Prevention, social emancipation, and paradigmatic transition: a 40-year interdisciplinary Brazilian trajectory on accidents and disasters

Prevenção, emancipação social e transição paradigmática: uma trajetória interdisciplinar de 40 anos no Brasil sobre acidentes e desastres

Prevención, emancipación social y transición paradigmática: una trayectoria interdisciplinaria de 40 años en Brasil sobre accidentes y desastres

Marcelo Firpo Porto [1]

Abstract

The article, in the form of an essay, systematizes a 40-year-long professional trajectory of interdisciplinary and socially engaged experiences around the analysis and prevention of accidents and disasters. This study was mainly developed within the scope of research and postgraduate studies in Public Health in Brazil, driven by the sanitarian movement and the construction of Brazilian Unified National Health System (SUS) in its search for democracy and social and health justices. Its empirical basis involved workers' health and environmental surveillance actions organized in networks led by SUS in conjunction with universities, unions, social movements, environmental nongovernmental organizations (NGO), and Public Prosecutors' Offices. Events of greater socio-environmental complexity in sectors such as steel, petrochemicals, mining, agribusiness, and energy forged the search for new epistemic and interdisciplinary references that encompassed two new justices, i.e., environmental and cognitive. This essay systematizes this trajectory of conceptual contributions in three movements from the 1980s to the present day (each corresponding to a socio-political and institutional context) to reflect on paradigmatic transition movements in the analysis and prevention of accidents and disasters from an interdisciplinary perspective. It ends by suggesting abyssal and emancipatory prevention to face different current crises, including environmental, health, democratic, and civilizing ones.

Disaster Prevention; Epidemiology; Social Inequality; Empowerment

Correspondence
M. F. Porto
Rua Cândido Mendes 359, apto. 403, Rio de Janeiro, RJ
20241-220, Brasil.
mfirpo2@gmail.com

[1] Escola Nacional de Saúde Pública Sergio Arouca, Fundação Oswaldo Cruz, Rio de Janeiro, Brasil.

Introduction: paradigmatic transition and three movements in the post-military dictatorship context

This essay seeks to retrieve and systematize the appropriation of some concepts and conceptions about the analysis and prevention of accidents and disasters in an interdisciplinary and socially engaged perspective as an epistemological strategy of paradigmatic transition and policy of social transformation. It aims to inspire emancipatory processes within Public Health and other interdisciplinary fields that integrate different knowledge and practices.

It chose the theme of analysis and prevention of accidents and disasters to reflect on possibilities of paradigmatic transition in the author's interdisciplinary trajectory involving different collectives in the last four decades. Over time, efforts have tried to incorporate references and concepts as an epistemological strategy to face challenges and proposals for social transformation in political, institutional, and academic contexts marked by a peripheral society made subaltern that sought to free itself from the shackles of a military dictatorship that prevented advances for democracy and social and health justice.

This article mixes elements of reflective essays and narrative reviews and refers to the systematization of the author's academic, institutional, and engaged experiences in different academic and institutional collectives, especially those related to Brazilian Unified National Health System (SUS, acronym in Portuguese), the Public Prosecutor's Office, and social movements such as unions and environmental organizations. In other words, this essay is based on singular experiences involving the author's trajectory with the systematization and analysis of moments in which counter-hegemonic collectives organized themselves to fight for democracy, health, better living and working conditions, and territorial rights. As we shall see, the search for paradigmatic transition (the focus of this essay) means changing conceptions and references about how accidents and disasters occurred, what their consequences and forms of prevention were, and the role of various social subjects, such as workers, unions, nongovernmental organizations (NGOs), and various institutions. The length limitations of this essay preclude the detailing of the modus operandi and the empirical characteristics of the field experiences that enabled the creation of spaces and application of the new conceptions of analysis and prevention of accidents and disasters in the search for paradigmatic transition in each movement of the described trajectory.

One of the inspirations for this essay comes from Oscar Jara [1], a popular educator and sociologist who helps us to think creatively about experiences to build knowledge. Jara proposes the systematization of experiences to originally and critically articulate theoretical references and singularities as sources of learning along personal and collective trajectories. Another reference for this essay is the concept of paradigmatic transition based both on Kuhn's [2] initial conception and later on the contributions of postcolonial studies, especially the Epistemologies of the South and notions such as cognitive justice and ecology of knowledges [3].

The idea of paradigmatic transition has been in the wake of epistemological debates in recent decades around the criteria of production, legitimation, and validation of scientific knowledge, driven by dynamics that strengthen interdisciplinarity. The growing relevance of comprehensive theories such as those of systems and complexity has been remarkable in the field of Public Health, incorporating authors such as Ilya Prigogine & Isabele Stengers and Edgar Morin, along with the notion of social determination of health-disease processes [4,5]. More recently, critical contributions have been formulated by the Social Sciences and Humanities based on postcolonial approaches that articulate social emancipation, interdisciplinarity, and interculturality around the ideas of coloniality of power, knowledge, and being [6], with specific debates, for example, on possible connections between Epidemiology and Anthropology around the concept of culture [7] or even on cognitive justice and ecologies of knowledges [3] as alternatives to recognize and validate the dialogue between knowledge produced inside and outside modern science given the plurality internal and external to the scientific environment of knowledge systems that respond to practical, political, symbolic, and spiritual needs in different societies [8].

