically unpack the relationship between technologies and the climate crisis. Rather than opposing techno-fixing frameworks as conducive to socio-ecological change, we focus on exploring and describing the creation of local technologies as tools of deep transformation. In doing so, we rely on a long tradition of reflection on the emancipatory and transformative role of grassroot technologies (Hossain 2018; Illich 1973; Smith et al. 2017), to advance the deployment of alternative forms of connecting technological tools and climate action.

We do so by presenting the main theoretical and methodological aspects that emerged from the development of a local technologies catalog for climate action. This catalog – in development since 2019 – is a platform aimed at visibilizing and circulating different artifacts, strategies, and practices developed and/or adapted to solve or mitigate a specific socio-environmental problem by communities in different territories of Chile. Currently, 54 technologies associated with renewable energy, water resource management, sustainable productive activities, and environmental care and repair have been registered and made available.

Relying on the process and result of the catalog, we seek to contribute to the ongoing discussion on the role of local and alternative technologies for transformative environmental action. We focus on unpacking four aspects that relate both to the process of cataloging and the technologies we identified. First, we describe the process of defining and implementing the catalog. From here, we discuss some of the challenges and limitations of creating a local technologies catalog. Subsequently, we address three additional theoretical aspects that emerge from the examination of the local technologies we identified. First, we describe how these technologies open up spaces for problematization (and not only for solutions) that are anchored in the entanglement of situated trajectories and environmental concerns. Here, local technologies involve communities taking a central role in defining what is problematic in specific environmental issues, thus defining the

[1]See for instance the Climate Technology Centre and Network (CTCN) and Technology Executive Committee as key bodies created as a result of the Paris Agreement. https://www.ctc-n.org/about-ctcn/what-we-do.

path of solutions. Second, we describe the different forms of value that are mobilized during the assemblage of such technologies. In doing so, we show how these artifacts are often entangled in the reproduction of life amid increasing environmental degradation. Third, we describe the logic of combination, adaptation, and variation that underlies many of the technologies we cataloged.

As a result of this analysis and following recent work on popular and baroque economies in Latin America (Echeverría 2013; Gago 2015), we propose approaching local technologies as a kind of baroque tool that results from the situated assemblage and combination of different logics, values, and artifacts. Therefore, we seek to complement existing research on grassroot and frugal innovation by highlighting how local technologies do not necessarily oppose institutional forms of sustainable innovation but involve the local assembling of practices, knowledge, and values that originate and circulate in different territories and also in institutional spaces.

The rest of the article is organized in the following way. In Section 2 we address the conceptual foundations for thinking about local technologies in light of the debates about the relationship between technology and climate action. To do this, we reconnect with current and classic debates around developing alternative ways of understanding technology that go beyond a purely instrumentalist view. Thus, we anchor ourselves to a long tradition of STS, where technology is considered as an area in which normative preferences, worldviews, and possible futures are expressed (Bijker and Law 1992; Jasanoff 2016; Winner 1980). From here, we move on to discuss the literature on convivial technologies introducing the concept of baroque technologies as a way to further enrich this discussion. Against this backdrop, we introduce the concept of local technologies.

Section 3 presents the methodological aspects of the catalog, describing some of the challenges that came to light based on this cataloging exercise. Section 4 unfolds the three theoretical aspects previously described that emerged from the analysis of the cataloging process, namely, the centrality of the control of problematization as a connection space, the forms of valuation at stake, and the trajectories and logic of juxtaposition that define these technologies. Based on the previous analysis, section 5 further develops the argument of the baroque character of cataloged local technologies. The last section expands on how the dynamics of problematization, the particular definition of value, and the forms of circulation of these baroque local technologies might constitute a productive space to deploy more radical forms of climate action.

2. Conceptual framework. What are local technologies and why study them?

In this section, we address the relationship between technology and climate action based on three aspects. We first describe how the ecomodernist tradition has approached the link between technology and environmental change. We then develop some of the central criticisms to this paradigm elaborated by Science and Technology Studies (STS) and Latin American technology traditions. Second, we present alternative approaches to technology and environmental action. From here, we discuss the concept of *convivial* (Illich 1973) and *baroque* technologies as a framework to move towards an operational concept. Finally, based on the above, we introduce the concept of local technologies for climate action that is developed in the catalog.

2.1. Climate technologies beyond ecomodernism

With the rise of the climate crisis, technological progress is proposed as one of the main tools to mitigate damage to the environment and generate necessary adaptations. Ecomodernist perspectives posit that innovation and technological change can be the central pieces to prevent a socio-environmental collapse while protecting well-being and economic growth. Here, knowledge and technology are the tools that allow for "stabilizing the climate, leading better lives, and protecting the environment" (*Ecomodernism Manifiesto 2015*). Technological development makes it possible to increase efficiency to advance in the decoupling of the economy and natural resources (Isenhour 2016), in addition to developing effective and efficient forms of mitigation and adaptation. A key element here concerns the faith that material and energy consumption can be decoupled from economic growth (Kallis 2021). The appraisal of technological development as the main tool for climate action has also recently been recovered by radical intellectual traditions, who have shown a growing revaluation of technological innovation as a fundamental tool to transcend carbon capitalism (Avanessian et al. 2017; Buck 2019). In this framework, many of the alternatives that are addressed and proposed are associated with the possibility of developing large-scale interventions or incubating technologies that can later be transferred and massified.

The idea that technological development is the central key to human progress has, however, been heavily criticized since the origins of Science and Technology Studies (Bijker and Law 1992; Winner 1980). At the base of this criticism is the claim that technological artifacts and systems are inseparable from the social, political, and cultural aspects that participate in their production and also define their possibilities and consequences. Three aspects of this critique are particularly relevant to our argument.

