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## Finnish Air Pollution Experts and the International Quest for Safe Air, 1940s-1970s

Janne Mäkiranta

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Doctoral programme in History, Culture and Arts Studies (Juno)


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## ABSTRACT

The purpose of this study is to examine how and why the measurement and research of air pollution became established in Finland between the 1940s and the early 1970s. The study is concerned with the fundamental question of how our knowledge about environmental problems has been formed. The growing concern for urban air quality in the mid-twentieth century gave rise to scientific expertise on air pollution that would have a vital influence on how the problem of urban air quality was framed. By focusing on Finland and its nascent environmental health expertise this study offers a different viewpoint to the more customary focus on great industrial centres and pioneering scientific establishments. Rather than inventions, scientific breakthroughs, or disastrous pollution incidents this study examines the transnational formation of air pollution expertise and its appropriation into a country with limited resources to tackle the problems that come with being an urban industrialized society.

The focus of the examination is on the Finnish Institute of Occupational Health (FIOH). More specifically this study examines the FIOH's transnational networks and pioneering role in Finnish environmental expertise, which has hitherto received little historical scrutiny. The research is conducted by examining correspondence, publications, textbooks and other material produced by researchers in Finland and in other countries. The purpose is to analyse the ways of knowing about urban air quality by examining how knowledge about the environment and health is produced, framed and communicated.

The results of this study show how the issue of urban air quality changed due to new scientific expertise on air pollution. The complex societal problem was effectively transformed into a scientific puzzle that could be solved through the accumulation of a certain kind of knowledge. Beginning from occupational environments and industrial hygiene, the idea of managing air quality through safe levels became the cornerstone of the new air pollution research. Although originating from the United States, this idea proliferated through the novel international institutions and the transnational networks of experts. The study shows how increased scientific scrutiny of air pollution did not merely produce more knowledge, but also determined what kind of knowledge would be needed to solve the problem. The case of the FIOH shows how the ways of knowing about air pollution and the questions in need of answering were co-produced transnationally by medical and scientific disciplines, alongside the concerns of the public and the regulatory needs of a modern administration.

KEYWORDS: Air pollution, Occupational Health, Environmental pollution, Pollution, Transnationalism, Finland, Finnish Institute of Occupational Health Expertise, History of Science, History of Medicine, Environmental history, History of Knowledge, The twentieth century

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## TIIVISTELMÄ

Väitöskirjassani tutkin, miksi ilmansaasteista tuli systemaattisen tieteellisen tutkimuksen kohde Suomessa 1940-luvun ja 1970-luvun välisellä ajanjaksolla. Tutkimukseni tarkoituksena on käsitellä ympäristöhistorian keskeistä kysymystä siitä, miten tietomme ympäristöongelmista muodostuu. Toisen maailmansodan jälkeen huoli ilmansaasteiden haitoista nousi sekä Euroopassa että Yhdysvalloissa uudelle tasolle. Samalla ongelmaa ratkaisemaan muodostui tieteellinen asiantuntijuus, jolla oli keskeinen merkitys ongelman määrittelyssä. Tutkimuksen tarkoituksena on tuoda uudenlainen näkökulma ilmansaasteiden historiaan tarkastelemalla suurten teollisuusmaiden sijaan ilmansaastetutkimuksen ylirajaista muodostumista ja leviämistä Suomeen. Verrattain myöhään teollistuneena ja resursseiltaan rajoittuneena maana Suomi tarjoaa paremmin yleistettävän näkökulman urbaanin teollisuusyhteiskunnan ympäristöongelmien ja niiden ratkaisemiseen historiaan.

Tutkimuksen painopiste on Työterveyslaitoksen ja sen avainhenkilöiden toiminnassa sekä kotimaassa, että kansainvälisesti. Työterveyslaitos on merkittävä, joskin vähän tunnettu toimija Suomen ympäristöhistoriassa. Se on myös modernin ilmansaastetutkimuksen pioneeri Suomessa. Tutkimus toteutetaan analysoimalla ilmansaastetutkijoiden tuottamaa aineistoa kuten julkaisuja, kirjeenvaihtoa ja oppikirjoja. Tarkoituksena on tarkastella tiedon tuottamisen proseseja ja niitä tietämisen tapoja, joilla kaupukien ilmansaasteita pyrittiin ymmärtämään.

Tutkimus osoittaa, miten ongelma kaupunki-ilman saastumisesta muuttui monitahoisesta yhteiskunnallisesta kysymyksestä tieteelliseksi arvoitukseksi, joka voitaisiin ratkaista tuottamalla tarpeeksi tietyn tyyppistä tietoa. Ilmansaasteiden tutkimus Suomessa Työterveyslaitoksen toimesta oli osa tätä ylirajaista kehitystä, jossa uusi tieteellinen asiantuntijuus nostettiin ongelman ratkaisun keskiöön. Alkaen työpaikkojen sisäilmasta 1940-luvulla, vanha epämääräinen idea puhtaan ilman terveellisestä vaikutuksesta korvattiin idealla turvallisesta ilmasta, jota voitiin hallita tieteellisesti määritetyillä turva-rajoilla. Tutkimukseni osoittaa, miten ilmansaasteiden tutkimus ei pelkästään lisännyt tietoa niiden vaikutuksista, vaan myös määritti uudelleen sen, mitä on tiedettävä, jotta ongelma voidaan ratkaista.

ASIASANAT: Ilmansaasteet, Suomi, Työterveyslaitos, kansanterveys, 1900-luku, ympäristöhistoria, tieteenhistoria, tiedon historia, asiantuntijuus, ympäristöongelmat

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Since a dissertation project is somewhat comparable to an expedition to the Antarctic, I have reserved final remarks for the seemingly timeless description of any scholarly work by one particular expeditioner:

> Some will tell you that you are mad, and nearly all will say, 'What is the use?' For we are a nation of shopkeepers, and no shopkeeper will look at research which does not promise him a financial return within a year. And so you will sledge nearly alone, but those with whom you sledge will not be shopkeepers: that is worth a good deal. If you march your Winter Journeys you will have your reward, so long as all you want is a penguin's egg.
>
> Appsley Cherry-Garrard, 1922

4.4.2022
*Janne Mäkiranta*

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# 1 Introduction

## 1.1 The Management of Urban Air

In 1972, the World Health Organization (WHO) first published numerical values that could be used as guidelines for the regulation of urban air pollution.[1] This was an important milestone in the long effort to use medical and scientific knowledge in order to regulate air pollution based on its effect on human health. Although local air quality standards had been used in many countries, the publication of the WHO report was a valuable add-on to this type of regulation and a first step towards universal air quality guidelines. With the example of the WHO report, the Finnish authorities produced guidelines for different air pollutants in the early 1970s. These guidelines were the result of two decades of medical and scientific research and provided, at least in principle, an objective way to manage the health effects of urban air via the scientific utilisation of numbers and measurements. The Finnish Institute of Occupational Health (FIOH) had established itself by the 1970s as the national centre of expertise regarding air pollution issues. At this time, the FIOH was in the process of expanding its air quality monitoring as officials became increasingly interested in air pollution measurements, due to the growing public awareness of the problem. In the early 1970s, it seemed in Finland that urban air quality could be managed satisfactorily with the combination of medical knowledge and technical measurements. Similar levels of management had already been achieved vis-à-vis the control of water and indoor air.

The management of urban air in Finland can be seen as part of a transnational effort that intensified after World War Two to control the modern industrial environment through science and expert knowledge. The FIOH can be seen as a local manifestation of this broader trend. Since its foundation in the early 1950s the FIOH aspired to not only manage hazards within the workplace in Finland, but also the overall problems created by modern society in terms of the health and well-being of the public, including the impurities in the ambient air. However, as public indignation and calls for clean air grew in the 1960s, the medical authority given to

[1] *Air Quality Criteria and Guides for Urban Air Pollutants*. WHO Technical Report Series, No. 506, 1972.

the FIOH regarding environmental health matters began to be challenged. Aligning with general concerns about environmental degradation, the new advocates for clean air emphasised the subtle long-term effects of poisons in the urban air. As environmentalism became more prevalent in Finnish society and different disciplines claimed expertise over the natural environment, the FIOH's position was seen as overgrown and even harmful to the cause; it had distanced itself from its core activities in occupational health and its attitudes were often perceived as dismissive. Hence, at the height of its expertise regarding air pollution, the FIOH was streamlined, and its role was limited to dealing with occupational health problems. The management of air quality and the rest of the environment was transferred to other agencies.

The purpose of this study is to examine the rise and fall of the FIOH's air pollution expertise and to show how the scientific management of urban air became established as an environmental expertise in the mid-twentieth century. The study will begin with an examination of occupational hygiene research in Finland in the late 1940s, when the impurities of air first became the focus of medical research in the country. More fundamentally, this study will show how occupational environments and their actors are deeply intertwined with the history of The Environment and environmental knowledge. The significance of the knowledge and expertise developed in industrial settings is often eclipsed in environmental history by the so-called songbirds and suburbs narrative, in which an emphasis is given to the environmentalism of the 1960s. Actors from occupational and industrial environments are, however, essential when examining the history of how knowledge about environment and its relationship to humans has been formed. It has been argued that the rise of expertise, knowledge society and technocracy are among the most under-researched topics in environmental history. The significance of the expansion of academic expertise regarding the environment during the twentieth century and the subsequent erosion of its authority have been important aspects in the shaping of environmental concerns and policies.[2] The premise of this study is that the case of the FIOH is not simply a local curiosity but signifies the wider development of environmental expertise and accumulation of knowledge. Thus, the aim is to chart the transnational process in which air as an urban environment became an object of medicine and science; a puzzle that could be solved by an accumulation of knowledge and through expert power.

2 Uekötter 2010b, 139.

## 1.2 Air Pollution in Historical Research

Air has been afforded an essential meaning as a personal living environment in western societies. The significance of air has attracted increasing attention in recent years from historians of science, social sciences and philosophers. In 1999, the philosopher Luce Irigaray famously argued that air has been largely forgotten in western philosophical thought and that it often represents mere emptiness and a void.[3] Recent interest in air from philosophers and social scientists has not only corrected this oversight but also challenged Irigaray's original argument. The political scientist Marijn Nieuwenhuis has shown, for example, that air has held an important place in western philosophical and political thought. The act of breathing air in itself puzzled ancient philosophers, while the right to breathe clean air and the criminality of poisoning the air breathed by individuals have long traditions in western legal philosophy. Nieuwenhuis argues that poisoning someone's air and thus destroying their personal living environment has been regarded as a special crime, which is reflected in the strong reactions against the use of chemical weapons in the twentieth century.[4] The importance of air has also been asserted by historians of medicine, who have noted that clean air has been one of the enduring elements of a healthy environment in western thought, although the reasoning behind this idea has changed.[5] Historians of science have also examined how an understanding the nature and the composition of air has been an enduring question in western natural philosophical thought: it has shaped the formation of science as well as the social and cultural meanings given to air.[6]

Historical work on air pollution has been both separate and connected to wider scholarship on breathing and air, stemming mostly from urban environmental history. The best-known images of air pollution are probably the clouds of black smoke rising from factories and domestic smokestacks in the nineteenth-century cities of Europe and United States. Historical research on air pollution has paid a great deal of attention to this so-called age of smoke.[7] As an iconic feature of

3 See, Luce Irigaray. *The Forgetting of the Air*. Athlone Press, 1999 London. It has also been suggested that the elemental aspects of environment, such as air, have been neglected due to the strong focus on physics in history and philosophy of science. See Väyrynen 2006.

4 Nieuwenhuis 2018. Atmospheric Governance: Gassing as Law for the Protection and Killing of Life. See also, *Atmospheres of Breathing.* Edited by Lenart Škof and Petri Berndtson. State University of New York Press, New York 2018. For the weaponization of air, see Peter Sloterdijk, *Terror from the Air*. Semiotext, 2001.

5 Burnham 2005, 93.

6 See, for example, Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Lif*e. Princeton University Press, Princeton 1989.

7 The term comes from the environmental historian Frank Uekötter.

nineteenth-century cities, smoke has been studied quite widely from the perspectives of environmental and urban histories. The earlier works in particular, tend to examine air pollution from the point of view of environmental change. Peter Brimblecombe's *The Big Smoke: A History of Air Pollution in London Since Medieval Times*, for example, focuses on the early measurements of dust fall and emission.[8] Other works from the late twentieth century have examined air pollution as a part of the history of urban sanitation and problems of industrialisation since the early nineteenth century.[9] The early twenty first century has witnessed rising interest in the history of air pollution from sociopolitical and cultural perspectives. Perhaps the most wide-ranging sociopolitical account of air pollution is Frank Uekötter's *The Age of Smoke*, which examines the parallel development of air pollution control politics in the United States and Germany.[10] Many historians have departed from air pollution measurements and atmospheric science and instead examined the changing cultural and social meanings of air pollution in different locales. Peter Thorsheim, for example, has shown how the meaning of pollution changed in Britain from miasmatic fumes to coal smoke over the course of two centuries.[11] Thorsheim's work connects the history of air pollution with the wider history of senses and urban sensecapes, which has become an increasingly important way to examine the history of the urban environment.[12]

Finnish historical studies on air pollution have mostly followed the same trends as elsewhere. Since the turn of the twenty first century, air pollution in Finland has been examined from cultural and social historical perspectives in addition to the reconstruction of historical changes of air quality.[13] The most comprehensive work the history of Finnish air pollution policies is Paula Schönach's doctoral dissertation about the history of air pollution prevention in Helsinki.[14] Air pollution has also been studied as part of the environmental movements and politics of the 1960s and

8 Peter Brimblecombe, The Big Smoke: *A History of Air Pollution in London Since Medieval Times*. Methuen, London and New York 1987.

9 See, for example, Tarr 1996; Melosi 2008.

10 Uekötter 2009.

11 Thorsheim 2006. See also *Smoke and Mirrors: The Politics and Culture of Air Pollution*. Ed. By DuPuis, E. Melanie. New York University Press, New York 2004. On air pollution in France see Charvolin et al. 2015 and Frioux 2019.

12 See, for example, Alain Corbin, *The Foul and the Fragrant: Odour and the French Social Imagination*. Harvard University Press, Boston 1987. See also *Smell and History: A Reader.* Ed. By Mark Smith. West Virginia University Press, Morgantown 2018.

13 Kruut 1999; Mattson 2001; Hosiaisluoma 2001; Kivistö & Laakkonen 2001; Mattila 2001; Schönach 2006; Laakonen 2006; Myllyntaus & Kunnas 2007; Myllyntaus & Kunnas 2009.

14 Schönach 2008.

1970s.[15] Histories of public health and hygiene have also contributed to this theme by examining the significance of clean air in Finnish hygienic thought and the controversies that developed concerning smoke and dusts in the air.[16] In other words, Finnish historical studies of air pollution have followed the Anglo-Saxon world by examining the variety of cultural and social aspects of air pollution rather than simply its physical change over time.

Whilst air pollution has been viewed as a complex cultural construct, rather than a simple object of measurement, historical research has been less successful at examining the construction of air pollution by science and medicine and the intertwining of this process into other aspects of air pollution. As historian Stéphane Frioux has argued, the history of air pollution is often studied via the traditional sources of cultural history, focusing on how people perceived the state of air and how administrators acted on it. Emphasising the entanglement of natural, socio-technical, and human sides of air pollution, Frioux proposes the wider use of technical documents and expert material. This can be used to examine the processes and actors—both human and non-human—that shape the way air pollution is perceived.[17]

Though Frioux writes about examining the techniques needed to monitor air pollution, a similar argument can be made about examining the ways to ascertain the effects of air pollution. Medical and scientific knowledge have been an integral part of the politics and policies of abatement and the conceptions people have had about polluted air. The accumulation of medical knowledge regarding the effects of air pollution is deemed to be important in historical works, but it is mostly something that occurs in the background as either a provider of facts or an excuse for real action by governments and/or industry. The problem is that the accumulation of knowledge is not analysed as a social, political and material process in itself, even though the use of scientific knowledge forms a major part of the modern understanding and relationship towards the environment. In short, to understand the process in which air pollution became recognised as a hazard to public health and an object worthy of

15 Nienstedt 1997. Despite the relatively small number of works written about environmental history in Finland, Helsinki has been studied in quite a versatile manner as an urban environment. See, for example, *Näkökulmia Helsingin ympäristöhistoriaan.* Toim. Simo Laakkonen, Sari Laurila, Pekka Kansanen ja Harry Schuman. Edita, Helsinki 2001. Also, *Nokea ja Pilvenhattaroita. Heslinkiläinen ympäristö 1900-luvun vaihteessa.* Toim. Simo Laakkonen, Sari Laurila, Marjatta Rahikainen ja Päivikki Kallio. Helsingin kaupunginmuseo, Helsinki 1999.

16 Lehtonen 1995; Harjula 2003; Nygård 2004; Harjula 2007.

17 Frioux 2019, 218–219. This is, in some sense, what Mark Whitehead has done in *State, Science and the Skies: Governmentalities of the British Atmosphere.* Wiley-Blackwell, 2009.

medical research, more attention must be given to the intertwinement of the environment, health and knowledge.

## The Entangled Histories of the Environment, Health and Knowledge

As the environmental historian Timo Myllyntaus has pointed out, there is a long tradition of studies that examine changes in nature and ideas about nature, but far fewer about the changing ways we have come to know about nature.[18] There is a reason for this, since, as Frank Uekötter and Uwe Lübken have noted, environmental historians are often interested in action rather than knowledge or the lack thereof.[19] However, since the late twentieth century historical scholarship has emphasised the social and material aspects of the science that is used to define and control the environment.[20] One aspect of this interest was the entanglement of environmental history and the history of medicine and science, which has been examined, for example, in the works of Greg Mittman, Michelle Murphy, Christopher Sellers and Linda Nash.[21] These studies have shown the special significance of modern medical science and industrial toxicology in the formation of the relationship between health and the environment in the twentieth century. In particular, it has been shown how the practices and concepts that became the essence of environmental health science in the twentieth century originated from the management of industrial environments earlier in the century.[22] In other words, the significance of knowledge in environmental history is not only based on the discovery of environmental problems, but also in the ways that these problems are depicted and by whom. As Sverker Sörlin and Paul Warde have argued, the environment is co-produced between natural elements and the ways humans give meanings to them.[23] Thus, the entanglement of the environment, health and medical knowledge can be seen as only one part of the wider intertwinement between the environment and ways of knowing.

Subsequently, the examination of the ways of knowing about nature has become an essential theme in environmental history, especially regarding the formation of

18 Myllyntaus 2012, 7.
19 Uekötter 2014, 1–4.
20 See, for example, Gregg Mittman. *The State of Nature: Ecology, Community, and American Social Thought, 1900–1950.* University of Chicago Press, 1992; Bruno Latour, *The Pasteurization of France.*
Harvard University Press, 1993; Sheila Jasanoff, *Science at the Bar: Law, Science, and Technology in America.* Cambridge, MA: Harvard University Press, 1995.
21 See Landscapes of Exposure: Knowledge and Illness in Modern Environments. *Osiris,* volume 19, 2004.
22 See Nash 2004 and Sellers 1997.
23 See Sörlin & Warde 2007.

environmental expertise.[24] Although the importance of environmental expertise has long been noted in environmental history, later studies have placed more emphasis on the methods, traditions and ideas behind the expertise and the significance they have for our understanding of environmental problems. For example, in their recent work on the history of the idea of the Environment, Sverker Sörlin, Libby Robin and Paul Warde have shown the significance of expert knowledge in the formation of the idea of a global environment.[25] The significance of expert knowledge is apparent in environmental aspects that cannot be observed as such, with global climate change being the prime example.

However, expert knowledge has the potential to be no less significant in more mundane issues, such as the quality of urban air. In this case, rather than the discovery of a problem, the significance of expertise comes from its ability to dominate the ways of knowing that can be used to frame the issue. In short, the social and political importance of expertise is not only derived from the ability to provide useful answers, but also emanates from the power to decide what are the right questions. Furthermore, this power does not solely arise from the rationalism and practical abilities of science. As Stephen Bocking has argued, modern environmental expertise also gains its power from other actors in society that have a stake in the problem.[26] In short, the purpose of this study is to view environmental expertise as a medium between specific ways of knowing about the environment and the problems faced by modern society.

Many aspects of the air and health have been examined from this point of view. The formation of new threats, for example, such as the ozone, lead, or radioactive pollutants, have been investigated as part of the history of environmental toxins.[27] Studies on premodern knowledge of air and health have also contributed to the issue by showing the enduring and yet vague position air has had in western medical knowledge.[28] Rather than focusing on a specific problematic aspect of air pollution, the aim in this study is to examine air pollution as a whole. This requires some specification regarding the concept of air pollution itself. Indeed, the term air pollution seems to be a rather vague concept that can be used in historical works to describe the problems associated with coal smoke in the eighteenth century as well

24 *New Natures: Joining Environmental History with Science and Technology Studies.* Ed. By Dolly Jørgensen, Finn Arne Jørgensen and Sara Pritchard. University of Pittsburgh Press, 2013.

25 Sörlin, Warde, Robin. The *Environment. A History of The Idea.* Johns Hopkins University Press, Baltimore 2018.

26 Bocking 2004, 7.

27 See, for example, *Toxic Airs: Body, Place, Planet in Historical Perspective.* Ed. By James Rodger Fleming, Ann Johnson. University of Pittsburgh Press, Pittsburgh 2014.

28 Hamlin 2014, 23–25.

as the modern problem with carbon dioxide and climate change. This makes any attempt to undertake an all-encompassing examination of air pollution futile in practice.

One premise of this study is, therefore, to consider air pollution in a much narrower sense, namely, as a specific concept that developed after the Second World War most notably in the United States. The justification for this derives from the fact that it was after the Second World War, as environmental historians Robert Gottlieb and Frank Uekötter have argued, that the notion of air pollution began to proliferate as a single concept that encompassed all the aspects and effects of bad urban air quality, which had previously been seen as separate issues. In addition to old nuisances and economic questions, air pollution also covered the potential health effects from a plethora of impurities in urban air. Furthermore, as Uekötter has shown, this notion of air pollution began to attract an increasing amount of medical and scientific research.[29] The formation and proliferation of this research and expertise on air pollution and its significance for urban air, in terms of a living environment, forms the basis of this study.

## Local and Global in Histories of Air Pollution

Focusing on the ways of knowing about air pollution also enables the use of a transnational scale. Most historical studies on air pollution are geographically confined to either one city or on a national scale, focusing on large industrialised countries, such as Germany, USA, France and Great Britain. Smaller scale studies have included exceptional cases such as the Ruhr Valley region, London, Pittsburgh, St. Louis and Los Angeles. National and local focus is justified given the fact that these studies usually examine the policies of regulation and public abatement movements. Problems of air pollution were, after all, local by character and were dealt with by local authorities, produced by local sources and endured by local people. Even from the point of view of a knowledge accumulation, it was in these special localities and a select few chosen countries that research about air pollution has largely been conducted. Special attention on some locales thus seems justified. As the historian Rachel Rothschild has shown in her recent study, it was only after acid rains brought attention to bear on long-range air pollution that the problem gained a transboundary character, similar to that of many other toxins present in the modern world.[30]

However, despite the seemingly local status of traditional air quality issues, the process by which the knowledge and expertise of urban air quality was constructed

29 Gottlieb 2005, 116–118; Uekötter 2009, 86.
30 Rothschild 2019, 2–13.

can be seen as a transnational phenomenon in many senses. One way to grasp this is to examine it from the viewpoints developed by historians of science in recent decades. The movement of scientific ideas has long been a matter of great interest and debate. The influential theories of the economist Walt W. Rostow and the historian George Basalla vis-à-vis the spread of western science throughout the world due to its universal rationality has been contradicted by post-colonial studies emphasizing the agency and significance of non-western peoples.[31] At the same time, the very idea of scientific knowledge being accepted by merit of its rationality alone has been challenged. The critique of the universal rationality of science since the 1970s has revealed both the social and material sides in the production and movement of knowledge. Lowering the tone of science, as historian Steven Shapin has described it, revealed a practice that was thoroughly human and inseparable from its social and material appearances.[32]

This lowering of the tone makes the spread and status of scientific knowledge an intriguing question. As the historian of science James Secord phrased it in 2004:

> How and why does knowledge circulate? How does it cease to be the exclusive property of a single individual or group and become part of the taken-for-granted understanding of much wider groups of people?[33]

This question has been cited as a reason to shift attention from rare places of innovation and invention to common places of appropriation and use. In a similar vein, the historian of technology David Edgerton has argued that imitation and the use of things, rather than inventions should be the focal point in his field of study.[34] This emphasis also has clear relevance for environmental history. As Uekötter has stated, the purpose of environmental history is to have a wide view on history that includes animals, plants, the sea and air, and to focus on ideas and practices that integrate these with human communities. An important question to ask, therefore, is, why and how these ideas and practices change and how this change spreads and establishes itself in different locales.[35]

To examine air pollution from this point of view calls for a different kind of study than those that focus on specific locales with large endemic air pollution issues. International institutions have been used as a means to shift the focus from local

31 See, for example, Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650–1900*. Palgrave Macmillan, London 2007.
32 Shapin 2010, 1–15.
33 Secord 2004, 655.
34 Edgerton 2011, xi.
35 Uekötter 2010a, 1–2.

developments into the global or transnational sphere. Christopher Sellers and Joseph Melling argued ten years ago that the significance of international institutions in sustaining networks of expertise and epistemic communities had been largely unearthed.[36] A similar argument is outlined by Jan Henrik Meyer and Wolfram Kaiser in their more recent and somewhat pioneering work on the role of international organisations in environmental protection.[37] Some institutions, such as the World Health Organization, have received a reasonable degree of attention from historians.[38]

However, a focus on international institutions has limitations. Though international institutions are, or at least aspire to be, global agents, their significance in shaping local events is hard to scrutinise from the point of view of the institutions alone. The environmental historian Thomas Lekan, for example, has cast doubt on the significance of the post-World War Two internationalism in environmental politics despite its strong rhetorical presence.[39] On the other hand, the historian Paul N. Edwards has emphasised the significance of international organisations as global actors and claims that the local-global perspective confuses matters more than it is able to elucidate.[40] One solution would be to compromise. As Frioux has argued, the history of air pollution should be examined from a mixture of local, national and international perspectives.[41] Works on the so-called Cold War sciences, for example,

36 Sellers & Melling 2012, 10.

37 Kaiser, W., Meyer, J.-H. Ed. *International Organizations and Environmental Protection. Conservation and Globalization in the Twentieth Century*, Berghahn, New York 2017.

38 The significance of these institutions in the so-called era of new internationalism has been examined most notably by Akira Iriye. See Akira, Iriye, *Global Community: The Role of International Organizations in the Making of the Contemporary World*, University of California Press 2002. On the World Health Organization, see *The First Ten Years of the World Health Organization,* WHO 1958; Javed Siddiqi, *World Health and World Politics: The World Health Organization and the UN System.* University of South Carolina Press 1995; John Farley, *Brock Chisholm, The World Health Organization, and the Cold War*, 2009; Randal M. Packard, *A History of Global Health: Interventions into the Lives of Others*, 2016. On The League of Nations health organisation, see Iris Borowy, *Coming to Terms with World Health: The League of Nations Health Organisation 1921–1946*, 2009. For the International Labor Organization, see Cayet & Rosenthal & Thébaud-Sorger 2009 How International Organizations Compete: Occupational Safety and Health at the ILO, a Diplomacy of Expertise. *Journal of Modern European History*. Volume 7, issue 2, 2009. On the World Meteorological Organization, see Edwards 2010. On the United Nations in general, see Mark Mazower, *No Enchanted Palace: The End of Empire and the Ideological Origins of the United Nations, Princeton University Press, 2009.*

39 Lekan 2010, 68.

40 Edwards 2010, 1–27.

41 Frioux 2019, 217.

have shown the importance of foreign policy in science. In the same vein, they have also highlighted the important movement and connections that were made outside official channels.[42]

One way to overcome the local/global dilemma is to abandon the concept of the global actor and approach the issue via the flow of material and ideas. This view has been theorised by the anthropologist Arjun Appadurai, who, following the ideas of Benedict Anderson, views objects and ideas as local manifestations of the global.[43] Appadurai argues that the difference between the local and the global lies in quality rather than scale. This has clear relevance with regard to knowledge of the environment and health. As Sverker Sörlin, Paul Warde and Libby Robin have stated, the idea of the global environment was created by the practices and methods that produced universal knowledge about local conditions.[44]

In other words, the aim should be to examine the flow of ideas and agents, both human and non-human, which affect the construction of local conditions. The purpose of this study is to combine this transnational approach with a focus on the ways of knowing by examining the appropriation of the new expertise and the means by which its ways of knowing changed the local problem of urban air quality. International organisations are one important phenomenon in this movement of knowledge and practices, but they are not a shortcut to a global view. In fact, it could be argued that when examining the movement, appropriation and use of knowledge, it is the periphery that provides the material and result that can be generalised. After all, most urban areas in the world are not like London or Los Angeles. Thus, a focus on use rather than invention and on small-scale pollution rather than disasters is to concentrate on the common and typical rather than the rare and the exceptional.

Perhaps due to the country's relatively peripheral position, historical studies of Finnish society have tended, on the whole, to have a transnational viewpoint at some level. However, the extent to which this point of view is developed varies. In his studies on the electrification of Finland, Myllyntaus has examined how technology that was developed and produced by others was implemented in Finnish society.[45] A similar examination has been expounded by Karl-Erik Michelsen in his historical

42 See John Krige, *How Knowledge Moves: Writing the Transnational History of Science and Technology*. University of Chicago Press, Chicago and New York 2019. Also see, *Winter Kept Us Warm: Cold War Interactions Reconsidered*. Ed. By Sari Autio-Sarasmo and Brendan Humphreys. Kikimora Publications, Helsinki 2010.

43 Appadurai 2013, 65–70.

44 Sörlin & Warde 2015, 49. See also Sörlin, Warde & Robin 2018.

45 Myllyntaus, Timo, *Electrifying Finland: The Transfer of a New Technology into a Late Industrialising Economy*. Elinkeinoelämän tutkimuslaitos. Helsinki 1991.

study of the engineering profession in Finland.[46] In environmental history, Tuomas Räsänen has shown how scientific knowledge about the polluted coastal waters of Finland drew on Swedish research.[47]

One important aspect of transnational studies has been how scholars have provided a more nuanced view on the interchange of ideas and things below the level of official state relations.[48] This is especially important in regard to the Cold War era, as its historical examination has been traditionally tilted towards superpower politics. In other words, there is already a rich tradition of transnational research to which this study aims to make a contribution. However, despite extensive international networks and the pioneering status of the Finnish Institute of Occupational Health (FIOH) in environmental health research, it has received surprisingly little attention in historical studies. Though the institution appears in works on the histories of public health, labour and environmental health controversies, its operations and significance have not been scrutinised outside its own history surveys.[49] Thus, the story of the FIOH and its air pollution research is an important addition to Finnish environmental and public health history, as well as the transnational development of air pollution research.

After the Second World War, Finland was perceived as being on the relative periphery of Europe. The country shared the ever-increasing problems associated with industrialisation that beset affluent countries, but on a smaller scale, as more than half the population still lived agrarian lifestyles. Academics and other experts were often of high quality and were well-connected to their European and American peers. But the number of experts in Finland was small and suffered a chronic lack of resources to keep up with the advances made elsewhere. The country's geographic position also placed it on the outskirts of Europe, making physical contact with the academic centres, such as The United States, expensive and time consuming. On the other hand, Finland was geographically and culturally close to the Scandinavian countries and their high-quality community of experts.

