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Unions and NGOs positions on the risks and regulation of nanotechnology

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ABSTRACT

This article discusses the perspectives of a number of Non-Governmental Organizations (NGOs) and trade unions on the risks and regulation of nanotechnology. In the context of large public and private investments in nanotechnology, and its rapid incorporation into processes and products, these groups have sought to advance their interests through diverse strategies. Their positions are centered in the application of the precautionary principle and include demands for moratoria, more investigation on environmental, health and occupational risks, specific and mandatory regulation, transparent information and broad public participation in the governance of nanotechnology. We show that these civil society organizations are constructing collaborations and alliances and have had some degree of success in placing the issues of risks and regulation into the government's agendas.

KEYWORDS: Nanotechnology; Risks; Regulation; NGOs; Trade Unions.



Introduction

The development of nanotechnology began in the context of a complex relationship between society and science, wherein it was a closely scrutinized by a variety of actors in civil society. As Jassanof¹ points out, as of the 1990s, there was a growing mobilization of social groups who believed they were being marginalized from the technical decision-making process regarding environmental, technological, and economic issues that affect people on a daily basis, and they consequently began to claim greater participation. Several civil society organizations became involved in controversies regarding scientific-technological development, most importantly the paradigmatic case of genetically modified foods. The lack of transparency regarding the assessment of the health and environment risks of such foods was one of the sparks that initiated strong mobilization, and even resistance, in response to this technology^{2,3}.

In the wake of these issues, policies on nanotechnology, especially in Europe and the United States, promptly and more decisively incorporated concerns with regard to the assessment of ethical, social, and legal implications (ELSI – ethical, legal and social issues) of nanotechnology as well as the potential risks posed to health and the environment (EHS aspects – environmental, health, and safety issues). In addition, policies included scientific dissemination and several modes of public engagement aimed at increasing public discussion and participation^{4,5}.

In addition, social groups focused on consumer rights and social justice, environmentalists, and labor unions, among others, began to rapidly mobilize themselves to represent their own interests. This article primarily analyzes the concerns and demands of these groups with regard to the risks and regulation of nanotechnology. We demonstrate that even though policies on nanotechnology represented progress in governance proposals, after a little more than a decade, this progress has not focused on preventing the risks of nanotechnology. Commercial development of nanotechnology overpassed the time necessary for the assessment of risks, which on one hand, has resulted in the lack of research regarding the risks posed to health and the environment, and on the other hand, has led to the prevalence of voluntary regulation proposals that had reduced effects. However, this does not render the mobilization of these organized social groups worthless. We believe that their actions, claims, and alliances were crucial in calling attention to the lack of research on risks as well as in making the issue of regulation a high priority on the agendas of national governments and international organizations.

In section one, we briefly review the evidence regarding the potential risks of nanotechnology and the main affected groups, thus indicating the gap between the rate of development of nanotechnology and that of research regarding the associated risks. In section two, we present a summary of the actual state of regulation. In section three, we examine the positions and claims of NGOs and labor unions. We conclude with some final considerations.

Risks of nanomaterials and potentially affected agents

Not only is there great uncertainty regarding the risks of nanomaterials but there is also no standardized method to assess them⁶. The most common argument presented by industries and governments for opposing the regulation of nanotechnology is the lack of conclusive scientific evidence about the risks of nanotechnology. On the other hand, these risks constitute a typical case of *undone* science, one which is not (or only marginally) incorporated in the agendas of these bodies⁸. Around the middle of the last decade, in the United States, a multimillion dollar program, the National Nanotechnology Initiative (NNI), only allocated 4% of their funding to research on EHS⁹. In Brazil, in 2010, a tender was launched for the formation of networks of research on nanotoxicology. As Miller and Scrinis⁷ observe, the current situation is strongly asymmetrical. The promises of nanotechnology, such as new markets, skilled labor jobs, and cures for diseases, are commonly noted in political debates; however, these benefits have been insufficiently examined and proven, and conclusive evidence is required before implementing regulation on nanotechnology.

Despite limited financing for research, there is increasing evidence of the toxicity of various nanoparticles. The International Council on Nanotechnology¹⁰ registered a continuous increase between 2000 and 2010 of scientific articles addressing the risks of nanomaterials to human health and the environment, with 563 articles published in 2010. Another organization, the Nanotechnology Citizen Engagement Organization (NanoCeo)¹¹, created a database of scientific articles concerning the risks posed by specific types of materials manufactured through nanotechnology. Between 2000 and 2010, there were 176 articles regarding the risks of carbon nanotubes, 190 on the risks of nanosilver, and 70 on the risks of titanium dioxide; all these materials are used in products already available in the market. The Brazilian Academy of International Law (ABDI)¹² conducted a study based on an analysis of the publications on ISI Web of Science, showing that even though the number of studies about toxicity is increasing, it is still insufficient, and that there is a clear discrepancy between the amounts of research on nanotechnology and that on its risks. A cross-reference using a set of key words from several areas of nanotechnology, including words such as toxicity, safety, and risk assessment, clearly indicates that only a small portion of articles focus on these aspects. Moreover, among those that address these issues, the importance given to safety and risk assessment is extremely low (cf. Table 1).