The first aspect regards the fact that technologies always mobilize normative and ontological frameworks that in turn define the possibilities and limits of social and political transformation. This implies that different artifacts and technological interventions always mobilize specific ways of *posing a problem* (Stengers and Goffey 2015), that is, of defining what is fundamental and what the possible solutions are. Secondly, the above also supposes that different technologies and their trajectories mobilize different definitions of what is relevant. In other words, what is at stake is the problem of what we value and how it is valued. This occurs to the extent that technologies organize problems and solutions based on certain forms of valuing things, for instance, as economically viable; therefore, some specific artifacts and technological interventions become viable and others become impossible (Mazzucato 2018; Ariztia, Fonseca and Bernasconi 2019).

A third aspect is that technologies cannot be thought of, therefore, as the result of linear development processes, but rather as effects of processes in which actors, groups, or collectives participate and bring into play these different ways of problematizing and defining what is relevant (Bijker and Law 1992, 23). The dynamics of the creation and development of technological artifacts generally result from the specific ways in which these artifacts are put into play and redefine the nature of each technology in relation to uses, contexts, and normative assumptions (Akrich 1992). This implies attending to how different technologies travel and transform in relation to different contexts and relationships (De Laet and Mol 2000).

In short, technical artifacts, systems, or processes aimed at solving problems that arise from the climate crisis always mobilize normative and ontological assumptions, define spaces of relevance, and offer possibilities to different actors or groups, enabling different transformation paths and possible futures.

2.2. Thinking local technologies for climate action

Since the 1970s, different authors and movements have sought to reconnect the development of artifacts and technological systems with questions and definitions of what is desirable for local actors and territories. This interest in thinking about technology from and with groups and territories is also associated with the search to deploy our own ways of saying and doing technology from the global south, avoiding narratives of the inevitability of a single form of technological development (Escobar 2018). This search has been embodied in different traditions and movements such as appropriate technology (Patnaik and Bhowmick 2019; Schumacher and McKibben 2010; Smith et al. 2017); frugal innovation with a focus on developing low-cost, human-scale artifacts based on traditional knowledge (Pansera 2017) (Bhatti 2012); social technologies whose focus is on their replicability and development in iteration with communities (Smith, Fressoli, and Thomas 2014) or design for transitions (Escobar 2018). A central aspect of these forms of grassroots innovations is the involvement of actors in terms of knowledge, process, and results (Smith, Fressoli, and Thomas 2014).

Many of these proposals and movements are created or have had relevance in the Latin American context. The appropriate technology movement, for example, which emerged in the work of Schumacher (2011) and had significant growth in Latin America (Smith et al. 2017), sought to develop technologies that focused on human needs and that were appropriate for different contexts and territories (Patnaik and Bhowmick 2019). More recently, in the Valle del Cauca in Colombia, the design for the transitions movement has materialized the idea of creating artifacts and technologies that are the result of a process of reflection and production based on experiences and forms of local knowledge (Escobar 2018).

There is an important link between this search to reconnect technology with local actors and territories and the socio-environmental crisis. In fact, many of these movements originate in the verification of ecological deterioration and the contradiction between economic growth and environmental sustainability (Martínez Alier 2009), which explains that a key aspect of their work often consists of offering alternative pathways to radical forms of sustainable change. A key work here concerns the emergent field of political ecology and its focus on exploring how ecological deterioration relates to local distributive conflicts in which different knowledges, languages, and modes of valuing are at stake (Martínez Alier 2009). Here, a common assumption is that technological tools require that we problematize and open the normative assumptions and ontologies from which they are defined, including actors and groups in the definitions of the scope of problems and possible solutions.

Thus, technologies, understood in a broad sense as tools that seek to solve a specific problem, appear to be critical means for an accelerated socio-ecological transformation: They express visions and possible worlds of emancipatory transformation. To the extent

that these traditions converge in the search to connect the development of technological artifacts and systems with local actors and knowledge, they also open up spaces to think about other forms of relationships between technology and the world, or cosmotechnics (Hui and Lima 2020), from the global south. They, therefore, constitute spaces for experimentation of possible futures (Ariztia, Fonseca, and Law 2019).

2.3. Local technologies as convivial technologies

The local technologies catalog connects with the tradition described above in that it seeks to address technologies for climate action by placing groups and territories at the center, as a space in which problems and concrete solutions are defined in a situated manner. In this sense, a concept that helps to clarify this understanding of technologies is that of convivial technologies (Illich 1973; Pansera and Fressoli 2020). According to Illich, convivial technologies are those that, along with being tools to solve specific problems, allow for progress in forms of autonomy of individuals and groups. These would be different from other forms of technology, especially those anchored to large socio-technical systems, which, due to their scale or focus, end up affecting the autonomy and possibilities of their users, extending external forms of expert control over uses and possibilities. To the extent that technologies grow and move away from users, they run the risk of generating these negative consequences and of responding to forms of valuation that are alien to their original use (Illich 1973, 13). In opposition to industrial technologies, convivial technologies enhance the possibility of imagining possible futures by the communities that occupy them because they facilitate "the purpose of permitting all people to define the images of their own future" (Illich 1973, 13). Illich's concept of conviviality has recently been recovered as crucial in proposing a new way of thinking about the relationship between technologies and the socio-environmental crisis (Pansera and Fressoli 2020; Vetter 2018). Among other elements, convivial technologies are linked with people through forms of open access and control for their production and use; they present a contextual nature that depends on local knowledge, values, and world views, and emerge from a relationship with the environment in a non-harmful way that involves constant change (Illich 1973, 13).