The Cold War had its own effects on transnational relations, especially in the late 1940s, when contacts to western countries were limited. The Cold War context should not, however, downplay the fact that Finnish academic communities had been traditionally connected to western countries and that this continued after the Second

46 Michelsen 1999.

47 Räsänen 2015.

48 See, for example, *Tutkijat ja sota. Suomalaisten tutkijoiden kontakteja ja kohtaloita toisen maailmansodan aikana*. Toim. Marjatta Hietala. SKS, Helsinki 2006; *Beyond the Divide: Entangled Histories of Cold War Europe.* Ed by Koivunen, Pia & Mikkonen, Simo. Berghahn Books, New York and Oxford 2015; *Reassessing Cold War Europe* Ed. By Autio-Sarasmo&Miklóssy. Routledge, New York and London 2010.

49 Noro 1979; Väänänen & Rantanen 1995; Ketola 2015.

World War, with The United States becoming the most important source of ideas and practices. Finally, it should be noted that being on the periphery or in isolation are not necessarily negative features. Economic history has shown the so-called advantages of backwardness in economic development and also the negative effects of being culturally and geographically close to economic and academic centres.[50] Thus, to examine the history of Finnish air pollution research from the viewpoint of the transnational movement of knowledge provides a means to study how modern expertise of environmental health, with its specialised ways of knowing, formed in a location that did not have the resources to fully develop this trend. In other words, this study will focus on the movement of knowledge, the imitation of technology and how these processes affected the idea of air as a living environment.

## 1.3 Aims of the Study

The aim of this study is to examine how and why the measurement and research of air pollution became established in Finland between the 1940s and the early 1970s. This question will be examined by following the central agents in air pollution research; namely the researchers at the FIOH, who became pioneers of Finnish air pollution research. At the most basic level, this study contributes to the Finnish history of public health and environmental history by providing a detailed picture of an environmental health issue that has received relatively little scholarly attention. By focusing on the FIOH, this study also provides an account that differs from the usual historical works on public health or air pollution. Rather than emphasising the role of the usual agents—public health boards and other officials—this study focuses on the significance of occupational health and its experts in the formation of public health knowledge. Similarly, rather than beginning with the atmospheric scientists who worked in early twentieth-century Great Britain, and who are commonly referred to as the pioneers of air pollution research, this study follows the historical studies that have shown the importance of industrial environment experts in the formation of environmental concerns. In short, by focusing on the FIOH, this study will highlight the less well-known historical roots of public health and environmental concerns. It will also subsequently tie them more closely to industrial environments and the process of industrialisation itself.

The process of industrialisation and its entanglements with the development of environmental health expertise forms the second aspect that stems from the results of the present study. By examining the transnational flow of materials and the

[50] For example, it has been argued that Ireland suffered from a so-called brain drain after the Second World War, as the country's most talented individuals often emigrated to United States or Great Britain. Persson & Sharp 2015, 107–110.

formation of expert networks this study will demonstrate that air pollution research should be regarded as part of the wider co-development of industrial production and rational management. It will also highlight its significance in the formation of environmental health expertise. The formation of expertise and knowledge about the environment forms the third and highest area of analysis in the present work. This aspect of the thesis will contribute to wider discussions on how knowledge about the environment is constructed, moved and appropriated by society.

The timeline of this study follows the FIOH and its leading experts in environmental health, beginning from their examination of air in terms of hygienic thought in Finland in the 1940s. This was a period when the institution's inner circle received their training in medicine and hygiene. The first chapter examines how medical expertise on industrial air became established in Finland through the FIOH, which changed the status of air in hygienic practice. From this point, the study follows the leading figures as they began to work with the hazards prevalent in a modern, industrialised society, with a particular focus on carbon monoxide poisoning. The second chapter examines how expertise concerning industrial environments gradually spread outside this industrial setting into the urban environment. This development took place as a result of FIOH researchers becoming more integrated into the transnational networks of environmental health experts, who were grounded in occupational medicine and industrial hygiene.

The third chapter examines how urban air pollution became integrated into Finnish public health concerns and, subsequently, into the ascending concern for the environment. From the late 1950s to the late 1960s, air pollution expertise was institutionalised in the FIOH. The institution became recognised as the national authority on physical and chemical hazards in the environment. The end point of the present study comes in the early 1970s, when the new environmentalist critique and new forms of environmental expertise displaced the medical-hygienic expertise of the FIOH. What runs through the entire study, is the examination of the Finnish setting as part of wider developments and networks stemming from the problems faced by modern societies in Europe and North America in particular, beginning form the scientific management of occupational environments in the 1940s and continuing to the environmentalists' critique of medical expertise in the late 1960s.

## 1.4 Materials and Methods

As Frioux has noted, the history of air pollution is usually written by drawing on sources that depict the cultural, social and political sides of the issue.[51] Materials from public health officials, activists and newspapers often form the core of these studies. Materials from air pollution research are not neglected, but they are at the fringes of the examination rather than at its centre. The purpose of this study is to flip the situation in order to focus on the materials produced by scholars in air pollution research. Furthermore, it is also the aim of this study to examine these sources not only as purveyors of facts from nature that provide knowledge for wider discussion, but also from the point of view used mostly in the history of science. The most essential (and basic) dictum in the history of science is to examine what the scientists do, rather than what they say they do.[52]

Thus, the purpose of this study is to examine the publications, correspondence and other sources produced by researchers and to analyse how knowledge about the environment and health is produced. How is this knowledge framed, displayed and communicated? What are the technical and theoretical roots that guide these procedures? What kind of presuppositions, compromises or simplifications may have been needed in order to gain knowledge about the environment and health? What is meant by reliable knowledge, how is uncertainty or ignorance expressed, communicated, and conquered? And finally, what is the relationship between these ways of knowing and society at large? The concept of 'ways of knowing', put forward by the historian of medicine John Pickstone twenty years ago, is especially useful when examining a multidisciplinary issue such as air pollution. As Pickstone suggests, the disciplinary borders between science and medicine can be overcome in historical analysis by focusing on the more general aspects of knowledge production that he termed ways of knowing.[53] Even though one might not accept the specifics of Pickstone's idea, the concept still serves a purpose as a term that connects science and medicine together, as well as to other forms of knowledge production.

Much ado has recently been made about material and non-human agents in historical narratives, including in historical research on the creation and movement of knowledge. This idea has been central in the study of the circulation of knowledge, in which the tangible forms of the movement of knowledge have been essential. As Secord has noted, the fact that knowledge can only move via something, be it books, people or instruments, is rather self-evident. The task is to make this perspective the

51 Frioux 2019, 272.
52 Shapin 2010, 38–40.
53 Pickstone 2000, 1–1. Also see *Ways of Knowing: New Approaches in the Anthropology of Knowledge and Learning.* Ed. by Mark Harris. Berghahn Books, New York and Oxford 2007.

analytical point of view.[54] Rather than fully embracing the viewpoints from the circulation studies, the purpose in this study is to acknowledge the materiality of knowledge and its movement. This entails that although materiality is not the focus of the analysis as such, it must be accounted for in the description of the proliferation of air pollution research. In practice this means a more nuanced form of writing, in which the function of the sources as non-human agents of change is openly described. This serves to embrace the material limits of the movement of knowledge and prevents vague expressions of what was known at the time and why.

The archives of the FIOH have rarely been used in historical studies. Due to the organisational style of the FIOH archives it provides a comprehensive pool of sources about the first director, Leo Noro, but little about the other researchers. Fortunately, Noro was one of the key figures in FIOH's air pollution research and in the overall development of the institution as a leader in studies concerning environmental health. The other main figures can be examined through their correspondence with Noro, which was frequent especially during study trips abroad.[55] In addition to archival material, this study will also draw on published studies, textbooks, and popular articles by FIOH researchers. By covering three layers of communication, that is, teaching, research and popular science, these materials provide a wide picture on how knowledge about air pollution was disseminated in different forums.

Textbooks and other teaching materials form one essential source which are often neglected in the historical study science and knowledge. The importance of textbooks in understanding how modern science operates was famously argued in the 1960s by Thomas Kuhn. According to Kuhn, textbooks present exemplars that teach how science is carried out and highlight the puzzles that need to be solved. It is through education that the science community gains its coherence and unity.[56] Despite the importance attributed to textbooks by Kuhn, they have not received much attention within the discipline of the history of science. As the historian David Kaiser has noted, textbooks are largely viewed as windows to so-called normal science. In this sense, they are not viewed as containing innovative or imaginative ideas, which, consequently entails that they are regarded as rather unimportant sources within a field traditionally interested in invention and novelty.[57] There have been recent

54 Secord 2004, 658. For a critique of the idea of circulation of knowledge, see Peter Dear, Science Is Dead; Long Live Science. *Osiris,* volume 27, number 1, 2012.

55 This situation changed in the late 1960s, when the Government Council for Air Pollution Control and Noise Abatement was founded. The materials of the council include the correspondence of Arvo Laamanen, the most senior air pollution researcher at the FIOH.

56 Kuhn 1996, 35–40.

57 Kaiser 2005, 6–7.

attempts to widen this view and to regard textbooks as an important means of shaping and creating knowledge.[58] Though these studies have revealed the interesting features that textbooks can have in creating knowledge, they are, nonetheless, based mainly on an interest in innovation. Yet, moving from how knowledge was invented to how it was transmitted and used in different localities attaches a new kind of importance to textbooks. If we incorporate Kuhn's view into the research on texts, things and humans as mediums of knowledge, the power of exemplars becomes more meaningful and textbooks become more significant sources.

In order to examine the accumulation and transnational movement of knowledge, some use is being made of the viewpoint developed in the 1970s by Imre Lakatos. Lakatos attempted to examine the accumulation of science from the viewpoint of what he called 'research programs', meaning a series of research that shares the same fundamental question and that engages in joint discussion. In practice, these research programmes can be traced by following the use citations, since this is the principal way researchers indicate their mutual interest and acceptance of one another's methods.[59] Lakatos' method can serve as a way to focus the examination from the wealth of research published about air pollution over the course of several decades into what the individuals at FIOH supposedly did read and considered important.

However, this focused perspective is insufficient when undertaken on its own. Lakatos' idea, vis-à-vis research programmes was already being criticised in the 1980s as it only followed the path of winners and disregarded what was happening outside of these so-called programmes. To use this method to focus on what FIOH researchers read also has the potential of neglecting much that was not simply cited, but still had significance, such as a general understanding of the problem. Thus, the focused search of publications should be joined with another kind of perspective; namely the examination of entire journals from the period in question. This examination will include the Finnish medical journals *Duodecim*, *Lääkärilehti*, *Sosiaalilääketieteellinen aikauslehti, Työ ja Terveys, Työterveysuutiset* and also the more popular magazine *Terveys* that was aimed at a broader audience. Since air pollution was as much a technical issue as a medical one, the forum for industrial rationalisation, *Tehostaja*, is also included.

Whereas the Finnish discussions are relatively easy to examine in full, due to their limited scale, foreign research is a different matter. It is quite impossible to read

58 See Antonio García-Belmar, José Ramón Bertomeu-Sánchez, and Bernadette Bensaude-Vincent, in *Pedagogy and the Practice of Science: Historical and Contemporary Perspectives*. Ed. By David Kaiser. MIT Press, Cambridge 2005.

59 See, Imre Lakatos, *The Methodology of Scientific Research Programmes: Volume 1: Philosophical Papers.* Cambridge University Press, 1980; For more recent usage of this principle see. Kay Carter Codel, *The Rise of Causal Concepts of Disease: Case Histories,* Ashgate, Farnham 2003.

everything written about air pollution and health in the era, given the fact that in the 1950s and 1960s the research was scattered into different disciplines and appeared in various journals. But it is also difficult to grasp the general process if a focus is only given to acclaimed studies and studies cited by the objects of the present study. Since medical journals only occasionally covered air pollution issues, a better picture of the research can be given by the journals devoted to air pollution research. Of these, the U.S. based *Journal of the Air Pollution Control Association* (*JAPCA*) founded in 1952 ranks as the oldest, most prominent, and also the widely cited by FIOH researchers. In addition to being the leading journal concerning air pollution control, *JAPCA* provides a view on research undertaken in the United States, the top country in the field. Combined with Finnish medical journals, *JAPCA* provides a means to study the general process of air pollution research in the context of wider medical discussions.[60]

Material from the World Health Organization provides an additional source from an international perspective. This material should, however, be approached with caution. It would probably be a mistake to regard it as an official consensus of the experts in the field. Rather than presupposing the significance and authority of the WHO's publications and actions, they should be viewed as forming part of the examination of the transnational networks of expertise. Material produced in and for conferences provides an additional source in this regard. Despite their institutional status in academia and their presumed importance in proliferating knowledge, not much has been written about conferences as forums and venues for the exchange of expert knowledge. Though some conferences hold significant positions in historical narratives, such as the 1972 Stockholm conference on environment, their overall significance seems to be rather vague. In this light, the sources from conferences provide a view on this ambiguous forum and its functioning in the transnational networks of air pollution research.

Finally, in order to execute the point of view of the history of science effectively, this study attempts to make use of the simple literal device of not using the concepts that are under scrutiny. The reasoning behind this is that when something is labelled as being *scientific* or *scientifically made,* for example, the essential aspects of the practice are concealed by these vague terms.[61] Thus, by abandoning these terms in historical research one is forced to describe more graphically what is actually being

60 Another possible choice would have been the British *International Journal of Air Pollution* founded in 1958. However, this journal does not seem to have been as important for FIOH researchers as *JAPCA*.

61 See, for example, Bruno Latour *The Pasteurization of France*. Harvard University Press, 1988.

done and what the objects under scrutiny actually are. In a sense, this serves as a practical tool to focus on the essential questions in the history of science.

A similar conceptual outlining should be made for the use of the concept of 'air pollution'. As noted earlier, air pollution is used in historical studies as a term that refers to air quality problems in general, while at the same time it is shown that the concept changed in the mid-twentieth century and began to represent the plethora of air quality problems that were previously dealt separately. The historian Adam Rome has argued that the term "pollution" only came to signify environmental degradation in the United States in the late nineteenth and early twentieth centuries, while "air pollution" was used in a modern sense only from the 1930s.[62] As Schönach has also shown in her historical study on Finnish air pollution control, the Finnish terminology used to describe air quality problems was versatile and unestablished well into the 1970s. Indeed, the Finnish equivalent of the term pollution only became common in the latter part of the 1960s.[63] The point is that the terminology by which the environment and its qualities are described must be part of the examination, which is downplayed by the overuse of the term pollution. Rather than using air pollution as a general term, it should be seen as a distinct concept that can be used to describe environmental degradation. Thus, when embarking on an examination of the history of air pollution since the 1940s in Finland, the concept itself must be abandoned and the terminology to describe the relationship between air and health must come from the sources. In this way, when air pollution does appear, it can be viewed as a specific historical concept with a distinct meaning.

62 Rome 1996, 6.

63 Schönach 2008, 90–94. A similar development appears to have occurred in Germany. The term *luftverunreiningung,* referring to impure (*unrein*) was commonly used in technical publications during the 1940s, while the term *luftverschmutzung, referring to pollution* (Schmutz) became prevalent in popular discussion in the 1960s. For a comparison of Finnish and German environmental terminology, see Liimatainen, Annikki, *Untersuchungen zur Fachsprache der Ökologie und des Umweltschutzes im Deutschen und Finnischen: Bezeichnungsvarianten unter einem geschichtlichen, lexikographischen, morphologischen und linguistisch-pragmatischen Aspekt.* Doctoral dissertation. University of Helsinki, Faculty of Arts, Department of German, 2008.

# 2 From Fresh Air to Safe Air

## 2.1 Air and Finnish Public Health in the 1940s

> Bad, foul smelling air is not as such a predisposition for disease conditions. Fumes of decay are unpleasant due to their disgusting smell, and as such unhygienic, but do not cause a danger to health. Their presence merely shows that the conditions are not healthy.[64]

This was how Woldemar Lojander, professor of hygiene at The University of Helsinki, described the medical and hygienic significance of foul-smelling air in a lecture he delivered in 1942. Lojander continued by stating that some foreign authors, however, regarded smells themselves as a cause of disease.[65] One of Lojander's students, Leo Noro, wrote a note on this idea stating simply "unfounded."[66] Both Lojander's description and Noro's note reflect a well-known development in the history of medicine and public health, wherein the idea of bad air, or miasma, as a threat to health became viewed as implausible. This change in opinion developed from the bacteriological explanations that came to the fore from the late nineteenth century. By the 1940s, they had come to attach a tremendous significance to air as an intrinsic element in public health. As the historian Peter Thorsheim has argued, in the mid-nineteenth century air was seen as a complex medical concept and the most important element in terms of public health, held together by the theory of miasma.[67]

By the early twentieth century, however, references to miasma as an atmospheric poison or noxious vapour had disappeared from literature.[68] Though traditionally viewed as a triumph of medicine and public health, the primacy of bacteriological models of disease over miasma have also been seen to have caused less expert attention being devoted to other potentially harmful areas of public health, such as

64 Printed lectures of Woldemar Lojander 1942, 4, AFIOH.
65 Printed lectures of Woldemar Lojander 1942, 4, AFIOH.
66 Noro's notes on the printed lectures of Woldemar Lojander 1942, 4, AFIOH.
67 Thorsheim 2006, 12–17.
68 Homburg & Vaupel 2019, 3–11.

the smoke that negatively affected the inhabitants of large cities.[69] It seems then that the significance of the air was diminished on all fronts. The gaze of hygienists, for example, was steadily directed away from odours to bacteria and from air to water.

How did the study of air evolve from this apparent state of decline to become perhaps the most important element of public health within the space of a few decades? The purpose of this chapter is to begin the examination of the history of air pollution research in Finland by studying the medical and hygienic significance attached to air in the 1940s. The chapter operates as a starting point on two levels: in chronological terms, the 1940s was the decade when the future pioneers of Finnish air pollution research, such as Leo Noro, received their medical education and began their careers. From a theoretical point of view, the relationship between air and health examined in this chapter can be seen as the most fundamental issue in the history of air pollution. It ties the matter into the more general historical question regarding the relationship of the environment and health. Linda Nash and Angela Gugliotta have argued, for example, that due to bacteriological dominance the complex connection between the environment and human health was neglected in the early twentieth century. It was only to be rediscovered in the form of pollution and environmental toxins in the latter half of the century.[70]

Some re-evaluation is needed vis-à-vis the idea that bacteriology supersedes dust and fumes and toxins as the primary pathogens in air. Christopher Sellers, for example, has criticised the prominent medical historical tradition that disregards smoke and fumes from twentieth-century medical history, which instead has focused on the viewpoint of experts and diseases. Sellers argues that the longer tradition of the links between the environment and health that co-existed with reductionist medical thought should be recognised.[71] Similarly, in their study on the history of autoimmunity, Anderson and Mackay have criticised the tendency to regard twentieth-century medicine solely in terms of biomedical reductionism, and disregard topics such as individuality and sensitivity.[72] In addition, the theory of biomedical reductionism and its stance on how the effects of smoke and fumes were regarded should perhaps not be simply shown as bacteriological domination. According to Codell Carter, a philosopher of science, the fundamental aspect in the rise of modern medicine since the late nineteenth century was not the realisation that microbes cause diseases. It was, rather, the etiological point of view that emphasised

69 Thorsheim 2006, 2; Gugliotta 2003, 123. For example, in George Rosen's still widely referred classic of public health history the turn from miasma to germ theory is seen as the defining moment of western medical thought. See George Rosen, *A History of Public Health.* Johns Hopkins University Press, Baltimore 2015 (1958).

70 Nash 2006 6–10; Gugliotta 2003, 120–123.

71 Sellers 2003, 257.

72 Anderson & Mackay 2014, 3–5.

that all diseases should be conceptualised through universal, natural and necessary causes. To be sure, bacteriology was miraculously successful. However, Carter argues that instead of making other causes implausible, the success of bacteriology inspired the search for similar causation in other illnesses, such as beriberi or mental health issues. Moreover, he posited that this development has been neglected by the critique against reductionism in twentieth-century medicine.[73] In fact, historical studies on poisons have shown how non-microbial causes of disease were a great concern in the early twentieth century, for example, in the use of food additives.[74] Thus, if concerns about dust, smoke and fumes declined, it might not be sufficient to simply explain this as the predominance of bacteriological conceptions of disease. The reasons behind the apparent neglect of dust, fumes and smells deserve closer scrutiny, beginning from the importance of air in hygienic thought.

## Pettenkofer's Figure and the Importance of Fresh Air

The status of hygiene in public health and medical studies began to be institutionalised in Finland at the turn of the twentieth century. With its emphasis on a clean environment, the hygiene movement brought to Finnish urban areas a way of thinking that promoted the connection between environment and health. This was most evidently put to use in the control of sewage and water resources.[75] The primary example of public health policy came from Great Britain, while the active promoters of public health also introduced germ theory into Finnish medicine and public health practices from central Europe at this time.[76] However, the significance of clean air did not disappear as it remained a central aspect of hygiene. Health education at the time warned that still and stuffy air was a breeding ground for disease and promoted ventilation and open spaces.[77] This was a seemingly transnational feature. As Thorsheim has argued, the idea that clean air was good for health and development was common on both sides of the Atlantic in the early decades of the twentieth century.[78]

The enduring significance of clean air has puzzled historians. The question is often seen as a dichotomy between germ theory and miasma. It has been argued that

73 Carter 2016, 1–3, 147–150. According to Carter, this etiological view is only found in western medicine from the late nineteenth century.

74 See, for example, Hormburg & Vaupel 2019. See also *Banned: A History of Pesticides and the Science of Toxicology.* Davis, Frederick Rowe. Yale University Press, New Haven 2014.

75 Laakkonen. 2001, 42.

76 See Jauho 2007.

77 Lehtonen 1995, 55–57. Saarikangas 1998, 198–200.

78 Thorsheim 2004, 67.

views on hygiene in the first half of the twentieth century posited that bad air itself was not considered to be a cause of ill health, but was rather viewed as a sign of bacterial presence. Kirsi Saarikangas, for example, sees the promotion of clean air in Finnish public health as being a mixture of bacteriological and miasmatic ideas, or a "vulgarized bacteriology".[79] Following the ideas of Bruno Latour and Philip Sarasin, others have argued that the old idea of healthy clean air was appropriated into the fields of bacteriology and physiology in the early twentieth century. It was in the practical instructions given to lay people that the idea of miasma still seemed to linger, even though hygienists themselves no longer believed in the theory.[80]

In other words, the significance of germ theory on air and health was not straightforward, as new ideas became integrated with older ideas, rather than simply replacing them. Thus, air still had a prominent place in hygiene teaching in the 1940s. As Lojander stated, "air is the first topic in every book on hygiene"[81], a structure that apparently followed Hippocrates' *Airs, Waters, and Places*. In Lojander's lectures, the chemical composition of the atmosphere, the mechanisms of air pressure, humidity, temperature, wind and climactic differences were all aspects of air that affected health and wellbeing and, as such, formed the basic foundation of knowledge for medical students. It seems that foul smells, the essence of miasma, are the only substance in air that are given no significance for health. The basis of the problem was that practically all hygienic aspects of air were somewhat vague in their significance. As Lojander noted: "We suspect and in part even know that climate affects people in a certain way, but this knowledge is mainly based on empirical experience."[82] In other words, scientists had little idea precisely why and how air affected health.

In Lojander's lectures on hygiene, he argued that fresh air was one of the principal ways to maintain health and to build resistance against illness, alongside cleanliness, a good diet, physical exercise and traditional family values. Though Lojander did not explain the specific benefits of fresh air, he emphasised that everyone was able to sense the unpleasantness of stale and stuffy air in a crowded room. Unfortunately, this stuffiness was hard to explain via a study of the chemical composition of air. Experiments had shown that no single component, even the quantity of oxygen, was responsible for the change from fresh to stuffy air. The most probable cause was carbon dioxide, since its quantity in the air increased through the process of exhalation and was known to be toxic in large amounts. Carbon dioxide had, however, been of interest to hygienists and medical researchers in the nineteenth

79 Saarikangas 1998, 200.
80 Lehtonen 1995, 57; Jauho 2007, 345.
81 Lojander 1954 128.
82 Lojander 1954, 128.

century. It was determined at this time that despite limited ventilation, levels of $CO_2$ did not increase enough to explain any negative effects. Lacking any specific cause, Lojander explained that stuffy air was caused by a rise in temperature, humidity and the immobility of air. Leo Noro wrote "fresh air" in his lecture notes in this section.[83] In other words, bad and fresh air were important concepts in terms of theories of hygiene in the 1940s, as they had been already at the turn of the twentieth century, despite the lack of a specific explanation.

The ambiguity of fresh air was also reflected in the practice of monitoring air quality. The standard practice of evaluating air quality originated from an unlikely source; namely Max von Pettenkoffer, the late nineteenth-century Bavarian chemist mostly known for his critique against germ theory.[84] Though von Pettenkoffer has been viewed as an important figure in making hygiene a discipline taught in universities, his research and ideas have been viewed as being less influential in the long run. His main work addressed the theory of localism, which emphasised the importance of soil in illnesses, and was influential in the late nineteenth century but it was ultimately abandoned in favour of a bacterial explanation of disease causation.[85] Ironically, von Pettenkoffer's plan to remove air from its premier place in hygienic curriculums failed; instead he helped to make air measurements a hygienic practice. This was due to his research on the effects of $CO_2$ on health, from which he determined a standard figure that can be used as an indicator of air quality. According to this so called Pettenkoffer's figure, air is corrupted if the carbon dioxide content in it reaches 0.1–0.2% and ventilation is needed at this point. This figure formed the basis of the hygienic practice in the 1940s of measuring healthy air.[86] Though carbon dioxide was not the cause, as such, it was used as an indicator of bad air. This was the case because it was easy to determine if carbon dioxide levels in the air were too high when compared to combined changes in temperature, humidity and air movement. Thus, the measurement of $CO_2$ content in air was one of the simplest practical tools hygienists used to manage and monitor the environment.[87]

Not a great deal of historical attention has been devoted to the measurement of carbon dioxide levels in the air, despite it being recognised as important for a long time in hygienic practice. Indeed, a general survey of the hygiene textbooks that were published in Finland between 1900 and the 1940s shows that the reasons for

83 Noro's notes on the printed lectures of Woldemar Lojander 1942, 4/ AFIOH.
84 Printed lectures of Woldemar Lojander 1942, 1–2 /AFIOH; Erkkilä 1946, 1–2.
85 Nygård 2004, 68.
86 Printed lectures of Woldemar Lojander 1942, 3 /AFIOH; Erkkilä 1946, 7; Lojander 1954, 129–130.
87 Printed lectures of Woldemar Lojander 1942, 3 /AFIOH.

advocating clean air and its practical management seemed change little over this time. There is no general argument in these textbooks regarding the fact that bad air actually causes illness. It was widely believed that germs, or "seeds of diseases", actually made air a health danger. Moreover, the textbooks consistently advocate for the positive effects of fresh air, rather than the negative effects of bad air. Still, the standard practice was to use $CO_2$ as an indicator of bad air. It was repeatedly pointed out that unhealthy air is neither the result of an increase in carbon dioxide, nor a lack of oxygen, but derived from something more complicated in its chemical and physical constitution.[88]

The importance of von Pettenkoferian air analysis derived from its physical-chemical view of air, which showed that there was more to it than germs and remnants of miasma. The idea of fresh air being beneficial to health certainly seems analogous to the miasmic ideas of the nineteenth century, or even to the environmental medicine of Hippocrates. But as the historian of medicine John C. Burnham has noted, many of the central notions of a healthy environment and a healthy life have stayed the same for long periods in history, while the ideas behind them have changed.[89] Furthermore, though the preoccupation with diseases and their specific causes has been viewed as a sin of modern medicine, many efforts to preserve and increase health were also grounded in late nineteenth-century disciplines, such as immunology and physiology, which sought to optimise the human condition.[90] In a similar fashion, the significance of fresh air in hygiene was not grounded in the old ideas of bad air that had persisted in the bacteriological onslaught. The significance came from ways of measuring local physical conditions that were able to improve bacteriological explanations. As the sociologist Mikko Jauho has shown in his study on the introduction of germ theory into Finland, physicians only accepted the idea after it was connected with the concept of predisposition. The bacterial cause of a disease often only shifted the debate into the question of hereditary or environmental predisposition.[91] In other words, the seemingly vague notions of fresh air in hygiene should not be seen as a remnant of

88 See, for example, Oker-Blom 1908; Oker-Blom 1912; Tigerstedt 1921; Oker-Blom 1925; Vartia 1931.

89 Burnham 2005, 93.

90 Anderson & Mackay 2014, 16–31.

91 Jauho 2007, 83–85. For debates on heredity factors in Finnish public health, see Henry Nygård, Tieteellisen maailmankuvan vakiinnuttaminen. Perinnöllisyystiede ja politiikan legitimointi vuosina 1900–1945. *Usko, tiede ja historiankirjoitus: Suomalaisia maailmankuvia keskiajalta nykypäivään.* Toim. Irma Sulkunen, Marjaana Niemi, Sari Katajala-Peltomaa. SKS, Helsinki 2016. For more on the debate between eugenics and a clean environment, see also, Thorsheim 2006, 69–70.

miasma theory, but a puzzle that formed part of the bigger question about the role of predisposition, sensitivity, resilience and environment in the etiology of diseases.

## Pathogens in the Air

While fresh air and stale air were vague hygienic concepts, ambient air could also function as a medium for more specific causes of illness. In a 1909 report on the conditions in the Finnish sulphate industry, Wilhelm Sucksdorff, a professor of hygiene (and Lojander's predecessor), warned about the long-term effects of dusty air and advised that people should avoid all kinds of impurities in air. He emphasised that 'subtle' diseases were able to affect those who endured long exposure to unhealthy environments.[92] This report has been often quoted in historical studies as one example indicating that he hygienic though in Finland was more comprehensive and less reductionist in its views in the early twentieth century compared to following decades. At the turn of the twentieth century, Helsinki even appointed a smoke inspector to monitor coal smoke, although this position only existed for a year.[93] According to historical studies of Finnish public health, interest in dusts and stale air declined from the 1930s. The reason for this trend is primarily seen as resulting from the increasing prominence of bacteriological explanations. Especially important in this regard was the discovery in the 1930s that tuberculosis was caused by droplet infection rather than infection from dust. Heikki Vuorinen argues that the turn from dusts to droplets set back the interest in the former until it was increasingly flagged as an issue by trade unions and environmentalists in the latter half of the twentieth century.[94]

However, Lojander still devoted considerable attention to the matter in his lectures. The Finnish equivalent of the term 'air pollution' does not appear in Lojander's lectures nor in any of the textbooks used in the early decades of the twentieth century. Instead, the potentially deleterious substances air could contain are divided into gases and solid particles. Many substances were known to be toxic or otherwise harmful and textbooks on hygiene customarily contained lists of these gases and types of dust and their effects on health. Ammoniac, carbon monoxide, mercury and nitrogen oxide, for example, were regarded as dangerous due to their toxicity. Some specific types of dust, such as quartz, glass, metals and Thomas slag[95]

92 Harjula 2007, 33; Laakkonen & Vuorisalo 2019, 280.

93 Schönach 2008, 44, 112; Harjula 2003, 81. The smoke inspector institution in Helsinki was based on a similar establishment in Munich.