This essay starts from Thomas Kuhn's [2] notion of paradigm related to consensuses shared by the members of a scientific community in a given period on points of view about problems and possible solutions, influencing the development of a set of theories, methods, and instruments that analyze,

predict, and control a certain reality. However, every theory within a community of peers is always submerged in a broader, subtle, and often unexplained dominant paradigm linked to social, human, and philosophical values and dimensions inherent to the society and historical moment that produce and use it. Every paradigm reflects the spirit of an epoch, which is why, when we speak of paradigmatic transition, we are fleeing from a positivist position that sees the evolution of "normal" science [9] in the Kuhnian sense as something restricted to a specialized community of peers. A positivist position that defends scientific debates restricted to specialists produces a tendency to silence or leave unquestioned the hegemonic paradigm in the face of the simultaneously scientific and social challenges of a certain time. The tension to the dominant paradigm is put into practice by an expanded community of peers [10] that encompasses new subjects, whether they are academics who incorporate new references by inter/transdisciplinarity or whether they come from social movements such as workers, peasants, Indigenous people, environmentalists, or those affected by racism or sexism. Thus, a paradigmatic transition would correspond to the processes that challenge current paradigms by elaborating new problems and alternative solutions to them.

The author's main institutional, academic, and empirical basis for constructing this essay lies in Brazilian Collective Health (how Public Health influenced by Social Medicine is called in Brazil) in the areas of worker's health and health and environment, which represent the Collective Health perspective for the areas of Occupational and Environmental Health. This work was developed in two collective dimensions: an academic one, linked to research and graduate studies predominantly in Public Health and a political and institutional one related mainly to the sanitarian movement and the construction of the SUS and its surveillance system (in the areas of Occupational and Environmental Health) in its initial search for democracy and social and sanitation justices. Thus, the empirical basis on accidents simultaneously linked itself to the structuring of SUS surveillance and to research, doctoral dissertations and master thesis that sought to theoretically and methodologically in understanding of accidents.

The freedom of the academic environment enabled certain references and even articulations with social movements to sometimes move away from the logic of the construction of the SUS and the health movement, as by what this essay will call later the third movement. As academic studies incorporated new references on analysis and prevention of accidents and disasters that supported practices of investigation and surveillance of accidents, these studies involved networks that were often – but not always – led by SUS together with universities, trade unions, social movements, environmental and community NGOs, Public Prosecutor's Offices, and environmental agencies, among others.

The trajectory of experiences was organized into three movements marked by distinct political, academic, and institutional contexts. Each movement has a set of unique professional experiences articulated with the search for and incorporation of schools of thought that offered new theoretical frameworks and concepts. These sought to renew the analysis and intervention around accidents and disasters, which became objects of investigation due to the mobilization of diverse networks and collectives over time. The idea of paradigmatic transition adopted here expresses the processes of deconstruction and reconstruction of the concept of accidents and their origins, consequences, and forms of prevention that opposed dominant paradigms that failed to meet the interests for transformation brought by the collectives and social movements with which we worked in each movement.

This essay chose some strategic concepts for each of the three movements to rethink elements of the paradigmatic transition around analysis and prevention of accidents and disasters based on interdisciplinary dialogues supported by certain authors and theoretical schools that continue to represent, in the author's assessment, relevant contributions to thinking about academic challenges and social transformation today.

First movement: symbolic and artificial prevention in workers' health

The context of the first moment, from the 1980s and mid-1990s, is strongly related to the construction of the health reform and the SUS in the process of redemocratizing its society after its military, civil, and business dictatorship. The paradigmatic transition in this movement sought to deconstruct forms of analysis and prevention of accidents and disasters that blamed workers for accidents, con-

cealed organizational and technological failures in factory work processes, and denied the importance of workers' knowledge and more participatory processes for prevention.

Several young researchers have dedicated themselves to building Workers' Health in Public Health and new surveillance practices with the strong participation of unions and trade union federations involved in redemocratizing Brazil and struggling for better working conditions. Interdisciplinary dialogues with professional and academic groups brought together professionals from the health movement with the Social Sciences and – of special relevance to the author's trajectory – from engineering, which are strategic for the analysis of work processes and their technologies and risks. In empirical terms, workers' health surveillance actions took place after the creation of state and municipal councils, which occurred with the participation of trade union organizations, often in partnership with the Public Prosecutor's Offices. The states of Rio de Janeiro and São Paulo formed a privileged space for action due to the strength of some of their economic, academic, and trade union movements sectors, with the remarkable performance of militant professionals who moved between academia and SUS, such as Machado [11], Vasconcellos & Ribeiro [12], and Lacaz [13].