In a recent effort to enrich Illich's work on convivial tools, Vetter develops a matrix of convivial technologies in which she proposes six critical properties, namely: relatedness, accessibility, adaptability, bio interaction, and appropriateness (Vetter 2018, 1784). These properties can be identified in different aspects of the economic lifecycle, such as production, materials, use, and infrastructure. Extending Illich's argument, Vetter argues that a key aspect of convivial technologies is their interdependence, that is, the fact that they result from a set of existing relations between people, artifacts, and other entities.

In this article, we want to push further the argument that interdependence is a central feature of convivial and local technologies. We do so by highlighting the often baroque and hybrid character of these tools. A common element of previously described literature on grassroot innovation and local technologies is that it often approaches local technologies as opposed to other scales and modes of sustainable intervention, either market-oriented or public-led technological intervention. Here, convivial technologies appear as an alternative as well as a relative coherent form of intervention that is based on

local modes of knowledge and action (Escobar 2018; Smith, Fressoli, and Thomas 2014). By maintaining the focus of this literature on connecting technological tools and process with local actors, practices, and knowledge, we are interested here on highlighting how convivial technologies also relate to the juxtaposition and combination of different and often tensioned forms of knowledge, mixing logics that do not necessarily come from local contexts. By doing so, in the next paragraphs, we introduce the concept of baroque as a mode of unpacking the entangled and assembled nature of local technologies.

2.4. Exploring the baroque dimension of convivial technologies

In her book on Latin American street markets, Veronica Gago relies on ethnographic work in La Salada Market (Argentina) to underline the baroque character of Latin American popular economies. With a long tradition in Latin American social reflection (Echeverría 2013), the concept of baroque highlights the contradictory but also vital character of how popular economies manage to articulate heterogeneous forms of knowledge, practices, or materialities, superimposing local and global, institutional, and everyday elements (Gago 2015, 102).[2] Thus, by baroque Gago refers to a type of assemblage that assumes the co-existence of dissimilar logics and rationalities.

We propose using the concept of baroque to further explore the properties and possibilities of local technologies. By doing so, we seek to enrich the debate about convivial technologies developed by Vetter and others (2018). The emphasis on mixture and juxtaposition as key aspects of grassroot innovation has been widely discussed in grassroot innovation scholar literature, mostly around the concept of bricolage -the combination and use of elements at hand in contexts of scarcity (Pansera and Sarkar 2016). By introducing the idea of baroque technologies, however, we want to emphasize how local and convivial technologies not only rely on local practices, knowledge, and materials but also depend on processes of reappropriation, resignification, and tactical adaptation of elements that come from other contexts such as institutional logics or other territories (Miller 1998).

Furthermore, considering the baroque character of convivial technologies entails bringing into the analysis frictions and tensions as constitutive in their assemblage. In this sense we seek to balance the scholarly overemphasis of placing convivial and local technologies and grassroot innovation in opposition to institutional logic and processes, which overlooks the different combinations, mixtures, and tensions between local technologies and institutional spaces of environmental innovation.

2.5. Towards a definition of local technology for climate action

Based on the previous discussion, we propose understanding local technologies as those artifacts, strategies, or practices aimed at solving or mitigating a specific socio-environmental problem in a given territory. From this point of view, local technologies are those that are created by the communities in their territories and that rest on the use of territorial knowledge to solve their environmental problems. They are, therefore,

[2]The concept of baroque differs from concepts such as hybridization, in that it does not seek to overemphasize synthesis by expelling the contradictions and tensions that subsist in processes of recombination (Gago 2015, 200).

convivial tools or processes in the terms described before. This is because the control of the questions and problems, as well as the process and results, are anchored to the circumstances and context of the local actors and groups that develop, adapt, or use them. In line with the previous discussion, we propose that the approach and research of local technologies imply connecting the material dimension of artifacts, systems, or processes with the normative, ontological, and political aspects that are part of each technology. As previously discussed, we are also interested in highlighting the baroque nature of these technologies (Gago 2015), that is, the fact that they often involve the juxtaposition and mixture of elements and entities that come from different artifacts, practices, knowledge, and value logics that are combined during the development of these technologies.

Specifically, and related to what was discussed above, we consider three central aspects to address these technologies and their relationship with the communities and territories from which they emerge. The first element refers to the forms of entanglement between technologies and communities. Specifically, we are interested in investigating how specific artifacts are related to spaces of problematization that arise from local groups and in relation to specific territories and ecosystems. These forms of problematization can be connected with different aspects of the territories and communities, and arise as a result of forms of relationship and care of the communities with their environment in the context of socio-environmental deterioration (Tironi and Rodríguez-Giralt 2017). The second element refers to the forms of value that are mobilized in the development and use of these technologies. Specifically, we are interested in studying the practices and relationships from which what is relevant is defined, as well as the tensions between different value grammars. Based on the previous discussion, we will explore how local technologies often incorporate expanded forms of value (Mazzucato 2018; Pansera and Fressoli 2020) anchored to the reproduction of life and the environment in specific territories. We are interested in how the trajectory and use of local technologies involve potential tensions between different forms of value. Finally, a third aspect consists of addressing the dynamics of juxtaposition, circulation, and adaptation that are at the base of many of the technologies included in the catalog. As we will discuss, local technologies for climate action imply forms of adaptation and recombination that distinguish them from other forms of intervention or technology transfer.

In the next section, we discuss the methodological aspects of the implementation of the local technologies catalog and their relationship with the conceptual aspects presented.