The currently available evidence indicates that several nanoparticles are highly toxic, e.g., carbon nanotubes may behave in a similar manner to asbestos. The extremely small size of nanoparticles implies that, if they are inhaled, they can pass through the respiratory tract and the blood barriers before reaching the brain. Furthermore, they can overcome the



Table 1. Publications on toxicity, safety, and risk assessments on ISI Web of Science 1999-2008.

Keyword	Total # of publications	Cross reference × Toxicity	Cross reference × Safety	Cross reference × Risk assessment
Nanoparticles	71,113	1,101	279	78
Nanotubes	38,687	388	80	39
Nanostructures	24,470	33	9	2
Quantum dots	22,294	169	36	13
Nanocrystals	21,799	84	11	1
Nanocomposites	17,562	33	25	4
Fullerenes	7,039	81	17	7
Nanomaterials	5,628	309	88	61
Nanospheres	3,265	77	17	1
Engineered nanomaterials	177	45	14	17

Source: Taken from ABDI 12.

barrier between a mother and a fetus and may even reappear in future generations, as they undergo slow biodegradation. It has been highlighted that some nanoparticles affect cell metabolism and even damage and modify DNA¹³. However, many of these results were obtained through in vitro laboratory studies or animal testing; thus, these effects may not apply to human beings. However, in late 2009, a case was registered in China in which seven employees of a factory were hospitalized because of respiratory problems; two of them eventually died. Investigations indicated the formation of granulomas and fibrosis in the lungs, which contained nanoparticles of acrylic resin^{14,i}. Thus, the available information allows us to assert that there is a reasonable possibility that certain nanoparticles pose risks to workers, consumers, and ecosystems^{15,16}.

While the number of scientific articles indicating the existence of risks was increasing along with the need for further investigation, nanotechnology was rapidly being incorporated in industrial processes, and the first batch of products containing nanomaterials was released in the market. The Directory of Nanotechnology Businesses created by Nanowerk¹⁷ reports on 2,094 businesses in 50 countries in September 2013. This and other international inventories report the situation in Latin America and other developing countries. For example, a survey conducted in Brazil in 2011 indicated that there were 155 businesses producing nanomaterials or incorporating nanomaterials in their products¹⁸; in Mexico, Zayago, Foladori, and Arteaga¹⁹ reported 101 such businesses in the same year; and in Argentina, a report from 2009 indicated the existence of 22 businesses with nanotechnology-related activities²⁰.

With regard to commercialized products, an inventory (not exhaustive) of consumer goods created by the Woodrow Wilson Center's Project on Emerging Nanotechnologies reports on 1,628 products manufactured in 30 countries until October 2013²¹. BCC Research²², a consultancy agency that claims to perform "realistic" market evaluations, indicates that the global market of products and materials which incorporate nano-

technology reached 2.1 billion dollars in 2011, and it estimates that by 2017, the total sales will reach 48.9 billion dollars.

This rapid incorporation of nanotechnology in industrial processes and the growing market of consumer products imply that workers, consumers, and the environment are exposed to potential risks that have barely been studied. According to an analysis by the FramingNano²³ project, the first to be affected in the chain of exposure to risks are the workers who synthesize the nanoparticles and nanostructures. They can receive nanoparticles through inhalation, their skin, or even direct ingestion. To control these risks, safety measures and extreme sanitation are required in the laboratories that manufacture these materials.

The next stage is the manufacturing of consumer products, in which nanoparticles and nanostructures are added as primary raw materials to grant specific properties, new functionalities, extra durability, etc. During this phase, occupational risks increase significantly, not only because thousands of industrial workers from a wide range of production sectors within the industry are involved, but also because there is less experience regarding the toxicity risks in these industries as compared with that in the previous stage, which primarily involved the chemical industry. Furthermore, there is evidence suggesting that subcontracted companies offer less protection from toxicity risks.

The third level of exposure to risk involves consumers of the products that contain nanomaterials. The population as a whole is exposed to these risks through inhalation, dermal exposure, or ingestion. Trouiller et al.²⁴ particularly highlights the use of sprays containing titanium dioxide nanoparticles, commonly used in cosmetics, because laboratory studies on rats have demonstrated that they damage DNA.

Finally, the environment can be affected throughout the production cycle owing to industrial debris and the disposal of the products. Studies indicate that nanoparticles can remain in the air for long periods because of their reduced size and

i Even though it was subsequently debated whether the deaths were exclusively related to nanoparticles, it is certain that the protection of women workers who manipulated nanoparticles in industrial processes was inadequate. .



weight and can travel long distances. In water, suspended and scattered nanoparticles may combine and acquire new functionalities, and in soil, there is considerable uncertainty about their biodegradation²⁵.

Norms and regulations of nanotechnology

After more than a decade of increased public financing and commercial development of nanotechnology on a worldwide scale, there has been negligible progress in terms of regulation.

There are at least two main reasons to initiate regulation. First, nanoparticles and nanostructures manifest new and unknown physicochemical and biological properties with regard to the same matter on a larger scale. This means that they can also develop different and unknown toxicity properties. Second, since the 1990s, as noted in the previous section, investigations have indicated that some nanomaterials were found to be toxic when analyzed *in vitro* and through animal testing in laboratories. Both reasons are widely known and should be sufficient to motivate the implementation of a precautionary stance for reinforcing research on the issue and boosting a consistent regulatory effort.