An aspect to be highlighted in this first movement, a singular expression of the trajectory of the author of this essay, are the contributions from the interdisciplinary dialogue with the graduate program at Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Federal University of Rio de Janeiro (Coppe/UFRJ, acronym in Portuguese) in constructing workers' health. Production engineering had, since the 1970s, supported industrial modernization in Brazil by studying and designing production systems involving work, its environments, technologies, and organizations. At Coppe/UFRJ, cracks were opened for the creation of a libertarian space that enabled interdisciplinary and engaged work. A strong interface with the social sciences and humanities began in the critical analysis of capitalist work processes [14], influencing disciplines such as ergonomics and occupational safety and hygiene, which were incorporated into the training of staff who would work in occupational health surveillance actions. As a form of memory and tribute, we especially highlight three very active interdisciplinary engineers from this period who are no longer with us: Miguel de Simoni left in 2002; Oswaldo Sevá, in 2015; and Luiz Antonio Meirelles, in 2017, all with marked influence on public health groups and on the author's intellectual and existential formation. The three worked in partnership with physicians aimed at constructing workers' health at the time, such as Anamaria Tambellini (Oswaldo Cruz Foundation – Fiocruz, acronym in Portuguese) and Volney Câmara (UFRJ). The interdisciplinary and libertarian spirit these and other intellectuals of production engineering influenced remains alive in the –unfortunately few organizations that continue to work in activities that integrate activism, social technology, solidarity economy, extension, research, and teaching. Examples include the Technical Solidarity Center (Soltec/UFRJ, acronym in Portuguese) – linked to the Interdisciplinary Center for Social Development (Nides/UFRJ, acronym in Portuguese) – and the Oswaldo Sevá People's Engineering Network (Repos, acronym in Portuguese).

An important academic challenge for the paradigmatic transition of this first moment involved deconstructing backward and still hegemonic conceptions of accident prevention at the time in the business environment and the Brazilian State. For example, so-called technical but ideological and reductionist approaches still predominated within the Brazilian Ministry of Labor (which up to the advent of SUS was responsible for inspecting work environments), blaming workers for accidents based on the theory of unsafe acts and conditions [15].

The approaches derived from the collective health of the time concerned themselves more with social determination and the appropriation of Marxist sociological proposed concepts, such as the important works of Laurell & Noriega [16], which related workers' forms of exhaustion and burdens (expressed in the generation of diseases and accidents) with the production processes of absolute and relative surplus value. Another epistemological and methodological important classic (but more pragmatic) refers to *Ambiente de Trabalho: a Luta dos Trabalhadores pela Saúde* [Work Environment: the Workers' Struggle for Health] by Re et al. [17], published in 1986 (and recently republished), which originated in the Italian trade union struggle and influenced the construction of ergology in Brazil [18].

The interdisciplinary and engaged dialogue between production engineering and the French ergonomics of the activity with workers' health contributed at the time to the paradigmatic transition of analysis and prevention of accidents and disaster with three important concepts of prevention: symbolic, artificial, and real. The concept of symbolic prevention was strategic throughout our sub-

sequent trajectory as it marked our understanding that the paradigmatic transition in societies with undemocratic and authoritarian social and labor relations implied processes of unveiling the studied reality that hindered social transformation. The aforementioned Oswaldo Sevá introduced the concept of symbolic prevention, which has its origin in the work of French sociologist Denis Duclos [19,20]. His research in the 1970s and 1980s focused on analyzing the risk perception of chemical industry workers in France and the United States and showed the tendency toward erasing or annulling the different views and concrete experiences, especially of workers, about risks and accident prevention. This apparent consensus produced a specific form of prevention, called symbolic, which quite differed from what could be called real prevention, i.e., effectively aimed at controlling risks and reducing accidents. For Duclos, symbolic prevention mainly functioned to control the workforce and stabilize the social production relations within factories, seeking to convince everyone that risks were under control and preventive measures were effective. Symbolic prevention made more concrete perceptions about working conditions invisible but the latter subsisted in different ways in workers and their collectives and emerged by the juxtaposition of contradictory discourses about the confidence and efficiency of control over existing hazards.

Such critical positions emerged more clearly and explosively in the contexts of post-accident crises, a phenomenon interpreted as an appeal to the reality of risk that destabilized the social function of symbolic prevention, at least until its return by discourses, reports, and punitive measures companies and institutions circulated to try to restabilize social relations of work and production. This context evinced the not only symbolic and normative but also controlling and oppressive function of theories such as unsafe acts, which described human errors as the main cause of accidents. The other side of the coin was the possibility of ruptures and opportunities for the paradigmatic transition that emerged in the cracks opened by post-accident crises, providing instituting processes with spaces to mobilize and reconstruct new conceptual references, policies, and actions. The emancipatory perspective at the time stemmed from the incorporation of this critical view into workers' health surveillance actions, which involved SUS professionals, engineers, and other specialists in occupational safety and hygiene together with workers and their unions, often in the context of complaints from companies and sectors that experienced serious accidents.

The paradigmatic transition from this critical view and surveillance actions aimed to transform the hegemonic view of accidents at the time and can be summarized as follows: in unequal and authoritarian societies with strong economic and power concentration, analysis and prevention of accidents and disasters strengthens the symbolic and artificial role of prevention to normalize the dangers of technologies and work processes instead of serving as an effective engine for transformation by improving working conditions and democratizing society. Later on, several sociologists corroborated this conception – with the idea, for example, of normal abnormality [21] – to analyze the hidden technological and organizational risks whose manifestations would be expressed in accidents in an increasing severity until they produced events such as deaths and disasters. Therefore, by concealing the risks, symbolic prevention defended capitalist interests and their management by nonexplicitly assuming a strategy of control of the workforce that was deemed as technical prevention but corresponded to a simulacrum of the reality of work experienced in daily life.