3. Methods: cataloging local technologies

Since 2019, we started working with a team of social scientists, designers, and programmers to create a platform to register, visibilize, and circulate different artifacts, strategies, and practices developed and/or adapted by communities in different territories of Chile that strive to solve or mitigate a specific socio-environmental problem. The use of a catalog to archive and circulate technologies in relation to environmental action has a long tradition in the world of environmental movements. The most common reference is *The Whole Earth Catalog*, a countercultural catalog developed in the US during the

1970s as a space to circulate forms of environmental and alternative knowledge (Kirk 2001). Unlike the concept of an inventory or a list, a catalog reflects the necessary action of selecting or "curating" the objects or artifacts that are part of it. There is also a space of agency, on the part of the cataloger, that results from the necessary inductive nature of the process of cataloging and selection. In our case, cataloging local technologies implied going out to look for specific artifacts, systems, and processes to later select and publish them in the catalog. Cataloging also involves devising a connection with an audience, a public for whom the objects of the catalog may be relevant or valuable. In our case, we aimed at creating a platform whose use by other communities allows for connecting and weaving relationships between different users while inspiring and mobilizing communities and actors to develop solutions whose origin is situated.

Based on this consideration, the focus of the local technologies catalog was defined to identify artifacts, strategies, and practices developed and/or adapted by communities, mainly in the rural world, whose existence makes it possible to solve or mitigate a specific socio-environmental problem. We also considered a gradual registration form limited to the technical-economic viability that can grow in the next stages.

The first stage lasted 2 years,[3] and we focused on 7 Chilean communes: Alhué and María Pinto, from the Metropolitan Region of Santiago; Pichidegua, Pumanque, Lolol, Paredones, and La Estrella, from the Sixth Region of Libertador Bernardo O'Higgins. These towns all correspond to rural communes in central Chile that belong to the dry coastal and interior ecological area, geographical spaces located around the Chilean Coastal Range (*Cordillera de la Costa*), characterized by its prolonged periods of drought and high thermal amplitude. In turn, the selected communes all share a decentralized demographic distribution as they have several localities outside the center of the commune, and they have a wide variety of geographical configurations and unequal service access conditions.

Regarding the creation of the catalog and the exercise of cataloging, we identified four critical aspects of the cataloging process and the construction of the platform.

The first aspect relates to the strategy and actions that were taken to identify and contact the different technologies and their producers. In order to connect with communities and the actors who created and designed solutions based on their problems, we worked with different actors who served as intermediaries and gatekeepers simultaneously and in a multi-scalar manner, considering that the catalog sought to cover different territories. A central aspect consisted of the work of creating alliances with institutions with territorial density. Specifically, the work in partnership with the Foundation for Overcoming Poverty [*Fundación para la Superación de la Pobreza* (FUSUPO)] and the professionals of its Country Service program was essential. Through this program, 300 young professionals carry out annual interventions in rural communities throughout Chile, to generate professional immersion while increasing the availability of technical knowledge in these communities. The experience and complete knowledge of the territories of this institution facilitated our access and the possibility of identifying possible technologies. This organization also facilitated contact with grassroots organizations in different territories such as neighborhood associations, agroecological groups,

[3]From March 2020 to December 2021.

and cooperatives as well as professionals or personnel from the municipalities: those in charge of the Community Development Directorates, the Environment Directorate, Productive Development, the Local Development Program [*Programa de Desarrollo Local* (PRODESAL)], among others. Based on these contacts and with the support of the Country Service teams, we prepared lists of possible people and communities to visit and technologies to catalog.

The second central aspect was the work of approaching and contacting the different communities once we knew of them. In the face of the global COVID-19 pandemic and the physical distance required, we were not able to immediately travel to the selected territories, so initial contact was made by telephone. We initially proposed this process as a *distance ethnography*, where we sought to familiarize ourselves with the circumstances of each technology and locality over several phone calls. We used this strategy to generate the initial links with the producers of the technologies. After some time, regulations for the pandemic began to loosen, resulting in an increase in the number of people allowed in closed areas and permission to travel, so we reconsidered moving on to a second stage: carrying out fieldwork that was adapted to the pandemic circumstances and restrictions. This called for exhaustive planning of the work agenda. We scheduled the visits ahead of time and made sure that they lasted only a few days, giving preference to places in open spaces. During these visits, we conducted ethnographic interviews with the technology producers identified in the previous stage. The interviews involved a tour of the place where the technology was developed, which was usually the land where the technology producer lived, but it also included spaces of collective or public property. From our field experience, we determined that the ethnographic interviews should be carried out by a pair of researchers to adequately characterize the technologies, so it was necessary to have two records: an audio recording of the interview and a photograph of the technology and its context. Thus, interviews were carried out by a main interviewer and a secondary interviewer/photographer.

The third central aspect in the cataloging process was the reflection and work to define the registration form of the identified technologies and communities. How do we account for the density of the experience of the producers anchored to the territories? Our focus in this context was on reconciling descriptive aspects of the technologies as such with the register of a story that could situate artifacts and/or processes and their trajectories within the framework of the communities' histories. To do this, we relied on previous works about grassroots innovations in Latin America and in other countries of the global south as a reference for organizing some key elements of artifacts trajectories (Escobar 2018; Smith et al. 2017). The emphasis was on reconciling a record of the trajectory and origin of each registered artifact, process, or system with its material and technical characteristics. As a result, each record incorporated a descriptive dimension with a social trajectory dimension of each technology. In addition, we also registered the problem and community in which the technologies are located, the possibilities for the future, and the visions of solutions that were mobilized. At the same time, an attempt was made to collect relevant information from the realizers and their contexts, especially in relation to the technology that we identified. Regarding the trajectory of the technologies, we wondered about their origin, their associated knowledge, and the problems that resulted in their creation, along with the possible modifications that they have

undergone. When considering how the technologies work from a more technical point of view, we sought to understand the roles or stages associated with the process of use, their composition, the materials or resources they require (for example, solar energy), and the variation that these processes have undergone. Finally, we asked ourselves about their projections, contemplating their potentialities and risks. Based on these elements, we prepared the first synthesis for the catalog (Figure 1).