However, instead of being a straightforward technical process based on scientific evidence, regulation is an issue that involves conflict among several interests. NGOs such as the ETC Group, Friends of the Earth Australia (FOE-A), and the International Center for Technology Assessment (ICTA) have been pioneers and have forcefully demanded greater focus on precaution and regulation^{26,27,28}. Major union federations such as the UITA in Latin America and the ETUC in Europe have also advocated the same views^{29,30}.

The chemical industry, on the other hand, which has a significantly greater influence on governments, has directed the lobby toward impeding any attempt at regulation. In the United States, this has been documented by the Environmental Defense Fund³¹. At the international preparatory forums and the International Conference on Chemical Management (ICCM), the chemical industries and governments that share their views on regulation have systematically blocked any initiative toward precaution and regulation^{32,33,34}. Furthermore, industries have opposed even the mildest regulation measures such as labeling of products, as in the case of Johnson & Johnson³⁵. However, some business sectors have favored voluntary norms such as codes of conduct, as in the case of DuPont, BASF, Bayer, Johnson & Johnson, and Unileverⁱⁱ.

Other business sectors favor partial regulations. Swiss supermarket associations, for example, have expressed interest in labeling products that use nanotechnology³⁶. Moreover, the insurance company Continental Western cancelled their insurance contracts with all companies that process or utilize carbon nanotubes³⁷.

In addition, some local governments began to request information about production processes involving nanotechno-

logy. In 2006, the city of Berkeley, California demanded information on the utilization and risks of nanomaterials from all industries that used nanomaterials³⁸. Since 2008, the city of Cambridge, Massachusetts has demanded mandatory reports, including risk assessments, from companies that utilize nanomaterials³⁹. In 2009, the state of California issued a regulation that requires all companies producing or importing carbon nanotubes to clarify their methods for evaluating risk and occupational safety⁴⁰.

France recently began to demand a mandatory registration from all producers, distributors, and importers of products with nanoparticles. The companies must state the type, quantity, and utility of the products; identify the professionals who utilize them; and clarify the risks posed to health and the environment⁴¹. Countries such as Denmark and Belgium followed this path⁴², and others such as Norway, Sweden, and Italy are about to implement these measures⁴³.

At a supranational level, the European Union took the lead, approving a regulation on biocides that requires companies utilizing nanomaterials to obtain a specific approval⁴⁴. Another regulation was approved for cosmetics companies, requiring them to both use labels detailing their contents and inform authorities before releasing products containing nanomaterials to the public⁴⁵. A similar measure is required for food labels, to inform consumers about the content of manufactured nanoparticles⁴⁶.

There are efforts focused on establishing international guidelines for regulation; however, they are voluntary and primarily focused on assisting product commercialization, even though they contain specifications on occupational and environmental risks. The International Standards Organization (ISO) has formed a committee to develop standards for nanotechnology, such as terms and common processes that establish parameters for the industry and assist in the subsequent development of regulations. The Organization for Cooperation and Economic Development created one work group on nanomanufactured materials and another to elaborate definitions and guidelines for the member countries⁴⁷. Furthermore, there are collective and multilateral negotiations in which governments, companies, NGOs, international organizations, and unions participate, such as the ICCM and its agency, the Strategic Approach to International Chemicals Management (SAICM). Despite their decisions not being mandatory, in 2012, the ICCM-3 included nanomanufactured products in the SAICM's Global Action Plan, implying that countries should (1) implement actions toward developing programs for monitoring and for the safety of laborers, consumers, and the environment and (2) disseminate and enhance knowledge on nanomanufactured materials.

This brief review shows that, even though there have been some endeavors to implement mandatory reports of activities in nanotechnology as well as some mandatory norms for specific production sectors, the focus on voluntary (*soft law*) norms is still

ii In addition to these companies, codes of conduct and/or voluntary certification were also issued in 2008 by Rusnano, formerly the Russian Corporation of Nanotechnology, and the European Union.



Table 2. Documents produced by NGOs, unions, and coalitions of various social organizations.