On the other hand, especially in the context of the destabilization due to serious accidents, discontent, mobilizations, and leadership arose among workers and organized unions driven by revolts and a thirst for justice. The still under construction SUS harnessed this mobilization energy, strengthening partnerships between trade union movements and sectors of the state apparatus in a context of society redemocratization. The produced surveillance actions and reports, anchored by new references and sometimes with the support of Public Prosecutor's Offices, pressured companies and government agencies to deconstruct their official narratives.

To Duclos' [22] contributions we must add the importance of French ergonomics focused on the study of human work, or even, in a more interdisciplinary perspective focused on health, by Dejours' [23] psychopathology or psychodynamics, both of which had a strong presence in the production engineering and public health of that period. An important discovery of French ergonomics with implications for analysis and prevention of accidents and disasters is related to the concepts of prescribed (task) and actual work (activity), as well as the conflicts and problems arising from the differences between them. Prescribed work is related to the designs of technologies, workstations,

and organizations, as well as to the production standards and requirements (quality, productivity, and behavior) defined by management. On the other hand, real work expresses how workers perform it in an activity, including the cognitive processes in evaluating and making decisions about what is done as they must daily deal with the production demands imposed by management and unforeseen variabilities, defend their lives, and endure different workloads, including tiredness, stress, and various types of suffering. Ergonomics always finds differences between the expected task and the activity performed, and authoritarian and hierarchical societies tend to accentuate such differences due to the lack of interactions and dialogues between designers and managers with workers that hinder the humanization of working conditions, worsened when the state apparatus itself and its institutions are not very democratic and close to the business community, making the tripartite proposal of the International Labour Organization (ILO) unfeasible. This imbalance is evident in societies with strong inequalities and social asymmetries, strengthening the power of management that defends the logic of capital and productivity, whereas the most vulnerable workers defend their lives, dignity, and jobs. Thus, workers are unable to develop and use more fully various individual and collective skills to carry out their work in a safer and more humane way, risking themselves in the face of dangers and contradictions with the demands of management, added to the poor quality of projects and maintenance of various equipments and environments. Analysis and prevention of accidents and disasters can be seen as the result of these contradictions and conflicts, expressing the stage of delays or achievements toward more just, democratic, and inclusive societies.

For this reason, the paradigmatic transition implied, at that moment, the introduction of devices that accessed real work and made evident symbolic prevention and artificial risk management, a concept developed by authors such as Machado [11]. To deconstruct artificial prevention, it was strategic to adopt and disseminate participatory methodologies involving workers and their collectives within a broader process of democratization of society made possible by the creation of participatory instances with workers' unions in surveillance actions. Such actions were based on social determination and the Italian workers' model [17] to guide the surveillance of workers' health by the still under construction SUS at the time. Therefore, the paradigmatic transition of that moment aimed to point out more democratic and participatory technological and organizational measures that valued workers' lives.

Second moment: the complexity of environmental disasters, vulnerabilities, and the proposal of post-normal science to deal with uncertainties

The political-institutional context of this movement describes a paradoxical picture: despite the greater freedom for the organization of trade union and other civil society movements in the post-dictatorship period – including the health movement itself around the implementation of SUS –, the emergence of neoliberal governments and policies restricted the advances of occupational health surveillance actions. A remarkable fact in the mid-1990s for analysis and prevention of accidents and disasters was the transition from occupational accidents to environmental accidents and disasters, which were characterized in the chemical industries as amplified chemical accidents in the works of social scientist Carlos Machado de Freitas, together with the author, in dialogue with trade union movements. He and Jorge Machado were the main companions of this journey in the 1990s, organizing a book [24] on the subject in 2000 that, among other proposals, described the Interdisciplinary and Participatory Analysis of Accidents.

An emblematic event at the time was the accident at the chemical plant of the German multinational Bayer shortly before the United Nations Conference on Environment and Development (UNCED or Rio-92), which released a toxic cloud that reached Belford Roxo, at Baixada Fluminense on the outskirts of Rio de Janeiro (Brazil). Despite the company and the state environmental agency releasing a statement denying any danger, several residents showed symptoms of chemical poisoning, many being rushed to urgent care at nearby health centers and hospitals. At the time, several surveillance actions were carried out involving the workers' union, SUS, the Labor Public Prosecutor's Office, universities, and Fiocruz. The first master's thesis the author supervised in the Postgraduate Program in Public Health, Sergio Arouca National School of Public Health (PPGSP/ENSP, acronym in Portuguese) (defended in 1995 [25]) analyzed this accident. Since then, several projects and orienta-

tions related to PPGSP/ENSP and other graduate programs have involved issues related to analysis and prevention of accidents and disasters.

This event evinced that, by breaking down factory walls, environmental disasters represented a much more complex phenomenon that required new approaches. The first bibliographic studies and cooperation with international institutions showed a vast set of publications on the subject with the visibility of the so-called (at the time) major accidents, such as those in the Italian municipality of Seveso in 1976 and in the Indian municipality of Bhopal in 1984. The latter involved a US multinational factory (Union Carbide) that produced pesticides in cooperation with the Indian government to enable the "green revolution" in that country releasing a highly toxic gas (methyl isocyanate). The Bhopal disaster is considered the worst industrial accident in history in terms of short (about 3,000) and medium-term deaths (more than 20,000), being emblematic for peripheral countries such as Brazil and others with late industrialization.