CATÁLOGO DE TECNOLOGÍAS LOCALES

Calefón solar

Calefón solar para agua ducha y lavado.
Trabajo llevado a cabo por Grupo la unidad de Peumayen de Nerquihue (Nerquihue).
https://tecnologiaslocales.cl/t/hZxlL

Este artefacto consiste en un calefón solar que abastece de agua para ducha y lavado a temperaturas de hasta ochenta grados Celsius aproximadamente. Para su funcionamiento es necesario contar con una manguera negra de plansa (polietileno) instalada en altura, concretamente en el techo de la vivienda, de modo que reciba luz directa del sol y acumule calor. La manguera se comunica con una cañería de PVC con salida de agua para la ducha y conexión a un pozo, el cual está provisto de una bomba de agua que otorga la presión. De esta forma se genera un proceso similar al de un calefón corriente. Arturo, de la comuna de Nerquihue, realizador de esta tecnología, cuenta que esta es sólo una versión preliminar. Su intención es mejorar el proceso aprovechando la altura para obtener presión de manera natural.

NOMBRE TECNOLOGÍA	CALEFÓN SOLAR
Realizadores	Grupo la unidad de Peumayen de Nerquihue (Nerquihue)
Comunas	Nerquihue
Zona	Centro
Territorio	Valle

Descripción de tecnología: artefacto o proceso	
En qué consiste	Manguera que al calentarse con el sol produce agua caliente.
Problema que busca resolver	Ahorro de combustible (gas).
Materiales	Manguera o cañería de plansa (HDPE) de 50 metros de extensión, tubos de PVC, bomba centrífuga con regulador de presión.
Aspectos técnicos	Manguera ubicada en altura para exposición solar y permitir paso de agua conectado a ducha para subir la temperatura.
Costos y dificultad	Costo bajo debido a que no necesita gran inversión de dinero; nivel medio de dificultad.

Figure 1. Catalog record card.

Each record card originated based on the material of the fieldwork, the interviews, and the ethnographic record. However, in addition to having the researchers' writing, each record card was subsequently reviewed by a technical editor and a style editor. The first editor was used to attend to the details regarding the functions, materials used, and context of use of the technology mostly in terms of their terminology, and the second editor was used to standardize the writing format of the record cards. As a final stage, the record cards were received by an illustrator, who created a vignette based on the photos of the technology. This work sequence of the cards allowed the process of approaching each technology to be interdisciplinary. The last step was the signing of the informed consent and the validation of the information included on the record card by the producers of each technology.

The fourth aspect refers to the construction of the catalog itself, that is, the platform in which all the cataloged technologies are accounted for. This involved a curatorial process of technology selection, which was done after gathering the information. In parallel to the development of the record cards, a user-centered design process was carried out to determine who the target audience would be for the catalog (producers, local communities, and professionals or officials who could be intermediaries), what content would be presented (technology, context, and projections), and in what format it would be available (website, printable, and to share on social networks).

The building of the catalog has entailed several difficulties and findings. A key issue has concerned the process of identification, curation, and organization of the selected technologies. In order to determine the different categories and to select the technologies, we had to engage in a process of constant revision and adjustment. The question of what a local technology is has been constantly addressed and reworked throughout the process of cataloging. In this sense, the analysis we present here is also a result of the practical work of sorting and organizing the different technologies. For instance, a key question for us concerned specifying whether a technology is local and, therefore, having to define boundaries of grassroot versus institutional technologies. We also had to deal with the fact that several technologies repeat themselves in different territories. Again, this prompted us to consider how we could bring the problem of circulation into a working definition of local technologies. We dealt with these tensions partly by theorizing and problematizing existing definitions.

3.1. Thinking about local technologies with and from the catalog

To date, we have cataloged 53 technologies, all belonging to central Chile and mainly to the geographical territory corresponding to the valley or interior dry land. In general, we have grouped these technologies into five categories: water, energy, productive activities, environment care, and reuse. However, we have additionally identified some particular types of technology, such as the production of organic pesticides, rainwater collection and storage systems, efficient forms of irrigation, collective resource management systems, among others. Due to the characteristics of the cataloged territories and the climactic moment in which we find ourselves, technologies associated with water scarcity made up the majority, where they sought to optimize the obtaining and use of water, and others related to subsistence agriculture. Of all the cataloged technologies, 17 focused on artifacts, systems, or processes for water management, particularly, with a

Figure 2. Poplar wood crates for beekeeping. Original photo presented in the catalog.
Source: Catálogo de Tecnologías Locales para la Acción Climática (www.tecnologiaslocales.cl).

focus on the accumulation of water in drought areas. We also recorded a significant number of technologies (14) aimed at reusing waste for small-scale production activities. Another important set of technologies focused on systems or processes to prevent the deterioration of soils and ecosystems, through strategies to regenerate soils or deal with deforestation. Finally, in the case of energy, 2 technologies were found, which used efficient irrigation with solar energy (Figure 2).

4. Thinking about local technologies: critical nodes from the catalog

In this section, we present three central aspects that come from our examination of the artifacts and processes that we have cataloged so far as well as the process of cataloging. These aspects are in dialogue with the previous theoretical discussion about how to think about and approach local technologies as tools for climate action. By doing so, we are also interested in exploring the baroque character of these technologies, studying the different tensions, scales, trajectories, and relationships that are central in the assemblage of these technologies.