Organization	Country/ region	Documents	Content: Stand and claims
Trade Unions Congress (TUC)	Great Britain	<i>Nanotechnology Fact Sheet</i> . 2004 http://www.tuc.org.uk/h_and_s/tuc-8350-f0.cfm	Possible risks of nanotechnology and the importance of prevention. Supports the recommendation of the Health and Safety Executive to businesses, indicating the need for companies to adopt a precautionary approach and ensure that workers are not exposed to nanoparticles. Strategy should be to reduce exposure to nanoparticles as much as possible. Nanomaterials should be treated as any other material that presents a serious health risk, and regulations such as COSHH should be strictly enforced. It is important that unions act decisively to ensure that another tragedy such as that due to asbestos does not occur.
Australian Council of Trade Unions (ACTU)	Australia	<i>Submission to the Senate Community Affairs Committee: Inquiry into workplace exposure to toxic dust</i> . 2005 http://www.actu.org.au/Images/Dynamic/attachments/6463/Senate%20Inquiry%20on%20Toxic%20Dust%20050805.pdf <i>Comment on DITR Nanotechnology Strategy</i> . 2006 http://www.actu.org.au/Publications/DITRNanoStrategy.aspx <i>FACT SHEET Nanotechnology - why unions are concerned</i> . 2009 http://www.actu.org.au/Images/Dynamic/attachments/6494/actu_factsheet_ohs_nanotech_090409.pdf	Demands from the Senate the need to discuss the risks of nanotechnology and the urgency in its regulation. Requests that nanoparticles be assessed by a threefold agency prior to being utilized in products (2005). Demands that the Australian Nanotechnology Strategy immediately adopt measures to address the environmental and health risks of nanomaterials and ensure safety of workers and the public. Indicates the need to increase research on EHS (2006). Emphasizes that nanoparticles may pose risks owing to their size, surface area, and toxicity. Nonetheless, they are already used in many products. The unions believe that although nanotechnology has great potential, regulating it is essential. Despite growing scientific evidence regarding the specific risks that nanotechnology poses to health, no country has produced specific regulations. Regulatory agencies, including those from Australia, use existing regulations that were not designed to protect workers from the risks posed by nanoscale materials (2009).
União dos Trabalhadores da Agricultura e Alimentação (IUF/UITA)	Latin America and the Caribbean/ Global	<i>Nanotecnologia: A Resolução da UITA 2006/2007</i> http://www.rel-uita.org/nanotecnologia/resolucion_uita_nano_esp.htm	Calls upon the affiliated unions to discuss the possible impacts of nanotechnology. Demands the implementation of the precautionary principle and risk assessment prior to commercialization. Demands investigation of impacts to the health of consumers and workers in the fields of agriculture and food. Demands banning of commercialization of foods, beverages, animal feed, and agricultural inputs that incorporate nanotechnology until the technology is proven to be safe and demands a specific international regulation.
Central Única de Trabalhadores (CUT), Força Sindical, Organização Regional Interamericana de Trabalhadores (ORIT), UITA. Com apoio de organizações sociais	Brazil	<i>Apontamentos para um posicionamento sindical sobre os impactos éticos, sociais e ambientais da introdução de nanotecnologias nos alimentos, produtos e processos produtivos</i> . 2007 http://www.iiep.org.br/nano/fundacentro/posicion_sindical.pdf	Demands research that will enable the identification of issues and problems relating to the impacts of nanotechnology on work processes, organization, and training of workers. Demands identification of all products and production processes that use nanotechnology. Demands public participation in forums that discuss and promote policies for the development of nanotechnology. Requests regulatory agencies to discuss mechanisms for the regulation of nanotechnology.
European Trade Union Congress (ETUC)	Europe	<i>ETUC resolution on nanotechnology and nanomaterials</i> . 2008 http://www.etuc.org/IMG/pdf_ETUC_resolution_on_nano_-_EN_-_25_June_08.pdf <i>ETUC 2nd resolution on nanotechnologies and nanomaterials</i> . 2010 www.etuc.org/a/8047	ETUC expresses their position on European Policy of Nanotechnology, acknowledging the potential benefits of this technology, but expressing concern on significant uncertainties regarding the risks of manufactured nanomaterials to human health and the environment. Risks should be further investigated. Demands responsible and transparent development of nanotechnology driven by the precautionary principle. Calls on the European Commission to conduct a review of the REACH regulation, indicating flaws in addressing manufactured nanomaterials (2008). Reinforces previous demands, and further demands that concrete measures be taken in workplaces to identify who is being exposed, to what extent they are exposed, and what kind of materials they are exposed to, in order to identify the best means of protection. Calls on the European Commission to adopt an international regulation and reinforces the need to review REACH in order to consider nanomaterials as new substances. Implementation of the “no data, no market” principle.