The approximation with two theoretical frameworks was very important in this period to understand the complexity of these events and advance the paradigmatic transition about analysis and prevention of accidents and disasters in dialogue, which has been growing since then with the international academic community. The first is the concept of social vulnerability, which public health already addressed at the time [26]. Our case approached the concept of vulnerability constructed in the field of disasters [27], which sought to answer the following question based on the social sciences: how to explain that so-called "natural" or technological disasters of similar magnitude (in terms of the release of dangerous energies or chemical substances) could generate such radically different consequences in terms of deaths? Not coincidentally, this difference in deaths was more stark when comparing the richer countries of Western Europe, North America, or Japan, with countries such as Brazil, Mexico, and India. Well-known authors in Brazil, such as Barry Castleman [28] and his concept of double standards, had already discussed this phenomenon. He aimed to analyze how the prohibition of dangerous technologies and substances, such as carcinogen asbestos, occurred in the richest and most "developed" countries, whereas, in the opposite way, their import, production, and consumption were increasing in "developing" countries such as Brazil.

Our entry into the international academic debate on the subject was marked by the publication of an article [29] in 1996 on *Risk Analysis* (a prestigious international journal on risk analysis and management). The intention was to introduce the geopolitical debate and the international division of labor and risks using sociologist Immanuel Wallerstein [30] on the capitalist world-system as a reference. In a long process of discussion with reviewers, we had to remove terms such as peripheral and semi-peripheral countries to publish the paper as they were considered "ideological" and to reach an agreement that put in their place "industrializing countries" instead of "developing", a concept proposed by the reviewers and flatly rejected by the authors. This example evinced that the paradigmatic transition would be complex at the international academic level since the so-called more "objective and neutral" and "less ideological" scientific debate was controlled by research centers of the most powerful so-called "developed" countries, the central countries in Wallerstein's world-system, subordinating articles and funding of research projects to the hegemonic canons of quality.

Another reference of special relevance that brought the epistemological dimension to our debate was post-normal science, whose initial contact occurred by chance in 1993 when the author visited the Joint Research Centre in Ispra, Italy, in the context of the sandwich doctorate he was doing in Europe. From that time on, dialogues of great epistemological and methodological depth were initiated with the two main authors of this proposal, Funtowicz & Ravetz [10,31]. In summary, the post-normal science proposal results from a political, economic, and institutional context in Western Europe concerned with how to democratically deal with an increasingly complex society involving multiple risks, the so-called knowledge, information, and risk society. The post-normal science proposed an alternative to managing complex problems, mainly environmental ones, related to the science-policy interface by assuming that specialized or normal science disregarded uncertainties, the weight of values in decision-making, and the plurality of legitimate perspectives. The increase in uncertainties would require a more democratic and participatory mode of management since problems such as chemical, nuclear, or biological contamination are unable to be solved by specialists alone and require an expanded community of peers.

Although its diffusion in Brazilian public health has been limited to a restricted academic group, we highlight some of the post-normal science contributions. First, the importance of epistemological refinement of the knowledge to assess and communicate the three types of uncertainties in post-normal science: technical, such as the imprecision of measuring instruments and their uses; methodological, related to the mastery of theories of production and data analysis; and epistemological, related to the lack of more consistent theories to deal with the complexity of the phenomenon. While advances in the acquisition and maintenance of equipment and scientific training of professionals at different levels could surpass the first two and would express the degree of technical-scientific and technological development of a country or region, the latter would reflect the highest degree of uncertainty, epistemic ignorance. At its limit, the more complex and mysterious the problem at hand could be irreducible, which would lead science to take a more humble and wise perspective in recognizing what is unknown. For the post-normal science, normal science, in the sense given by Kuhn [2], tended to affirm more certainties than to make explicit its uncertainties, which remained hidden. This would hinder the paradigmatic transition by facilitating the manipulation of scientific production according to the interests that financed or defined the conditions of specialized scientific and professional work, especially in the context of decision-making processes about what would be acceptable risks or not.

The solution to this dilemma would be as much the ability to explain the uncertainties at stake and education and scientific dissemination in society as a whole. The latter had legitimate conditions to participate in the decision-making processes (rather than only experts) since they had legitimate values and interests. The utopia of the new information society would move toward a continuous process of improvement and training of dialogue in environments of open, democratic, and robust debates that would avoid more radical social conflicts due to the polarization of positions and interests.

The construction of expanded peer communities the post-normal science proposed can be considered a reasonably naïve utopia because it disregards the social and interest conflicts in unequal capitalist societies with strong power asymmetries. Its proposal would depend on a high moral level, sincerity, intelligence, and willingness to dialogue from the various groups involved in complex decision-making. This would be the case, for example, of the release of dangerous technologies such as nuclear, chemical, and biological technologies or even the pesticides and transgenics necessary for the agribusiness model. But how can we expect this high moral level of argumentative robustness, openness to dialogue, and wisdom from politicians, businessmen, and religious and political groups when they become very powerful and dogmatic? The very current examples related to climate change and the threats to democracy with the expansion of the far right and fake news show the failure of the European utopia of the democratic information society.