94 Saarikangas 1998, 199; Harjula 2003, 201; Harjula 2007, 39; Jauho 2007, 374; Vuorinen 2010, 264.

95 A by-product of steel making named after Sidney Gilchrist Thomas, the inventor of the separating process.

were considered dangerous due to their sharp form that could potentially damage lungs.[96]

As for the question infection via dusts, Lojander stated that large particles of domestic dust are able to contain bacteria, but that these particles were usually too heavy to disperse in the air in normal conditions. Furthermore, particles that do float in the air are usually too dry for microbes to inhabit. Still, Lojander presented the relative importance of dust and droplets in infections as a contested matter expressed by different schools of thought.[97] Those belonging to the so-called school of Carl Flügge, named after the German bacteriologist, emphasised that minute droplets capable of carrying microbes were even produced in normal speech. This idea had, however, been contested in the 1930s by the German bacteriologist Bruno Lange, who had demonstrated in animal experiments that droplets were rather ineffective disease mediums. Thus, Lange's school emphasised the importance of dust as a primary cause of infection.[98] In a similar vein, a book on school hygiene from the 1930s argued that "increasingly strong evidence has been gained recently of the harmfulness of dust."[99]

Lojander's lectures highlight the fact that rather than steadily declining the importance of dusts and fumes was growing in the early twentieth century medicine in United States and Europe due to increasing knowledge acquired in occupational health.[100] Similarly, dust retained a place in hygienic teaching in the 1940s Finland. In fact, in a similar manner to carbon dioxide, dust measurement was a standard practice in hygiene. Lojander and his colleague in the Helsinki School of Technology presented the German Zeiss Konimeter and Dunkelfeld microscope as a standardised measuring apparatus that could be used with relatively little experience in order to determine both the quantity and quality of dust in the air.[101] In other words, as chemical components, elements or mediums of bacteria, dust and gases could be seen as the cause of illnesses from the same etiological view as microbes. What made these gases and dust a rather special case was the fact that most of them only appeared in special occupational environments, a fact repeatedly stated by Lojander.

96 Printed lectures of Woldemar Lojander 1942, 7/AFIOH; Erkkilä 1946, 7, 91; Wirgin 1931, 220–232. See also Ernst Baader's *Gewerbekrankheiten: klinische Grundlagen der 31 meldepflichtigen Berufskrankheiten.* Urban & Schwarzenberg 1943.

97 Printed lectures of Woldemar Lojander 1942, 9 /AFIOH. Lange's studies specifically consider tuberculosis, but Lojander discusses infections in general.

98 Printed lectures of Woldemar Lojander 1942, 9 /AFIOH.

99 Vartia 1931, 37–38.

100 Sellers 1997, 148–160.

101 Printed lectures of Woldemar Lojander 1942, 8 /AFIOH; Erkkilä 1946, 7; Lojander 1954, 136–137.

With the exception of house dust, the hazards of contaminated air were not relevant to general hygiene simply by being absent from the environment in general.

Smoke was an exception. Though smoke, especially coal smoke, is often seen almost as a synonym for air pollution, in 1940s hygienic teaching it was viewed as a specific type of airborne dust. The historical view on the health effects of smoke has been rather ambiguous. Many historians argue that smoke was not regarded as a threat to health until the mid-twentieth century and that early smoke abatement movements were largely motivated by economic and aesthetic concerns.[102] Others seem to hold the view that smoke was already known to be dangerous to humans in the nineteenth century and officially treated as a health issue, but that its negative effects were hard to prove.[103] An examination of opinions regarding the teaching of hygiene in the 1940s supports the former view. Both Lojander and his colleague Sven Erkkilä at the Helsinki School of Technology describe smoke as "not dangerous to health as such."[104] Erkkilä argued that smoke was only dangerous in repeated and extremely large doses. Both saw the hygienic significance of smoke in its indirect effects, namely, the inability to ventilate apartments with fresh air and a decrease in sunlight.[105] The textbooks also support the same notion. Although the book on school hygiene advises not to build schools in smoky areas, smoke is generally given little attention. Since most books consistently emphasise the importance of clean and fresh air, smoke is seen as a nuisance that lowers the quality of air but is not deleterious to health as such.[106]

The emphasis on the indirect effects of smoke is also shown by Thorsheim. He has shown that smoke was held indirectly responsible for affecting health in early twentieth-century Britain, mostly due to it leading to a decrease in sunlight.[107] The seeming ambiguity with regard to the health effects of smoke can be understood in the context of early twentieth-century medicine and hygiene, in which the more or less vague notions of healthy and unhealthy environments co-existed with specific diseases and their etiology. Unlike Thomas slag, smoke was not seen as being a direct cause of any specific illness. Instead, it was perceived to be a nuisance that prevented ideal hygienic conditions; namely, clean and fresh air. The prevalence of dust and bad air in hygiene teaching supports the view that air and the environment in general held a position in hygienic and medical thought that was not simply a remnant of old ideas, but rather a genuine question based on

102 Rome 1996, 15–16; Uekötter 2009, 4; Thorsheim 2006, 67–70.
103 Platt 2004, 30–43; Mosley 2004, 51–71; Schönach 2008, 44–45, 95–96.
104 Printed lectures of Woldemar Lojander 1942, 8 /AFIOH; Erkkilä 1946, 7.
105 Printed lectures of Woldemar Lojander 1942, 8 /AFIOH; Erkkilä 1946, 7.
106 Oker-Blom 1908, 122–127; Oker-Blom 1912, 48–51; Tigerstedt 1921, 7–11; Oker-Blom 1925, 38–46; Vartia 1931, 7.
107 Thorsheim 2006, 70.

observations and recent research. This view, however, does not question the stance outlined in many historical works in terms of how public health officials were in practice relatively uninterested in such matters and were more focused on the war against bacteria.

Indeed, evidence suggests that dust and smoke were regarded as uninteresting topics in Finnish hygienic teaching. Though the relative popularity of different hygienic subjects can be hard to demonstrate, some idea can be gained by examining a list of compulsory student works written in parallel with the hygiene course in the University of Helsinki. Students had to express their subject of interest and were subsequently assigned a suitable research topic. Though these works were usually never published, Lojander compiled the topics into a publication that he thought would be an interesting source to examine in terms of the development of hygiene. It seems that air did not figure well in this development. Of the 683 studies conducted between 1935 and 1959, only 38 dealt with air and its impurities. The majority of these studies dealt with airborne bacteria, while dust was only measured in a handful of studies, including those devoted to occupational hygiene. Only one of these studies, conducted in the 1930s, dealt with dust present in outdoor air. The list clearly demonstrates that bacteriology (and particularly disinfection) ruled supreme in hygiene teaching. Furthermore, disinfection, be it in concerned with water, sewage or milk, was also an obligatory part of the practical work carried out in the course.[108] No wonder then that almost all of Leo Noro's notes on the hygiene course consider the disinfection of milk.[109] However, as Lojander noted, topics related to nutrition and social medicine also constitute a considerable and growing share of the student works during the 1940s and 1950s. This observation further strengthened Lojander's argument about how the development of hygiene was changing from a bacteriological phase to a social one.[110] In other words, the hygiene education in 1940s Finland was a war against microbes, while the war against poverty and deficient social conditions was beginning. In contrast, interest in air and its impurities remained sporadic.

Why the lack of interest in urban air and the impurities in it? The most obvious explanation is that smoke and other dust in the air did not raise concerns because they seemed to have little effect on public health. Perhaps the most common explanation given in historical studies vis-à-vis the lack of attention paid to air pollution is the difficulty to see the long-term effects of dust and smoke, combined with a general lack of interest in towards the so-called chronic diseases. Only after the epidemiological transition from infectious to non-infectious diseases and the

108 Lojander 1959, 7–8.
109 Noro's notes on the printed lectures of Woldemar Lojander 1942, 4, AFIOH.
110 Lojander 1959, 5.

accumulation of medical knowledge was air pollution regarded as a genuine public health menace as such.[111] This argument is closely related to the ones that blame bacteriological reduction. As Gugliotta argues, it was the bacteriological modes of disease that made it hard to see smoke as a threat to public health in the early decades of the twentieth century.[112] Minna Harjula has argued that the impact of smoke in Finnish towns was hard to demonstrate, even when people complained about its adverse effects, largely because they could not be seen in morbidity and mortality statistics.[113] After all, statistics were, as Lojander stated, "the mother of hygiene".[114]

The rise of statistics has been one of the core features in histories of public health as they changed the way that public health was perceived in the nineteenth century. In effect, this development heralded the beginning of the professionalisation of disease prevention.[115] In Finland, statistics on mortality, deriving in part from older Swedish population statistics, also became the core of the national health programme. In short, statistics on mortality and to some extent morbidity, were the lens through which the health concerns of nations were evaluated in twentieth-century public health. In the first half of this century, this lens showed how rural and urban areas shifted roles in terms of being regarded as healthy environments. During much of the nineteenth century, towns in Europe were considered unhealthy compared to rural locales. Yet, during the first half of twentieth century urban living conditions improved, and a point was reached when statistics suggested that rural areas had become unhealthier. In Finland, this change took place in the 1930s, when, as Harjula has argued, the focus of public health turned towards rural areas and rural elements in urban environments.[116]

111 Uekötter 2009, 226; Harjula 2007, 65, 104.
112 Gugliotta 2003, 123.
113 Harjula 2003, 181. It has also been argued that the Second World War changed attitudes towards environmental hygiene in Finnish towns, as the wartime priorities on production lingered long after the conclusion of the conflict. Though this may provide an explanation for the decrease in public discussion on environmental hygiene or for government inaction, it does not explain why the impurities in air were not deemed to be of interest even in hygienic teaching. Indeed, there had apparently been little change on this matter since the early decades of the century. See Lahtinen & Vuorisalo 2004, 685–690.
114 Lojander 1954, 9.
115 Porter 1999, 63–73.
116 Harjula 2007, 39. An oral history survey on the sensescapes of Helsinki in the twentieth century also indicates that air quality was made worse by many factors, not merely by emissions from burning substances. The smell of human faeces and the stench emanating from landfills was still present in the 1940s in Helsinki, indicating that the rural-urban divide at the time was less clear. See Kivistö & Laakkonen 2001, 152–164.

This priority on the countryside and rural elements, as opposed to urban menaces such as smoke is also visible in Lojander's lectures. Poverty and bad infrastructure in the Finnish countryside, especially in terms of the sewage system, were seen as the primary menace to public health. Towns, on the other hand, showed a continuing increase in the wellbeing of their inhabitants: people lived longer, child mortality was lower as were the morbidity levels of adults. In fact, Lojander saw a strong need for better infrastructure in rural areas because in his opinion this could prevent a rural exodus looming in the near future.[117] Even the more industrialised areas in Europe did not seem to be of concern for Lojander in regards to the potential health problems related to urban environments. When introducing different climates and their effects on health, Lojander also discusses a so-called "metropole climate", present in great cities such as London. This climate was known for dust and heat, both of which were deemed to be unhygienic, but not dangerous to health as such.[118] In other words, the menaces of rural environment strongly outweighed the potential threats of urbanization such as decreasing air quality.

Of course, public health statistics were in many ways compiled using the same etiological view that dominated twentieth-century medicine. Alain Desrosières has shown how cause of death—the essential factor in mortality statistics—is a seemingly arbitrary concept that needed to be standardised in order to be effectively used in statistical representations of public health.[119] Through this reductive lens of mortality and morbidity statistics some causes became more visible than others. In short, as opposed to specific toxins, the vague effects of smoke could not be seen in statistics.[120] However, historian George Weisz has criticised the use of public health statistics as a form of explanation on the grounds that contemporaries did not take them for granted and saw statistics as unreliable and an insufficient measure of public health.[121] Comments from Finnish hygienists seem to support this view. Lojander, for example, described morbidity statistics as "the most unreliable statistics possible". He also noted that despite the primacy of statistical knowledge, public health policies were often implemented without any statistical basis. Respiratory diseases, argued Lojander, were the most common reason for sick leave yet nothing was being done to improve this situation.[122] Sven Erkkilä, Lojander's colleague from

117 Lojander 1954, 2–3.
118 Printed lectures of Woldemar Lojander 1942, 10 /AFIOH.
119 Desrosières 1998, 60–82. For statistics and medical knowledge, see also *The Empire of Change: How Probability Changed Science and Everyday Life*. Gerd Gigerenzer, Zeno Swijtink, Theodore Porter, Lorraine Daston, John Beatty and Lorenz Krüger. Cambridge University Press, Cambridge 1989.
120 Harjula 2003, 147,181.
121 Weisz 2014, 10–11.
122 Lojander 1959, 37.

the school of technology, went as far as to cast doubt on whether urban environments were in fact healthier places to live than the countryside. He suspected that the statistics might be flawed because of migration from rural areas and argued that the countryside was healthier than statistics suggested.[123] It seems that Weisz's criticism has some relevance and that not too much should be presumed on the grounds of public health statistics.

Thus, the role of air and its impurities in the teaching of hygiene in Finland in the 1940s can be seen to be rather ambiguous, with clear relevance for health and yet little practical interest. The importance of clean and fresh air had not diminished from hygienic thought, but it did not translate into heightened interest in air impurities. Though the canonical critique about the reductionism of twentieth-century medicine should not be taken for granted, it seems that the apparent lack of specific data about the health effects of smoke in outdoor air, in contrast to the fumes and dust in occupational environments, limited its significance as a hygienic and a public health issue. It should be noted, however, that no clear shift in attitudes can be noted since the early part of the twentieth century, at least in textbooks. The much-cited comment of Professor Sucksdorff about the long-term effects of dust in the sulphate industry should be contrasted with the consistent lack of interest towards smoke or other impurities in outdoor air in textbooks on hygiene. In other words, the almost self-evidently held importance of fresh air in hygiene should not be confused with as a nascent concern for impurities in air.

It would also seem, following the critique offered by Carter, that the lack of interest in smoke cannot be explained solely by bacteriological reductionism. Impurities in air were not implausible causes of disease. They were simply marginal since their effects were thought to be limited to specific occupational and industrial environments. In these environments, which were saturated with dusts, chemicals and a variety of physical hazards, microbes were not the primary concern. The goal of fresh air was hardly even a dream. These environments and the health concerns related to them were beginning to receive increasing attention from medical research in mid-twentieth-century Finland. In fact, the significance of occupational environments for public health and the complexities related to the hazards in these environments, impurities in air included, became especially evident during the 1940s, when an epidemic of carbon monoxide poisonings tormented the country. This epidemic initially helped to spark a systematic medical attention for air quality in Finland.

123 Erkkilä 1946, 58.

## 2.2 The Carbon Monoxide Poisoning Epidemic

At a meeting of Duodecim, a Finnish medical society, in 1941, a concern was raised about the rising levels of carbon monoxide poisonings in the country. For three years these cases had increased considerably and had already caused dozens of deaths and hundreds of poisonings. The overall cause of this epidemic was no mystery. As petrol imports were disrupted by the war, internal combustion engines in most vehicles were replaced with wood gas generators. This power source was based on a technique in which wood was incinerated to create large quantities of carbon monoxide, which then fuelled the generator. Wood gas generators had already been manufactured and developed in the nineteenth century and interest in them increased after the First World War in many countries. The first gas generators were introduced to Finnish drivers in the 1920s, but they quickly turned out to be inferior to internal combustion engines in many ways. However, as the war disrupted imports and oil reserves turned out to be insufficient, a swift turn to domestic biofuel was ordered by the government.[124]

This peculiar energy transition introduced a new kind of environmental hazard into Finland from car exhausts. Pollution from motor traffic had already driven lichen out of the central areas of Helsinki and the exhaust smoke from automobiles was an occasional cause of complaint in larger towns. But, from a public health perspective, car exhaust fumes were deemed to be of little concern. Wood gas generators, however, were a different matter. One of the many downsides of this technology was the hefty quantities of carbon monoxide it emitted into ambient air, especially in the hands of unskilled users. And since the generators had been appropriated quite suddenly, most people were unskilled in their use. During 1941 approximately 150 cases of carbon monoxide poisoning were treated in hospitals when the usual number before the war had been less than ten.[125] The first medical investigation into the issue was carried out by Lojander's student, Leo Noro, who had become interested in carbon monoxide poisoning and intoxication in general during the war. During 1944, Noro conducted a questionnaire on 16,000 professional drivers. The results showed that almost 70% of the drivers had suffered from a variety of symptoms related to carbon monoxide poisoning. This made it by far the most dangerous occupational disease of the time.[126]

It could be said that carbon monoxide poisoning formed the country's first industrial epidemic, something that differed from the usual public health concerns. Whereas epidemics stemming from infectious diseases were problems in

124 Myllyntaus 2010, 103–108; Pyökäri 2012, 118–122.
125 Pyökäri 2012, 122.
126 Noro 1944, 307–309.

underdeveloped and rural areas, carbon monoxide was a problem related to industrialisation and the modern technological environment. Most importantly, carbon monoxide was part of the management of hazards in occupational environments that would have significant effect on medical research into impurities in air.

## Managing the Hazards of Modern Occupational Environments

Joel Mokyr, the doyen of economic history, has argued that one of the most significant changes during the Industrial Revolution was that for the first time in history the majority of the populace shifted to working outside of their homes.[127] Though Mokyr emphasises the more efficient movement of knowledge, as people shifted from small, secluded workshops and farms to densely-populated factories, this development also brought fundamental change into people's environmental experience. Though environmental historical studies have tended to focus on the effects of industrialisation on the surrounding environment, the factories, mines and smelting workshops also acted as environments that were vastly different from what most people were accustomed to. Finland was relatively late to industrialise, compared to much of the Western Europe. Hence, it can be argued, with reference to David Edgerton, that the industrial revolution begun to fully shock Finnish society only after the Second World War.[128] Indeed, it has been argued that industrial work never gained a position in Finnish society comparable to that of earlier industrialised nations, as the service sector also began to grow considerably after the war.[129]

Nevertheless, despite the meagre size of its industrial sector, the legal institutions of modern liberal labour were already appropriated in Finland in the late nineteenth century. In the same manner as elsewhere in Europe, the old master-servant relationships were superseded by free individuals selling their labour through contracts.[130] As the number of these free workers slowly increased, the so-called "labour question" also became a pressing political matter. In the face of this problem, Finnish politicians took heed of the more industrialised countries and adopted legal institutions to protect workers' rights and safety.[131] As Pauli Kettunen has shown, reactions to the labour question became part of a more general tendency to promote rationalisation and modernisation in Finland, which was shaped by the wilful

127 Mokyr 2011, 122.
128 David Edgerton has argued that for most people the Industrial Revolution took place in the mid-twentieth century. See Edgerton 2010.
129 Hannikainen & Heikkinen 2006, 166–167.
130 Kettunen 2001, 82; Hannikainen & Heikkinen 2006, 170.
131 Kettunen 2006, 288.

embrace of centre-periphery setting as a method to develop a modern, industrialised society.[132]

In other words, the idea that Finland was a nation on the industrial periphery was utilised as an advantage in order to learn from the choices and mistakes made elsewhere in the development of modern society. This manifested itself most clearly in Finland in the form of study trips. This way of thinking reflects the belief in progress and development as a universal and linear path to prosperity and happiness in which some nations were ahead of others. Thus, the measures taken to deal with the labour question and other effects of industrialisation can be seen as a part of the same idea of "development orthodoxy" that Randal Packard and Frederick Cooper have argued dominated international public health thinking since the 1940s.[133] Beginning from the measures taken to answer the labour question, this form of knowledge appropriation can be seen as a continuing theme in the efforts to understand environmental pollution as part of the wider vices of industrial society.

Factory inspectors are rightfully seen as helping to bring about an important improvement in workplace conditions and the legal position of workers. But from the point of view of medical research and the health aspects of the occupational environment, it was the Workers' Compensation Act. Issued in Finland in 1895 that had perhaps the most fundamental effect. The policy that employers were liable for accidents in the workplace had been used in many countries since the nineteenth century. Moreover, from 1919 this policy was actively promoted by the International Labour Association as a universal right of workers. It has been argued that this principle, which was designed to protect workers from the hazards of occupational environments, had wide ranging effects in terms of medical research of industrial environments. As Beris Penrose has argued, employer compensation formed a turning point in occupational medicine. The expertise of physicians became crucial in determining the cause of illness through diagnosis.[134] The cause of illness was no longer merely part of the medical knowledge used for therapeutics and prevention; it was also key to the question of liability. In the conflict of interests between workers, employers and insurance companies, diagnosis and the cause of illness became central, as did the expertise of occupational medicine.

In response to their liability and the negative effects of ill health to production in general, employers sought to control hazards in the workplace in a similar manner as they had begun to manage production in general; namely, through science and

132 Kettunen 2006, 288–294. For a rationalisation in Finnish industry, also see Pauli Kettunen *Työjärjestys. Tutkielmia työnja tiedon poliittisesta historiasta.* Tutkijaliitto, Helsinki 1997.

133 Packard&Cooper 1997, 2.

134 Penrose 2014, 28; Boudia & Jas 2015, 4.

rationalisation. In his study of medical science and modern labour, Anson Rabinbach shows how the European science of work, along with American ideas of scientific management, sought to provide an objective and rational answer to the complicated problems of modern labour brought on by industrialisation.[135] In other words, research on workers' health was integrated into the efforts to manage work that manifested itself in a variety of doctrines and disciplines in Europe and the United States. Though Finnish management experts and employers initially saw Germany as the model of rationalisation, it was U.S. doctrines and research that quickly begun to dominate this field. In the early twentieth century, the Finnish lumber industry had already adopted the safety-first doctrine from the United States, a rather paternalistic endeavour to enlighten workers about the dangers of their environment.[136] More sophisticated forms of rationalisation and scientific management, particularly in the spirit of Taylorism, were also appropriated by Finnish industrialists in the early twentieth century.[137]

Many historical studies on occupational diseases have emphasised a lack of interest in these diseases by those in power, as well as the difficulty in being able to recognise and prevent them because of political struggles.[138] Nonetheless, the safety of the occupational environment was also, to some extent, a problem shared by both workers and employers. It has been argued that the initial improvement in hygiene in industries from the late nineteenth century had less to do with political emancipation of the working class than with the management of efficient production. Christopher Warren has, for example, argued that in the late nineteenth century and early twentieth century factory hygiene improved and that many chemical substances were even banned in workplaces despite the working class having little or no power.[139] Kettunen has also shown how Finnish employers—at least in major industries—were willing to improve hygiene and redesign the production process in order to minimise accidents and to maintain an efficient output.

However, it seems this common-sense relationship between health and the environment only applied to acute dangers, such as physical accidents and severe poisoning. In contrast, employers were much less willing to take the blame for the

135 Rabinbach 1992, et passim.

136 For occupational safety in early twentieth century Finland see Kettunen 1994.

137 Michelsen 2001, 105–124. For a more detailed study of rationalisation and occupational mental health in post-war Finland, see Mannevuo 2020.

138 For struggles and controversies over occupational diseases, see, for example, *Silicosis: A World History* ed. by Paul-Andre Rosental; Michelle Follette Turk, *A History of Occupational Health and Safety: From 1905 to the Present*; Gerald Markowitz and David Rosner, *Lead Wars: The Politics of Science and the Fate of America's Children*; Alan Derickson, *Black Lung: Anatomy of a Public Health Disaster* Cornel University Press, 2015.

139 Warren 2001, 4–6.

suffering of workers from various vague illnesses that did not seem to be work-related. Hence, Kettunen argues that these so-called vague illnesses with no clear cause did not fit into the safety management ethos of mid-twentieth-century factories. This explains the relatively few substances included in the list of occupational poisons that could be cited as grounds for worker compensation.[140] In short, health, environment, efficiency and medical knowledge were all entangled in the mid-twentieth-century industrial environment as patients, their employers, insurance companies and medical experts all had a stake in the matter.

It was in this peculiar entanglement that the dilemma between the specific causes of disease—as opposed to vague notions of unhealthy environment—gained importance and became an essential topic for medical research. It was not merely the state of occupational environments that drove research into the effects of dust and fumes; it was the relationship between worker safety, efficient production and employer compensation that made it a conflictual issue. This lack of agreement made it all the more important to obtain expert evaluation. Though the question of worker safety received limited interest from the Finnish medical community, the carbon monoxide epidemic in the 1940s brought the issue of its long-term effects to the attention of the public.

## The Question of Chronic Carbon Monoxide Poisoning

Acute carbon monoxide poisoning was a well-known industrial hazard in the 1940s in Finland and was included in the list of compensable hazards. In addition, the lethal qualities of the substance were recognised in the dangerous use of domestic stoves. Consequently, despite the fact that the gas could neither be smelled, tasted nor seen, carbon monoxide was perhaps one of the most widely-known poisons. In contrast, medical interest in the possible long-term effects of low carbon monoxide concentrations was a relatively recent phenomenon. Indeed, it was a controversial subject in the 1940s medical community.

As in Finland in the 1940s, the Danes and Swedes also utilised wood and coal gas generators at this time due to petrol rationing. As a result they also suffered soaring rates of carbon monoxide poisoning. Increasing exposure to carbon monoxide also became an issue in the United States, although this was not due to a lack of oil products. In affluent American cities, particularly Los Angeles, the sheer number of private cars and traffic jams raised concerns about the effects of carbon monoxide on the police and others forced to linger for a long time in close proximity to traffic.[141] Due to increased exposure and its known toxic effects, chronic carbon

140 Kettunen 1994, 154.
141 Grut 1949, 11–13.

monoxide poisoning became a disputed topic after World War Two in terms of the long-term effects of the chemical in low doses.

Leo Noro became aware of the dispute as he visited a carbon monoxide research centre in Stockholm before he undertook his own investigation into the issue in Finland.[142] Noro first became acquainted with carbon monoxide poisoning during World War Two and had carried out some research on the effects of exhaust emissions on tank crews.[143] He had also become more generally interested in incidences of occupational poisoning after studying the toxic effects of trotyl and trityl on workers in an ammunition factory for his doctoral dissertation.[144] Noro later remarked that it was his wartime observation of the conditions of the working class that led to his interest in occupational medicine.[145] Subsequently, Noro joined a small group of Finnish medical experts in the second half of the 1940s who were studying the hazards present in occupational environments. As part of his contribution to this research Noro was sent to Stockholm to learn about the similar carbon monoxide issues that had occurred there. This marked the first of Noro's many study trips abroad.

The historian Helena Ekerholm has shown how the diagnosis of chronic carbon monoxide poisoning in Sweden in the 1940s was a very controversial issue among medical experts. Indeed, some even made accusations that it was a fake medical condition.[146] During his visit to Sweden, Noro was introduced to the debate and the studies from other countries that offered contradictory views on the matter. At the heart of the controversy was the vague nature of chronic carbon monoxide poisoning. The clinical symptoms claimed attributed to the illness were subjective and non-specific, including, for example, fatigue, headaches, poor attention span and testiness. In addition, the known biological mechanism of carbon monoxide poisoning—hypoxia caused by carbon monoxide replacing oxygen—did not support the idea, since the chemical did not accumulate in the body and did not cause any specific toxic effects that could explain the accumulation of damage to the body.

Thus, many occupational health experts, including the esteemed Cecil Drinker from the Harvard School of Public Health, claimed chronic carbon monoxide poisoning was implausible and that the apparent symptoms observed in industry must be derived from repeated incidences of acute poisoning and not from long

142 Noro 1944, 311.
143 Väänen 1995, 22–23.
144 Ketola 2015, 23.
145 Noro 1979, 44.
146 Ekerholm 2010, 82.

exposure to lower quantities of the chemical.[147] The researchers who promoted the existence of this medical condition also admitted its vagueness. The Danish occupational health expert Aage Grut, one of the foremost researchers of chronic carbon monoxide poisoning in the 1940s, for example, stated: "it is a matter of temper, rather than of proof whether one believes in a disease such as chronic poisoning".[148] However, Grut also stated that the greatest sceptics were often those who undertook theoretical research without direct contact with workers and their environments.[149] Chronic carbon monoxide poisoning was, thus, an example of condition that was vague in eyes of many medical experts and did not easily fit into the safety management doctrines. As such it was not only a debate inside medical profession but also a matter of liability in occupational health.

Given the considerable controversy concerning the matter, it is interesting to note how readily Noro seems to have accepted the idea of chronic carbon monoxide poisoning as a relevant to the contemporary situation in Finland. On the other hand, he was a researcher who had gained first-hand experience of workers and their environment during the war. In his initial survey, carried out in 1944 and published in Nordic medical journals, Noro refers only to the experts he met in Sweden who were favourable to the idea and makes no mention of any critiques to the medical theory or to the heated debate taking place in Sweden. Noro admitted that the subjective symptoms related to carbon monoxide poisoning could be found in many diseases and could be caused by many other factors, such as long working hours and poor diet, both of which were common during the war. Nevertheless, he retained the view that the illnesses he came across were the result of prolonged exposure to low levels of carbon monoxide, since the prevalence of these symptoms in chauffeurs would be too much of a coincidence. As automobile-related occupations alone employed over 40,000 workers, the issue of carbon monoxide poisoning was a serious concern.

However, Noro saw the issue to be of even wider importance, since carbon monoxide was present in many industrial environments. He also argued that domestic environments could also be impacted by carbon monoxide poisoning, due to stoves and furnaces. In addition, he saw carbon monoxide poisoning as the likely cause for the various ailments related to cigarette smoking.[150] Thus, Noro argued that carbon monoxide poisoning was more than simply an occupational hazard due to its prevalence in modern society and the potential harm it could cause even in minute concentrations. As with the problems related to environmental pollution that came

147 Grut 1949, 11.
148 Grut 1949, 10–11.
149 Grut 1949, 10–11.
150 Noro 1944, 297–298.

to the fore in the 1960s, the problem of carbon monoxide poisoning was rooted in the everyday processes of modern society and their subtle side-effects on the living environment.

The fact that the mechanism of chronic carbon monoxide poisoning was hard to explain seemed to be more of an interesting puzzle for Noro than an indication of implausibility. Referring to a German neurological study, Noro speculated that low levels of carbon monoxide could cause damage to vegetative nervous systems, thus explaining the vague and multiform symptoms. Due to this connection, Noro argued that being able to recognise chronic carbon monoxide poisoning could help to specify a medical diagnosis related to mental disorders: "The symptoms occurring, especially in chronic poisonings, remind us primarily of the wide-ranging diagnosis called neurosis, which we tend to give when we have little idea what exactly is going on. There is no question that with carbon monoxide we can yet again cleave away part of this concept."[151] The connection between neurosis—the vague menace of modern civilisations since the mid-nineteenth century—and chronic poisoning can be seen as an early reflection of a wider development towards viewing environmental pollution as the new menace to society. As the historian of medicine Charles Rosenberg has argued, it was in the late twentieth century that chronic diseases and the environment superseded mental conditions, such as hysteria and neurasthenia, as the primary corrupting effects of civilisation.[152] It could be said that in medical causality neurosis and chronic CO poisoning represented opposite explanations. The former highlighted individual traits while the latter emphasized effects of the environment. As such they also represented the opposite liabilities in industrial environment between workers and their employers.

Due to the relatively high number of people working with automobiles, the question of carbon monoxide poisoning was especially important in this regard. In his investigation, Noro warned that when people working with automobiles realise that they are suffering from a compensable occupational disease the economic costs of the situation will skyrocket. This would subsequently make carbon monoxide poisoning a serious concern not only for public health, but also for national economies. Consequently, Noro argued that there was a need for accurate diagnosis based, as much as possible, on objective observations rather than subjective symptoms.[153] In other words, the legal status of carbon monoxide prompted the need

151 Noro 1944, 305.

152 Rosenberg, 1998, 715–726. The distinction between the environment and the individual is also shown in Finnish occupational management in general in the 1940s and 1950s, which was heavily based on ideas of individual sensitivity that derived from psychology and neuroscience. See Mannevuo 2020, *et passim*.

