

# Research between science, society and politics

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## Research Impact

*The Regulations for Obtaining the Doctoral Degree: Maastricht University* require a reflection on the (scientific) impact of the knowledge gathered during this PhD project, including the spin-offs for society.

The title of this PhD thesis *Research between Science, Society and Politics: The History and Scientific Development of Green Chemistry* already indicates that major attention is paid to society. Public environmental concerns with respect to the chemical sciences are discussed in particular, in order to assess the meaning and emergence of the umbrella term “green chemistry”. The subject of this book therefore bears relevance to society, which matches my general personal interests as well.

## Sharing Research Findings

Part of the research done for this PhD project has already been published and, subsequently, communicated to society. The latter is an important step in valorization.<sup>1</sup> As a PhD candidate, I communicated my first research findings by giving lectures at symposia for historians and philosophers of chemistry.<sup>2</sup> But, I also lectured for audiences consisting of non-specialists in, for instance, my place of birth, and I wrote some popular science articles in Dutch as well.<sup>3</sup> Although valorization was not my first reason for carrying out PhD research, I clearly have contributed to that. This is illustrated by my article published in *Foundations of Chemistry* in 2010 (which is the most cited one of this journal and also among the most downloaded ones ( $\pm$  11,000 downloads) according to Springer).<sup>4</sup> This article discusses the first research

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<sup>1</sup> Andreas Mitzschke, “Elusive Publics: Understanding Techno-scientific Controversy and Democratic Governance in the GM Crops Debate,” (PhD diss., Maastricht University, 2018), 225-230. In UM Research Publications; available from <https://cris.maastrichtuniversity.nl/en/publications/elusive-publics-understanding-techno-scientific-controversy-and-d>, accessed May 22, 2022. Mitzschke discusses in his Valorization Addendum the positions that scientists can adopt in the valorization of their knowledge production.

<sup>2</sup> For instance: J.A. Linthorst, “Green Chemistry: Image, Environment and Chemical Societies” (2012 Summer Symposium of The International Society for the Philosophy of Chemistry, Leuven, Belgium, August 7-10, 2012); J.A. Linthorst, “The Scientific Development of Green Chemistry” (9<sup>th</sup> International Conference for the History of Chemistry, Uppsala, Sweden, August 21-24, 2013).

<sup>3</sup> J.A. Linthorst, “Het Nut in Vuur en Vlam: Magie der Chemie” (lecture given at the meeting of Nut & Genoegen, Ruinen, April 7, 2013). See also for example: Arjan Linthorst, “De Ongrijpbare Chemie,” NEMO Kennislink, last modified November 16, 2010, <https://www.nemokennislink.nl/publicaties/de-ongrijpbare-chemie/>.

<sup>4</sup> Johan A. Linthorst, “An Overview: Origins and Development of Green Chemistry,” *Foundations of Chemistry* 12 (2010): 55-68. See for facts and figures about my article: “Foundations of Chemistry,”

findings of my PhD journey, and has been translated and published in Chinese.<sup>5</sup> According to Google Scholar it has been cited by chemists, who often used my article to sketch the importance of combatting environmental problems, and historians and philosophers of chemistry who attempted to characterize the identity of green chemistry by building on my insights. Major international organizations in domains of chemistry education, science policy and environmental policy also cited my article, and used the historical development of green chemistry that I sketched in their policy making processes.<sup>6</sup> Obviously, the results I published in *Foundations of Chemistry* have been read and utilized by scientists and policy officers from rather different professional backgrounds. In this thesis I publish new research findings that might again be relevant to people inside and outside the academic circle of historians and philosophers of chemistry, and which I hopefully will further be disseminated with the aid of a publisher.

## Trust and the Chemical Sciences

The subfield of environmental chemistry grew significantly within the chemical sciences between 1970 and 2000, as witnessed by the increase in relative membership numbers of this subfield within the American Chemical Society (ACS), the Royal Society of Chemistry (RSC) and the Royal Netherlands Chemical Society [Koninklijke Nederlandse Chemische Vereniging] (KNCV). There were also small differences, as that growth was culturally conditioned and thus varied from one political culture to another.<sup>7</sup> But, the ACS, RSC and KNCV do have in common that environmental chemistry became an established subfield, which has been part and parcel of the chemical sciences since the 1970s. In addition to that, environmental policy measures of national governments have often been based on knowledge of environmental chemistry in order to improve the quality of the environment for the benefit of society. This topic is discussed in the chapters 2 through 4 in this thesis. So, this study in

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Springer, accessed May 22, 2022, <https://link.springer.com/article/10.1007/s10698-009-9079-4>. See also: Johan A. Linthorst, "The Image of Chemistry and Curriculum Changes," *Educacion Quimica* 23 (2012): 240-242.

<sup>5</sup> On request of Shuang Li (Chinese Academy of Sciences) this article was translated into Chinese: Shuang Li, "简论绿色化学的起源与发展," *Science & Culture Review* 14 (2017): 44-59.