At the same time, the evolution of the scientific modus operandi offers a paradox that is difficult to overcome for the most sophisticated and specialized areas of science: how scientists and technicians trained over many years, who adhered to certain paradigms and adopted a particular grammar that is difficult for nonspecialists to understand, such as nuclear physics, economics, and epidemiology, will they open themselves up to cross the boundaries that can contradict, expose weaknesses, and question the values, assumptions, and certainties of the paradigms and models they operate? In reality, we found a closure from specialized communities, tipifying the functioning of normal science and techno-bureaucratic decision-making processes.

This problem evinced the strategic role of alternative counter- or anti-hegemonic specialists to produce analyses and reports of counter-expertise that could recognize and translate the limits of the most sophisticated theories and methods for analysis and prevention of accidents and disasters. They function as a kind of engaged technical-scientific "guardian angels" who act in the destabilization of so-called technical hegemonic positions by making explicit the assumptions, methodological bifurcations, uncertainties, interests, and different outcomes at stake, sometimes radically different from those in the hegemonic media. These systematically concealed uncertainties and interests at stake on the official reports from company or government or academic institutions, but with dissimulated conflicts of interest.

The symbolic prevention of analysis and prevention of accidents and disasters, pointed out in the previous moment, persisted in environmental licensing reports or in those on disasters involving complex and dangerous technologies and production processes. However, effects in this second movement exceeded the factory spaces since the dangers were amplified on much broader spatial,

temporal, and social scales. In other words, the role of symbolic prevention in stabilizing the social relations of production and the productivist or neoliberal paradigm of scientific and technological progress that underlay the ongoing globalization process became evident. The second movement served as a passage to a new moment of paradigmatic transition that accentuated both industrial and broader ecological disasters at the same time new struggles for social emancipation arose in the country and on the planet.

The current moment: struggles for environmental and cognitive justices and abyssal vs. emancipatory prevention to address contemporary challenges

To conclude, we describe the third and current moment with the proposal of abyssal and emancipatory prevention, which completes our conceptual and empirical trajectory at the turn of the 21st century up to the present day. It is of special interest currently as it reflects a contradictory, paradoxical, and highly complex context due to the worsening of numerous global, regional, national, local, economic, existential, and ontological socio-environmental and health crises. The latter are related to the questioning of the sense of progress and humanity by modernity, which requires us to think more and more about the notion of social emancipation based on the necessary connection between paradigmatic transition and a broader civilizing transition in an increasingly globalized society.

Nationally, since 2003 an era of Workers' Party (PT, acronym in Portuguese) federal governments showed redistributive and participatory policies favored by economic growth. The incorporation into the new government of several union leaders and active politicians reinforced the institutionalization of public policies and State actions aimed at equity, poverty reduction, the fight against hunger, participation, and social inclusion. At the same time that it reinforced a paradox between instituting and instituted cycles involved in social transformation. The idea of social engagement and paradigmatic transition depends on the strengthening of counter-hegemonic or, as we prefer, anti-hegemonic instituting processes, which contribute to altering the status quo that maintains inequalities and injustices. However, the imbalance between instituting processes and those instituted in weak democracies becomes more evident under unstable and quickly reversed social gains. In Brazil, this fragility was exposed by the limitations of the PT's coalition government involving center-right groups, which tragically ended in 2016 with the impeachment of President Dilma Rousseff and the rise in 2018 of a far-right government, which seemed unthinkable up to then. This is one of the explanations why the social engagement related to analysis and prevention of accidents and disasters in this third movement approached networks and organizations that were relatively independent of the federal government and institutions, such as Brazilian Environmental Justice Network (RBJA, acronym in Portuguese).

International globalization and neoliberalism were making great strides with the end of the Union of Soviet Socialist Republics (USSR), reversing the apparent advances made with Rio-92 or UNCED around the problematic concept of sustainable development, linking the practice of democracy to the idea of governance. The global picture of democratic crisis shows how the very idea of strong democracy is being put in check in regions deemed more stable and resilient, such as in Western European and North American countries. Parallel to the policies of inclusion, globalization reinforced developmentalism, consumerism, and neo-extractivism in countries with greater potential for the production of agricultural and mineral commodities. The period expanded and accelerated the precariousness of work and ecological degradation, the reprimarization of the economy, and the neoliberal flexibilization of social, environmental, labor, and social security rules. Brazil has further driven different forms of dispossession and violence in territories, especially traditional ones (such as Indigenous and *Quilombolas*) and family farming, to expand agribusiness, mining, logistics, and associated infrastructure projects. This process was dialectically accompanied by increasingly organized resistance from peasant, Indigenous, and Quilombola peoples and communities and populations from the urban peripheries. In this context, it has become increasingly important to approach and understand the meaning of these resistances and social struggles led by these subjects since instituted official processes shaped public policies and institutional practices, although quite resilient so as not

to collapse quickly such as SUS, were moving away from utopias and emancipatory processes in the course of social transformation.

To understand this complex picture, we approached theoretical frameworks from two interdisciplinary fields with strong social engagement. The first is that of political ecology and movements for environmental justice [32], and the second is that of postcolonial approaches, including the epistemologies of the South, which privilege the analysis of social struggles for the recognition of other ways of being, power, and knowledge [3,6]. Therefore, they bring politics understood in its classical sense closer to territorial, ontological, and knowledge policies and add two new dimensions of justice (environmental and cognitive) to the two previously privileged by Collective Health (social and sanitary) [33]. These frameworks innovatively contributed to understanding burning issues that had been intensifying with the growing centrality of ecological and ontological issues, including environmentalism, racism, and feminism. The political geography in the construction of Collective Health was updated by the idea of the return of the territory as an expression of disputes between the global and the local, or the vertical and the horizontal in Brazilian geographer Milton Santos' terms [34].