153 Noro 1944, 305–308.

for thorough investigations of its effects and methods in order to objectively diagnose cases of chronic poisoning. Again, the issue is not only on accurate diagnosis as such, but in the need for neutral and objective evaluation of the liabilities, which the medical experts purported to provide. The occupational disease clinic that was founded in Helsinki in 1945 primarily for this purpose became the first institution of its kind in which the health effects of the occupational environment received systematic medical research.

Noro was appointed to direct the newly founded occupational disease clinic and as the wood gas generator situation was still an on-going problem the diagnosis of CO poisoning became the core aspect of the clinic's work. Though initially established in a modest setting and with a small staff, the clinic quickly expanded its scope to different fields of medical research. Carbon monoxide poisoning was examined by clinical doctors, neurologists, ophthalmologists, psychiatrists and otolaryngologists. The clinic also employed a chemist, a rare thing in Finnish hospitals at the time, who developed instruments and methods in order to measure levels of carbon monoxide in occupational environments.[154] Apparently the motivation for such broad diagnosing of CO poisoning derived from lessons learned from Sweden. One of the doctors, Pertti Sumari, later remarked that the more general diagnoses made in Stockholm's clinic led to a great deal of controversy and long legal battles about compensation. Thus, the aim of the Helsinki clinic was to apply specialities in order to make the diagnoses so thorough that no room for doubt was left. This was not done merely to affirm employers and insurance companies. According to Sumari, many patients already suspected their illness had been caused by their occupational environment and countering this vague suspicion would require extensive evidence.[155]

This shows how the epidemic of CO poisoning in late 1940s Finland resembled in many ways the problem of lead poisoning in the United States in the early twentieth century. The aspiration to provide objective diagnosis for lead poisoning became the core of the rising occupational health expertise, which culminated in the establishment of the discipline of industrial hygiene Harvard School of Public Health. As Sellers has argued, the problem with lead poisoning at the time concerned over-diagnosis, widespread fear, and the difficulty in being able to make accurate, plausible diagnoses.[156] Similarly, chronic CO poisoning was a controversial disease that was causing great concern for workers while at the same time posing a potential

154 Väänänen 1995, 33.
155 Quoted in Väänänen 1995, 29–32.
156 Sellers 1998, 148; As historian Paul Starr has argued, making diagnoses plausible to the lay people was a wider problem of the early twentieth century medicine. See Paul Starr *The Social Transformation of American Medicine.* Basic Books, New York, 1982.

financial problem for employers. For medical experts these poisonings represented the overall problem medicine faced when dealing with many of the health concerns that stemmed from industrial environments. Individuality, generic subjective symptoms and lack of objective signs made accurate diagnoses, in the sense required by the medical community at the time, extremely difficult.

Yet, it was not only medical peers who required sound evidence. Patients and employers both had interests at stake and every diagnosis was a judgement in this conflict. In other words, the hazards of industrial air were a problem for the medical profession, but were also tied to the labour question and the management of occupational safety. This controversial aspect of CO poisoning produced the need for neutral expert knowledge on the dust and fumes present in the occupational environment. In the case of Finland this begun in the occupational disease clinic at the University of Helsinki. This group of young medical experts, and a chemist, formed the inner circle of what would in a few years become the Finnish Institute of Occupational Health (FIOH).

## The End of the Epidemic: A Pyrrhic Victory

In addition to research and diagnostics, efforts were also made to end the CO poisoning epidemic. The primary strategy adopted in Finland was to educate the public on the dangers of CO, even in small concentrations, via the distribution of pamphlets and the publication of advertisements in newspapers. In a small booklet aimed at educating workers, Noro argued that the main causes of CO poisoning were ignorance of the danger and a disregard of safety: "Someone says 'I didn't know', a second person says 'I didn't think', a third person says 'I didn't notice'". By exercising proper caution and skill, so the message went, most hazards associated with carbon monoxide could be avoided.[157] The prevention and management of chronic CO poisoning seems to accord with the paternalistic measures of the safety-first doctrine, in which correct attitudes and knowledge made work safer. As Noro argued, even occupational diseases do not strike suddenly, but are the "results of those numerous mistakes we make in life" that slowly lead to the degradation of the body.[158]

The issue of individuality is also present. The educational booklet states that chronic poisoning is said to be particularly hazardous for sensitive individuals.[159] In light of this, the best way for individuals to prevent chronic CO poisoning was to

157 Noro & Rainio 1945, 3.
158 Noro 1950, 7.
159 Noro & Rainio 1945, 9.

exercise, enjoy a good diet and to get as much fresh air as possible.[160] Noro treated the CO poisoning epidemic in a similar manner that acute hazards and accidents were being treated in the industrial sector. Little blame was placed on the state of the environment itself and on those who controlled it. It seems then that despite the similarity of the CO poisoning epidemic and the beginning of environmental pollution concerns in the 1960s, the Finnish medical experts presented the problem as something that could be dealt with by individual actions. Rather than changing the system of energy production, the cure was to enlighten workers. In short, the CO poisoning epidemic was primarily viewed as a safety issue, rather than as an environmental pollutant.

However, in other more private contexts the ability of individuals to avoid this hazard by their own actions is viewed less optimistically. In a petition to the Council of State, Noro and his colleagues pleaded with the Finnish authorities to take swift action regarding the matter of CO poisoning. They argued that despite the best efforts of employers and workers, it would remain impossible to prevent the CO poisoning as long as it was still being used as a source of power. Although acute CO poisoning was becoming rarer, chronic CO poisoning had become regular and would, they feared, only increase over time. They argued that the only effective way to prevent people from coming in too close contact with carbon monoxide was to return to using petrol as fuel.[161]

In other words, despite the paternalistic attitudes prevalent in safety booklets, Noro and others also saw the CO poisoning epidemic as unmanageable and a result of the poor choice of energy source. The only way to stop chronic poisoning was to transition to a different energy source. This came about rather swiftly as petrol rationing ended in 1949. Although CO poisoning decreased considerably, the steady increase in the use of trucks and cars meant that it remained an occupational hazard in workshops and garages. More importantly, it would only take a little over a decade until petrol and the private cars powered by it would become the primary menace in ambient air, with carbon monoxide one source of concern. In short, the sense of relief engendered by the transition to petrol energy in 1949 proved to be short-lived.

While the epidemic receded, it left lasting impact in Finnish medical research. The question of diagnosing chronic CO poisoning became the starting point for a new kind of multidisciplinary research concerning occupational environments. The medical examinations carried out in the clinic were also used by the clinic employees

160 Noro 1944, 310.
161 Draft of a petition to the Council of State, AFIOH.

to further industrial medicine research.[162] This research was presented by Noro and many of his colleagues at the Ninth International Congress on Industrial Medicine held in London in 1948, signifying a beginning in the integration into the transnational networks of industrial medicine.[163] In his report on the conference, Noro stated that Sumari's presentation on chronic carbon monoxide poisoning caused a heated debate at the conference between the Nordic representatives who believed the condition to be plausible, and the Anglo-Saxon representatives who were more sceptical.[164] With such excellent material to study Noro was eager to cultivate exhaustive diagnostic methods into his research. In a funding application for the Finnish Red Cross, Noro emphasised the urgent need for more research resources as it would not be long until petrol rationing would end and the material used for CO studies would diminish.[165] The application to the Finnish Red Cross can be seen as part of the wider promotion of the need for occupational health research by Noro and his allies, claiming that it was vital for all industrialised nations. According to Noro it would not be enough to simply rely on observations made in other countries, as had primarily been the case before, in a rapidly changing industrial society.[166]

In other words, the peculiar circumstances brought on by the carbon monoxide epidemic and its nature as an occupational hazard led to systematic medical research of the long-term effects of occupational environments in Finland. It also prompted the integration of a growing number of Finnish experts into the burgeoning transnational networks of industrial medicine. The developments in the United States particularly proved to be of great significance in Finland. As Noro and his colleagues began to design their own institution dedicated to studying the hazards of occupational environment, they followed the old practice of seeking examples from abroad.

162 Lumio Jaakko S., Otoneurological Studies of Chronic Carbon Monoxide Poisoning in Finland. *Acta Oto-Laryngologica* Vol 36, Issue 67, 65–75, 1948; Helminen Tauno, Om synfaltsförandringar vid kroniska gengasförgiftningar. Nordisk Medicine, 30 945; Noro, Leo, Gengasgasförgiftningar. *Nordisk Medicine*, 26, 771.

163 Sumari Pertti, Chronic Carbon Monoxide Poisoning in Finland, 1940–1947. *Proceedings of the Ninth International Congress on Industrial Medicine.* John Wright & Sons, London 1949.

164 Noro 1949a, 450–451.

165 Application to the Finnish Red Cross 1945, AFIOH.

166 Ketola 2015, 25–32.

## 2.3 The FIOH and U.S. Industrial Hygiene

Although the war and the subsequent indemnities significantly constrained Finland's budgetary resources for medical research and public health measures, the vision for an occupational health institute promoted by Leo Noro and others received surprisingly wide support from the government, labour unions, medical authorities and industrialists. In fact, the institute even preceded the plan for a national health institute, which remained a government bacteriological laboratory attached to the University of Helsinki.[167] One reason for such wide support can be seen in the institute's role as part of the government's plans to appease the working population after the war in order to curb the communist sentiments. In a way, the institute was a continuum to the management of the labour question through its emphasis on objective scientific knowledge and expertise.

The political dimension of the question should not, however, completely hide the fact that occupational diseases had become an increasingly noteworthy medical problem during the first decades of the twentieth century. This was not only a consequence of the growth of industrial production, but, perhaps even more importantly, its diversification. In the past, bulk of Finnish industrial sector had primarily consisted of sawmills and wood processing facilities, but domestic production had become extremely versatile by the 1940s. This had direct consequences on occupational environments. For example, in a letter to one his colleagues, Noro lists the most important industries for occupational health in Finland in the late 1940s: "the white lead and dye industry, battery manufacturing, the cable industry, shipbuilding, the rayon industry, various sectors of the chemical industry, old foundries, mines and vitriol plants."[168]

Though many of these sectors were relatively small, they presented a bewildering array of potential dangers to human health, not least due to the variety of ways they contributed to environmental contamination. These dangers had also been increasingly well documented in the occupational health literature in more

[167] Ketola 2015, 17–24. The reason why Noro was able to rise to a central figure in the planning of the institute, and later became its director, was as much to do with his pioneering work in occupational poisoning as with his good connections to the chief of the National Medical Council and the fact that most of the senior Finnish medical community were uninterested in occupational health.

[168] Noro in a letter to Urpo Hilska 4.1.1949, FIOH archives. It should be noted that the diversification of production did not only take place in small and less industrialised countries, such as Finland. For example, prior to the First World War, the United States had relied almost entirely on German industry for its dye supply. Because of this, the serious occupational health hazards related to this industry, namely, occupational cancer, were relatively unknown in the United States when it began its own dye production. See, Patterson 1987.

industrialised countries.[169] Though the increase of occupational hazards can be seen simply as an aspect of a modern industrialising society, the diversification of domestic industrial production was also to a great extent a result of the fall of the free trade era after the First World War, which was supplanted with protectionism and autarchy. The world became less global, which had a great impact on the economy and industry in Finland and therefore on the environment and health.[170]

This well-known economic development, which greatly diversified the range of harmful residues from industrial production to local environments, has received little systematic attention from environmental historians or historians of medicine and health. In the spirit of global and transnational historical points of view, historians in both disciplines seem to have given more attention to the global flow of pollution and diseases, rather than examining the consequences of a system in which everyone makes their own poison.[171] In light of this, Linda Nash has argued that rather than tracking the pathogens themselves, historians of medicine should concentrate more widely on the material flows and conditions that affect medical research.[172] It could be said therefore that it was the increasingly diverse industrial production in Finland, driven by a vision of autarchy, that provided grounds for medical research on modern environments. The epidemic of carbon monoxide poisonings was simply one dramatic example of the dangers inherent in the complex material flows and technological processes of a post-World War Two society.

However, the possibility to undertake medical research into these new environments was greatly hampered in Finland, not only due to economic constraints. The Second World War severed many foreign networks, especially to Germany, shrinking the transnational connections of the academic community. Due to both economic circumstances and political restrictions, the ability to order academic journals and books virtually stopped in wartime. In addition, many important connections to Germany were lost for good and the role of German as the main academic language in Finland began to steadily decline. Though the extent of this stifling of external links varied between disciplines, its effects were severe and in many disciplines it took well into the 1950s to reassemble effective networks.[173] Though medicine in general was one of the fields least affected by wartime disruptions, the nascent discipline of occupational health was, according to Leo

169 See Sellers 1998.

170 Edgerton 2011, 115; For the effects of this change into Finnish economy see for example *Suomen poliittinen taloushistoria 1000–2000*. Helsinki, Siltala, 2009.

171 For global history of medicine see for example Mark Harrison, A Global Perspective: Reframing the History of Health, Medicine, and Disease. *Bulletin of the History of Medicine*,89(4): 639–689, 2015.

172 Nash 2018, 50–54.

173 Hietala 2006, 129–131.

Noro's complaint in a letter, greatly hampered by a shortage of foreign books and journals.[174]

Finnish academics were, of course, not alone in this situation. After the war, the reassembly of networks and the enhancement of interactions between experts became one of the core practices of post-war internationalism. In contrast to economic relations, the international flow of research and knowledge lost little of its attraction during the wars. For Finnish medical researchers, Noro and his colleagues included, this internationalism materialised in the form of grant money and scholarships offered by the newly-founded World Health Organization and U.S. foundations, particularly the Rockefeller Foundation. This form of transnational movement of knowledge, paid for by U.S. foundations and new international organisations, played an essential role in post-war networks of knowledge.

It would be easy to interpret this solely in a Cold War context as one feature of U.S. competition against the Soviet Union, but this would be too simplistic. As David Ekbladh has shown the Rockefeller Foundation (and other U.S. bodies) had their ideological roots in the so-called progressive era of the early twentieth century, and its genuine interest in the development and wellbeing of the world. Cold War policies adopted this idea of universal development, but it was an invention of this era.[175] In fact, the Rockefeller Foundation had already had a significant impact on the formation of Finnish public health nursing through its funding and collaboration in the interwar period.[176] The historian of Cold War science, John Krige, has also pointed out that U.S. hegemony in post-World War Two science should be seen as a compilation of different attempts to influence, such as grant money, rather than deterministic force.[177] Thus, it was under this ethos of internationalism and universal development that Leo Noro and his colleagues sought to institutionalise the management of industrial environments into Finnish society.

## Imitating Uncle Sam

At the time when the FIOH was in its planning phase in the late 1940s, Noro made several study trips in order to gather knowledge about health institutions and occupational health practices in other countries. Though he visited many European countries, only a few of them gave him particular ideas on how to form a research institution for a modern society. In Noro's opinion, Germany maintained only a shadow of its former academic prestige, although he regarded dust control in West

174 Leo Noro's letter to the Government License Committee, 14.2.1946, AFIOH.
175 Ekbladh 2010, *et passim*.
176 Yrjälä 2005, *et passim*.
177 Krige 2006, 9–10.

German factories to be excellent and valued his acquaintanceship with the notable hygienist Ernst Baader. However, the Federal Republic offered no examples of a multidisciplinary institution, something Noro saw vital in occupational health. The same applied to Great Britain and France. Even though Noro regarded Paris to be the centre of the civilised world and admired the recent British introduction of National Health Insurance, he believed the most interesting facilities in Europe at the time were to be found in Italy and the Netherlands, where medical research and hygiene were more efficiently integrated into the practical problems of industrialisation.[178]

Noro's account of the state of occupational medical research in Europe resonated in other accounts of study trips at the time. Noro's colleague, the head of the FIOH's physiological department, later argued that German research had been in a state of stagnation even before the war, which was realised in the late 1940s.[179] Due to this situation, study trips were increasingly directed to the United States and, to a lesser extent, Great Britain. The fact that the United States became the leading nation in medical and scientific research after the Second World War proved to be a hindrance within Finnish academia. Not only was the journey long and expensive for Finnish experts and material, but, in addition, German was still the main foreign language taught in schools and most of the senior academic practitioners spoke little English.[180] Nonetheless, the trend in study trips to the United States had already begun in many medical fields in the 1930s. As Eino Ketola has stated, the route to the United States was already somewhat congested in the late 1940s.[181] Despite this congestion, Noro was able to visit health institutions and several industries in the United States in 1947 with the help of a Rockefeller scholarship. These trips showed that although Europe still had some models to offer for an industrialising society, it was the United States that provided the most powerful example.

Krige has shown how the U.S. influence over scientific research in Europe during the post-war years often faced European resistance or contempt of American ways.[182] In Noro's case, this is hard to see. His views on U.S. occupational medicine and hygiene are depicted in a published travel account, *Uncle Sam Cherishes the Health of His Workers.* There seems to be no limit to his admiration for the U.S. system of occupational medicine and medical research in general, with the exception of architecture, which he regarded as being too functional to be beautiful. Noro's admiration was not simply due to the spectacular resources and levels of efficiency Americans displayed in comparison to Finnish medicine. The feature he highlights

178 Noro 1949c, 155–167; Noro 1951a, 8–10; Noro 1953, 14–15; Noro 1955, 25–26.
179 Quoted in Väänen 1995, 43.
180 Tiitta 2009, 278.
181 Ketola 2015, 85–86. See also Hietala 2006.
182 Krige 2006, 266.

most frequently is the way in which humans, especially workers, were incorporated into the fabric of the country's modern industrial society. He refers repeatedly to the increasing complexity of society, which requires doctors to have a wider knowledge of social and environmental factors than before.[183] This was also related to Noro's statements on the necessity of doctors to unite with other experts of modern society, especially engineers, which he thought had hitherto not been sufficiently carried out in Finland.[184]

The underlaying issue—the complexity of industrialised society—was something that, according to Noro, Americans had understood better than others.[185] He also endorsed the fact that Americans had effectively brought out the monetary value of workers' health. Although he regards this money-oriented attitude as being characteristic of Americans, Noro also presents it as a clear and efficient way to show the profitability of occupational health measures. In order to demonstrate this efficiency Noro included a table produced by the Metropolitan Life Insurance Company, in which the dollar value of individuals was calculated by means of age and annual income. Noro described this as "a particularly clear way of pointing out the value of human life".[186] In effect, what the United States represented to Noro was a means of solving the problems associated with industrialised societies. Noro noted that the sight of U.S. skyscrapers and factories made him feel in awe of technology, but also made him worry for humans in this world:

> But what is the place of man in this new technical world? How have his needs been taken into account? What actions have been taken so that he can be free and healthy to enjoy the benefits of modern society? Is he falling into the shadow of the machine, to work monotonously on an assembly line, or will he be helped to find circumstances where he feels joy from work? How can the increasing accidents in the workplace and in free time be prevented?[187]

183 Noro 1949b, *et passm*. Although other FIOH personnel were also generally favourable towards the USA in their study trips, there were exceptions. In a letter to Noro, one of his colleagues describes Los Angeles as the worst place he has seen since the war; a place where life is luxurious and university professors seem to be retired athletes, or, at the very least, trainers. See the letter From Mikko Kunnas to Leo Noro, undated**,** AFIOH.

184 Noro 1957, 299–300.

185 Noro 1949b, 28–36.

186 Noro 1949b, 24.

187 Noro 1949b, 18–19.

For Noro, industrial hygiene and social medicine in the United States were tackling the fundamental questions of industrial society; questions that would soon become topical in every industrialised society.

During his visit, Noro toured many medical institutions and industrial facilities, such as Esso, Du Pont, Kodak, Standard Oil and General Motors. While he made many contacts during his visit and subsequently cultivated an extensive network of correspondence, the most important contact with regards to his research on the impurities of air was probably Philip Drinker, professor of industrial hygiene at the Harvard School of Public Health. Noro was impressed with the Harvard school and American techniques of industrial hygiene in general. Hence, he began to advocate that a Finnish researcher should be sent to study under Drinker at a time when the industrial hygiene department of the FIOH was being planned. As a result, a young engineer, Urpo Hilska, who was a wartime comrade of Noro and whom the latter had handpicked to run the industrial hygiene department of the Finnish institution, was sent to Harvard in order to complete a Master's degree that was financed with a scholarship paid for by the World Health Organization.[188] It seems quite clear that the United States was the new centre in the centre-periphery doctrine of Finnish experts in industrial medicine.

## Safe Air and U.S. Industrial Hygiene

Although the field of occupational medicine was considerably younger in the United States than in most European countries, the U.S. research on toxins and other industrial hazards increased significantly in the early decades of the twentieth century. The pioneering works on industrial poisoning written in the early twentieth century by Alice Hamilton, for example, were known in Europe.[189] However, what stands out as the most essential special feature of U.S. industrial hygiene was the extensive and efficient use of threshold values as management tools in occupational environments. At the heart of the idea of thresholds for exposures was the old adage attributed to Paracelsus, 'dose makes the poison', which had also become a principle

188 It seems that most of the senior staff at the FIOH were in fact handpicked by Noro. See Ketola 2015, 95–97; Noro 1978. Phillip Drinker also acted as an expert appraiser in the selection of the FIOH's administrator and recommended Noro. As Ketola has noted, the way in which FIOH personnel, including Noro, were chosen reflected the fact that occupational health was a marginal field in the Finnish medical community and senior figures were not interested in the institution and its positions. Ketola 2015, 94.

189 Noro, for example, uses Hamilton's work in his doctoral dissertation.

in modern physiology and toxicology during the nineteenth century.[190] An extension of this principle was the idea that substances were harmless until their quantity reached a certain threshold level. This idea was first developed by German toxicologists in the nineteenth century, but the use of threshold values as a tool to manage the environment later became widespread among American industrial hygienists and toxicologists.[191]

Christopher Sellers has shown that the discrepancies in the United States regarding the health effects of chemicals in occupational environments, especially lead poisoning, led to the development of the concept of Maximum Allowable Concentration (MAC). This constituted a value that determined the maximum quantity of a substance over an eight-hour period of exposure. Backed by toxicological analysis and presented as clear numbers, the MAC values could be used as a seemingly neutral and objective tool between different interest groups and experts, settlement Sellers refers to as the *Pax toxicologica*. As Sellers has shown, the MAC values were an epitome of the development in which occupational health experts aimed to distance themselves from the complicated value laden problems in workplaces. Thus, despite their apparent objectivity, MAC values were in effect moral judgements on what kind of impairments were allowed in a workplace.[192] Perhaps the most significant aspect of U.S. MAC levels, regarding Finnish industrial hygiene, was their apparent universality. Whereas the threshold values usually used had been local and designed for a specific mine or factory, MAC levels were based on the toxicological qualities of substances. Hence, in theory they were universally applicable.

The Harvard School of Public Health was a central institution in this development. Urpo Hilska began his studies at this institution in 1948, when the school offered a two-year Master's decree on industrial hygiene that was partly taught by the School of Public Health and partly by the School of Engineering. In contrast to hygiene teaching in Finland, whether it be in a medical school or in a school of technology, the teaching in Harvard had a stronger focus on air analysis, ventilation, analytical chemistry and even the rather novel issue of air conditioning. Special attention was given to the measurement and analysis of dust, fumes and gases

190 Vaupel & Homburg 2019, 4–8. Vaupel and Homburg argue that the famous adage was originally about quality and that it was only used in reference to quantity from the nineteenth century.

191 Henschler 1991, 9–16; Vaupel & Hormburg 2019, 11–13. For thresholds in environmental regulation, see *Powerless Science?: Science and Politics in a Toxic World.* Ed. By Soraya Boudia, Nathalie Jas. Berghahn Books, Oxford and London 2014. Also see, *Toxicants, Health and Regulation since 1945*. Ed. by Soraya Boudia, Nathalie Jas. Routledge, New York 2013.

192 Sellers 1997, *et passim*.

in occupational environments. This is not to suggest that U.S. industrial hygiene was solely interested in air impurities. The Harvard course also included other aspects of sanitation and environmental physiology and, as Hilska noted, no individual was capable of mastering the entire field of industrial hygiene.[193] Yet, the measurement and analysis of dust and fumes was what Hilska brought with him to the Finnish Institute of Occupational Health.

The correspondence between Hilska and Noro shows how the discipline was transported across the Atlantic in practice. During his trip, Hilska actively corresponded with Noro, as the planning of the institution was underway at this time. The majority of their correspondence concerned the materials that should be acquired for a functioning industrial hygiene department. Noro asked Hilska to send a list of relevant textbooks and journals that would be needed.[194] Hilska also brought with him lecture materials that he thought would be useful in conducting laboratory tests, and a trunk full of brochures from industrial laboratories and instrument manufacturers.[195] More difficult was the question of measuring apparatuses and other instruments, due to the limited budget of the Finnish institution. In collaboration with the Harvard professors Philip Drinker and Leslie Silverman, Hilska designed an economical version of an industrial hygiene department that would be specifically suited to the problems faced by Finnish industry, as outlined by Noro. He was also attentive to the tight financial constraints and meagre staff of the planned novel department in Helsinki. This meant that the measurement and analysis would be based primarily on standardised and mass-produced shelf-products that were relatively cheap, easy to use and did not require extensive laboratory analysis.[196]

The main problem concerning these products was their scarcity in Europe after the war. This was not merely a problem in the field of industrial hygiene, but also medical measurements in general. This issue was caused by the fact that products from German manufacturers, especially Zeiss, were still off the market.[197] Hilska thought that the U.S. instruments were of high quality, but the problem he faced was a shortage of dollars in Finland at the time. Consequently, Hilska advised Noro to buy as much from Europe as possible, which, in reality, meant Sweden and Great Britain.[198] Some relief was gained when the Rockefeller Foundation donated $50,000 to the nascent institute, part of which was used to buy equipment for the industrial hygiene department from the United States.[199] The Rockefeller support was partly to

193 Urpo Hilska's travel account 8.8.1949, 1–15/FIOH Archives.
194 Leo Noro's letter to Urpo Hilska, 4.1.1949 /FIOH Archives.
195 Letters from Urpo Hilska to Leo Noro/FIOH Archives.
196 Letters from Urpo Hilska to Leo Noro/FIOH Archives.
197 Letter from Aimo Vannas to Leo Noro, 28.11.1948/FIOH Archives.
198 Letters from Urpo Hilska to Leo Noro/FIOH Archives.
199 Ketola 2015, 90.

do with the overall U.S. aid to war-torn Europe, since Finland had turned down Marshall Aid, and partly with the foundations semi-open battle against communism. As the representative of the Rockefeller Foundation in Europe stated, the FIOH could be of great international importance in occupational health studies because of its multidisciplinary nature, and also "a significant way to block the rise of communism by enhancing workers' conditions."[200]

With the help of the Rockefeller Foundation, the industrial hygiene department became part of the Finnish Institute of Occupational Health when it began to operate in 1951. Noro led the institute and Hilska was the director of the department. Consequently, the measurement of impurities in indoor air became one of the new services that was regularly provided by the FIOH. During the first year of its existence the FIOH undertook almost three hundred air quality measurements, almost all of which were requested by employers.[201] In other words, air measurements were incorporated rather quickly into the management of industrial hygiene, at least among major industries. Noro and Hilska were both prolific writers and extensively advertised the new services offered by the FIOH in Finnish forums devoted to occupational safety and the rationalisation of industrial production. The Finnish journal for rationalisation experts, *Tehostaja* became an important platform for industrial hygiene and occupational health in general.

The examination of how the discipline was transported across the Atlantic highlights the importance of standard and, in a way, elementary material forms of knowledge production. The poor availability of low-priced shelf-products continued to hamper the functioning of the department, as some instruments had to be substituted with self-made apparatus.[202] Study trips and travelling in general are often seen to play an important role in the transnational movement of knowledge. Recent scholarship has scrutinised what this transnationality actually entails in terms of the history of science, with a focus on the movement and appropriation of knowledge in practice. These studies tend to emphasise the difficulties, transformations and interactive aspects inherent in the movement of knowledge and practices as opposed to simple diffusion. In other words, the scholarship on appropriation and the circulation of knowledge has blurred the line between the production and movement of knowledge.[203]

However, the founding of the industrial hygiene department at the FIOH is more of a reflection of the statements made by David Edgerton, who has emphasised the

200 Letter from John Grant to Wilhelm Wahlroos [Copied to Leo Noro] 14.2.1950/AFIOH.
201 Annual report of the Institute of Occupational Health 1951, 30–32. The most common objects of measurements were carbon monoxide, dust and carbon disulphide.
202 Väänänen 1995, 62.
203 See Secord 2004.

significance of imitation in the proliferation of practices and techniques. Edgerton has shown how older, well-known and often simpler technologies have been significant in developments that have usually been seen as being driven by discoveries and novel technology.[204] In fact, there were few novelties needed in the list of instruments in an early 1950s industrial hygiene department. The apparatus that Hilska listed were, in essence, fine-tuned versions of a dust impinger, a microscope and a suction pump, which were all invented in the nineteenth century.

In other words, the importance of industrial hygiene to occupational safety lay not in the sophistication or novelty of its methods of measurement and analysis. Rather, it was in the incorporation of these old techniques into an idea of optimal environmental conditions that made industrial hygiene efficient in the management of the occupational environment. The basis of this expertise was the concept of MAC. As Theodor Porter has argued, the essential quality of numbers is their ability to transport information across great distances with relatively little need for interpretation, trust or even comprehension of the ways of knowing that lay behind the figures.[205] As such, the numbers representing the MAC levels were even more easily appropriated than the methods of measurement. In addition, the use of numbers to evaluate the state of the environment allowed expertise from physicians and their clinical examinations to be transmitted to engineers and chemists. Engineers had enjoyed a high status in many aspects of hygiene since the late nineteenth century, due to their expertise in controlling the processes that caused environmental contamination. This status, however, was often contested by medical experts.[206] Industrial hygiene can therefore be seen as a continuum in the specialisation and diffusion of hygiene practice into different disciplines, but also as a part of the rise of engineers in post-war society.