(1) Who defines a problem? Local technologies as problematization spaces

As we have discussed, the first aspect of the catalog's local technologies is that they are deeply connected to the local realities from where they emerged. This entanglement is not so much related to the control or ownership of these technologies, but

more widely to the fact that artifacts are entangled in local forms of defining which problems and needs are relevant. This problematization is anchored to multiple elements that define the relevance and trajectory of the technologies we found. We can identify and illustrate at least three modalities in which this connection is manifested: traditional knowledge and the historical trajectory of activities, the specific problems and environmental deterioration of each territory, and the forms of collective organization.

The first common path that appears in the trajectory of technologies in the catalog is that they are created from an activity or form of knowledge that has a long history in the territories and that, due to the environmental crisis, has begun to be valued again. One of the technologies in the catalog that illustrates this relationship is the use of native wood to improve beekeeping in Alhué. According to its inhabitants, Alhué is "a terminal commune," it has a single entry and exit road due to the hills that surround it. This geographical feature is useful for organic production because the town is not exposed to agrochemicals that travel through the air from large industries. For the production of honey in the area, pinewood boxes are often used, which are prone to fungi during production and are less durable. Due to this, Ángel began to produce boxes with poplar wood, which is common in the territory, and has antifungal properties, which returns to traditional techniques in their elaboration. The need to look for alternatives to pine arose from Ángel's history and his relationship with local and family knowledge, from which he developed new ways of using wood in beekeeping.

Secondly, some artifacts or processes that we identified are not necessarily linked to the historical dimension, but to the existence of specific environmental problems experienced by the communities. These open up the need and possibility to look for solutions based on knowledge and available resources. In the catalog, we collected different technologies that were created from the development of environmental remediation or repair processes against increasing erosion. For example, the gully filling technology developed by the Peumayén de Nerquihue community, in the Lolol commune, focuses on mitigating the problem of gullies, cracks, or ditches resulting from soil erosion in places with slopes, which progressively increase in size and reduce the water retention capacity on slopes. Due to this problem, an improvement system called "gully filling" was developed, where an accumulation of organic matter is used to protect the exposed soil profile and thus form a substrate for the future rooting of plant species. This has even allowed the recovery of plant species, such as perennial ryegrass – of high value to feed grazing animals.

Thirdly, local technologies might also relate to the organizational dynamics of the communities associated to the history of the groups and their relationship with territories. For example, several of the selected communes were part of the agrarian reform carried out in Chile in the 1960s, in which land was redistributed among peasants working on large estates and haciendas. In the La Estrella commune, we identified a particular experience in which a system of collective production of alfalfa for cattle was developed on land inherited from these property regimes. As a result of the agrarian reform, a piece of land turned out to be the collective property of 18 farmers from the town of Guadalao, who also have water rights in the sector. Through this organization, they defined a collective farming system that allowed each farmer to receive

between 25 and 75 bales of alfalfa after harvest. Nevertheless, difficulties have arisen regarding decision-making, collective participation, and the technical operation of crop management, which keeps this production system in constant improvement.

The spaces of problematization from which local technologies emerge can be linked to several different elements, such as the historical entanglement of tools and local actors, or the specificities of the environmental problems localities are facing. In each of the different cases, these elements frame the specific space of problematization from where the relevance and core aspects of technologies are defined.

(2) The value of technologies

A second related aspect refers to the question of value. That is, how technologies are conferred with different forms of worth through their development and use. What are the technologies for? In many of the technologies that we cataloged in this first stage, a central aspect is that the value of the artifact relies on the fact that it contributes to maintaining family production, especially small-scale agriculture, in the face of deteriorating irrigation and soil conditions. In other words, technologies were valued in terms of their concrete contribution to the bundle of activities concerning reproduction of life and nature in rural contexts, but also in economic terms as tools to generate economic income.

One aspect where this centrality of use is visible is in the wide array of technologies that focus on water use. In many communes in dry sectors (where we collected the information for the catalog), the absence of water for irrigation has significantly affected family gardens and small farms. In this context, different artifacts and systems have been developed to take advantage of the gray water that results from domestic activities, improving irrigation possibilities. An example is the home gray water reuse system developed by Patricio Cerda in the Alhué commune. Patricio devised a way to connect the wastewater from the washing machine and the kitchen sink with two tanks with a capacity of one thousand liters each. Some other technologies focus on the development of biofilters, for example, the biofilter developed by Katherine Pérez in the María Pinto commune, where three gray water filtering processes are combined to generate a capacity of three thousand liters of water. These filters were oriented to both sustaining production to generate incomes and maintain family food production.

Cataloged technologies also appear as a way to preserve the operation of small-scale agricultural processes or tasks in contexts of increasing water scarcity and soil deterioration. A case related to the above is the rainwater and mist storage tank made by Fresia Bustamante from the Paredones commune, who, with financing from PRODESAL, installed and adapted the roof of her home to store rainwater in a plastic tank and also take advantage of the condensation of the fog in the area. This made it possible to increase the capacity of water, which consequently also helped to expand the diversity of crops on her land.

In other cases, the value of technologies derives from the fact that they are used to manage communes. For example, the need to collectively manage Villa Alhué Agricultural Community's common lands is at the origin of several technologies that we identified: community management of nurseries and techniques to increase reforestation on hills. This over 200-year-old community brings together community members who collectively

own a piece of land of approximately one thousand hectares on one of the hills that surround the commune. They have developed a reforestation process on the hills as well as recovery techniques, and the accumulation of water in the soil to help the survival of native species. They also created a native community nursery to reproduce native species for reforestation. Since it is in the development stage, the nursery is not financially self-sustainable and requires the economic support of other organizations, pointing to a greater difficulty in its implementation or replication.