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Dutch Trade Union Federation (FNV)	Holanda	<p><i>Occupational health risks of nanoparticles. Preliminary position of the Dutch trade union FNV.</i> E-mail letter to the Minister of Social Affairs. 2008 http://hesa.etui-rehs.org/uk/newsevents/files/Brandbrief%20Engels.doc</p>	<p>FNV expresses concern about the risks associated with manufacturing, processing, and use of nanoparticles. Demands implementation of the precautionary principle to control exposure to workers, as there is a considerable lack of knowledge about possible risks, poor development of equipment to measure levels of exposure, and a lack of benchmarks for interpreting such measures. Criticizes measures of voluntary regulation and demands reports on the use of nanoparticles, labels, and data sheets with information about them. Indicates flaws in REACH for the regulation of nanomaterials and demands changes.</p>
Unite the Union	Great Britain and Ireland	<p><i>Unite the union's position on nanotechnology.</i> 2008 http://www.nanocap.eu/Flex/Site/Download7d29.pdf</p>	<p>FNV expresses concern about the risks associated with manufacturing, processing, and use of nanoparticles. Demands implementation of the precautionary principle to control exposure to workers, as there is a considerable lack of knowledge about possible risks, poor development of equipment to measure levels of exposure, and a lack of benchmarks for interpreting such measures. Criticizes measures of voluntary regulation and demands reports on the use of nanoparticles, labels, and data sheets with information about them. Indicates flaws in REACH for the regulation of nanomaterials and demands changes.</p>
Canadian Labour Congress (CLC)	Canada	<p><i>Nanotechnology - Small ingredients, Big Risks.</i> Aosto 2008 http://www.canadianlabour.ca/news-room/publications/nanotechnology-small-ingredients-big-risks</p>	<p>Highlights contradictions between patents based on the novelty of nanotechnology and non-assessment of the safety of new nanomaterials. Indicates that despite growing evidence of the risks of nanomaterials, there is no mandatory measure of protection in the workplace. Demands that toxicological research be conducted at a similar pace as that of nanotechnology research and that 15% of the funding be directed for this purpose. Demands specific and mandatory regulation of nanotechnology and that liabilities for damages fall on companies. Implementation of the precautionary principle. Broad participation in risk assessment.</p>
ETC Group (ETC)	Canada	<p><i>The Big Down: Atomtech: Technologies Converging at the Nano-Scale.</i> 2003 http://www.etcgroup.org/upload/publication/171/01/thebigdown.pdf <i>Size Matters!</i> 2003 http://www.etcgroup.org/sites/www.etcgroup.org/files/publication/165/01/occ.paper_nanosafety.pdf <i>Down on the Farm: The Impact of Nano-scale Technologies on Food and Agriculture</i> 2012 http://www.etcgroup.org/sites/www.etcgroup.org/files/publication/80/02/etc_dotfarm2004.pdf</p>	<p>Demands an immediate moratorium on the research, production, and commercialization of nanotechnology until protocols are established to protect workers and regulations are designed to protect consumers. Implementation of the precautionary principle by governments, who should initiate preventive actions to avoid environmental and health damage. Further research, as there is evidence of toxicity of materials owing to the different behavior of matter on the nanoscale; however, there is little research on risks to health and the environment. It is necessary to assess risks throughout the cycle of the product. Specific regulation should be elaborated by national governments to address the health and environmental risks posed by nanotechnology. Creation of a specific UN body to monitor, evaluate, and accept or ban nanotechnology and products that contain it. Broad engagement of civil society in the discussion regarding the implications and risks of nanotechnology.</p>
Friends of the Earth Australia (FOE-A)	Austrália	<p><i>Friends of the Earth (Australia) Nanotechnology Policy Statement.</i> 2006 http://nano.foe.org.au/sites/default/files/FoEA%20Nanotechnology%20Policy%20May%202007_0.pdf <i>Nanomaterials, sunscreens and cosmetics: small ingredients big risks.</i> 2006 http://nano.foe.org.au/node/125 <i>Out of the laboratory and on to our plates. Nanoehnology in food and agriculture.</i> 2008 http://nano.foe.org.au/sites/default/files/Nanotechnology%20in%20food%20and%20agriculture%20-%20text%20only%20version_0.pdf</p>	<p>Highlights the health and environmental risks of nanotechnology, which is already affecting workers, consumers, and ecosystems. Draws attention to the scarce investment focused toward research on risk and demands further investigation. Despite evidence of risks, the Australian government has not established regulations. Demands a precautionary approach in the development of nanotechnology. In the absence of a regulatory system, demands an immediate moratorium on commercial research, development, and release of nanomaterials and products in the environment. Regulation should be mandatory to protect workers, consumers, and the environment and should be created on the basis of social participation. Use of labels on products. Transparency of companies regarding the use of nanotechnology in their processes and products.</p>

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http://www.visaemdebate.incqs.fiocruz.br/



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Greenpeace	Great Britain	<i>Greenpeace position on nanotechnology.</i> [s/d] http://www.greenpeace.org.uk/about/nanotechnology <i>Future technologies, today's choices.</i> 2003 http://www.greenpeace.org.uk/media/reports/future-technologies-todays-choices	Acknowledges the beneficial uses of nanotechnology, but considers that these depend on how the technology will be developed in the future. Calls for a moratorium on the release of nanoparticles into the environment until their safety is proven, as they may pose risks. Demands implementation of the precautionary principle. More research on the risks of nanomaterials is needed. Demands mandatory regulation. Transparency and public participation.
International Center for Technology Assessment (ICTA)	EUA	<i>Citizen petition for rulemaking to the United States Environmental Protection Agency.</i> 2008 http://www.centerforfoodsafety.org/files/cta_nano-silver-petition_final_5_1_08.pdf	Demands immediate stopping of the sale of products containing nanoparticles until their safety is proven. Regulation should focus on specific risks of nanoparticles and should be compulsory under the coordination of various agencies. Specific demands through litigation. Demands that the EPA regulate products containing nanosilver. Demands that nanoparticles be assessed regarding regulation for pesticides.
Coalition of 70 + civil society organizations and trade unions	International	<i>Principles for the oversight of nanotechnology and nanomaterials.</i> 2007 http://www.nanoaction.org/doc/Principles%20for%20the%20Oversight%20of%20Nanotechnologies%20and%20Nanomaterials_finalJan08sigs.pdf	Declares eight fundamental principles that should serve as the structure of the adequate and effective assessment and supervision of nanotechnology, including products that are already commercialized. I. Precautionary principle II. Specific mandatory regulation III. Health and safety of the public and workers IV. Environmental protection V. Transparency VI. Public participation VII. Inclusion of broader impacts VIII. Manufacturer responsibility.
Coalizão de organizações da sociedade civil e sindicatos	International	<i>Civil Society-Labor Coalition Rejects Fundamentally Flawed DuPont-ED Proposed Framework.</i> 2007 http://ethics.iit.edu/NanoEthicsBank/node/1358	The document rejects the proposal for voluntary regulation presented by DuPont Chemicals and the Environmental Defense NGO. It believes that the process is an attempt at usurpation by the companies and of broad public participation in governmental supervision of nanotechnology It believes that voluntary regulation generally slows down the mandatory regulation. In the context of rapid commercialization, further research on health and environmental risks is urgent. Demands broad social participation in the governmental supervision of nanotechnology.
Coalition of NGOs, trade unions, and government representatives	Latin America and the Caribbean	<i>Resolução de SAICM (Enfoque estratégico sobre gestão internacional de produtos químicos) sobre nanotecnologia e nanomateriais manufacturados 2010</i> http://www.saicm.org/documents/meeting/grulac/Panama%202011/Meeting%20documents/LAC3%20Report%20of%20LAC%20reg%20mtg_Sp.pdf	Develop a regulatory framework with a precautionary approach in relation to occupational hazards, public health, and the environment, which encompasses the entire life cycle of nanomanufactured products. Demands that manufacturers are transparent in providing information about the presence of nanomaterials and their risks to workers and consumers. Mandatory labeling of products. Demands implementation of the principle of extended responsibility of the producer, which renders the producer responsible for any risks throughout the life cycle of the product. - Establish specific regulations for foreign trade.