The change in hygiene expertise in Finland can be examined by comparing older textbooks with those written in the early 1950s, when Hilska and Noro had returned from their research trips to the United States and began to renew the genre in Finland. In his first book on occupational hygiene, published in 1945, Noro writes little about the impurities of air. The chemical section of the book focuses on recognising the symptoms of disease caused by different chemicals. Noro considers breathing to be of secondary importance in preventing poisoning, because nasal filtering works as a sturdy defense mechanism for the body. Hence, Noro emphasises the importance of personal hygiene when eating and drinking. Similar instructions are given by factory inspector Vera Hjelt in her textbook on occupational hygiene from 1939, in which she argues that "[cigarette] smoke does not cause intoxication. It is caused by the

204 Ederton 2011, *et passim*.
205 Porter 1996, viii–xi.
206 Harjula 2003, 91–101; Jauho 2007 122.

hands covered by poison that put cigarette to the lips".[207] Her only advice on air impurities was to breathe through the nose and to spend free time in the fresh air and participating in refreshing activities.[208] Although bacteria were not the primary concern in industrial environments, personal hygiene continued to be viewed as paramount in occupational hygiene textbook guides in terms of preventing illness. Workers were advised to maintain strict hygiene by washing their hands before eating and preventing any hand-to-mouth contact in general. Hazards prevalent in the air are represented by listing known gases and types of dust that can cause occupational diseases. In this sense, Noro's first textbooks on occupational hygiene and work-related diseases, written in 1945 and 1948, differ little from those written in the 1930s.[209]

Hilska offers different conclusions in a textbook he wrote on industrial hygiene for engineers in 1953. Air is described as the most important environment and Hilska argues that the purpose of engineers is to measure its content so that it can be made safe for workers. The logic propounded by Hilska in his book is reminiscent to the ideas expounded by Philip Drinker in his textbooks.[210] In this framework, everything can be described mechanically and measured objectively, be it movements of dust in the air or the physical activities of the human body. Practices are about the use of instruments, such as a dust impinger to measure the content of air or chemical methods to analyse particles.[211]

Yet, to merely measure the content of air would be insufficient. As Hilska stated, the chemical composition of air is similar everywhere, so all deviations from this norm can be regarded as impurities. The problem centred on the fact that not all impurities were dangerous to humans. The body has defense mechanisms to a certain extent, so only amounts of impurities that exceed the body's limits are dangerous to an individual's health. Thus, while the older textbooks contained descriptions of diseases that could be used in clinical examinations, Hilska's book also had a list of MAC levels for each chemical substance.[212] In the handbook on industrial hygiene written in 1951 Noro also describes MAC levels as the "findings of industrial hygiene research" that help to make industrial environments safer.[213] In short, for the experts of industrial hygiene the concept of Maximum Allowable Concentration

207 Hjelt 1939, 215.
208 Hjelt 1939, 216.
209 Noro 1945, *et passim*; Noro 1948, 59–82.
210 Drinker & Hatch 1930; Drinker & Hatch 1954.
211 Hilska 1953, 16–17. Hilska was as impressed as Noro by U.S. industrial hygiene as Noro. See Urpo Hilska, Miten työmiehen terveydestä ja turvallisuudesta huolehditaan nykypäivien Amerikassa. *Tehostaja*, 9, 1949.
212 Noro 1951b, 156–158; Hilska 1953, 14–22.
213 Noro 1951b, 156–158.

provided a safe point for all substances that could be objectively measured. Little notice was paid to the moral judgements that were inherent in these figures.

There were, however, certain problems that made the idea less universal, even in the eyes of the experts themselves. In his textbook, Hilska reminds the reader that these safety standards were impossible to determine in principle because they simply did not exist. Individuals are different. What is more, each individual at different times has differing levels of physical strength. Hence, a value that would be safe for everyone all the time is simply an impossibility. In addition, it was very difficult to study the effects of chemicals on humans via an experimental process. Laboratory experiments were carried out on animals, yet their bodies had different defense mechanisms. Consequently, scientisits could not apply the conclusions of experiments on animals to humans.

For these reasons Hilska advised that these values should be used as recommended maxims that should not be taken literally.[214] Again, Hilska's views aligned with those of his teacher. In his textbook on industrial dust, Drinker was extremely critical of the use of threshold values as exact figures in legislation.[215] Both Drinker and Hilska saw the use of thresholds, such as MAC, as a means to attain a general view on air quality and as an aid to design ventilation systems and other devices used to improve air quality. As Drinker noted, the provision of figures for safe levels is more of an art form than science.[216] Noro also warned employers and factory doctors not to use these figures as indicative of safe levels as such. Instead, he advised that they should strive to attain the cleanest possible air as possible in their work environments.[217] In other words, although Noro and Hilska referred to MAC levels as scientific discoveries, they did acknowledge that these figures should not be blindly followed in the pursuit of safe air.

Despite this lowering of the tone by the expert themselves, U.S. MAC levels proliferated successfully into Europe. When the U.S. Public Health Service created national standards that were recommended throughout the nation, based on large epidemiological studies and laboratory experiments, these same values were also adopted by the International Labour Organization (ILO) in its 1953 "Recommendation for the Protections of Workers Health", which stipulated for the

214 Hilska 1953, 14–22.
215 Drinker & Hatch 1930, 12–30.
216 Drinker & Hatch 1930, 27.
217 When the chief physician of a viscose factory in Finland asked Noro for the MAC levels of certain substances in order to counter opposition from workers, the latter remarked that the environment in the factory should not be evaluated by these numbers alone as they were merely suggestive rather than strict thresholds. Correspondence between Leo Noro and the chief physician of the Säteri company, 4.4.1962,12.4.1962, AFIOH.

first time that there should be regular monitoring of the air in workplaces.[218] The FIOH's industrial hygiene department was just in time: U.S. MAC levels, now referred to as 'international norms', formed the basis on which the air quality inside factories was compared. This universality, in terms of MAC levels and the measurements provided, stood in stark contrast with the locality and individuality of the previous methods used to examine occupational environments.

## Environment and Individual Sensitivity

A dissertation on the effects of cement dust by Otto Meurman provides one of the few examples of a study on occupational dust undertaken in the 1940s Finland, before the appropriation of U.S. industrial hygiene. According to Meurman, standard textbooks on rhinology claimed that cement and limestone dust could cause many clinical symptoms in the nose and in the linings of other upper respiratory organs. Meurman sought to find out whether these symptoms were found in Finnish cement and limestone plants. Using health statistics, clinical examination and a questionnaire on subjective symptoms, Meurman produced a detailed study on the health of workers. He observed that health statistics from the factories showed only a few cases of respiratory diseases. Although he acknowledged the limited value of these statistics due to inaccurate diagnostics, he concluded that the effects of dust must nevertheless be mild since they did not seem to force workers to seek medical attention.

However, the questionnaire showed that almost all the workers suffered from acute symptoms when they were initially introduced to the extremely dusty air in their respective factories. Symptoms, including coughing, sneezing and nosebleeds, were only temporary and disappeared when workers became accustomed to their new occupational environment. The adaptation time varied between individuals: from a few weeks to months and sometimes even years. In addition to acute symptoms, some workers also experienced common chronic symptoms, such as persistent colds, a loss of sense of smell and clogged up noses. As for the symptoms described in the handbooks, Meurman found them to be extremely rare. He concluded that limestone and cement dust used in Finnish plants seemed relatively harmless vis-à-vis the upper respiratory organs of workers. Moreover, he noted that the labourers themselves also did not seem to regard dust as being too dangerous. He added, however, that dust may be dangerous for those with weak membranous constitutions.[219]

218 ILO R097 – Protection of Workers' Health Recommendation, 1953 (No. 97).
219 Meurman 1947, 669–683.

Meurman's research shows the significance of locality and individuality in occupational medicine studies that seek to unravel the relationship between health and the environment. He did not turn a blind eye to workers' subjective experiences. He knew very well not to trust medical statistics alone, nor did he rely solely on symptoms that could be proved by objective examination. But subjective symptoms only emphasised the fact that there were large and unexplained differences relating to how individuals reacted to the substances in their working environment. The conclusion made by Meurman from all the observed deleterious effects that he observed was not that limestone and cement dust were harmful to breathe in as such. Instead, he argued that some individuals were simply not able to deal with their effects on their bodies. Whereas individuality made it difficult to prove strict causalities, locality made generalisations less plausible. Meurman did not argue that limestone and cement dust could not cause harmful effects. He merely stated that they did not seem to do so in Finnish industrial sites at their present levels of hygiene. The variety of different causes that led to health issues among the workers was also a problem. Even dusty workplaces were not identical to each other. Furthermore, other causes, such as persistent cold, could also be present and affect the health of workers.

In other words, the significance of individual predisposition and environmental health aspects, which lowered the tone of germ theory, also made it less plausible to view dust, for example, as a cause of illness. Even when the toxicity of a substance was well known, such as in the case of carbon disulphate used in the viscose industry, it was plausible to monitor the health of workers and remove the most sensitive individuals to other tasks.[220] This individual approach was an important aspect of occupational hygiene. According to Noro, it was necessary to find suitable workers who were able to withstand the negative effects of dust and fumes in these occupational environments.[221] The use of MAC levels and measurements of air quality helped to shift the focus of occupational hygiene from individual sensitivity into the environment itself, but only to some extent. Noro, for example, continued to emphasise the fluctuating nature of the most well-known occupational diseases, such as silicosis. For some symptoms of this condition appeared after a week, but for others the disease only emerged after ten years. There was simply no way to foresee this. One of the main tasks of occupational medicine was still therefore to find "the right man for the right place."[222]

220 Presentation delivered by H. Nyman at a seminar of the Association of Industrial Medicine, 7.6.1947, AFIOH.
221 Noro 1948, 26.
222 Noro 1951b, 194.

Thus, neither did U.S. industrial hygiene supersede the importance of clinical examinations, nor did it remove the issue of individuality. In effect, U.S. industrial hygiene provided a plausible way to monitor occupational environments in order to maintain the health of those with a so-called normal constitution. After all, the purpose of MAC levels was not to obtain clean air, but to determine a safe air for a worker who worked for eight hours on a daily basis. By enhancing the management of environmental contamination in factories through universal standards, industrial hygiene paradoxically promoted the notion of individual sensitivity in the case of those who could not cope with air that was determined safe. The somewhat arbitrary nature of the MAC levels and the safe air they determined was further highlighted when Soviet industrial hygienists brought their own safe levels into the fore at the late 1950s.

## Soviet Thresholds: The Question of Harmful Effect

In 1957, the twelfth International Congress on Occupational Health was held in Helsinki and organised by the FIOH as an opportunity to promote the novel institution and the nascent research and work that was being undertaken in Finland.[223] Perhaps more interesting for the international guests, however, were the presentations delivered by the attendees from the previously more or less secluded Soviet Union. In fact, due to numerous requests from conference participants, a trip was organised to Leningrad to see the Soviet institutions of occupational medicine and hygiene. This was not initially scheduled to be part of the conference itinerary.[224]

The Soviet presentations were particularly significant in regard to air impurities in occupational environments. In their presentations, the Soviet attendees demonstrated a MAC level system of their own design that differed considerably from the U.S. model. Based on the physiological research undertaken by Ivan Pavlov, the Soviets had developed a method to observe how even the most subtle exposures were able to affect the central nervous system. These effects, such as sensory changes and slower reflexes, which were not regarded as toxic effects in the U.S. model were seen by the Soviets as a form of poisoning that should be prevented in occupational environments. This model, in theory, allowed no factors to negatively affect the wellbeing of humans regardless of whether it constituted a disease. Hence, the most apparent difference between the two sets of values was that the Soviet figures were much lower than the U.S. equivalents. A further difference, although more political than scientific, was that the U.S. values were

223 Ketola 2015, 170–173.
224 Proceedings of the XII International Congress on Occupational Health 1957, 53.

recommendations, whereas the Soviet levels were legalised norms.[225] In other words, the Soviet norms provided a different way to approach the issue of air and health in industrial environments, which was also based on scientific and medical research.

The Soviet model did not, however, simply present a new method of observation. It also highlighted the vagueness of the concepts of harmfulness and toxicity when attempting to manage environmental health effects. The U.S. and Soviet researchers seem to have had different ideas about what was constituted as harmful and what was deemed worthy of prevention. For example, Americans criticised the notion that slowed reflexes constituted an illness.[226] Sellers has shown how the U.S. and Soviet perspectives clashed at a Prague symposium for MAC values in 1959. According to Sellers, the American delegates were largely dismissive of the Soviet methods. However, the acceptance of European experts and the International Labour Organization forced the American delegates to recognise the competing standards put forward by the Soviet delegates.[227]

Although Sellers describes the American attitudes at the Prague symposium as rather lukewarm, there are indications that the Soviet physiological methods were received with interest and a certain degree of acceptance. One of the American participants at the Helsinki conference, C.R. Williams, took a copy of the Soviet presentation to the United States, where it was distributed to members of the Industrial Hygiene Association. In a discussion about threshold limit values, the Soviet methods were seen as an important addition to the usual toxicological methods. The Soviet's versatile examination of symptoms and criticism towards special disease etiology appeared more subtle compared to mainstream toxicology in the U.S. In addition, the Soviet method was deemed to be compatible with the novel stress theory, developed by the Hungarian-Canadian endocrinologist Hans Selye, which emphasised the non-specific effects of stressors on biological organisms. In other words, for U.S. industrial hygienists and toxicologists, the Soviet method presented one way to examine more subtle physiological effects in the growing amount of research on the health effects of dust, fumes and gases.[228] As Sellers has argued, the Soviet method offered a precautionary approach in the mid-twentieth century.[229]

225 For the differences between Soviet and U.S. thresholds see Sellers 2015.
226 Ball W.L, Report of the Prague Symposium. *American Industrial Hygiene Association Journal.* Vol. 20 no. 5, 1959.
227 Sellers 2015, 37–44.
228 See, for example, *American Industrial Hygiene Association Journal.* Vol. 20 no. 5, 1959.
229 Sellers 2015, 37–44.

In practice however, the significance of the Soviet way remained somewhat limited. Noro described the Soviet MAC levels as sophisticated, but doubted their practical use.[230] The Soviet norms were considerably lower and would have been difficult to enforce and supervise. Although the links between the FIOH and the Soviet Union remained somewhat steady after 1953 and increased from the 1960s, the Pavlovian physiological approach did not seem to take root in the Finnish institution and the research and management of dust and fumes remained predominantly an Anglo-Saxon discipline. Likewise, the official Finnish norms for industrial air, which were put to use in the early 1960s, were based on U.S. MAC levels. Despite the prevalence of the U.S. industrial hygiene, the Soviet thresholds and their approach remained as an alternative way to evaluate the state of environment. The result was, however, that the measurement and management of air quality was institutionalized at the FIOH in the mid-twentieth century, and was based on the toxicological notion of safe air manifested by the MAC levels. This meant that the air was not deemed to be dangerous until it caused effects that constituted an illness. As such, the metrics and the 'quality' of air that industrial hygienists examined were narrow compared to the complex relationship of air and health in hygienic thought that was examined in the preceding chapter. Whereas fresh air was a vague concept entailing the various positive effects of clean air, safe air was a narrow concept based on the absence of harmful substances that could be measured and presented in clear numbers.

However, this change was only occurring in factories. In other occupational environments, including smaller workshops, there was still a reliance on factory inspectors and occupational doctors. The use of MAC levels spread gradually as did the measurements made by the FIOH's industrial hygiene department. A large increase in routine measurements occurred in the early 1960s, when the monitoring of air in workplaces became compulsory. Still, these were unusual environments in that clean air was simply not seen as a realistic possibility, yet environmental management was deemed to be necessary. At the outset there seems to have been little connection between this development and the concern for the quality of air in urban environments. Sellers has emphasised the importance of industrial hygiene in developing the methods by which air pollution and environmental pollution in general were initially examined. He has also shown that U.S. industrial hygienists were among the first to systematically investigate air pollution as a threat to health.[231] This shift from inside air to outside air, whilst still applying the same ideas and methods seems to have also been a popular depiction in Finnish historical accounts,

230 Noro 1954, 101.
231 Sellers 1997, 187–192.

albeit with a different viewpoint.[232] Noro himself later described the FIOH's initial interest in air pollution as natural, since they had already begun to study air inside factories.[233] However, as the basic precept of historical research argues, when some historical event or process is explained as natural, it demands closer scrutiny from historians.

232 Schönach 2008, 148–150; Lahdes 2006, 59.
233 Noro 1979, 131.

# 3 The Formation of Air Pollution Research

## 3.1 From Donora to Helsinki: The Circulation of Air Pollution Research in the 1950s

> The most interesting thing that's happened here is the series of fatal accidents from industrial gases at Donora, Pennsylvania. It was the main topic of conversation at the recent meetings of the Industrial Hygiene Foundation at Pittsburgh. But I fear we will not discover the cause as no samples of the air were taken for some days after the deaths -- 20 of them -- It seems much like the disaster of 1930 at Liege.[234]

Through this telegram message from Philip Drinker, Leo Noro was introduced to the Donora disaster of 1948, which would later become one of the key benchmarks in the history of air pollution control. Due to weather conditions, the emissions from the huge industrial facilities in Donora did not disperse into the air as they usually had done, creating a blanket of smoke and fumes over the area that lasted for days and caused mass sickness and fatalities. As Drinker states, the fatalities were presumed to have been caused by the air quality. This hypothesis attracted the interest of industrial hygienists, who wished to identify the cause in the same way as they did inside factories. Though the disaster at Donora was not the first of its kind, as Drinker also noted, the attention it received, and its consequences have made it one of the most well-researched events in the history of air pollution. Indeed, it is perhaps more (in)famous than any other air-related catastrophe, bar, perhaps the Great Smog of London in 1952, in which thousands of people died due to high levels of coal smoke that remained above the British capital for weeks. These two events have come to represent a turning point in attitudes towards air quality as a public health problem on a transnational scale. The idea that the London smog in 1952 changed the way air pollution was perceived in terms of the politics of public health

234 Telegram from Philip Drinker to Leo Noro, 27.11.1948, AFIOH.

has become textbook material.[235] The purpose here is to evaluate the transnational significance of these events as calls for action by examining how the quality of outside air became a matter of concern in Finland. Was it a reaction to the events in Donora and London or perhaps a natural extension of industrial air analysis, as Noro argued, or something else?

Though Donora and the 1952 smog above London received great coverage at the time, historical research has subsequently put this attention into perspective. Uekötter has suggested that the events themselves were less important than the fact that they coincided with the overall rise of indignation towards air quality after the Second World War in many countries.[236] Others have shown how public health officials and industrial hygienists in Donora were largely dismissive of the threat posed by the emissions in general, instead emphasising the peculiar weather conditions during the disaster. Lynn Page Snyder has argued that Donora marked the occasion when an explicit connection was made between air pollution and human health, which, nonetheless, had little effect on public health policies.[237] Finnish historical studies seem to have a somewhat ambivalent view on the matter. Schönach sees the events as significant in making air pollution a matter of public health, but states that the events received little attention in Finland at the time.[238] By focusing on the FIOH, rather than the overall attention in Finland, it is possible to examine more closely the relationship of these (in)famous events to the Finnish experts of industrial air and their eventual expansion to undertaking research about outside air.

## Non-Event of the Early 1950s

It is unclear how much attention the incidents in Donora and London received in Finland. The 1952 smog in London was covered by the Finnish press, but only in brief articles with no reflection on the domestic situation. It has been argued that the situation in Great Britain became known in Finland mainly due to British football matches being cancelled because of smog. There was also no immediate reaction from officials, and public health boards continued to address smoke and fumes on a case-by-case basis according to nuisance and public health laws. The problems caused by rural industries were seen as economic and compensation was paid to farmers.[239] As the telegram from Drinker shows, Noro was at least aware of the Donora disaster and the interest given to it by U.S. industrial hygienists. There is,

235 See, for example, Mosley 2014, 155.
236 Uekötter 2009, 118. As Uekötter points out, the disaster at Meuse Valley in 1930 was forgotten rather quickly even though it received attention internationally.
237 Snyder 2003, 126.127.
238 Schönach 2008, 96, 144–146.
239 Schönach 2008, 95–98.

however, little evidence that either of these events sparked particular interest in the FIOH. This can be seen most clearly in the absence of any efforts to measure and analyse ambient air by FIOH researchers until the late 1950s. Apparently the FIOH did undertake some dust measurements in the 1950s at the behest of public health officials in Helsinki in order to assess complaints from inhabitants. However, these measurements did not seem to spur any wider interest towards ambient air quality. The silence on the matter is in itself some indication that air quality was not high on their list of priorities. Indeed, the few remarks on the issue seem to strengthen this argument.

In the early 1950s, for example, effluents from a sulphuric acid factory in the small town of Harjavalta levelled a forest and all vegetation within a three-kilometre radius. Some damage was even observed eight kilometres from the factory. In a newspaper article reporting on the situation in 1954, the journalist was mainly concerned about the economic impact. Farmers, gardeners and landowners demanded compensation for the damage inflicted by the "disastrous fumes".[240] Damaged crops appear to have been a common occurrence near rural industrial facilities, since these industries regularly paid compensation to farmers.[241] According to a review of the case by Noro a few years later, the inhabitants near the factory had been concerned about the potential health effects of the fumes. Noro argued that this was a rather common fear in industrial communities. However, he stated that no indication of ill effects to health had been found in medical surveys, except for "potential psychogenetic fear reactions that might cause harm to individuals of a frail state of mind". In general, morbidity in these communities was not above average.[242] The local health board in Harjavalta was similarly unalarmed about the potential health effects of the effluents from the factory. Though the board effectively controlled environmental hygiene, there is not a single remark on issues caused by the factories before the late 1960s.[243] In short, there seemed to be little concern for the health effects by FIOH experts in this specific case.

The layperson's fear that an area in which toxic air was able to suffocate entire forests and vegetation might not be a healthy place to live does not seem far-fetched. Yet, according to the medical authorities at the time it was not an issue. No symptoms that affected humans were found. This made sense according to physiological and chemical principles, as although even small quantities of sulphur were known to be disastrous for plant life, it was believed that humans could be predisposed to larger

240 HS, 15.5.1954.
241 Noro 1958, 236–237.
242 Noro 1958, 235–236.
243 Records of the Harjavalta Board of Health 1947–1967, Municipal Archives of Harjavalta.

amounts without any ill effects on health. In fact, Noro stated that experiments on animals had shown that sulphur dioxide could even be beneficial to humans in small amounts.[244] This discrepancy between expert and lay views seems to support the assertion made by Nash; namely that lay people never abandoned the so-called Hippocratic view on health to the same extent as medical experts, and continued to emphasise a holistic unity between the environment and health.[245] Industrial hygiene no exception in this regard. It has been noted that industrial hygienists in United States were often initially dismissive of the hazards of ambient air quality, since the quantities of chemicals were low compared to air inside factories.[246] As the case of Harjavalta demonstrates, the subjective and unspecific symptoms that people complained of could be regarded as individual weakness similar to the vague ailments in occupational environments.

The lack of concern about air quality was based on low levels of impurities compared to observations in industry but it was also united with the idea that natural ventilation was able to remedy any air quality issues. For example, when the chief physician of the National Railway Company consulted Noro on the potential dangers of apatite dust to workers who unloaded it from wagons, Noro replied that apatite can be dangerous if it contains phosphorus. He added, however, that "since this work takes place in outside air, there is in practice no danger of lung disease".[247] Noro further stated that if such claims are made by workers, which was indeed the case, an x-ray must be sent to a specialist, who would be able to verify the diagnosis. He did note that such dust undoubtedly causes a nuisance and masks should be provided by the company.[248] Such open-air occupational health issues could be presumed to be the natural next step in air quality monitoring by industrial hygienists. However, as the FIOH's chemist Aulis Jormalainen stated, measuring the quality of air during dusty work that took place outside was practically impossible because of weather conditions.

One solution to this problem was to analyse the content of suspected chemicals in workers' bodies, as was done in CO studies. This biochemical analysis also had limitations. Many of the suspected chemicals occurred naturally in the human body and, in addition, their chemical constitution tended to change overtime. Since the significance of biochemical analysis came down to extremely small amounts, the

244 Noro 195, 236.
245 Nash 2006, 211.
246 Sellers 1997, 232–235. Also see Snyder 2003.
247 Correspondence between Leo Noro and the chief physician of the National Railway Company, 19.1.1953, 8.1.1953, AFIOH.
248 Correspondence between Noro and the chief physician of the National Railway Company, 19.1.1953, 8.1.1953, AFIOH.

accuracy of measurements was unreliable.[249] In other words, in addition of there being no clear concern about ambient air quality, the shift from inside to outside air, with regards to measurement practices, was not a simple matter. Thus, the early 1950s offers little evidence to suggest increasing levels of interest in ambient air quality or heightened scrutiny of the ill effects of smoke after the incidents in Donora and London.

One simple explanation for the lack of interest towards air quality measurements by the FIOH would be the fact that as an institute focused on occupational health, matters such as general urban air quality was outside its operational mandate. However, Noro actively sought to widen this mandate and expand the research and expertise in the FIOH so that it could pursue issues outside the workplace and in society at large.[250] This had already begun in 1950 when Noro participated in the WHO-ILO Joint Committee on Occupational Health, which resulted in the composition of a new definition for occupational medicine. Occupational medicine in Europe had traditionally been strictly restricted to diseases and injuries stemming from work. According to Noro, the aim of the working group of which he was a member was to widen the definition from the old limits of occupational disease, which were deemed to be too narrow for a modern, industrialised society.[251] In effect the definition outlined in 1950 by this committee stated that the purpose of occupational health was to maintain the entire physical and psychological wellbeing of workers, including, in theory, life beyond factory walls. Noro later wrote that his goals in the committee were partly motivated by the lack of a public health institution in Finland. With its new definition of occupational health, the FIOH could potentially take on issues that officially belonged to the sphere of public health.[252]

It is hard to say what significance Noro had in forming the definition, but the way occupational health was defined by the WHO-ILO committee greatly increased the scope of the discipline. After all, the state of workers' health was not determined solely inside factories. In short, there is little reason why Noro and the FIOH would have scorned air quality studies on the grounds that they did not belong to occupational medicine. In fact, such matters as urban noise pollution, school hygiene and sport physiology were actively studied despite being outside the official mandate of the FIOH. Furthermore, Noro's views on health in the 1950s were apparently framed by the discipline of social medicine, which emphasised the societal aspects

249 Jormalainen 1954, 114–115.
250 Ketola 2015, 98–100, 151–155.
251 Noro 1979, 82–83. Also see Joint ILO-WHO Expert Committee on Occupational Health.
252 Noro 1979, 82–83.

of wellbeing in the prevention of diseases.[253] In his writings, Noro complained about the depreciation of preventive measures in contrast to curative medicine in Finnish healthcare. He emphasised the importance of physical exercise, diet and a healthy environment as the cheapest and most efficient way to improve the health of the population. Many of his concerns were linked to societal changes in that he thought were unhealthy, such as monotonous work, hectic lifestyles, a toxic environment and harmful leisure activities.[254] Part of this view can be seen in Noro's statements that refer to the authority of Hippocrates when stating that diseases do not appear suddenly but are the results of countless mistakes we make in life.[255]

Despite Noro's respect for less reductionist views on healthcare and despite the efforts to widen the research carried out by the FIOH, air quality was rarely mentioned even in this context. The efforts for more emphasis on public health-oriented research were amplified later in the decade when the FIOH faced increased financial difficulties. Despite grand promises, private industries had inadequately supported occupational health research. As a result, although the FIOH had large clientele that supported its routine activities, the institution faced an acute shortage of funds to undertake basic research on occupational health. In this situation, public health issues were seen as a possible means of securing more funding.[256] The FIOH administration discussed possible fields of research in radioactivity, noise pollution and water pollution, but air pollution was not mentioned.[257] In fact, Noro only mentioned air pollution in a letter to a FIOH employee studying in the United States, who had asked him about relevant industrial toxicology issues in Finland. In his reply, Noro suggests noise and air pollution around industrial facilities, among other issues.[258] In short, there seems to have only been limited interest in the FIOH towards impurities of outdoor air in the first half of the 1950s. There is also no indication that the incidents in Donora and London caused any immediate concern or interest in

253 Ketola 2015, 67–69. The WHO maintained these views under its first director Brock Chisholm in particular. The general enthusiasm for hospitals, antibiotics and vaccines was resented by those who saw the causes of ill health in wider terms in relation to society and the environment. This led to conflict within the WHO. See John Farley, *Brock Chisholm, the World Health Organization, and the Cold War*. UBC Press, Vancouver & Toronto 2009.

254 These views are most comprehensively depicted in Noro's textbook on social medicine, *Sosiaalilääketieteen perusteet*, WSOY, Porvoo & Helsinki 1961.

255 Resorting to Hippocrates as the ancient voice in any given medical field is a continuous theme in western medicine, of which environmental and social medicine are one example. See David Cantor ed., *Reinventing Hippocrates*. Ashgate, New York 2001.

256 In 1949, the Finnish WHO official Erkki Leppo advised Noro to widen the scope of the FIOH into public health in order to receive more funding from the WHO. Letter from Erkki Leppo to Noro 16.11.1949, 24.11.1949, FIOH Archives.

257 J6-7/57, 14.10.1957, Records of the FIOH Board of Directors, FIOH Archives.

258 Noro's letter to Teuvo Niemioja 13.4.1955, FIOH Archives.

Finland towards urban air quality issues. These events were distant and unlikely threats in a Finnish context.

## Appropriating Air Pollution from the United States

The first clear comment on polluted air as a public health problem by an FIOH member appeared in an article in the industrial magazine *Tehostaja* in 1956. Herein, the chemist Aulis Jormalainen presented the quality of outside air as a potential public health problem. Despite being brief and focusing on technical ways to disperse emission by tall smokestacks, the article also considers the potential health effects of air pollution. According to Jormalainen, it is impossible to give a definitive answer to the question since although some incidents, such as the smog over London in 1952, caused fatalities, there was no evidence to gauge the overall health effects of impurities in air. He reminds the reader, however, that the benefits to health from clean air are indisputable.[259] Jormalainen thus embraces the hygienic view on air as vague but indisputably important element of healthy environment. In a way, the article represents the framework of air pollution control as it had been developed during the late nineteenth century and the early twentieth century, namely, with emphasis on technical means to prevent pollution rather than specific knowledge about their health effects.

The same issue of *Tehostaja* contained an article by an anonymous writer that discussed air pollution with a rather different attitude. Focusing on health effects, this article discussed toxic air and used the disasters in Liege, London and Donora as examples of the potential negative impact of air pollution. The author noted that even minute quantities of these poisons and a small decrease in oxygen could lead to impaired health for some individuals. The article presented a plethora of substances that can be found in the air of industrial areas and cities; substances that have either deleterious or unknown effects on health.[260] The article also quoted Professor Willy Hellpach, the pioneer of environmental psychology, who stated: "When even the respected textbooks of hygiene are not concerned over the biological effects of these chemicals due to their insignificant quantities it is doubly strange. For similarly we could be unconcerned over even the lethal bacteria and the toxins they produce simply because it is a matter of extremely small numbers and species."[261] Despite these alarmist views, the author placed faith in technology and in social planning by which the hazards of industrial production could be avoided if

259 Jormalainen 1956, 88–90.
260 Ilman saastumisen seurauksia, *Tehostaja* 2/1956, 93–95.
261 Quoted in Ilman saastumisen seurauksia, *Tehostaja* 2/1956, 95.

humans are placed at the centre of societal development.[262] The article seems to express the views of the lone voice of concern about the dangers of air pollution in Finland at the time. However, it features many of the viewpoints and attitudes that would become more widespread in the 1960s amidst the overall rise in environmental concerns. It also shows how the basic differences between the two points of view already existed in the 1950s, even though they only came into full contact in the late 1960s.

Although Jormalainen was apparently interested in the problem of posed by polluted air, the true turning point for the FIOH came in 1957 when the World Health Organization's European office decided to host a conference on the public health effects of air pollution. The impact of this plan came even before the conference itself as the WHO requested each country to prepare a summary of their situation and level of their respective problems. Noro was chosen to represent Finland at the conference, which seems to have given the FIOH the impetus to become more acquainted with air pollution research. Noro even requested funding from a private foundation in order to purchase relevant literature from abroad and to conduct preliminary measurements.[263] This particular funding was denied, but the FIOH managed to obtain literature on the subject, which marked the beginning of the institution's specialisation research into air pollution. Whilst Noro attended the conference as a representative of the FIOH, the institution designated Arvo Laamanen, a young biochemist, to specialise on air pollution. Laamanen had joined the FIOH's industrial hygiene department in the early 1950s and soon became its director. Noro initially hoped that Laamanen would become a toxicologist, as he foresaw the importance of the field growing in the future. However, due to a lack of funds, Noro was unable to send Laamanen to study in Britain as he had envisaged. Thus, Laamanen begun his work as a pioneering air pollution researcher at the FIOH.