Why does local technology matter? As the previously described cases illustrate, the technologies we cataloged were valued because they take part in different modes of value. We observed that, in many cases, technologies articulate different logics of value. A crucial aspect here relates to how local technologies are key elements in preserving family life, but they are also environmental dimensions of their reproduction. However, local technologies are likewise valued in terms of their contribution to generating income by taking part in productive activities. While the use value of the technologies was more relevant than its potential to generate income or economic gains, this latter element was also central. These different forms of valuing might involve frictions during the development of the technologies, as they might originate productive agricultural projects that require technologies to be productive, or in other cases, they might solve a specific household problem that can be later turned into a productive activity.

(3) Where do catalog technologies come from and how do they travel?

A third central aspect that emerges from the catalog process refers to the logics and trajectories of the identified technologies. Although technologies are entangled in spaces of problematization that are situated in specific territories, we also observed that it is not possible to recognize a trajectory or origin that is anchored to a single locality. These exist rather as a result of intersections, mixtures, and adaptations in which actors and groups from other territories participate. Many times in its trajectory, the recombination of technology transfer processes, traditional knowledge, and specific adaptations are also evident. We are interested in illustrating two aspects of this logic: First, the entanglement between local technologies and institutional projects, that is, the fact that technologies in the catalog recombine different scales of action in a territory. Second, we examine the dynamics of circulation and territorial adaptation of many technologies.

First, after the cataloging process, we observed that many of the local technologies originated based on dynamics of adaptation or dialogue with technology transfer policies developed at the institutional level. It was difficult to identify pristine or vernacular technologies, and what prevailed on several occasions were adaptations of technological transfer from these institutions or a coexistence of both logics. In this framework, it was often difficult to distinguish the decisive element: the adaptation or modification of the communities, the financing, or institutional project. In those cases, local adaptations involve a transformation of technological transfer in terms of local spaces of problematization as discussed before. For example, during the cataloging process, we often found financing from institutions such as the United Nations Development Program (UNDP), the Ministry of the Environment, or the Ministry of Agriculture through the Agricultural and Livestock Development Institute [*Instituto de Desarrollo Agropecuario*

(INDAP)] and its Local Development Program [*Programa de Desarrollo Local* (PRODESAL)], which could also involve technology transfer processes. However, these technologies were often adapted and/or modified in order to fit into the concerns of their users. An example of this is presented by the interconnection technology for rainwater harvesters carried out by Altamiro Becerra in the town of La Cabaña, in the commune of Lolol. This small farmer received a rainwater harvester with a capacity of 5,000 liters with financing from INDAP. However, in the winter or rainy season, the harvester overflowed and then in the summer, the amount of water stored was insufficient. He, therefore, acquired three more harvesters, two financed by himself and the other by a UNDP project. Relying on these elements, Altamiro created an interconnection system that uses gutters to receive the rainwater that falls on his roof. These gutters direct the rainwater towards the different harvesters that are connected to each other in a circuit. When the rains are very intense, the four harvesters can still be filled, but there is a manual system for disconnecting the piping and gutters system.

In other cases, technologies are created based on the problems and needs of the communities, and are later implemented or improved in conjunction with external institutions. An example of this is the greenhouse created by Marcial Berrios with the support of Country Service. Marcial built a low-cost greenhouse with PVC pipes and a small amount of plastic for its cover. After, gutters and a fog catcher were installed to allow for the accumulation of rainwater to irrigate the greenhouse crops. The idea had to be adapted because of the wind in the area, so its structure and the angle of the layout were modified during its installation. In short, technologies in the catalog often imply the coexistence of local practices and knowledge with dynamics and forms of institutional financing. In these cases, it is not possible to distinguish between "purely local" technological artifacts and others that may be the result of transfer policies, since in practice there is a continuum.

Second, we also observed the existence of different territorial variations of specific artifacts or processes in the catalog. In different locations, specific ways of using an artifact to deal with a problem varied. Common aspects, such as the use of a specific plant or a mechanism, coexisted with specific forms anchored to local situations. In practice, this form of circulation led us to merge several similar artifacts that presented minimal variations between different territories. For example, nettle slurry, which consists of macerating the plant leaf in a container with water in order to use it on crops, was recorded in several locations. In each case, different measures were taken to apply the slurry, different storage times, and different materials for its preparation. In addition, some producers used it as fertilizer and others for pest control.

Circulation not only appears in terms of the dynamics of the traditional knowledge shared for decades, but it also responds to deliberate efforts by the communities to make their knowledge available to other actors. For example, the Peumayén de Nerquihue community developed a seed bank to safeguard seeds of species typical of the sector, which works in a complementary way with the community network of food exchange and sale. They took advantage of the construction of greenhouses in various areas of the community to carry out differentiated crops and their subsequent exchange in the neighborhood.

As we have described in previous paragraphs, the technologies we cataloged not only mobilize different forms of value, but also involve the appropriation and recombination of institutional technological transfer projects. Here, the boundary between public transfer dynamics and the development of local artifacts is often porous. Furthermore, another

central aspect is the important circulation of artifacts and knowledge between different territories. As we will discuss in the next section, these and other elements highlight the heterogeneous and baroque nature of local technologies (Gago 2015).