Source: Compiled by the authors on the basis of the documents listed in the third column.

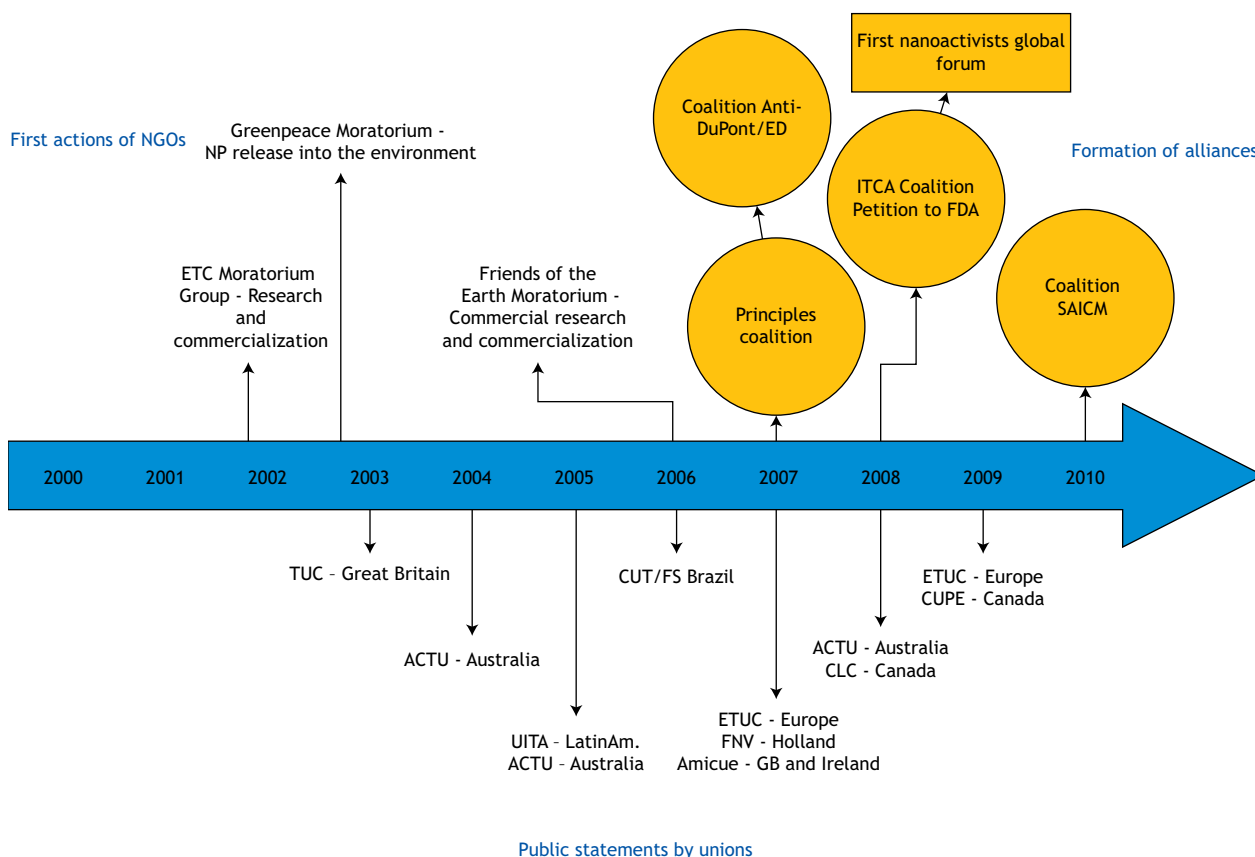
predominant. Moreover, studies have indicated that these voluntary guidelines within companies have not been effective^{6,48,49}.