The contributions of postcolonial approaches joined the socio-ecological dimension to broaden the geopolitical reading of the capitalist world-system and phenomena such as racism and the various forms of violence and oppression against Indigenous and African peoples and communities, women, among others. As a result, a conceptual shift moved away from dependent capitalist countries or Third Worlds, which became part of a broader group called the Global South. More than a geographical definition of countries (the Global South has a North as the Global North has a South), thet concept expresses the legacies and consequences of colonialism (or coloniality) [3]. It introduces an ontological politics (definitions of the human) that criticizes strategies of domination and invisibilization of the peoples of the Global South by the Global North, a metaphor for hegemonic Western modernity.

The cognitive justice proposed by the epistemologies of the South aims to understand and support the emancipatory processes that seek to recognize and legitimize other ways of being, knowing, and living in society and with nature in the Global South, which the combination of the three axes of modern domination – capitalism, colonialism (or coloniality), and patriarchy – have and continue to despise or annihilate. Therefore, in addition to permanent forms of social exclusion resulting from capital-labor exploitation, the radical ontological exclusion is proposed – as called by Santos [3] and Santos & Meneses [35] –, expressed by the idea of abyssal thinking that marks Eurocentric modernity. Radical exclusions involve issues such as racism and modern science when it imposes canons that despise and refuse to dialogue with traditional and popular knowledge systems of the Global South (epistemicides), such as those of peasants and Indigenous and African peoples.

The reflections for the paradigmatic transition on analysis and prevention of accidents and disasters have been currently built due to the growing relevance of disasters and tragedies the author has worked on by producing anti-hegemonic reports and public demonstrations in conjunction with various movements, organizations and entities, such as RBJA, Brazilian Public Health Associations (ABRASCO, acronym in Portuguese), and the National Articulation of Agroecology. At first with chemical and oil industries, such as the oil spill in Guanabara Bay (Rio de Janeiro, 2000), the sinking of the P-36 platform in the Campos Basin (Rio de Janeiro State, 2001), the leak of the dam in Cataguases (Minas Gerais State, 2003), and, more recently, the oil spill that hit the coast of the Northeast in 2019. In 2011, the climatic disaster occurred with heavy rains and landslides in the mountainous region that killed about a thousand people. Finally, the tragedies of mega-mining of steel, such as the collapse of the Mariana (Minas Gerais State) dam in 2015 at the Samarco company, and another dam collapse in Brumadinho (Minas Gerais State, 2019) at the Vale company, with 270 deaths [36]. Not to mention the environmental tragedy of chemically dependent agribusiness that produces fires, deforestation, and mass contamination due to the intensive use of pesticides that are indispensable for large-scale monocultures [37].

The emerging paradigm in investigations of these disasters highlights that the economic development projects of the neo-extractivist capitalist model strongly invisibilize and affect peasant, Indigenous, *Quilombola*, and traditional fishermen's territories. This new moment began to relate the systemic causes of these disasters with the development model and the processes of invisibility, environmental racism, and epistemicides that mark both environmental licensing processes and analysis and prevention of accidents and disasters after the events. Thus combining symbolic prevention with

an abyssal prevention that keeps responsible companies and the development model defended by governments in various instances unscathed and that generate disasters in the name of progress and economic growth.

To confront the abyssal prevention that makes affected social groups and territories invisible and their struggles based on their social class, race, and gender, we propose the idea of emancipatory prevention. It seeks the paradigmatic transition of analysis and prevention of accidents and disasters in convergence with civilizational transition by recognizing the existence and respectfully dialoguing with the diverse knowledges and practices of the various traditional peoples who act as guardians of nature and its sacred territories and build proposals such as Good Living and conviviality. It opposes the exploitative, controlling, and non-convivial perspective of Western modernity and its utilitarian conception of progress. Thus, the disaster becomes more than an event characterized by its quantifiable magnitude, a metaphor for our civilizational crisis, and the hope of understanding it can guide the challenge of the paradigmatic transition in several areas that can converge to reinventing social emancipation in our current times.

Conclusion

Although this essay focuses on accidents and disasters, different areas and objects of investigation can be inspired by its reflections to think about the potential for paradigmatic transition and social emancipation along the fields, areas of knowledge, and even specialized disciplines as long as they are open to interdisciplinary and socially engaged approaches. With the worsening of the ecological and democratic crises, the challenges of paradigmatic and civilizing transitions have become an increasingly transversal requirement for academia as a whole.