5. Discussion

In previous sections, we described some of the main characteristics of the technologies we cataloged. We identified three key elements. First, we described how technologies relate to localized spaces of problematization mediated by the interweaving of different problems, historical trajectories, and material challenges associated with the environmental crisis as it manifests in specific territories. Second, we explored how local technologies are valued in relation to different grammars of value, which mainly deal with the maintenance of life, but also intersect with economic considerations. Dominant among these different forms of value is the fact that these technologies are often valued in terms of their contribution to the reproduction of life and nature. Third, we described how the materialization of these technologies results from the combination of different elements and logics, and also participate in the dynamics of knowledge circulation between territories.

Many of these technologies' processes of adaptation and appropriation intersect with the circulation of artifacts and knowledge from different territories. As a result of this description, we can note how the trajectory of local technologies involves the juxtaposition and entanglement of heterogeneous elements. They relate to spaces of problematization which are framed with a mixture of environmental concerns, historical and political capacities; they articulate different modes of value, combining the aim of preserving family and environmental life with economic considerations; they also combine projects and institutional developments and local and situated adaptations. They are in this sense baroque (Gago 2015) because they emerge from the recombination of different elements and logics. To the extent that technologies juxtapose aspects of technology transfer projects, forms of knowledge that circulate in different territories, and adaptations and modifications anchored to collectives, questions, and local knowledge, these technologies make the concept of ownership and originality diffuse and problematic. At the same time, they make it difficult to trace the frontier between the reappropriation and adaptation of institutional technological projects and the creation of new artifacts.

By highlighting the baroque character of the local technologies, we want to enrich how the relationship between local technologies and other processes of technological intervention is thought and addressed by existing literature. We have tried to do so by thinking about the partial connections, but also the tensions and frictions (Tsing 2011) that intersect the trajectories and use of the artifacts we cataloged. At the same time, by doing so, we are interested in attending to processes of circulation, recombination, and mixture as key elements through which convivial technologies can be expanded.

6. Conclusion

In this article, we have focused on describing theoretical and methodological ideas that arose from the elaboration of a local technologies catalog for climate action in Chile. Our analysis emerges from a dialogue with the long tradition in the STS field aimed at proposing alternative ways of understanding and using technology in the context of the ongoing

socio-environmental crisis, particularly in Latin America. We draw from the fact that every artifact or technological system mobilizes normative and ontological assumptions, which embody paths of transformation and possible futures. In this framework and in dialogue with the literature (Illich 1973; Pansera and Fressoli 2020), we understand local technologies as artifacts, systems, and/or processes that, along with helping to solve a specific socio-environmental problem, arise from the ability of communities and territories to define spaces of problems and solutions. Against this backdrop, and following recent work with popular economies (Gago 2015), we have highlighted the baroque nature of the technologies we cataloged: the fact that they involve a combination and mixture of different elements and logics.

By way of conclusion, we want to propose reflections that emerge from the previous description and analysis. We are especially interested in proposing how the lessons learned in the creation of the catalog opened up possibilities to think about local technologies as a fundamental space for climate action. We also seek to point out differences or tensions between an approach based on local technologies and other dominant technological intervention logics. The first key result presented here has involved analyzing the methodological challenges and limitations to the development of a catalog. We hope that these considerations will be a contribution to the development of this type of platform in other regions and/or focus on other forms of technology.

Second, based on the results of the first stage of the catalog, we have discussed the main features we identified of local technologies. As we have described, local technologies generally assume and rely on control over problem definition and relevance, and both the use and ownership of artifacts. This allows for the possibility to imagine and mobilize alternative futures. Paying attention to how communities and actors define what is relevant concerning their territories and situated experiences of the current crisis allows us to open up the possibilities of imagination with regard to possible forms of intervention that often escape more rigid frameworks, where the design and problems are defined in advance, and where the participation of the communities occurs in the space of the use and appropriation of artifacts or technological systems. We also explored the different logics of value that are attached to the development of such technologies. While cataloged technologies appear primarily as entangled in the fabric of the reproduction of domestic life and their relationship with nature; forms of economic value also coexist during the creation and use of these technologies. The entanglement between the use and economic value of the technology we mapped might also explain frictions between local technologies, technology development, and transfer projects, which prioritize economic value, that is, their possibility to become profitable, or efficiency as main criterion of stating the value of technological solutions. Finally, we also described the logics of juxtaposition and circulation that we identified in the technologies we cataloged – where they generally combine elements of institutional projects and circulated, adapted, or modified in different territories – allowing us to look again at one of the main challenges of climate action, which is the magnitude and scale of the necessary transformations. By unpacking these elements, we suggest approaching local technologies as not only convivial but also as having a baroque character. Underlining this baroque character might help to enrich existent scholarly work on grassroot innovation, and particular convivial technologies, as it brings into the analysis the heterogenous elements and logics that explain the trajectories and assemblage of these tools.

The way in which we have understood and unpacked the local technologies of the catalog might help to think about forms of increasing and multiplying climate action without falling into the uniform dynamics of large technology transfer projects, or to reify local technologies as frictionless or completely separated from institutional settings.

As we described, local technologies rest on forms of circulation and multiplication that suppose variations and adaptations to territories and situated communities. In this way, although these technologies can grow and increase their coverage, they do not give up the heterogeneity of the world (Tsing 2012). In this sense, the catalog platform itself can also be thought of as a technological device to accelerate and extend these forms of technological circulation. They also allow us to imagine forms of growth and circulation that do not relate to top-down policies of technology transfer from institutions to communities, but rather as processes of multiplication and variation that involve the recombination of different forms of knowledge, practices, and materialities. The catalog works as a space where these actors can also travel and change to the extent that they are taken up in other contexts while, at the same time, communities and producers maintain control over the definition of the problem space and the solution paths from where they emerge (Jasanoff 2016).

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