Position of organized social groups

Even though research on nanotechnology has considerably increased since the 1990s, its public visibility, systematic financing, and characterization as *a revolutionary technology that would radically change the economy and society* only became widespread following the establishment of the NNI by the United States in 2000. If we consider this year as ground zero, we observe that the

mobilization of NGOs and unions with regard to the potential risks of nanotechnology began soon after on the basis of a moratorium request by the ETC Group in 2002. Figure 1 presents a timeline showing the main NGOs that supported the moratorium (superior section) and the unions that elaborated public statements about nanotechnology (inferior section). The orange highlights indicate a set of actions that resulted from alliances between NGOs and unions which were based on common concerns.

Several NGOs incorporated nanotechnology in their agendas. These NGOs included environmentalist organizations with



Source: Prepared by the authors on the basis of the documents listed in Table 2.
 Figure 1. First actions of NGOs, statements by unions, and joint stands.

diverse profiles, such as those focused on consumer rights, assessment of science and technology, and social justice. Triste et al.⁵⁰ registered 127 NGOs, of which 60 were actively involved in the issue of nanotechnology. Lee and Kigali⁵¹ identified 64 NGOs as being very active; among these, some were considered as “main” organizations, whose dedication to the theme was reflected by publication of articles and documents and by having their own policy about the issue. On the other hand, “secondary” organizations supported the main ones by signing statements and co-organizing events, even though nanotechnology was not a central theme in their agendas. Most NGOs identified in both studies were based in industrialized countries; however, it is important to take into consideration the potential linguistic bias. This article focuses on documents produced by four very active NGOs: the ETC Group (Canada), FOE-A (Australia), Greenpeace (Great Britain), and ICTA (the United States). Other NGOs are included in some collective documents that were analyzed.

As for the unions, Invernizzi⁵² identified several that have disseminated information about nanotechnology; yet, only few have further analyzed the issue and publicly stated their opinions. Between 2004 and 2010, 15 statements were signed by national unions and an international federation of unions, which involved a wide range of industrialized and developing countries.

Table 2 summarizes the main documents of the NGOs, unions, and coalitions formed by various social organizations. Using these documents as the basis for our analysis, we highlight the concerns and common demands of these social groups with regard to the risks associated with nanotechnology.

At the World Forum of Sustainable Development in Johannesburg in August 2002, the ETC Group called for a moratorium on nanotechnology on the basis of evidence suggesting severe potential risks to human health and the environment⁵³. The moratorium focused on the sale of products, as the risks had not yet been sufficiently studied, as well as on research, until protocols were developed to ensure safety in laboratories. In 2003, Greenpeace advocated not having a generic view on nanotechnology, given its variety of applications, and highlighted the potential benefits of this new technology.

However, Greenpeace also expressed their concern with regard to the possible health and environmental risks posed by nanoparticles owing to their small size and unknown properties and recommended a moratorium on the release of nanoparticles into the environment⁵⁴. Friends of the Earth (FOE), an international NGO whose Australian sector has been particularly active in nanotechnology, also reinforced a request for a moratorium in 2006. This proposed moratorium involved the immediate halt of commercial research, development, and



commercialization of products and materials containing nanotechnology. Because of new potential health and environmental risks, potentially disruptive economic effects of the new technology, and its possible use for the development of weapons, the NGO advocated the suspension of commercialization until the implementation of a regulatory regime that is based on the precautionary principle and that incorporates wide public participation⁵⁵.

The International Union of Food Workers added to these requests. At the Latin American congress in 2006, they approved a resolution that requested governments and international organizations to apply the precautionary principle, prohibiting the sale of foods, drinks, animal feed, and agricultural inputs containing nanotechnology until its safety is showcased and a specific regulation is implemented. This resolution was later approved in the federation's world congress, which includes 365 unions from 122 countries, representing 12 million workers³⁰. Other statements from unions such as ACTU⁵⁶, FNV⁵⁷, ETUC^{29,58}, and Unite the Union⁵⁹ suggested that commercialization of products should be halted until trustworthy data regarding their safety are made available. In the case of the last three, which are European, this view is in accordance with the recommendations of the current legislation on chemicals in the European Union (REACH – Registration, Evaluation, Authorization and Restriction of Chemicals), which establish the principle of protection, “no data, no market”ⁱⁱⁱ.

For all the above-mentioned groups, the moratorium is aimed at gaining the necessary time for further investigating the risks of nanomaterials. This additional time is necessary to carefully evaluate risks, determine whether certain nanomaterials should be banned owing to their risks, and build a specific regulatory framework. Hess⁸ points out that historically, requests for a moratorium by social movements have not been successful. They have, however, served as a strategy to access political opportunities for negotiating more specific demands.

According to research conducted by Lee and Kigali⁵¹, Leinonen and Kivisaari⁶⁰, Miller and Scrinis⁷, and Triste et al.⁵⁰, the impacts of nanotechnology on health and the environment constitute a central concern of several NGOs. In the case of the unions, Invernizzi⁵² and Foladori and Zayago⁶¹ suggest that occupational risks represent the greatest concern. The demands of these organized groups are directed at three main issues: more investigation about risks, implementation of the precautionary principle, and specific and mandatory regulation. In addition, the social movements and unions demand transparency of information and greater participation in decision making.