As had been the case in industrial hygiene, literature on air quality measurement and analysis was brought to the FIOH almost exclusively from the United States. This can be seen as a continuum of U.S. dominance in scientific and medical research after the Second World War. Uekötter has shown how even German public health officials saw U.S. research as the most advanced and read related publications in order to obtain the latest knowledge. However, he noted that German research was not more backward, but was more scattered and poorly institutionalised in the 1950s.[264] In contrast, U.S. research had been in the process of institutionalisation since the 1940s, especially after the incident at Donora. Expert meetings on air quality problems expanded from local gatherings into national and even international

262 Ilman saastumisen seurauksia, *Tehostaja* 2/1956, 95.
263 Letter from Noro to the Emil Aaltonen Foundation, 10.2.1957, AFIOH.
264 Uekötter 2009, 146–148.

conferences, in which the scientific contours of the problem were drawn. There was no Finnish representation at these events. In fact, despite the conference being labelled as international it only had U.S. and British attendees. However, the publications that stemmed from these meetings formed the early basic literature on the complex new discipline of air pollution research. Through these works the particular way of representing the problem proliferated outside the United States.

The basis of the increased attention to air quality research was the idea that the problem could only be solved by gaining expert knowledge on impurities in the air and their relationship to human health. As President Truman stated in the opening of the United States Technical Conference on Air Pollution in 1952: "there is an urgent need to bring to bear on the problem of air pollution all the scientific knowledge at the command of industry, government and scientific institutions".[265] Truman continued: "We need to find out all we can about the relationship between air contaminants and illness".[266] Though this may seem like a rather common-sense approach, it represents a fundamental change in attitudes towards air quality issues. According to Uekötter, it was only in the era after the Second World War that the lack of knowledge on the matter became an issue in the first place. Hitherto, even smoke abatement activists had viewed the occasional measurements of smoke and dust as being rather useless.[267] Both Truman's statement and the conferences themselves can therefore be seen as representative of the increasing reliance on scientific knowledge in societal affairs after the two world wars.

Another marked change was the concept of air pollution itself. During the nineteenth century and early twentieth century, problems of air quality were largely treated as separate issues, such as coal smoke and soot from heating, dust from roads and chemicals from factories. The equivalent of air pollution at this time was the visible effects of coal smoke and soot that tormented the populations of large cities and industrial areas. Angela Gugliotta has shown how the attempt to redefine air pollution in 1930s Pittsburgh through the measurement of air quality inspired by industrial hygiene was largely unsuccessful.[268] It was only after the Second World War that air pollution as a concept proliferated and began to represent the combination of impurities and their effects on health and the environment, both acute and long term.[269] This timeline also seems to apply to Finland. As documented in the first chapter, the Finnish equivalent of 'air pollution' did not appear at all in the medical literature of the 1940s; nor was it widely used in more popular publications.

265 McCabe 1952, s.v.
266 McCabe 1952, s.v.
267 Uekötter 2009, 129.
268 Gugliotta 2004, 108–110.
269 Gottlieb 2005, 117; Uekötter 2009, 86.

In other words, although air impurity was an old issue, the institutionalisation of research into the topic as a distinct discipline that took place in the mid-twentieth-century United States was an innovative development.

The study of air pollution was seen as a multidisciplinary field that combined the expertise of engineers, chemists, meteorologists, toxicologists, pathologists, public health experts and industrial hygienists among others. The number of different medical experts alone, ranging from epidemiologists to dermatologists, shows the versatile nature of the first conferences.[270] This multidisciplinary nature was also a problem when the systematic search for knowledge on air pollution was initiated. It was stated in the United States Technical Conference on Air Pollution in 1952 that although much research on various aspects of the problem had been made, the publications in the subject were scattered and represented specific viewpoints rather than the whole.[271] As Uekötter has also argued, the problem in the 1950s air pollution research was lack of synthesis in the knowledge produced up to that point, rather than in the quantity of knowledge.[272] Thus, the idea of gathering all possible knowledge turned into a question of what should be known about air pollution and how it should be studied systematically. The study of the health effects of air pollution became a category in its own right, in which the experience garnered from analysis of industrial air turned out to be of great significance.

As stated above, the disasters in Donora and London are often credited for establishing air pollution as a threat to human health. In this respect it is interesting to note that in the discussions on health effects in the early conferences these disasters provided relatively little valuable information. Even in the proceedings published before the London smog of 1952, there was no debate on the potential danger of air pollution at very high levels. These events were often referenced, but they were mainly seen as rare and unusual situations caused by peculiar weather circumstances. As John Phair, Professor of Preventive Medicine and Industrial Health at the University of Cincinnati, stated, these events provided experts with little knowledge on the state and potential hazards of normal urban air quality. He suggested that the air pollution disasters should be considered as epidemics and that authorities should technically control the factors that cause them.[273]

In a similar vein, Robert Kehoe, a prominent toxicologist from the Kettering Laboratory at the University of Cincinnati, stated that when he spoke of the effects of air pollution he did not mean Donora, London or Meuse Valley, but the usual state

270 McCabe 1952, 29–33.
271 McCabe 1952, s.v.
272 Uekötter 2009, 143.
273 Phair 1956, 7–10.

of air in urban areas.[274] In other words, the danger of air pollution to health as such was not the issue. What puzzled the researchers was what exactly caused the fatalities in these situations? It was repeatedly stated that even under the worst circumstances the amount of any single impurity in the air came nowhere near to the MAC values used in industry.[275] Thus, industrial hygienists and toxicologists were unable to show causality, just as Drinker had suspected.

Although the specific effects of air pollution in extreme circumstances was largely unknown, the real puzzle were the long-term chronic effects of daily exposure to low levels of pollution. Compared to rare smog episodes, the chronic effects of air pollution represented a potentially far greater public health hazard, of which little was known. This, rather than the prevention of extraordinary smog episodes, formed the fundamental question of air quality control. Both Phair and Kehoe viewed air pollution research in the same way as industrial hygiene research; namely that the objective was to know what effects different impurities caused in different quantities. According to this view, there was no such thing as clean air or even "optimal physiological air", as Phair expressed it. Rather than entirely cleaning air, Phair argued that the aim was to provide safe and "tolerable" air, a practical balance based on "calculated risk".[276] Kehoe emphasised that atmospheric contaminants were not dangerous as such and that it was a matter of their chemical composition, quantity and physiological effects. To find out what made air quality injurious was a question that could be solved "by the application of methods which are available for the most part in the technical armamentarium of industrial hygiene.[277] Hence, according to Kehoe, the quality of air outside could be rationalised utilising the same principles and methods as those employed inside workplaces.

The problem was that existing knowledge on air quality in urban areas and its potential health effects was at a completely different level compared to the study of industrial air. As Kehoe stated:

> It must be apparent, even to the novice, that any conclusion that might be given at this time concerning the specific origin of the chronic physiological effects of the pollution of the atmosphere of our cities, under present prevailing conditions,

274 The discussion section of Tabershaw 1952, 473.
275 See the discussions in McCabe 1952.
276 Phair 1956, 3–5.
277 Kehoe 1952, 477.

> must be derived from indirect and admittedly inadequate information and that the very existence of such effects is in some doubt.[278]

Most of what was known about the specific effects of the pollutants derived from industrial medicine. Thus, even the constitution of urban air quality was largely unknown.[279] It seems the problem was not merely in systematisation of knowledge but in its absence. As Kehoe stated, information on the matter was "scanty, largely conjectural, and, in considerable degree, irrelevant."[280] Similarly, Phair considered the main problem consisted of being able to find a reliable disease entity that could be used to evaluate the effects of air pollution. Without knowledge of the specific effects, he argued that it was impossible to separate the effects of air pollution from other environmental and socioeconomical factors in morbidity statistics. Although there was an attempt in one air pollution research manual to use Koch postulates[281] to assert causality for air pollution, Phair insisted that the use of these postulates was unrealistic in the real world, reminding the reader that they did not work properly, even with bacteria.[282] In short, the methods of industrial hygiene provided a way to determine safe urban air, but a great unknown stood before this goal in the mid-twentieth century.

The increase in research and the problematising of the lack of knowledge can be seen as a logical development before practical measures of air pollution control, as Frioux has argued.[283] It should be noted, however, that the logic behind this quest for knowledge was founded on the idea that problems in society could be solved rationally through objective knowledge about society and nature. This was an idea that was gaining unprecedented support in post-World War Two western societies. It was a continuation of the state formation process in which, as Corneil Zwierlein has argued, ignorance came to be viewed as a lack of knowledge of practical problems, rather than as a limitation of the human intellect.[284] The problem of air quality in urban areas was moulded into a scientific question that could be answered by knowing more about the composition of the air and its effects. Air pollution was now what the philosopher of science Thomas Kuhn termed a puzzle, namely, a

278 Kehoe 1952, 475.
279 Kehoe 1952, 477. In the discussion section, one commentator noted that in 1951 the United States Public Health Service had concluded that examining old measurements of atmospheric quality did not constitute research.
280 Kehoe 1952, 477.
281 The four criteria designed by the German physician Robert Koch in the late nineteenth century in order to establish a causative relationship between microbes and diseases.
282 Phair 1956, 3–5.
283 Frioux 2019, 272.
284 Zwierlein 2016, 38.

clearly defined problem of which everything is known except the exact results.[285] In other words, the logic of solving the problem of air pollution through the accumulation of knowledge and the conquest of ignorance can be seen as part of a long process of technocratic rationalisation.

That this approach was not necessarily the only one can be seen from the critique aimed at the sudden increase of research into polluted air. At the First International Congress on Air Pollution in 1955, Sir Hugh Beaver argued that there is, in fact, little new to be said about air pollution. Beaver's report on the London smog of 1952 has been viewed in historical research as an important milestone in establishing air pollution as a public health issue.[286] However, Beaver himself stated in the conference that most of what was contained in the report had already been written before. He viewed air pollution as a problem in which everything worth knowing had been known for decades, but nothing had been done. He recalled that the idea that air pollution is harmful for health had already been viewed as an axiomatic truth in a government report from 1921. According to Beaver, public opinion on the matter had changed in recent years, rather than knowledge about the issue itself. This shift made possible the control measures that had previously been out of the question.[287] Furthermore, he warned that this momentum should not be lost because of uncertainty about specifics:

> It is possible to have a subject so cluttered with technicalities and details, so clouded by the scientific battles of experts that, while we search for a perfect answer, the opportunity passes and nothing is done.[288]

Beaver presented air pollution as a matter of politics, propaganda and common sense, rather than a scientific puzzle. In this respect, his view resembles those of the older smoke abatement activists who saw little need for measurement and research. In a similar vein, some researchers warned of the overt specialisation of knowledge, emphasising that the aim should not be accumulated knowledge, but turning it into simple answers for everyday problems. It was, after all, "honest public opinion" that had made research on urban air quality possible in the first place.[289]

285 Kuhn 1996, 23–34.

286 Mosley, for example, regards Beaver's report as central evidence in terms of showing the health effects of pollution. See Mosley 2016.

287 Beaver 1955, 1–10.

288 Beaver 1955, 11.

289 McCabe 1952, 33. It was emphasised by Dr. Nicholson that women had always been central in air pollution abatement and that it was vital for experts to be their allies in the battle for clean air.

Despite these attempts to emphasise simplicity and common-sense solutions, air pollution research began to gain momentum as a way to approach air quality issues. These conference proceedings and manuals, along with the recently founded *Journal of the Air Pollution Control Association*, formed the core literature for Laamanen and other researchers at the FIOH as they began to widen their interest in air quality beyond factories. A few months before the WHO conference, Noro and Laamanen published an article in the medical journal *Duodecim*, in which air pollution in Finland was evaluated for the first time in a scientific journal. Referring to the U.S. publications Noro and Laamanen presented air pollution as a complex problem that required interdisciplinary research and sophisticated technology that was mostly unavailable in Finland. They saw no cause for concern in Finnish towns, but they did refer to the WHO's concern on the matter and urged that action was needed; namely, research on the present situation in Finland.[290] This idea of tackling or preventing air quality problems through research was further enhanced at WHO conferences in the late 1950s.

## International Action on Air Pollution

Some conferences in the United States were labelled as international, but it was the Milan conference on the public health aspects of air pollution, organised by the European Regional Office of the World Health Organization (EURO) in 1957, that first attracted participants outside the United States and Great Britain. Although the Milan conference was only attended by experts from European countries and from the United States, it represented a milestone in the formation of international networks on air pollution research. With this in mind, it is surprising that the event has not been thoroughly examined in historical research on air pollution. In fact, since most studies on the history of air pollution control have a national focus, the overall significance of the WHO in the matter has remained somewhat ambiguous. Historical studies on the WHO itself have mainly focused on the organisation's actions in developing countries and on its largescale campaigns aimed at eradicating malaria and smallpox.[291] The focus in studies on the environment and international organisations tends to centre on the late 1960s and the time after the noteworthy Stockholm conference.[292] In short, the WHO's

290 Noro & Laamanen 1958, *et passim*.

291 See, for example, Javed Siddiqi, *World Health and World Politics: The World Health Organization and the UN System*. University of South Carolina Press, 1995; John Farley, *Brock Chisholm, the World Health Organization, and the Cold War.* UBC Press, 2009; Randall M. Packard, *A History of Global Health: Interventions Into the Lives of Other Peoples.* JHU Press, 2016.

292 See Kaijser & Meyer 2019.

early action on air pollution seems to fall into a gap between different historical viewpoints. However, in her recent study, Rachel Rothschild has argued that although the WHO took some interest in air pollution in the 1950s, the primary focus of the organisation at the time was elsewhere. In contrast, an international forum on air pollution research was facilitated primarily by the OEEC and its successor the OECD.[293]

However, with its conference in Milan, the World Health Organization was the first agency to take up air pollution in an international forum as a public health problem that stemmed from industrialisation. This interest can be seen as forming part of the broader focus of the WHO towards the health effects of industrialisation, which had been viewed as an important topic at the 1957 World Health Assembly.[294] Furthermore, it was the first gathering of air pollution experts under the banner of new internationalism that had been promoted by the United Nations. Akira Iriye has described the WHO and the UN as bodies that represented the institutionalisation of global consciousness and sought to improve the world in the spirit of science and reason, with western societies as the yardstick.[295] Thus, the Milan conference can be seen as the first attempt to incorporate air pollution into the grand vision of the WHO to globally improve human health, with science and reason in the vanguard.

It could also be argued that expert conferences in general involve many grand ideas about knowledge, expertise, internationalism and the universal nature of science behind this seemingly mundane gathering of people. Surprisingly, not much has been written about the significance of conferences in the transnational movement of knowledge, despite their institutional character. It is clear that during the twentieth century, especially after the Second World War, the number of conferences multiplied and changed in character. General scientific conferences to facilitate cooperation and unity were replaced by gatherings of experts who focused on a specific problem, such as air pollution. This trend further highlighted the rise of science and expertise in resolving the problems of modern society.[296]

293 Rothschild 2019, 18–20.

294 See *Tenth World Health Assembly, Geneva, 7–24 May 1957: resolutions and decisions: plenary meetings: verbatim records: committees: minutes and reports: annexes.* Official Records of the World Health Organization No. 79, Geneva, 1957.

295 Iriye 2002, 5–28. This internationalism was in many ways a continuum of the earlier attempts at international cooperation in public health. See, for example, Iris Borowy, *Coming to Terms with World Health: The League of Nations Health Organisation 1921–1946.* Peter Lang, 2009.

296 See Wolfram Kaiser & Johan Schot, *Writing the Rules for Europe Experts, Cartels, and International Organizations.* Palgrave MacMillan, 2014.

The theme of the Milan conference was public health, but the diversity of the participants reflected the interdisciplinary attention given to the issue. The participants numbered sixty doctors, botanists, engineers, chemists and public health experts from across Europe. The USA was represented by Philip Drinker, the pioneer of industrial hygiene. In addition to presentations by individual participants, an interesting source coming out of this conference was the combination of questionnaires sent to each participating country. These surveys provide a view on how the problem of air pollution was regarded in Europe in different countries and how knowledge about the matter was gathered at the international level. The most striking observation from these questionnaires is that the severity of the air pollution problem was very hard to assess in comparable form. In their attempt to gather standardised information, the EURO officials had asked for mortality statistics on bronchitis, lung cancer and other respiratory diseases, as well as the variations between these figures in urban and rural areas.[297] Once again, the importance of statistics in the diagnosis of modern society is evident.

The downside of this plan was that the methods for compiling mortality statistics differed between countries. In Luxembourg, for example, physicians were not obligated to state the reason of death. In many countries, most notably in Italy, the recent availability of antibiotics had considerably reduced mortality resulting from pneumonia. This invalidated long-term statistics relating to lung diseases. Poland and Greece had practically no statistics at all. Even in countries with respectable mortality statistics, there seemed to be little clear evidence to support the ill effects of air pollution on human health. The only countries where lung disease mortality was higher in urban areas were Belgium and Great Britain. In the British report, however, it is stated that the division between rural and urban areas is not conclusive and should not be paralleled with that of town and country.[298] In the conference report itself it is stated that it is impractical and even dangerous to compare mortality data between countries due to differences in diagnostics and compiling statistics.[299]

The conference report also highlighted that there were considerable difficulties in the evaluation of air quality. Most European countries, including Finland, had no air quality monitoring system at all. Hence, there were no data to show whether air quality had improved or worsened. Britain was the only country in the world where air quality was continuously monitored in several locations. Yet, even the British report stated that it was difficult to detect which way the situation had developed.

297 Tuberculosis was excluded from the list of respiratory diseases, since it was known to be of bacterial origin.
298 Air Pollution in Europe, EURO-114/10, 1957, 1–75.
299 Conference on the Public Health Aspects of Air Pollution in Europe 1957, 9–16.

The British Clean Air Act of 1956 is often seen as an important milestone in the fight against pollution. At the time of the Milan conference this piece of legislation was still in its infancy and it was still hard to tell whether it had had any effect on air quality in the United Kingdom.[300] A common feature in almost all of the reports, however, is the observation that public concern and indignation about poor air quality was rising, and that there was urgent need to do something. Most reports also stated that in all likelihood air quality would worsen as a result of industrialisation and growth.[301] In tandem with their American counterparts, European experts argued that there was an urgent need for more research in order to solve the problem.[302] In other words, the rising concern was driven by public sentiment rather than new knowledge, as had been the case in the United States. Rather than acting as the vanguard in the fight against polluted air, experts struggled to contribute to the issue with their special ways of knowing.

The Finnish report in the conference was presented by Leo Noro, and it contained much of the same material as had been published in *Duodecim* with Laamanen. Actual research and statistics on the subject in Finland were thin, as was the case in most countries, but Noro was quite confident that poor air quality did not pose an acute danger in Finland. Some observations were made near specific industries, such as cement factories, sulphuric acid plants, with their plant-killing effluents, and the notoriously foul-smelling pulp industry. Noro also noted that a survey near a heating plant in Helsinki had found that emissions there were many times larger than the official limits in France for community air.[303] Noro regarded this as an isolated incident and concluded that the emissions from industrial facilities and heating did not have an effect on health because the amounts in outside air were so small. Moreover, some emissions, like the dust from cement plants, were harmless altogether. Odours from pulp factories were known to be unpleasant, but, according to Noro, this was considered an unavoidable byproduct of increasing wealth and the fact that people usually grew accustomed to the "smell of money".[304] Coal burning in domestic furnaces, which was believed to be the main cause of the smog that lingered above London in 1952, was rare in Finland due to extensive use of wood as fuel. Thus, Noro foresaw no threat of similar incidents in Finnish towns. In general, Noro did not deem air pollution to be a pressing concern in Finland in the near future

300 Air Pollution in Europe, EURO-114/10, 1957, 67–75. The Soviet Union apparently had some air quality monitoring systems in its cities, according the to the summary of Soviet situation presented at the conference by Inspector-General of Sanitation in the Soviet Union. See Zhdanov 1958, 267–279.

301 Air Pollution in Europe, EURO-114/10, 1957, 1–75.

302 Air Pollution in Europe, EURO-114/10, 1957,1–75.

303 These is no record of how this survey was completed and by whom.

304 Air Pollution in Europe, EURO-114/10, 1957, 9–14.

because of the country's low population density and relatively low level of industrialisation.[305]

A more acute problem derived from the environmental effects of air pollution. This entailed the harm caused to buildings, crops, forests and livestock. Acid pollutants had caused corrosion in rooftops. Furthermore, large areas of forest and crops had died due to fallouts from sulphuric acid factories. Noro saw these issues mainly as economic and they were also handled in an economic way; namely, factory owners paid out compensation. According to Noro, the practice of paying compensation for damages, along with the need to maintain cordial relationships with the local community, encouraged voluntary action from owners in order to reduce emissions. By utilising more efficient methods of combustion, more efficient use of raw materials and by filtering waste in order to reduce compensation payouts, there had been great advances in air quality near industrial facilities in Finland. In fact, Noro believed that industry and the manufacturers of air conditioning devices had hitherto been the most important promoters of clean air.[306] Noro's account of the effects of air pollutants was in line with the reports from other countries, in the sense that the effects of air pollution on plant life and the material damage it caused were better known and better documented. In other words, in many ways the situation in Finland resembled the overall situation in Europe, despite disparities in levels of industrialisation and population density.

However, the smog disaster of 1952 in London and the state of the air in great cities and industrial areas in Great Britain, Belgium and West Germany provided a dystopian view of industrialisation that could be averted by better control and research. Despite the seemingly good situation in Finland at the time, Noro did not disregard the threat of air pollution to Finnish communities in the future. His report concluded by stating that measures should be taken to prevent future problems that had already been witnessed in large cities of more industrialised nations. Since Finnish communities at the time did not have real problems with their air, they also lacked the means to deal with them in the future, via legislation, research and trained officials. By improving these measures in Finland before industrialisation and urban growth reached the levels of more developed countries, problems with air pollution could be avoided altogether.[307] Once again the idea of the periphery learning from the centre was knowingly applied as a course of action.

The surveys from each country were not included in the published report of the Milan conference. This report summarised the situation by describing air pollution

305 Air Pollution in Europe, EURO-114/10, 1957, 9–14. Wood, oil and gas were considered clean fuels, unlike coal.
306 Air Pollution in Europe, EURO-114/10, 1957, 9–14.
307 Air Pollution in Europe, EURO-114/10, 1957, 9–14.

as "the greatest and most urgent environmental evil facing the peoples of Europe."[308] Despite other environmental aspects, it was concluded that air pollution should be primarily seen as a public health problem and control measures should be designed to prevent the harmful effects of pollution. Conference participants emphasised that immediate action should be taken to prevent a further deterioration of urban air quality, despite the lack of knowledge on the specific health effects of air pollution:

> There was a definite feeling in the Conference that sufficient evidence was available of the evil results of air pollution to justify immediate action, and that control measures should not therefore be delayed until there was proof of such ill-effects.[309]

In other words, the stance adopted in Milan resembles the one Sir Hugh Beaver had advocated, in which the threat of air pollution to public health was an axiomatic truth rather than a puzzle.

However, despite the call for action and the urgency of the need for control measures, the Milan report also highlighted the lack of knowledge regarding health effects as "a serious handicap in the fight against air pollution".[310] Health statistics and studies had not provided a definitive answer and the matter was debated among the participants. Although it is repeatedly stated that a lack of knowledge was no cause for inaction, better knowledge of the specific ill-effects of air pollution was seen as being mandatory in order to attain effective control. Similar to the conferences in the United States, the question of the specific health effects of air pollution was regarded as a puzzle full of gaps that needed to be filled-in with knowledge. As the report stated, "in the light of the present knowledge there are so many 'unknowns' it is difficult to undertake rational methods of prevention and control."[311] Thus, more research was needed, which required not only medical studies, but also a massive increase in the measurement of air pollution. It was particularly emphasised, in the spirit of industrial hygiene, that research on the possibility of using MAC levels for outside air, which was deemed impossible at the time, should be urgently pursued.[312] Whilst the rhetoric was different, the European experts in public health and hygiene seem to have shared a similar stance on air pollution as their American counterparts, in which the rational and effective control

308 Conference on Public Health Aspects of Air Pollution in Europe 1957, 1.
309 Conference on Public Health Aspects of Air Pollution in Europe 1957, 13.
310 Conference on Public Health Aspects of Air Pollution in Europe 1957, 17.
311 Conference on Public Health Aspects of Air Pollution in Europe 1957, 19.
312 Conference on Public Health Aspects of Air Pollution in Europe 1957, 14.

of air quality was only possible through the acquisition of knowledge on the specific health effects of different pollutants.

The idea of air pollution research and control, which was outlined in the U.S. conferences and in Milan, was further embraced in Geneva at a WHO Expert Panel on Environmental Sanitation held in 1958. This was the first time that the WHO environmental health division had examined air pollution as a distinct public health matter. It was also in this panel and in the subsequent monograph that the contours of air pollution research were drawn under the auspices of the WHO. The panel declared air pollution to be a threat to public health, notwithstanding the lack of specific knowledge on the grounds that even irritation should be considered an impairment to health and well-being. The WHO's definition of health was a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. However, the panel argued that there was not enough knowledge to define safe levels for pollutants and that "much more medical and epidemiological research is needed if control of air pollution is to be more soundly based on the need to safeguard human health."[313] This echoed the consensus of opinion at the previous meeting of experts. The strategy to control air pollution through medical knowledge was perhaps explained most clearly by Harry Heiman, a member of the expert panel and chief of air pollution research at the United States Public Health Service. He wrote a report on the health effects of air pollution that would later be included in the monograph published by the WHO.

In his report, Heiman advocates that it is possible to entirely get rid of air pollution and this would probably be good for people's health. There was little doubt that clean air devoid of pollution would be the best to breathe. However, he warned that this would not happen at no cost, since it would entail a drastic reduction in industrial production. This cost, Heiman argued, would be too high to bear, since improvements in health and happiness and the increase in wealth in the modern world was largely due to industrialisation. To solve the dilemma between pollution and prosperity Heiman argued that it was possible to clarify air instead of simply removing all pollutants. This clarification process entailed limiting the content of different substances to such levels that they caused no harm to health. According to Heiman, the only economically viable way to fight pollution was to first verify what substances caused health issues and to what extent:

> If we should contemplate the clarification of the air on a selective basis in the interests of safeguarding human health, then it must first be clearly demonstrated

313 Air Pollution. Fifth Report of the Expert Panel on Environmental Sanitation 1958, 11.

> that there are specific air pollutants (or specific mixtures of air pollutants) that can cause or are causing ill health.[314]

After the health effects of different pollutants were known, they could be compared with economic and other costs. Subsequently, an evaluation would be needed to calculate whether it was feasible to decrease the levels of pollutants. In practice this would mean that extensive analysis would be necessary on all chemicals appearing in the atmosphere and also active measurements would need to be taken on the chemical content of community air.[315] In other words, the same principles that had ensured control of industrial air were now applied to outside air.

This attempt to manage air pollution should be seen as part of the wider rise of environmental regulation via the use of thresholds after the Second World War. Historical studies on environmental toxins have shown how this so-called threshold paradigm became the prevalent regulatory principle until its decline begun in the late 1960s.[316] In examinations of this paradigm, much significance has been given to the discipline of toxicology, which, as Linda Nash has argued, made everything a matter of quantity and in so doing blurred the difference between industrial environments and the environment in general. According to Nash, the same principles of efficiency, rather than health, that governed industrial toxicology were implemented in the research and regulation of air pollution.[317]

Though it is easy to agree with Nash on the diffusion of industrial regulation into the general environment, it may be that toxicology has received an unnecessary share of the blame. It was, after all, a somewhat general statement in all the conferences on air pollution research that toxicological research alone was unable to solve the issue of air pollution. After all, the mere prevention of explicit toxic effects would not make air harmless or even safe in the long term. Many emphasised the need for physiological research in order to observe the more subtle effects of each substance. The summary of the Milan report stated that the potential long-term effects worried the participants, in spite of the reassuring results from toxicological research. Similarly, the use of questionnaires to try and ascertain the subtle subjective irritation of polluted air was recommended by the Milan conference.[318] Rather than seeing industrial toxicology as the main culprit, it could be said that the aims the experts pursued, namely, to make industrial air safe and outside air tolerable were both based on the same idea of rational management by objective knowledge.

314 Heiman 1961, 209.
315 Heiman 1961, 209–210.
316 Homburg & Vaupel 2019, 11–28
317 Nash 2008, 652–654.
318 Conference on Public Health Aspects of Air Pollution in Europe 1957, 9–16.

As Heiman's account highlights, air outside factory walls was an economic matter in the same way as air inside factories. Uekötter has argued, however, that the idea of the 1950s being dominated by economic and industrial interests over the environment is a myth. As his study shows, people in the United States and West Germany were actively concerned about air pollution in the 1950s, but they saw no reason to choose between clean air or prosperity as a more prosperous society could also afford cleaner air.[319] Likewise, historical studies on the WHO and social medicine have also shown that for many of those concerned about the overall wellbeing of people it was economic prosperity and industrialisation, not vaccines, antibiotics or hospitals that they believed would eventually free people from the dirt, poverty and ignorance that plagued them.[320] It was a dilemma inside public health bodies because pollution—whether it be in the air, water or land—was an unwelcome byproduct of what was regarded as the most powerful form of preventive medicine: the industrialisation of society. Thus, the axiomatic truth that polluted air was not good for health was juxtaposed against the notion that the means to control the environment in modern society required the acquisition of rational knowledge on the specific harms of certain pollutants. It was not merely the ways of knowing developed in toxicology but the more fundamental need for certain kind of knowledge in modern environmental regulation that formed the underlaying logic in the expert fight against air pollution.

Seeing air pollution research as a form of scientific management of the environment also puts the novelty of the post-World War Two air pollution research into perspective. It could be argued that this approach was a continuum rather than a break from the longer tradition of perceiving air pollution as a technical issue. Thorsheim has shown how coal smoke in nineteenth-century Britain was seen as a technical problem and not something inherent in modernisation and the industrialisation of society itself. He argues that this was the essential reason why problems related to coal smoke were not successfully dealt with. Advances in science and technology were trusted to solve the problem of pollution without the need for fundamental changes in industrial society.[321] Similarly the strategy of 'clarifying the air', although it was grounded in a concern for health rather than economics, also shared the belief that problems related to industrialisation could be used to by the accumulation of knowledge and know-how.

For Noro and the Finnish Institute of Occupational Health, air pollution research represented a discipline that fitted perfectly with the institution's efforts to help manage modern industrial society in Finland in a rational way, taking into account

319 Uekötter 2009, 262.
320 Farley 2009, 111–114.
321 Thorsheim 2006, 106.

both human well-being and efficient production. Noro was partly right in stating that air pollution research was a natural continuum for industrial hygiene measurements. It appears that in practice, the FIOH was not particularly interested in ambient air quality before the Milan conference in 1957. In principle, however, the research on air pollution carried out by the FIOH was in many ways a continuum of industrial hygiene studies. It has been viewed as somewhat peculiar that air pollution research in Finland began in an occupational health institute.[322] This peculiarity disappears when the connection between industrial hygiene and air pollution is recognised. Whilst it is true that air quality research was mainly carried out by public health institutions of some form in other countries, the knowledge and expertise about the health effects of air pollution came from the industrial health sector. Thus, the pioneering status of the FIOH should be seen less as an oddity than as a representation of this connection at an institutional level. This was due to small academic circles and a lack of decent public health institutions in Finland. The idea that perhaps the FIOH was not the right institution to conduct air pollution research would only become prevalent in the late 1960s, amidst wider competition for expertise related to the rising status of environmental matters. In the late 1950s, however, the main problem of the nascent air pollution research carried out at the FIOH was to find someone willing to subsidise such studies. This occurred in 1959, as the authorities in Helsinki decided to commission a study on ambient air quality in the city.