In discussions on analysis and prevention of accidents and disasters, the role of symbolic prevention first aimed to stabilize social labor relations by concealing the contradictions of capitalist exploitation and authoritarian organizational practices, for which the proposed alternative considered prevention in relation to real work and the participation of workers. The symbolic prevention persisted in a second moment but its understanding expanded beyond the factory world. Maintaining stable social relations of production in the face of a globalized society in a growing socio-environmental crisis required hiding uncertainties and interests in the face of increasingly complex and uncertain work processes, technologies, and risks. The paradigmatic transition of the second movement proposed more democratic decision-making processes in expanded communities of peers, including vulnerable territories and populations in risk areas, together with environmentalists, as well as counter-experts who could translate and deconstruct the so-called "technical" arguments about "controlled technologies with acceptable risks". Finally, in the third moment, socio-environmental and health crises worsened in the development model, State, and modern science, configuring a crisis both paradigmatic and civilizing. Disasters are intertwined with issues of racism, the radical exclusions promoted by the notion of progress, control, and the alleged ontological superiority of Eurocentric modernity. Global and local are increasingly interconnected (as in the idea of glocal), and the socio-ecological crisis has driven the recognition of a new era, that of the Anthropocene or even capitalocene.

The answers to these challenges pass, from the point of view of knowledge production, by new epistemologies that promote respectful encounters between the knowledge of academia and the traditional and popular systems of knowledge and wisdom of the peoples of the Global South, whether they originate from the Americas, Africa, or Asia, which are permanently updated in new hybridisms that shape new systems of knowledge and practices. The agendas linked to the ecologist, traditional peoples and communities, anti-racist, and feminist movements show both emancipatory and potentially fragmenting tendencies when their various struggles are not articulated and opposed to each other. Articulating diversity and coexistence in the production of good-quality knowledge is a strategic challenge for academia in times of so much bellicosity and fake news.

Thus, the new challenge of knowledge transcends the one proposed more than 30 years ago by Minayo [38] to think about health research as it implies recognizing and dialoguing with knowledge systems and producing interdisciplinary and intercultural knowledges together with social move-

ments and territories to simultaneously support paradigmatic transition movements and emancipatory processes that fight for social transformation in a world under crisis.

The new challenge of knowledge brings the epistemological question of social transformation closer together and a new understanding of the meaning of emancipation. This will require more awareness, philosophy, art, and social engagement to build a science that is sensitive and open to the demands of the new times.

Additional information

ORCID: Marcelo Firpo Porto (0000-0002-9007-0584).

Acknowledgments

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Resumo

O artigo, na forma de ensaio, sistematiza uma trajetória profissional de experiências interdisciplinares e socialmente engajadas em torno da análise e prevenção de acidentes e desastres nos últimos 40 anos. O trabalho acadêmico se desenvolveu principalmente no âmbito da pesquisa e pós-graduação na Saúde Pública brasileira impulsionado pelo movimento sanitarista e a construção do Sistema Único de Saúde (SUS) em sua busca por democracia, justiça social e sanitária. A base empírica envolveu ações de vigilância em saúde dos trabalhadores e ambiental organizadas em redes protagonizadas pelo SUS em conjunto com universidades, sindicatos, movimentos sociais, organizações não governamentais (ONG) ambientalistas e Ministérios Públicos. Eventos de maior complexidade socioambiental em setores como siderurgia, petroquímico, mineração, agronegócio e energia forjaram a busca por novos referenciais epistêmicos e interdisciplinares que abarcam duas novas justiças: a ambiental e a cognitiva. Este artigo apresenta essa trajetória de contribuições conceituais em três movimentos a partir da década de 1980 até os dias atuais, cada qual correspondendo a um contexto sociopolítico e institucional, para pensar movimentos de transição paradigmática na análise e prevenção de acidentes e desastres numa perspectiva interdisciplinar. Finaliza-se com a sugestão de prevenção abissal e emancipatória para enfrentar diferentes crises da atualidade, como a ambiental, a sanitária, a democrática e a civilizatória.

Prevenção de Desastres; Epistemologia; Iniquidade Social; Empoderamento

Resumen

El artículo, en forma de ensayo, sistematiza una trayectoria profesional de experiencias interdisciplinarias y socialmente comprometidas en torno al análisis y la prevención de accidentes y desastres en los últimos 40 años. El trabajo académico se desarrolló principalmente en el ámbito de la investigación y postgrado en Salud Colectiva brasileña, impulsado por el movimiento sanitario y la construcción del Sistema Único de Salud (SUS) en su búsqueda por democracia, justicia social y sanitaria. La base empírica involucró acciones de vigilancia en salud y ambiental de los trabajadores, organizadas en redes protagonizadas por el SUS en conjunto con universidades, sindicatos, movimientos sociales, organizaciones no gubernamentales ambientalistas y Ministerios Públicos. Los acontecimientos de mayor complejidad socioambiental en sectores como la siderurgia, el petroquímico, la minería, el agronegocio y la energía han llevado a la búsqueda de nuevas referencias epistémicas e interdisciplinarias que abarcaron dos nuevas formas de justicia, la ambiental y la cognitiva. El artículo sistematiza esa trayectoria de contribuciones conceptuales en tres movimientos a partir de la década de 1980 hasta los días actuales, cada cual, correspondiendo a un contexto sociopolítico e institucional, para pensar movimientos de transición paradigmática en el análisis y prevención de accidentes y desastres desde una perspectiva interdisciplinaria. Se finaliza con la sugerencia de prevención abisal y una prevención emancipadora para enfrentar diferentes crisis de la actualidad, como la ambiental, la sanitaria, la democrática y la de civilización.

Prevención de Desastres; Epistemología; Iniquidad Social; Empoderamiento