More investigation: Unions and NGOs demand greater investments from governments and industries for research regarding risks in order to establish protective measures and effective regulation. Specifically, the unions focus on the need for identifying workers that are being exposed and investigating how they are exposed in the various phases of a production cycle. As part of issue, one can also include the need for

testing products and materials that already in use in order to assess their toxicity.

Precautionary principle: As long as there is evidence of the toxicity of some nanomaterials along with insufficient information about them, the precautionary principle must be implemented to avoid potential damage and ensure that these burdens of risks do not become the responsibility of producers and employees. Miller and Scrinis⁷ argue that industries and governments have tended to support the “responsible development” principle, which, unlike the precautionary principle, proposes to conduct research on risks without stopping commercialization.

Specific and mandatory regulation: Social organizations denounce the regulatory void in which nanotechnology is being developed. They demand that to protect workers, consumers, and the environment, nanomaterials should be classified as new substances for evaluation purposes, given their different properties compared with the same materials on larger scales, and that a specific and mandatory regulation should be developed, encompassing laboratory practices, production processes, and products. A coalition of civil society organizations and trade unions signed a manifesto in 2007, opposing the motion for voluntary regulation presented by DuPont and Environmental Defense. A specific aspect demanded was the mandatory labeling of products containing nanomaterials and the supply of information to workers on raw materials and products containing nanomaterials – with indications regarding safety.

Transparency of information and participation: A key demand of NGOs and unions is democratic governance of nanotechnology. Referring to historical situations, such as the lack of transparency in the risk assessment of genetically modified organisms or historical occupational hazards that were hidden or minimized, these organizations demand greater participation and transparency in decision making. Unions demand special attention on transparency of information provided by firms when firms incorporate nanotechnology in their products and processes.

In 2007, over 70 social organizations and unions from six continents signed the Principles for the Supervision of Nanotechnology and Nanomaterials. This document originated at the First Meeting of NGOs, which was organized by ICTA and FOE in Washington, DC, in January 2007 and at which strategies on nanotechnology were discussed. It materialized the construction of a global alliance of social groups organized around eight principles that should provide an appropriate and effective basis for assessing and monitoring nanotechnology: 1) precautionary approach; 2) specific mandatory regulation; 3) health and safety of the public and workers; 4) environmental protection; 5) transparency; 6) public participation; 7) inclusion of broader (social, ethical, and other) impacts; and 8) manufacturer responsibility.

Within the Brazilian context, it is important to highlight the first collective agreement achieved by a union on the right to information regarding the introduction of nanotechnology in production processes. Pharmaceutical workers managed, after several years of negotiation, to include an addendum to

iii REACH, which came into force in 2007, is the organization for the regulation of chemicals in the European Union.



the Collective Labor Agreement signed in 2012 between the Federation for Workers of the Chemical Sector of CUT in the state of Sao Paulo (FETQUIM) and the Employers Association of Pharmaceutical Industry in the state of Sao Paulo (SINDUSFARMA), ensuring that the company would inform members of the Internal Commission for Accident Prevention and the Specialized Safety Service and Occupational Medicine when nanotechnology was being used in the manufacturing process as well as ensuring workers' access to information about their health risks and protective measures in relation to nanotechnology⁶².

Final Considerations

Unions and NGOs discussed risks to human health and the environment from the earliest stages of nanotechnology development. Confronted by increasing public and private investment in research and development as well as rapid incorporation of nanotechnology in industrial processes and consumer products amid a regulatory void, these organized social groups converged on the demand of a precautionary approach, and many of them have advocated a moratorium until the safety of products and processes is guaranteed. How effective have these demands been? They have been met with idle regulations and voluntary approaches; with an increasing number of workers handling nanomaterials without protection standards being mandatory in workplaces, and most of them without even knowing that they are working with new materials that may pose risks; with consumers who lack information; and with disposal in the environment of substances whose contamination effects are unknown. Thus, the most logical conclusion is that unions and NGOs have been unsuccessful in including their interests in this emerging technological trajectory.

Nevertheless, there is an alternative interpretation. The call for a moratorium created a very strong impact as it occurred precisely when governments were articulating their plans for nanotechnology and when industries were beginning to increase their investment. Even though no government actually agreed to this demand, several requested additional studies. One such study, requested by the government of Great Britain, had a significant impact and created political opportunities for the demands of these social organizations. The study resulted in the well-known document created by the Royal Society and the Royal Academy of Engineering⁶³. As this is a highly prestigious academic organization, considered unbiased regardless of the interests at stake, the study was widely publicized and its recommendations were taken into account. The findings of the study coincided with the perspective of social organizations, emphasizing that nanotechnology involves unknown risks that should be immediately assessed and investigated. Thus, the claims made by unions and NGOs were strengthened following the publication of this study, and it certainly contributed to pressurizing governments toward initiating discussions on regulation. Furthermore, the study forced governments to acknowledge the shortcomings of their nanotechnology programs associated with research on the potential risks to health and

the environment and led them to increase their investments in research, as in the case of the document by the National Academies of Sciences⁶⁴ for the United States and that by Savolainen et al.⁶⁵ for the European Union.

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