322 Kulmala 2006, 32–33; Lahdes 2006, 61; Vuorinen & Mussalo-Rauhamaa 2020, 245.

## 3.2 First Investigations of the Air in Helsinki

A few months after the Milan conference on the public health aspects of air pollution, an investigation into the air quality of Helsinki was ordered by the city's real estate committee.[323] This investigation, conducted by the Finnish Institute of Occupational Health in 1959, is regarded as the first scientific study on air pollution in Finland. Contemporary accounts by FIOH researchers emphasised the modernity of the study and how it raised the level of Finnish air pollution control closer to the level of most other European countries.[324] Environmental historians have argued that the study came about because of international influence: due to rising concern within the WHO and the participation of Noro in the Milan conference. It has been posited that this investigation was the first step in Finland towards a more objective understanding of outdoor air pollution and a step away from older, vaguer practices of evaluation.[325] As such, the beginning of air pollution research at the FIOH can be seen as part of the development towards a more exact knowledge of the relationship between humans and their environment. After all, scientific knowledge has been regarded as a necessary, though insufficient reason, for recognising environmental threats, such as air pollution, and for the overall rise in environmental concerns in the 1960s.

Yet, rather than viewing air pollution measures simply as progress towards better knowledge of the environment, the topic should be examined from the viewpoints of the history of science. As scholarship on expertise, power and scientific methods has shown, to view science simply as a producer or a discipline that seeks objective knowledge gives an inadequate impression of its historicity, its connections and alliances in society and the constructivist nature of knowledge as a whole.[326] In their study on the social history of air pollution, Charvolin *et al*. argued that the institutionalisation of air pollution measurements since the 1950s in France was a political as well as scientific endeavour in which the knowledge of the environment was monopolised and distanced from the sensescape of common people.[327] Their study shows how the development towards a more objective and precise understanding of air pollution contains societal dimensions other than a mere accumulation of knowledge.

The purpose of this chapter is to examine more closely both the motives and the significance of the investigation of air pollution in Helsinki. By taking a closer look at the form and content of the investigation, and by comparing it to other practices

323 Records of the Real Estate Committee, 31.3.1958, HCA.
324 Noro 1959, 156.
325 Nienstedt 1997, 45; Mattson 2001, 189; Lahdes 2006, 60–61; Schönach 2008, 144.
326 See, for example, Bruno Latour, *Politics of Nature: How to Bring the Sciences into Democracy*. Translated by Catherine Porter. Harvard University Press, 2004.
327 Charvolin *et al*. 2015, 13–16.

employed to evaluate air pollution at the same time, it is possible to see beyond the mere notion of modern science and examine the change and significance of this form of knowledge acquisition. In other words, the important question to pose is not how the modern scientific research of air pollution was appropriated into Finland. Instead, one can ask why this particular form of studying pollution was seen as necessary and what significance it had on knowledge of medicine and the environment. Rather than perceiving this development as simply an increase of knowledge and know-how, it should be examined as the rise of a certain way or ways of knowing in terms of defining and controlling a phenomenon that connects the environment, health and society.

## Observing Smoke and Dust in the Air

The 1950s can be regarded as a milestone in the history of air pollution control, in the sense that it was in this decade that continuous measurement of air quality began to take root in many European countries and in the United States. Whilst many of the early measurement networks in France, West Germany, and the United States consisted of only a few apparatus in central cities, they can be regarded as the beginning of more widespread networks related to the monitoring of air quality that would be established in the 1960s. Furthermore, the 1950s also witnessed the establishment of expert associations and journals in many countries that were devoted to the study of air pollution.[328] The research conducted regarding air quality in Helsinki in the late 1950s was therefore part of a wider increase in the measurement of air pollution and the institutionalisation of this expertise in Europe and the United States.

It is important, however, to separate the post-World War Two concerns over the potential health effects of air pollution from the older tradition to evaluate air quality. Although the potential health effects of urban air had been a debatable issue, there had been a continuous inclination to control and evaluate air quality, with regard to economic and aesthetic effects, at least since the nineteenth century. As Thorsheim has shown, the early attempts to abate smoke in British towns were riven with disagreements over the amount of smoke.[329] This ambiguity was attempted to solve by various technical means to measure smoke objectively.[330] Two of the most famous and widespread techniques to evaluate smoke were the Ringleman Scale, developed in Paris in the late 1880s, and the deposit gauge invented in early twentieth-century Britain. The Ringleman Scale was essentially a standardised means of visually

328 Mosley 2009, 273–302; Uekötter 2009, 129–140; Charvolin *et al*. 2015, 15–18.
329 Thorsheim 2006, 28–70.
330 Uekötter 2005, 12.

evaluating the blackness of smoke. This had obvious limitations, but was widely used at least in the United States and Germany.[331] The deposit gauge, on the other hand, was a large rain gauge that was able to gather falling particles, later to be analysed in laboratory.[332] The purpose of both of these techniques was to bring objective facts to the contested matter of air quality.

There is no record of either the Ringleman Scale or deposit gauge being used in Finland in the early twentieth century, although a smoke inspector was established in Helsinki in 1901 in imitation of a similar office in Munich. The Helsinki smoke inspector was apparently established in response to a rising level of complaints concerning smoke in the city centre. The office of the inspector only lasted for a few years and there seems to have been little renewed interest in such expert evaluation until the late 1950s.[333] However, Finland had followed the examples of Great Britain and Germany in matters of hygiene and public health. Hence, municipal public health boards had been established in the 1870s and their responsibility was to safeguard environmental sanitation. This jurisdiction was further emphasised in the 1927 health care law, which banned the release of impurities into the air that could pose a danger to health.[334] Thus, the evaluation of air quality primarily rested on health boards and their inspectors, who sought to control air quality among other aspects of sanitation. As it happens, in the same year as the FIOH conducted its research on air quality in Helsinki, the local public health board inspectors were ordered to investigate complaints made by people living near the Paulig coffee factory. This case serves as an example of the more or less routine evaluation of air quality that was conducted by health officials in the city in comparison to the research of the FIOH. By comparing these cases, it is possible to examine different ways of evaluation and put the novelty and objectivity of the FIOH research into perspective.

In their complaint to the health board, the residents living near the Paulig factory claimed that the effluents from the plant fouled the surrounding air and affected their health. The board began to investigate the complaint and housing inspectors were ordered to evaluate the source and quantity of emissions from the factory. Conveniently, the office of the housing inspectors had a good view of the Paulig

331 Uekötter 2005, 19–22.

332 Brimblecombe 1987, 147–148.

333 Schönach 2008, 46–49. Schönach has noted that historical studies give a conflicting view of the Finnish environmental discussions in the interwar period. On the one hand, she highlights a declining interest, and, on the other hand, the rise of the hygiene movement and a concern for a clean environment.

334 Schönach 2008, 140–141. Individual citizens could also sue polluters in a civil court in relation to a law about neighbourly relations. However, this law was rarely used and never against major industries. See Harjula 2003.

factory. Based on a month-long observation of the factory, undertaken mainly through office windows, the inspectors concluded that the main source of the nuisance seemed to be the emissions from the roasting plant.[335] The inspectors further noted that the pipes of the plant regularly emitted white steam that sometimes fell near the ground and left brown dust on snow and the windows of nearby houses. In her report, the inspector recommended higher pipes or some other technical method to filter the steam. She admitted that raising the pipes would not solve the problem entirely. However, she concluded that the district in question was so heavily industrialised that residents should probably not expect a similar level of air quality as in more recently-built neighbourhoods.[336]

The Paulig Company responded by arguing that they had already made every possible effort to decrease the nuisance to nearby residents by purchasing state-of-the-art roasters from the United States and an effective cyclone system that completely separated solid particles from effluents. In addition, the pipes of the plant had already been raised to the maximum height possible for maintenance and sweeping.[337] The final word on the case came from the city hygienist. He agreed with the inspectors and stated that the cyclone system did not seem to be as effective as the Paulig company claimed, since brown dust was visible in the snow and on windows. He saw the smell and steam as the primary reasons for complaints and ordered Paulig to contain the smell as much as was technically possible. He also stated, similar to the first inspector, that the air in Helsinki contained so much dust and soot that the effluents from the coffee factory should not be seen as a special nuisance. It was also clear that this dust was not dangerous to health in the sense that would necessitate the relocation of the factory away from residential areas.[338]

Considering this case, one's attention is drawn to the rather subjective and casual evaluation methods that were employed to determine the significance and source of air pollution. The judgement of the hygienist was based merely on his observations and experience of outdoor air in Helsinki. It is not hard to imagine how this subjectivity and vagueness was seen by the parties as the underlying problem that they hoped to solve through more objective and sophisticated measurements. As Harjula and Schönach have argued, the difficulty of proving the ill effects of impurities in the air limited the use of health care laws to abate air pollution.[339]

335 Appendix 5, Records of the Public Health Committee, 1958, HCA.
336 Appendix 5, Records of the Public Health Committee, 1958, HCA. Heavy industries had been largely absent from the city centre since the 1930s. The main polluters in the 1950s were small industries, such as the Paulig factory, heating, and traffic.
337 Appendix 6, Records of the Public Health Committee, 1958, HCA.
338 Appendix 7, Records of the Public Health Committee, 1958, HCA.
339 Harjula 2003, 181; Schönach 2008, 140–141.

It should be noted, however, that the principal aim of the inspectors and the hygienists was not to evaluate the amount of dust in the air, but to gauge the level of nuisance it caused. The hygienist agreed that emissions from the factory caused a nuisance to local residents and that actions should be taken to reduce them. At the same time, the fact that air in industrial areas was more or less polluted was deemed a normal state of affairs, making demands for clean air all but unattainable. As an oral history survey on the state of air in Helsinki indicates, smoke and foul smells were a rather common feature of the urban sensecape.[340] The residents' complaint, on the other hand, was about the impact on their health of emissions from the Paulig factory. This possibility was not even considered in any detail, most likely because dust from coffee roasting was not on any list of hazardous substances. In other words, the conflict in this case lay not in the observations but in the judgements of what was unreasonable and unhealthy in regard to air quality.

The Paulig coffee factory case is an example of the dilemma that had been inherent in smoke abatement and other attempts to control urban air quality. The right to air devoid of unreasonable pollutants was confronted by the technical and economic limitations in the production of goods, heating and energy in modern society. The Paulig factory had already embraced the practice of lowering impurity levels by adopting the best practical means at the time, after which there was little that could be done, save for the relocation of the plant. A more precise measurement of the amount of emission from the factory would have brought little help to nearby residents. This was one reason why extensive measurements were deemed unnecessary by U.S. smoke abatement activists in the early century.[341] In contrast, as already noted, the nascent air pollution research that focused on the health effects of air quality was particularly interested in the amount and quality of the impurities in air. As in industrial hygiene, the chemical composition and quantity of different substances in the air was key to the clarification of the air.

However, the first attempt to examine this question in Finland did not come from the FIOH. Their research on air quality in Helsinki was preceded by a narrower and less well-known study carried out by chemists and pathologists under the auspices of the department of chemistry at the Helsinki Institute of Technology. Rather than examining air quality as such, the study focused on exhaust fumes from diesel engines in Helsinki. The use of diesel vehicles increased in the 1950s due to the gradual use of private cars in general and also due to the expanding public transport network that included many diesel buses. Complaints about irritating fumes and dense black smoke coming from diesel engines increased in the 1950s. By 1957 the problem reached a critical stage and a decree was passed that forbade offending

340 Kivistö & Laakkonen 2001, 152–164.
341 Uekötter 2009, 129.

emissions, albeit with little impact.[342] Thus, increasing exhaust fumes from cars served as the motivation of the study. Since the study is extensively referenced, it is possible to see the research traditions and individual studies that served as guides. The interest of these chemists in diesel smoke was based on studies predominantly undertaken in the United States and Great Britain on the health effects of car exhaust emissions.[343] The expansion of private car use in many countries, and especially in the United States, had made automobile exhaust emissions a growing point of research in all fields interested in the health effects of chemical substances.

As seen in the first chapter, petrol engines were already being studied in the 1940s, due to the carbon monoxide they emitted. It was commonly assumed that since diesel engines emitted no CO, they were safer and also less polluting in general. However, as the study explained measurements undertaken in urban streets and analysis carried out in laboratories had shown that diesel motors were in practice the worst polluters of their type, even though, in theory, this should not have been the case. In practice, poor maintenance and adjustment meant that diesel engines emitted visible smoke that contained nitrogen oxides and aldehydes that caused irritation, making them a particular nuisance. Furthermore, the study emphasised the carcinogenic potential of diesel smoke, which could potentially be a serious public health hazard.[344] This fear was predominantly based on studies undertaken by the pioneering U.S. cancer researchers Paul Kotin, and Hans Falk. They had examined the possible environmental causes of cancer and focused on emissions and air pollution. In their studies on diesel exhaust emissions, Kotin and Falk had demonstrated that the smoke contained polycyclic hydrocarbons that were shown, in laboratory tests, to cause cancer in mice.[345] With this in mind, the chemists of the Helsinki School of Technology undertook measurements of the amount of diesel smoke in the streets of the Finnish capital and the level of carcinogenic material in order to evaluate the potential threat to public health.

The background to this diesel study shows how interest in the health effects of air pollution came not only from the fields of public health and industrial medicine, but also from the more specialised field of chemical carcinogenesis. This field of research is usually traced back to cancer studies carried out by Ernst Kennaway in the 1920s. Though it was marginal in cancer research for a long time the study of

342 Schönach 2008, 65; The national reports delivered at the Milan conference show that the kind of nuisance laws that were designed specifically against car exhausts had been implemented in many European countries, but were deemed to be rather ineffective. In Belgium, for example, a similar law had never been enforced. See AFIOH, National Reports from the Milan Conference 1957.

343 Kajanne & Laiho 1958, 193–198.

344 Kajanne & Laiho 1958, 193–194.

345 Kotin *et al.* 1955, 113–120; Falk & Kotin 1957, 12–14.

chemical carcinogenesis generated a particular form of laboratory research based on the isolation of chemicals and animal testing.[346] This practice became an important part of the experimental cancer research that was conducted in Finland in the 1950s, most notably by Kai Setälä, a professor of pathology. It seems that the diesel study authored by colleagues of Setälä formed part of a wider project on cancer conducted by the Institute of Technology and the department of pathology at the Helsinki School of Medicine.[347] In other words, while the study of chemical carcinogens became part of air pollution research in the U.S., a similar scientific trend was emerging in Finland.

The results of the diesel study were rather unencouraging, as the level of impurities in Helsinki was deemed to be higher than the average rates in similar-sized cities. Cars were also stated as being the primary polluters in urban settings. The chemists were especially concerned over the amount of carcinogenic material in the air and recommended swift action to prevent further danger to human health. The authors emphasised that although there was no direct evidence between increasing rates of cancer and the inhalation of polluted air, this did not mean that exhaust emissions from cars was harmless. In addition, they noted that any attempt to clinically observe the effects of the impurities would be difficult, since the human body has mechanisms to transport chemicals. Thus, they are potentially able to cause harm far from the initial point of contact.[348] This concern over airborne carcinogens resembles the arguments made by Wilhelm Hueper, a U.S. occupational medicine expert whose ideas would become important for the pioneering environmentalists in the 1960s.[349] He had begun to argue already in the early 1950s that air pollution was a significant cause of cancer. According to Hueper, too much weight was laid on the unknowns in the specific mechanism and etiology of cancer, and not enough weight on the fact that forms of cancer with no clear cause were increasing at the same time as carcinogens proliferated in the environment.[350] The diesel study makes no direct reference to Hueper, but it seems to embrace a similar concern for environmental carcinogens even at minute levels, despite the lack of direct evidence.

In United States the awareness of environmental carcinogens was fairly widespread by the 1950s and this concern would later become central to the environmental movement of the late 1960s. However, despite its rather alarming

346 Armon 2012, 153–167.

347 See, for example, Setälä, Kai: Experimental Chemical Carcinogenesis and the Influence of Solvents: Research in Finland. *Nature* Vol. 174, 873–875 1954.

348 Kajanne & Laiho 1958, 193,198.

349 In fact, Hueper's magnum opus, *Occupational Tumors and Allied Diseases* (*1942*), became an important source for the environmental movement and he was regarded as pioneer of environmental cancer in Rachel Carson's *Silent Spring*. Patterson 1987, 187–191.

350 Hueper 1952, 479–485.

message the diesel study apparently attracted little attention in the late 1950s Finland and was not noted outside expert circles. According to Schönach, the study only became better known during the subsequent FIOH study that received more attention in the press.[351] Despite this, the study serves to show how Finnish air pollution research did not develop in a linear fashion from observing nuisances towards an examination of more and more subtle health effects. Due to their interest in the research of chemical carcinogenesis, the authors of the diesel study focused on the potential danger of long-term exposure before any attempts from the FIOH or the municipal authorities to measure air quality. Moreover, they apparently had no relation to the WHO or the air pollution conferences. The study of chemical carcinogenesis had its roots in occupational medicine, but it was also part of medical research of cancer with its own disciplines and institutions. For some reason the Institute of Technology did not continue research on air pollution and the diesel study remained an isolated case, although its authors continued their research of cancer. In short, the carcinogen-focused view on air pollution research did not take root in Finland and the Institute of Technology did not gain any significant position of expertise on air pollution.

Before examining the FIOH study of Helsinki air, one other study must be taken into account, which has not been regarded as part of air pollution research in historical studies. This study was also carried out in the FIOH, but it was undertaken in the department of physiology with the assistance of the new statistical section. This new branch was founded by Jaakko Khilberg, a mathematician who had studied biometrics in Great Britain, and he seems to have been a fervent supporter of statistics as the only true method of science.[352] In 1957, Khilberg and Matti Karvonen, the head of the physiology department, conducted an epidemiological study comparing the occurrence of chronic bronchitis in Finland and Great Britain. Karvonen later noted that the poor state of air in British cities and the miners suffering from chronic bronchitis that he had witnessed first-hand during his visits to the Pneumocosis Research Unit in Cardiff provided the incentive for him to undertake comparative epidemiological research on bronchitis.[353] Karvonen and Khilberg came to the conclusion that the reason for the high levels of chronic bronchitis in Britain was probably due to air pollution that irritated respiratory organs. This idea was supported by a previous comparative statistical study in which the levels of bronchitis mortality in European countries seemed to correlate with levels of industrialisation.[354]

351 Schönach 2008, 147,151.
352 Khilberg 1950, 781–782.
353 Karvonen 1991, 30–33.
354 Karvonen & Khilberg 1957, 689–696.

Despite the close connection to air pollution, this study seems to have elicited no discussion on the quality of air in Finland. After its publication in *Duodecim,* the study was criticised for the manner in which it compared mortality statistics between different countries. Critics pointed out the ambiguity of asserting cause of death, since doctors often only examined the final symptoms before death, thereby ignoring the more fundamental causes of weakened health. In addition, it was argued that the recent "heart awareness" among Finnish doctors had distorted mortality statistics towards causes related to heart problems.[355] This discussion again shows the difficulty in being able to examine prolonged health effects and multiple causes from medical statistics alone. The effects of air pollution were not specifically denied, but neither did they cause any alarm vis-à-vis Finland. Air pollution remained a problem in more industrialised countries. Studies on air pollution and bronchitis were not continued and the FIOH's physiology department focused largely on heart disease, which seemed, according to mortality statistics, to be a significant public health issue.[356] Thus, although a few studies preceded the air quality research of FIOH, they did not have a lasting impact and remained solitary examinations.

## The FIOH Investigation of Air in Helsinki

After the Milan conference of 1958, a new kind of interest in air pollution became evident at the FIOH. Noro instructed one of his employees, who was studying in the Netherlands, to find out everything necessary about 'air pollution' equipment and the opinions of local experts.[357] He also sought funding from a private foundation for a research plan entitled "Air pollution and Health", apparently with no success.[358] The first opportunity for the FIOH to conduct air pollution research came in 1958, when the real estate committee of Helsinki City Council suggested that there was a need to investigate air quality in the city. Whether this proposal had anything to do with nascent interest in air pollution in the FIOH is difficult to say. The proposal of the real estate committee was based on complaints about soot from small industries and the death of coniferous trees in newly-built neighbourhoods of Helsinki. The proposal stated that there was a need to undertake a preliminary survey in order to determine if special measures were necessary to abate pollution. The survey would,

355 Ohela 1958, 265–267; Karvonen & Khilberg 1958, 458–463.

356 A special incentive was provided by the studies of cholesterol studies carried out by Ancel Keyes in eastern Finland, which ultimately grew into an international comparative study with tremendous influence on public health policies regarding dietary habits. See Karvonen 1991.

357 Noro's letter to Lehtinen 15.5.1958, AFIOH. Noro often uses the English term 'air pollution' rather than a Finnish equivalent, which signifies the novelty of the concept.

358 Noro's Letter to the Finnish Cultural Foundation 16.5.1958, AFIOH.

they hoped, enable a comparison to be made between air pollution in Finland and foreign norms, thereby providing reliable standards of evaluation. The Institute of Occupational Health was chosen to conduct the survey due to its experience in measuring impurities in the air and its close scrutiny of air pollution research abroad.[359] Schönach argues that the FIOH had already established a position as a centre of expertise in environmental measurements, due to the examinations of noise and smoke it had undertaken on behalf of private citizens.[360] It appears that the diesel study had not gained the Institute of Technology any currency in this matter.

No mention is made of potential health effects in the initial proposal, but it was sent to the public health committee for comments. The real estate committee seemed most interested in dead trees that had presumably been killed by impurities in the air. There was little new in the fact that smoke and fumes killed vegetation. Indeed, botanists had observed the loss of lichens and coniferous trees in Helsinki since the nineteenth century.[361] Botanist Vilho Vaarna carried out a survey on lichens in Helsinki in 1934, in which he concluded that great sections of the city centre were deprived of any lichen, though they were common in more rural areas. Vaarna suspected that the reason behind this stemmed from noxious vapours emitted by traffic.[362] The fact that central Helsinki had been uninhabitable for lichens since at least the 1930s seems to have had little effect on smoke control or on views of the potential public health significance of air quality. As seen in the case of the sulphuric acid industry in Harjavalta, the death of vegetation was of little concern to medical experts, even though lay people seem to have viewed it as a threat to health.

What apparently made the difference to the real estate committee was that the dead trees were not in the city centre, but in the district of North Haaga. This was a new suburb that had been constructed in the 1950s as a separate area to the city and that was enclosed by forests. In contrast to the suburbs that would be built for the rural population that moved to urban areas in the 1960s, North Haaga was designed to be a clean, leafy neighbourhood for urban, middle-class families.[363] According to Laura Kolbe, this neighbourhood represented a modern, urban way of life with its strong emphasis on functionality, hygiene, cleanliness and healthy ways of life in general.[364] The dead trees in this green, middle-class area presumably attracted more attention than in the constantly dusty city centre and in industrial districts, as in the case of the Paulig factory. Although air pollution was not perceived to be as

359 Record of Real Estate Committee, 31.3.1958, HCA.
360 Schönach 2008, 150.
361 Hosiaisluoma 2001, 196–206.
362 Vaarna 1934, 1–29.
363 Roivainen 2001, 138–141.
364 Kolbe 2007, 32–38.

dangerous to health, as such, fresh and clean air was still perceived as an important promoter of good health in middle-class views of hygiene. Furthermore, historical studies on air pollution abatement have shown that middle-class districts often had more capabilities to protest against environmental pollution.[365] In comparison, it is also argued that working-class people, who were tormented by bad environmental conditions, developed a fatalistic relationship with the issue, which has made their presence in environmental history less visible.[366] In other words, it seems that the rising concern for air quality in Finland at the time derived in large measure from the changes in urban living that took place in the 1950s in which a clean environment was emphasised. Once again, the concern for unhealthy air came not from experts but from people who view dead trees unacceptable and as a sign of an unhealthy environment.

In its comment on the proposal, the public health committee concurred that air pollution was a rising concern in industrialised societies and that the 1952 great smog in London had increased attention on the matter, at least in the United States and Great Britain. No mention is made of potential health effects, but the committee describes the many forms of nuisance that different impurities in the air may cause to both people and the environment. Numerous complaints had also been received from people irritated by emissions from small industries in the city centre. The comment concluded that experience had shown that the air in Helsinki was not polluted in the same way as in large, industrialised cities. Nonetheless, attention should be given to the issue. As there had been no studies on the air quality of Helsinki, the committee agreed with the initial proposal to order an investigation from the FIOH.[367] There is no sign of any change of attitude towards the health effects of air pollution, notwithstanding the references to London smog. The committee embraced the same cautionary view as Noro had articulated in his report in Milan. The (in)famous smog disasters seem to have merely led to a more grounded fear for the future quality of Finnish air at a time when industrialisation and the population were continuing to grow. The essential thing, however, was to gain objective and comparable knowledge of the situation.

Thus, the FIOH survey was conducted between 1958 and 1959 and published in a Finnish chemistry journal in 1961. The description of the sampling techniques shows that the study was primarily based on British technology. FIOH researchers

365 See, for example, Strandling 1999. For the connection between environmentalism and suburbanization see Christopher Sellers, *Crabgrass Crucible: Suburban Nature and the Rise of Environmentalism in Twentieth-century America*. University of North Carolina Press, Chapel Hill 2012.

366 Laakkonen & Vuorisalo 2019, 288–289.

367 Record of Real Estate Committee, 26.7.1958, HCA.

sampled dust fall and rain in five locations using the British Standard Deposit Gauge, which was a standardised version of the device developed in the early twentieth century. It formed the backbone of the British air pollution monitoring system and was valued for its ability to produce comparable results in different locations. In addition to falling soot and dust, FIOH researchers measured so-called suspended particles with an electronic suction pump that drew in air through a filtered paper into a liquid.[368] This filtering device was technically more complex and more difficult to use than the deposit gauge, but it was also a standard instrument that had been part of the British monitoring network for decades.[369] As in the case of industrial hygiene discussed in the first chapter, the beginning of Finnish air pollution research shows the significance of standard instruments as a means to imitate research practices and produce comparable results. The importance of simple instruments can be compared to another case of nascent air pollution research in France. According to Frioux, there was an attempt in Lyon in the 1930s to imitate the British air pollution monitoring, but this effort was unsuccessful due to technical difficulties.[370] In short, FIOH researchers adopted a smaller version of the British air pollution monitoring network, which had been made into an export product in the same way as U.S. industrial hygiene.

The techniques of the FIOH air pollution study show how research on air pollution was, in practice, still very much tied to the concerns and practices of the so-called age of smoke. In other words, it did not constitute a pioneering inquiry into the public health aspects of urban air quality. Measuring the amount of dust fall, smoke and even sulphur dioxide in the ambient air were practices that had been mainly developed with regard to material damage and nuisance. As Peter Brimblecombe has shown, British scientists in the late nineteenth century had already begun to note that measuring soot with deposit gauges only provided a partial view of air quality.[371] From a medical point of view the measurement of falling soot and dust was even more questionable, since observations from occupational medicine had shown that such particles were too large to penetrate the defences in respiratory tracts. Hence, they posed little threat to lungs. Angela Gugliotta has shown that this problem was understood in 1920s Pittsburgh, when the Mellon Institute began to measure suspended particles instead of soot, with inspiration from industrial hygiene and the utilisation of MAC values.[372] This effort was short lived and largely unsuccessful. Consequently, deposit gauges remained the backbone of

368 Jormalainen, Laamanen and Lehtinen 1961, 152–153.
369 Brimlecombe 1987, 151–153.
370 Frioux 2019, 228.
371 Brimblecombe 1987, 151.
372 Gugliotta 2004, 102–108.

air pollution measurement, despite their limited value to medical research. The measurement of suspended particles and sulphur dioxide had already been added to the British networks in the 1930s in order to widen the air pollution sample. Yet, these measurement practices were also not designed from a public health perspective. As Brimblecombe has noted, sulphur dioxide was measured early on because of the damage it was believed to do to buildings and vegetation as it oxidised into sulphuric acid.[373] In other words, the practices developed by British atmospheric scientists at the turn of the twentieth century, which are often regarded as being pioneering in terms of air pollution measurement, were designed to give a comprehensive and comparable picture of air quality. Nonetheless, the 'air pollution' that these practices revealed was not necessarily the most significant aspect of air quality from the perspective of public health.

The FIOH researchers were by no means alone in their imitation of British measurements. It became clear at the International Clean Air Conference held in London in 1959 that many countries had adopted the same methods and had primarily undertaken measurements of dust fall, smoke, and sulphur dioxide. Whilst the participants were mostly concerned with standardising these measurements, some emphasised the limited knowledge provided. As one D.H. Grindell stated:

> The opacity of a chimney discharge measured by light obstruction instrument, the gross weight of solid particles determined, often tediously, by gas filtering and smoke darkness defined by the Ringleman Scale are not strictly factors of primary importance in the study of air pollution, for they are not directly related either to its basic characteristics or to its most tedious consequences. The dispersion of airborne particles, their fog-inducing tendencies and their detrimental effects upon health are governed more by size distribution, surface area and fundamental chemical and physical properties of the impurities.[374]

Grindell refers to the basic facts of occupational medicine and hygiene; namely, that it was the size, sharpness and chemical quality of impurities that constituted the main factors by which their potential danger was evaluated. There was, however, no cheap and reliable way to analyse these properties, as Grindell admitted when a member of the National Coal Board of Britain asked why, in this case, the optical and gravimetric methods were still so widely used.[375]

373 Brimblecombe 1987, 153–154.
374 Grindell 1960, 135.
375 The Proceedings of the Diamond Jubilee International Clean Air Conference, London 20–23 October 1959, Rapporteur's reviews and discussions on the paper, 258, 261.

This apparent gap between the concerns for the health effects of air pollution and the practices of its measurement were also noted in the same year by Benjamin Linsky, a Californian air pollution expert in a speech at the annual conference of the Air Pollution Control Association (ACPA). Linsky emphasised the significance of many novel instruments and techniques that were often not initially developed for air pollution research at all. Such instruments and techniques had brought to light new kinds of threat and had provided new ways to assemble and communicate knowledge. Despite this, Linsky argued that most cities operated on the logic that "if you measure and measure and measure the pollutants long enough, they will get up and walk away."[376] He further wondered how the recent research on the health effects of air pollution was surprisingly similar to the great study made on the air pollution of Chicago in 1915.[377] Thus, although the clear concern for the various potential health effects of air pollution was a new feature in the 1950s, the measurement of air pollution was still tied to older, well-established practices. This was also the case in the study of the air in Helsinki, even though it was made by the industrial hygiene department of the FIOH. It seems that air pollution measurement was far from simply entailing the transfer of the study of air quality from factories to the streets.

Measurement techniques, however, were not the sole concern of the FIOH study. In fact, the description of procedures to measure air pollution only warrant a minor place in the published study, while 90% of the report consists of graphs and tables that display levels of pollution between different locations, as well as their development over time, averages, peaks and relationship to seasonal weather. Of the five hundred different analyses made, some twenty tables and graphs were produced in order to chart the spatial and temporal change of dust fall, suspended particles, sulphur dioxide, chloride, and calcium.[378] The primacy of these tables and graphs might seem to be a mere way of showing the results of measurements. However, as the historical study on statistics has shown, the ability to efficiently provide general views by comparing single events should not be taken for granted. An important aspect of modern managerialism and state bureaucracy has been the quantification of societal spaces and events, combined with the ability to use statistical methods to create a whole comprised of equivalent single events.[379] As Alain Desrosieres has shown, the rise of statistical and numerical management was indivisible from the creation of political spaces of equivalence.[380] With statistics, the individual

376 Linsky 1959, 348.
377 Linsky 1959, 348.
378 Jormalainen, Laamanen and Lehtinen 1961, 153–164.
379 See, for example, James Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. Yale University Press, New Haven 1998.
380 Desrosieres 1998, 324–326.

measurements could be compiled into a form that represented both spatial and temporal changes in air quality. At the same time, air pollution began to take its expert form, defined by things that could be measured and counted and expressed in comparable form.