<sup>6</sup> For example: Environment Directorate, *Sustainable Chemistry: Evidence on Innovation from Patent Data* (Paris: OECD, 2011); UNEP, *Global Chemicals Outlook II: From Legacies to Innovative Solutions: Implementing the 2030 Agenda for Sustainable Development* (United Nations Environment Programme, 2019).

<sup>7</sup> Cf. Sheila Jasanoff, *Designs on Nature: Science and Democracy in Europe and the United States* (Princeton, NJ: Princeton University Press, 2005).

the history of chemistry shows as a spin-off that many chemists have been willing to improve environmental quality. Although we still have environmental challenges in front of us, it is also clear that important intellectual solutions have to come from the chemical sciences. Therefore, many scholars have concluded that the chemical sciences deserve more trust, and thus better conditions, from society.<sup>8</sup>

### **Wasting Public Money?**

I have also argued that many chemists felt distrusted by society. They experienced a negative public image. Although that might appear unfair when all advantages and disadvantages of chemical knowledge are balanced, the distrust triggered a major change in terminology within the chemical sciences. The umbrella term green chemistry emerged during the 1990s within academic circles, but also at the interface of science and society. An important example is the launching of the Presidential Green Chemistry Challenge Awards in the USA.<sup>9</sup>

Since the 1990s chemists are increasingly emphasizing economic and environmental benefits of their discipline, not in the last place by calling it “green”. Many chemists thus attempted to show the relevance of chemical knowledge to society and to improve the public image of the chemical sciences in order to receive better conditions for their research. They tried to raise the legitimacy and funding of their discipline. The chapters 2 through 4 also show that the term green chemistry developed along different culturally conditioned historical lines. Chapter 5 demonstrates that the term green chemistry lacks a unified internal scientific meaning. The precise content of green chemistry has been a matter of dispute at several occasions.

The social value of my research results presented in the two paragraphs above is twofold. Firstly, I demonstrated that time, public money and other resources have been spent in different countries to water down the negative public image of chemistry (as felt by chemists).<sup>10</sup> Secondly, I also argued that this went hand in hand with a major change in terminology used by chemists in the presentation of their (publicly funded) knowledge production. But, as I have shown, the precise meaning of that knowledge remains vague for

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<sup>8</sup> Laurens K. Hessels and Harro van Lente, “Practical Applications as a Source of Credibility: a Comparison of Three Fields of Dutch Academic Chemistry,” *Minerva* 49 (2011): 218.

<sup>9</sup> See Chapter 2 and 5 for the Presidential Green Chemistry Challenge Awards. See also: Arie Rip and Jan-Peter Voss, “Umbrella Terms as Mediators in the Governance of Emerging Science and Technology,” *Science, Technology & Innovation Studies* 9 (2013): 39-59.

<sup>10</sup> Of course, industries also spent money to green chemistry.

society. One can therefore raise the question whether public money has been wasted. By reading my thesis both society and the chemical sciences can get a stronger awareness of the roles played by umbrella terms such as green chemistry. Do they benefit us all?

### **Improving the Social Contract between Science and Society**

The insights presented on the history of environmental chemistry, the emergence of green chemistry and the public image of chemistry, mentioned above, will hopefully be utilized by professionals in the policy domains of science, environment and education. In my view the most important opportunity is organizing a broadly conceived dialogue, starting in the Netherlands.

People pay taxes. A part of those taxes is spent on academic research. In order to carry out that research, scientists thus have to receive funding from society. Next to some “academic freedom”, they have responsibility to society. Science and society therefore do have a relationship that can better be built on a reasonable basis of trust instead of distrust. In case of the chemical sciences, society should know that many chemists are willing to improve the environment, but meanwhile they feel often disrespected as well by that same society. The communication of chemical knowledge at the interface of science and society became therefore loaded with “umbrella terms” in the processes of obtaining research funding.<sup>11</sup>

These terms facilitate communication, but at the time – as I have shown – make it more obscure to the public at large which content is covered by those terms. That lack of understanding is influenced both by the negative public image of chemistry and by the poor scientific literacy of large parts of society.<sup>12</sup> It is important to change the tide. This thesis can trigger the start of a broadly conceived dialogue among stakeholders in our democracy – chemists from the laboratory included. That should lead to a covenant between NGOs, industries, government and academia that breathes an improved trust in science with a reduced place for (time and public money consuming) umbrella terms and give a bigger place for scientific content. Eventually, this could be followed by a reform of the public funding

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<sup>11</sup> Most likely, that rhetorical behavior of scientist is enforced by structural changes in public funding mechanisms, which increasingly rely on strong competition among scientists. See: Mitzschke, “Elusive Publics: Understanding Techno-scientific Controversy and Democratic Governance in the GM Crops Debate”, 225-230.

<sup>12</sup> See for the lack of scientific literacy: “PISA 2018 Science Framework,” OECD, accessed May 22, 2022, <https://www.oecd-ilibrary.org/sites/f30da688-en/index.html?itemId=/content/component/f30da688-en>.

mechanisms of academic research. The time and public money saved could then be spent in the academic laboratory in order to produce new chemical knowledge, for the benefit of us all. That's what I would call an improved social contract between science and society.