This significance of the statistical representation of air pollution has received relatively little attention in historical studies. Historical accounts have emphasised the development of chemical analysis, measurement techniques and toxicological experiments, with surprisingly little attention given to statistical representation as a way to produce quantified knowledge about society and for societal planning. Stephen Mosley has argued that the large statistics produced by the British air pollution monitoring network were deemed counterproductive, and that the policy makers in British towns did not like the idea of their air quality being compared to that of other towns.[381] Mosley's account is supported by the chief public health inspector Walsalla, who stated in the 1959 conference in London that "many of the statistical records in connection with atmospheric pollution were not in a form that tended to gain the confidence of the public."[382] He argued that people were distrustful of statistics and proposed that those forms of measurement should be used that clearly show people the quality of air, such as a filter paper blackened by smoke.[383] Nonetheless, in the opening address at the same conference, meteorologist Sir Graham Sutton emphasised the importance of statistics and numbers stating that "practical men can do little without figures, and it is the job of the scientist to supply the figures."[384] It could be argued, that the increasing use of statistic contributed to the process in which, as Charvolin *et al.* have argued, air quality matters were distanced from the sensescapes of the public.

In fact, it seems figures were just what was expected from the FIOH's study as the real estate committee's proposal explicitly stated the need for comparable knowledge. In its comment on the proposal, the public health committee also called for objective knowledge that could be used to compare the local situation to either standard norms or situations elsewhere.[385] The statistical view of the state of air differed from the case-by-case evaluation by hygienists, as numerical results could be compared to pre-given norms or results elsewhere. Moreover, this comparison allowed something about the nuisance caused by air pollution to be deduced. For reasons unknown, this comparison was not carried out openly in the published study. The study merely stated that air in

381 Mosley 2009, 287.
382 The Proceedings of the Diamond Jubilee International Clean Air Conference, London 20–23 October 1959, Rapporteur's reviews and discussions on the paper, 257.
383 The Proceedings of the Diamond Jubilee International Clean Air Conference, London 20–23 October 1959, Rapporteur's reviews and discussions on the paper, 257.
384 Sutton 1959, 17.
385 Appendix 1–2, 26.7.1958, Record of the Real Estate Committee, HCA.

Helsinki was moderately polluted, but not enough to cause a danger to health according to present knowledge.[386] As bacteriology had made plausible the quantitative analysis of water pollution at the end of the nineteenth century, so the proliferation of the British way of monitoring air pollution provided a way to quantitatively analyse urban air. Whereas the hygienist's evaluation in the Paulig case was grounded in the expertise and objectivity of his station, the new form of air pollution research presented its results as impersonal and quantitative.

As for the degree of nuisance caused by air pollution, which was the original concern of the real estate committee, the FIOH survey does not seem to answer this question. The committee wanted objective knowledge of the nuisance caused by pollution, but the FIOH survey did not measure this factor. Instead, it measured the quantity of certain impurities in air and arranged the results into a form that showed how the phenomenon had changed over time and space. It provided a view on air pollution that could be compared with other studies made elsewhere with the same methods. In this way the survey was part of—and dependent on—a community of experts and standardised measurements in a markedly different way than that used by the city hygienists in Helsinki. However, as seen in the Paulig case, it was not the amount of pollution per se or the objectivity of the measurement that was at stake, but the agreed level of reasonable pollution. This was something that the FIOH study had little to contribute.

A comparison of these three studies challenges the importance of more objective knowledge in air pollution abatement and also shows the irregularity in the movement and appropriation of knowledge. First, all investigations had their origins in local complaints against nuisances. The significance of transnational developments and the circulation of knowledge was more about how reactions occurred regarding this concern. The observations made in the Paulig case were rather subjective and unsystematic, being based on sensory experience and medical knowledge. The upside was that the hygienists could evaluate the nuisance, not only the pollution, which affected this case. The FIOH investigation provided a precise account of the amount of pollution, be it in particles per cubic metre or tons, but it had little to say about the nuisance it caused in Helsinki. The need for objective measurements produces a tendency to focus on things that can be measured. Measuring carcinogens in the air was technically difficult, but measuring a nuisance was impossible. In other words, the knowledge provided by the new research on air pollution by the FIOH could be presented as objective and nuanced, but it was also quite far removed from lay experience and not really attuned to the potential health effects of air pollution. Attitudes towards health effects were also rather different in the FIOH investigation compared to the diesel study. Although both expressed the need for more research—

386 Jormalainen, Laamanen and Lehtinen 1961, 152.

the FIOH outlined the need for more monitoring of general air pollution and the chemists called for an increase in measuring hydrocarbon—the diesel study framed the lack of knowledge as a potential hazard to health. In this respect, it differed from both the FIOH survey and hygienist practice. The different research background used in the diesel study, as well as attitudes towards carcinogens, led to a rather different view on the relationship between health and air pollution.

What is clear is that the FIOH survey, diesel study and the city hygienist assessment did not place much worth in the holistic view of health promoted by the WHO. All of these investigations noted a clear difference between a nuisance and a health hazard, even though the WHO urged an understanding of health as general wellbeing that was affected by daily nuisance. This shows the practical limitations of the definition of health put forth by the WHO, even though people in general seem to have embraced it rather intuitively. As a member of the Finnish health administration noted when reviewing the state of Finnish environmental hygiene in 1956:

> The WHO's definition of health equals nuisance and disease, but even so we cannot equate one nuisance with another. Prioritisation is needed, and those nuisances that cause acute harm should be given priority over those that merely test people's tolerance in the long term.[387]

Although the FIOH study does not give an account of health effects, other than dismissing them on the grounds of consensus, Leo Noro commented on the study and on the potential health effects in the popular press. He stated that there was no health risk associated with air pollution in Helsinki, emphasising that cigarette smokers expose themselves regularly to considerably higher quantities of dangerous substances. As was common in his statements, Noro stressed individual responsibility and refuted any complaints about urban air, even in the most polluted areas, when at the same time people freely poison the air with cigarette smoke. Interestingly Noro stated that some connection had been made between cigarettes and lung cancer but mentioned nothing about carcinogens in the air.[388] Similar to the industrial hygiene experts in United States, Noro emphasized the small quantity of substances in air compared to workplaces and in this case cigarette smoke. The minute amounts of carcinogens that worried the chemists of the school of technology seems to have given him little concern. However, Noro's comparison of cigarette smoke and air pollution reflects, albeit unintentionally, a great debate that was raging at the time in the journals and conferences of the anglophone medical community. This debate would soon have a significant effect on Finnish air pollution research.

387 Ojala 1956, 44.
388 Noro 1959, 167–168.

## 3.3 The Puzzle of Lung Cancer: Analysing Carcinogens in the Urban Environment in the Early 1960s

At the same time as Noro made his statement on the dangers of cigarette smoke compared to air pollution, this issue was the topic of a WHO Study group on the causes of cancer. The aim of this group was to review a question that had been a topic of debate for decades: what had caused the soaring rates of lung cancer deaths witnessed across industrialised nations? During the first half of the twentieth century lung cancer had overtaken other cancers as one of the leading causes of death in Europe and United States. This rise was initially viewed with scepticism, as it had previously been a rare affliction. Mortality statistics, the core of public health knowledge, were notoriously unreliable regarding specific diseases over long time periods. The cause of the rise may have been merely improved diagnosis and greater awareness of lung cancer. Another explanation was that people were living longer, due to rising standards of living and the eradication of infectious diseases, and therefore fell victim more often to so-called degenerative diseases.[389] However, as the mortality rates continued to rise and more sophisticated statistical methods were applied, the question of whether this increase was real lost relevance. In the WHO study group of 1959 the soaring mortality rates were accepted as being real and the question of the cause was principally narrowed down to two reasons: cigarette smoke and air pollution. This question would have a significant impact on the FIOH's air pollution research and on the concern about the health effects of air pollution in general.

The rise of cigarette smoke as the primary cause of lung cancer in the mid-twentieth century has been well documented in historical research. Indeed, studies were often inspired by the great debate that took place between cancer activists and the cigarette industry. The historians Robert Proctor and Allen Brandt have shown how the U.S. tobacco industry aimed to cast doubt over the health effects of cigarette smoke, thereby hampering efforts to ban or limit the sale of tobacco products.[390] Because of this conflict of interest, which is still an on-going issue, the historical analysis of the lung cancer debate is still a sensitive topic. Statements supporting the notion that the issue was a genuine scientific debate over statistical causation have found their way into the so-called doubt machine.[391] Examining the debate between

389 From 1912, old age was removed from the international standard of causes of death. This meant that every death now had a specific cause. This change had a far-reaching impact on diagnosis and public health statistics. See Desrosieres 1998.

390 Proctor 1995, 101–131; Brandt 2007, 159–209.

391 Proctor 2004, 1174–1175.

cigarettes and air pollution may thus inadvertently contribute to the views of the tobacco industry.

Still, a more subtle study of the debate can move beyond framing the issue simply as a conflict between those who foresaw the dangers of cigarette smoke and those who did not. The debate is often framed around the famous epidemiological studies by Bradford Hill and Richard Doll alongside the critique they received from statisticians Joseph Berkson and Ronald Fisher.[392] The purpose of the present examination is to focus specifically on the debate between air pollution and cigarette smoke and its significance in terms of air pollution research. Rather than the simplistic notion of a conflict between sceptics and believers, this debate concerned the relative importance of air pollution, and environmental carcinogens in general, in the spiralling rates of cancer. Rather than seeing the debate as a hindrance to cigarette abatement, the aim is to view it as part of the increasing interest in environmental causes of cancer; a concern that would become pivotal to the environmental activism of the late 1960s.

## The Lung Cancer Epidemic

The background for viewing air pollution as a cause of lung cancer can be divided into two separate but related fields of medical research. First, observations and research were carried out in European occupational medicine from the late nineteenth century that connected certain substances in the working environment with various forms of cancer. In light of these observations, substances, such as soot and tar, were suggested by some as being carcinogenic. Hence, the link between lung cancer and air pollution had already been asserted in the late nineteenth century.[393] In the United States the concept of occupational cancer began to come under scrutiny after the First World War as the country established its own dye industry. The German emigrant and occupational health physician, Wilhelm Hueper, who was employed at Du Pont Industries, became the most prominent spokesperson in the United States against carcinogens in occupational environments.[394] As discussed,

[392] An example of the strong significance given to this statistical debate comes from statistician Judea Pearl, who argues that "millions of lives were lost or shortened because scientists did not have adequate language or methodology for answering causal questions". See Judea Pearl & Dana Mackenzie, *The Book of Why,* Penguin Books, London 2019. The opposite argument is made by historian David Wootton, who claims that cigarette smoke was already widely accepted as a cause of lung cancer in the late 1940s, while the subsequent debate has been overemphasised largely by Richard Doll himself. See Wootton 2007.

[393] Proctor 1995, 22–29; Armon 2012, 155–161.

[394] Patterson 1987, 187–190.

Hueper also warned about the carcinogenic properties of air pollution at U.S. conferences in the 1950s. In other words, much of the knowledge on environmental pollution as a cause of cancer derived from observations related to occupational medicine. The idea of chemical carcinogenesis in relation to lung cancer, however, was also embraced by some in the nascent field of epidemiological or biometric research. The British epidemiologist Percy Stocks, a student of the famous mathematician Karl Pearson, conducted several studies on the prevalence of lung cancer in urban and rural areas and thereby became the most prominent defender of air pollution as a cause of cancer in the 1950s. The carcinogenic potential of air pollution was a topic of concern in its own right and was not tied to the debate on cigarette smoke, although they shared the same fundamental idea of chemical carcinogenesis.

However, the concerns of Hueper and Stocks seem to have been largely overlooked by the Finnish medical community. In fact, cancer was not the primary topic of debate in Finnish medicine in the 1950s. Minna Harjula has shown that the Finnish medical community in the 1950s, Noro included, was still unsure of the legitimate rise in cancer cases and the significance this held for public health in Finland. Cancer was, after all, predominantly a disease of the elderly while the focus of public health in Finland centred on children and working-age people.[395] The issue was not completely neglected, as the Finnish Cancer Registry was established in 1952 in order to collect statistical data about the problem. This initiative mirrored a trend prevalent in many European countries. Through these statistics it became clear during the course of the 1950s that Finland had a considerably higher rate of lung cancer cases than had previously been thought.[396] Some interest in the matter was raised in the medical journal *Duodecim* from the mid-1950s onwards. It seems that even though the actual increase in cancer cases in was still generally a topic of debate, the increase in lung cancer in industrialised countries was regarded as a well-established fact by 1955 that no serious medical expert cast doubt on this.[397] The articles in *Duodecim* show that cigarette smoke was seen as the most dangerous cause of cancer, while air pollution and other factors are hardly mentioned. Hueper is mentioned only once, while the focus of all the articles is in the examination of the effects of cigarettes.[398]

A similar emphasis can be seen in the popular press, where the rise of lung cancer was discussed throughout the 1950s. In the leading Finnish newspaper, *Helsingin*

395 Harjula 2007, 79–81.
396 See Saxen & Leppo, *Finnish Cancer Registry 1952–1977*. Helsinki 1978.
397 Holsti & Ermala 1955, 1116.
398 Holsti & Ermala 1955 1115–1134; Ermala & Holsti 1955, 733–747; Kumlin 1959, 1–9; Huttunen, Pensala, Valve 1960, 487–492.

*Sanomat*, most articles on the subject emphasised the evidence against smoking. References were predominantly to U.S. and British medical studies that had found correlation between smoking and lung cancer.[399] Other potential causes are only discussed in a handful of articles, while Hueper is mentioned only once.[400] Whilst the conferences of experts in air pollution in the late 1950s received some attention in the Finnish press, it seems clear that smoking was perceived to be a far more prevalent cause of lung cancer in Finland, both in public discussions as well as in the Finnish medical community.

Despite the nascent air pollution research carried out by FIOH experts, they seem to have been, on the whole, unalarmed about the rise of airborne carcinogens in the 1950s and made no public statements on the connection of air pollution to lung cancer. Even the 1959 investigation on air quality in Helsinki made no mention of carcinogens. Furthermore, after the 1959 study, the FIOH had little means to continue measuring air quality or to undertake any other form of air pollution research. This was a part of a wider problem that stemmed from the fact that the FIOH struggled to live up to the visions Leo Noro had for it as a multidisciplinary research institution. A chronic lack of funds, due to limited support from private industry, only worsened in the late 1950 and early 1960s. This forced the institution to focus more on the routine services it provided to industry and left the staff with less time for basic research.[401] The situation was especially dire for the department of industrial hygiene, which was almost completely preoccupied by routine measurements and analysis.[402] Furthermore, despite the positive press received by the FIOH air pollution study, other urban areas in Finland were apparently not yet as

399 Keuhkosyöpä ja tupakanpoltto, HS 25.10.1949; Mitä enemmän savukkeita sitä helpommin keuhkosyöpä, HS 16.10.1951; Lähes 1,5 miljardia markkaa Ruotsissa syövän tutkimukseen, HS 6.11.1953; Tupakka edistää keuhkosyöpää, HS 23.11.1953; Keuhkosyöpä ja tupakanpoltto, HS 6.12.1953; Savukkeet ja keuhkosyöpä, HS 3.8.1954; Keuhkosyöpä – Tupakka, HS 3.3.1954; Tupakka – Ruumisarkkunaula, HS 21.7.1954; Suodatin kaikkiin savukkeisiin USA:ssa, HS 1.8.1954; Tupakkalakko – keuhkosyövän vaara vähenee, HS 7.7.1955; Keuhkosyöpä pelottaa vain yhtä seitsämästä tupakanpolttajasta, HS 16.5.1956; Tupakkamarkkinamme käymistilassa 27.4.1957; Keuhkosyöpä kuolinsyynä lisääntynyt jatkuvasti, HS 20.3.1958.

400 Keuhkosyöpä ei johdu yksistään tupakasta, HS 8.11.1953; Huono ilma pahempi kuin tupakointi, HS 20.11.1956; Totuus syövästä, HS 4.7.1956; Tervalla käsitellyt tiet aiheuttavat keuhkosyöpää, HS 13.4.1957; Hengitysilmamme tappavaa myrkkyä?, HS 14.7.1959. One short article provided relief for drinkers as it stated that beer cannot cause lung cancer. Olut viaton syöpään, HS 3.7.1958.

401 Ketola 2015, 149, 152–160.

402 The annual reports of the FIOH show how the number of publications from the department of industrial hygiene were miniscule compared to other departments. See The Occupational Medical Foundation and Institute of Occupational Health, Annual reports 1957, 1958 and 1959.

interested in conducting such investigations. With the exception of one deposit gauge measurement, which was requested by the Finnish Asbestos Company, in 1960, the 1959 study remained a one-off in a similar manner to the diesel study by the Institute of Technology.[403] Due to lack of funds, the FIOH was unable to develop and make use of its new expertise. However, in the early 1960s the World Health Organization intervened after it became alerted to the high mortality rates from lung cancer in Finland.

## Study Group on the Epidemiology of Lung Cancer and the Curious Case of Finland

As the debate over the cause of lung cancer continued the WHO established an expert panel in 1959—the Study Group on The Epidemiology of Cancer of the Lung—to review and discuss the research carried out up to that point and to recommend courses of action. The main causes under consideration were essentially cigarette smoke and air pollution, with considerably more attention devoted to the former. Hueper was not among the participants, but Percy Stocks acted as a consultant to the WHO and chairman of the group. In his opening presentation, Stocks emphasised the study of environmental causes of cancer, in general, as an effective preventive measure.[404] He noted that such knowledge primarily derived from statistical studies, which were known for their limited ability to provide causality. This did not mean that such studies were of little value, as some had argued, but that the explanation for the correlation could take time and require the support of other observations. As Stocks stated, "Well-founded statistical correlations are 'facts' and should therefore be placed on record and not disregarded because no reason for them can be perceived."[405]

It was the combination of statistical observations from different studies, namely studies of mortality between urban and rural areas, that had led Stocks to see air pollution as a significant cause of lung cancer. Though he did not deny the evidence against smoking he argued it was an insufficient cause alone, since it did not explain some well-recorded observations: Why was lung cancer incidence lower in the British countryside in comparison to urban areas even when there was no significant difference in smoking habits? Moreover, why did British immigrants to New

403 The asbestos study was sparked by medical investigations that had found occurrences of non-occupational asbestos in the vicinity of mines. See Laamanen *et al*. 1961, 240–245; Kiviluoto 1965, 235–239.

404 Stocks refers to Sir Julian Huxley's work *Biological Aspects of Cancer*, in which Huxley sees environmental cancers as guides to cancer prevention. See Julian Huxley, *Biological Aspects of Cancer*. George Allen & Unwin, London 1958.

405 Stocks 1959a, 1–2.

Zealand seem to be afflicted with lung cancer at a higher rate than indigenous residents, despite similar smoking habits?[406] Stocks argued that coal smoke from domestic furnaces, in particular, was the main source of carcinogens rather than car exhaust emissions as some experts had emphasised.[407]

The central issue of concern for Stocks was statistics, but not in the same manner as the statisticians Bergson and Fisher, who completely dismissed the epidemiological evidence against cigarettes. Stocks also did not take the common stance adopted by sceptics, whereby statistics were believed to only reveal correlation and not causation and were therefore of little real value. Stocks' own hypothesis was simple: urban air pollution, coal smoke in particular, increased lung cancer mortality rates, but this had not been perceived "before the recent pandemic, seemingly due to cigarette smoking, began".[408] In other words, Stocks did not deny the primacy of smoking but proposed air pollution as a secondary, but still a significant, cause of lung cancer. In fact, not a single presentation at the WHO study group denied the overwhelming evidence against heavy smoking.[409] The problematic issue was rather the specific cause of lung cancer induced by cigarette smoke. An answer to this puzzle had the potential to widen control measures for other environmental aspects.

A leading suspect in cigarette-induced lung cancer had been the polycyclic hydrocarbon called 3:4-benzpyrene, a substance that Kennaway and his colleagues had shown to be a carcinogen. It had been detected in cigarette smoke, as well as in the tarry substances known to cause cancer in occupational environments. It was also present in the soot collected from urban air.[410] In other words, cigarette smoke and air pollution were not rival topics in this puzzle. Research indicated that it was chemical substances from the environment—present in occupational settings and in cigarette smoke—rather than biological factors that caused cancer. The research on chemical carcinogens, which had previously been largely confined to occupational environments, was now increasingly being extended into general living environments and consumer products. The problem, however, was that the quantity of hydrocarbons in cigarettes and in urban air was relatively small compared to occupational environments. This point was stressed by the Norwegian pathologist Leiv Kreyberg in the WHO study group. His studies showed that the average

406 Stocks 1959b, 7.
407 Stocks 1959b, 6.
408 Stocks 1959b, 7.
409 Moreover, in the list of medical studies compiled by Stocks for the study group, atmospheric pollution is only examined in seven studies, while twenty-seven studies confirmed the effects of heavy smoking. Stocks 1959a, 6–7.
410 Armon 2012, 152–156. For a more detailed study on the history of lung cancer, see Timmerman 2014.

Norwegian gas work employee came into contact with the equivalent of 5,000 cigarettes per day, in terms of hydrocarbons, during a typical 40-hour week. Yet, the gas workers did not suffer from an increase in lung cancer rates. As Kreyberg stated, "the role of 4:3-benspyrene in the development of cancer is very far from known."[411] Kreyberg's comment shows that the aspiration to find the specific cause of lung cancer was hampered by the same factors that made air pollution research difficult in general.

Thus, Stocks proposed an international epidemiological study in order to gain a better understanding of the potential significance of air pollution. He envisaged being able to compare the quantity of airborne carcinogens, lung cancer rates and smoking habits in different cities.[412] He proposed a study that would include nine European cities, five in the United States and one in Australia. Helsinki was one of the European cities he selected and was especially interesting for Stocks. Erkki Saxén, chief of the Finnish Cancer Registry, was part of the study group and he presented the state of lung cancer rates in Finland as recorded since 1952. Saxén's statistics showed that Finland had one of the highest rates of lung cancer in the world. In addition, there seemed to be no clear reason why this was the case. Population density and the level of industrialisation in Finland was similar to Norway, yet Finland had a mortality rate for lung cancer that was five times higher than its Nordic neighbour. Saxén hypothesised that smoking habits, as well as wood-fuelled saunas and domestic heating, might explain the issue, but he admitted that this was mere speculation.[413] This did not fit to the other statistical observations on the issue, which led Stocks to argue that "Finland's high death rate from lung cancer appears anomalous, and is deserving of special study in relation to methods of domestic heating and tobacco smoking."[414]

As a result of the work of the study group, the WHO began to sponsor a series of international epidemiological studies, one of which was a comparative study of Helsinki and Oslo. These studies were multidisciplinary as they required air pollution measurements and epidemiological analysis. In 1962, the WHO's chief medical officer, A. V. Chaklin, approached Noro and requested the assistance of the FIOH in the Oslo-Helsinki study.[415] The Finnish Institute of Occupational Health was given the responsibility to carry out the air quality measurement side of the research. This gave the nascent Finnish research into air pollution another nudge and also directed it towards the study of environmental carcinogens.

411 Kreyberg 1959 6.
412 Stocks 1959b, 7–8.
413 Saxen 1959, 2.
414 Stocks 1959b, 7.
415 Noro's letter to A. V. Chaklin 9.5.1962, AFIOH.

## Carcinogens in the Air in Helsinki

The study of carcinogens in Helsinki air began in 1962 and continued for two years. Compared to the first study undertaken by the FIOH in 1959, this study was more specifically aimed towards potential health hazards, rather than nuisances and overall air quality. It also required more sophisticated instruments since the task was to present the quantity of specific carcinogens. Unlike general air pollutants, such as soot, ash and smoke, polycyclic hydrocarbons appeared in small quantities and there was no cheap and easy method to identify and measure them. Consequently, the carcinogen study carried out by the FIOH brought it into contact with the emerging issue of environmental health, but also moved it towards a more instrument-oriented form of expertise of the environment.

FIOH research also benefitted from a turning point in the instrumental side of air pollution research, which derived from developments in the field of analytical chemistry. Since the late 1950s, many of the new sensitive methods developed in analytical chemistry began to become available as commercial instruments. This answered the increasing demand of industry and regulators for more precise measurements. In a sense, air pollution research benefitted from the wider trend – the promotion of manufacturing instruments for measuring the environment. One of these instruments was the gas chromatograph, which completely changed the possibilities of air pollution research**.** Described as "one of the greatest analytical achievements of all time"[416], the gas chromatograph method provided a versatile and sensitive technique that was able to separate a mixture into its component parts. From the point of view of airborne carcinogens, this method made it possible to identify various complex organic compounds, such as the notorious polycyclic hydrocarbons that had previously been largely out of reach for routine air pollution measurement.[417] This increase in analytical techniques employed since the late 1950s has also been viewed as being a central development in the move towards a wider concern for environmental poisons and the environment in general in the late 1960s.[418] The commercial production of these instruments made it possible to analyse more efficiently and in a more versatile manner not only the composition of air but all aspects of environmental pollution.

The downside of the new instruments was their cost. As Noro later remarked, the poorly-funded FIOH had to use 100,000 Finnish Marks to buy equipment in order to complete the carcinogen study.[419] A list of preferred new instruments made in 1958

416 Müller 1960, 125–126.
417 Research into Environmental Pollution, Report of Five WHO Scientific Groups 1968, 24.
418 Hormburg & Vaupel 2019, 13, 379.
419 Noro's Letter to the Ministry of Interior Affairs 4.6.1965, AFIOH.

indicates that a gas chromatograph and an infrared spectrometre would have cost 2% of the entire annual budget of the institute.[420] Thus, the necessity of needing to use these instruments also made air pollution research more expensive than ever before. Noro sought to mitigate costs and expand his research by taking advantage of the conflict inherent in the lung cancer debate. Although the conflict between the tobacco industry and health experts was mild in Finland compared to the United States, there was an ongoing public campaign against cigarettes by medical experts which intensified in the 1960s.[421]

As already noted, Noro himself had warned of the dangers of smoking when commenting on the previous air pollution study. However, he was apparently aware of the rising interest of cigarette manufacturers in other aspects of environmental health that could potentially mitigate the blame laid on smoking. As the carcinogen study was progressing, Noro sent letters to all of the Finnish cigarette manufacturers and asked for funding for further research. He argued that further research on airborne carcinogens had the potential to shift some of the blame from cigarettes to air pollution. He referred to some unnamed studies that stated that carcinogens in urban air could be as dangerous as cigarette smoke. It seems Noro was aware of the Hueperian view on environmental carcinogens after all. Thus, Noro requested financial support for research regarding environmental carcinogens as he argued that there was certain "propaganda value" for the tobacco industry in openly endorsing such studies.[422] The FIOH received two donations worth 12,000 Finnish Marks from the tobacco industry, a sum that was openly declared in the institution's newsletter.[423] This clearly shows how the expensive quest to examine environmental cancers could easily be turned into a rather dubious question about the relative significance of different causes; in this case air pollution and cigarettes.

The carcinogen study was more prestigious than the 1959 research had been in many respects. Patrick Lawther, head of the air pollution research unit of the British Medical Council, came to Helsinki to oversee the instalment of the instruments and to give instructions on their use. The Finnish Cancer Registry and the Meteorological Institution were also involved in the planning of this undertaking. Noro informed Lawther that he would take personal charge of the study on behalf of the FIOH, rather than let the industrial hygiene department handle it.[424] Whereas the previous study on air in Helsinki had been conducted solely by the poorly resourced industrial hygiene department, which had little previous experience on air pollution research,

420 A list of research projects and required instruments, dated 9.11.1958, AFIOH.
421 For discussion of Finnish cigarettes, see Hakkarainen 2000.
422 Noro's letter to the Finnish Tobacco Industry, 19.12.1962, AFIOH.
423 *Työterveysuutiset*, 1964 no. 3, 11.
424 Lawther's letter to Noro 5.3.1962; Noro's letter to Lawther 5.5.1962, AFIOH.

the carcinogen study was planned and executed as part of a high-quality international study. No wonder Noro later regarded the carcinogen study to be the most significant air pollution research ever carried out by the FIOH.[425]

The carcinogen study was also different to the investigation undertake in 1959 in the sense that it specifically focused on the health effects of air pollution. This time there were no deposit gauges and the measurements only focused on suspended particles and their composition. As Laamanen and Noro stated in their report, "suspended particles have significance in public health since they can penetrate the lungs and through them into body systems".[426] However, in the published report of the study, Laamanen and Noro made very few remarks on the potential health effects of carcinogens in the air. Although they described them as "cancer causing" and listed the considerable number of different carcinogenic substances that had been found in urban air in other studies, they also emphasised that the total amount of such substances in the air was nonetheless very small. The essence of the study considered the use of various carcinogens as trace elements that could be used to deduce sources of pollution in Helsinki. Coronene, for example, could be used to determine the amount of exhaust emissions from motor vehicles, since emissions from heating did not produce significant quantities of this chemical. Through this trace analysis it was revealed that the main sources of carcinogens were motor vehicles and oil heating. The average statistics showed Oslo to be somewhat more polluted than Helsinki, but the latter also had a small but consistent level of carcinogens in the air.[427]

The results of the FIOH measurements were published in the institute's own series in the form of an eight-page report, half of which discussed general knowledge about carcinogens. The most significant result of the study was that the FIOH continued to analyse carcinogens in Helsinki with its new instruments and expertise, beginning with a follow up study on the amount of vanadium, a carcinogenic metal, which had been measured in unusually high quantities in some parts of Helsinki.[428] It could be said that although the carcinogen study did not produce significant results, it did provide momentum for the FIOH's air pollution research. More essentially, it directed the FIOH research towards the measurement of polycyclic hydrocarbons and other carcinogens suspended in urban air, which was a marked deviation from the basic air pollution measurements based on dust fall, smoke and sulphur. In other words, the debate between smoking and air pollution served to promote and specialise research on air quality, even though cigarette smoke remained public enemy number one.

425 Noro 1979, 134.
426 Noro & Laamanen 1964, 5.
427 Noro & Laamanen 1964, 1–8.
428 Noro & Laamanen 1964, 8.

Outside the FIOH, the Helsinki-Oslo comparative study and the entire international study envisioned by Percy Stocks proved to be inconsequential. Stocks published his results in the *British Journal of Cancer* in 1966 and concluded that according to the statistics, neither smoking nor air pollution seem to cause lung cancer on their own. He suspected a third factor made some people susceptible to the disease, which was then triggered by a substance in cigarette smoke and in air pollution.[429] While discussions on the specific etiology and mechanisms of lung cancer continued, Stocks' studies seem to not have received any special attention. In 1964, the same year as the FIOH carcinogen study was published, the famous Surgeon General's Report on Smoking and Lung Cancer in the United States declared smoking to be the primary cause of the lung cancer epidemic. This landmark report, followed by WHO instructions to reduce smoking, further shifted the lung cancer debate towards prevention by reducing cigarette consumption, rather than trying to find out the specific causal agent.[430] In 1968, a WHO expert panel on environmental pollution concluded that these kinds of sponsored comparative international studies on the environmental causes of cancer had proven to be expensive, time consuming and ineffective, since there was no way to validate past exposure to pollution.[431] In short, the overall significance of the international studies remained limited, while, nonetheless, they had a marked effect on Finnish air pollution research.

## Atmospheric Carcinogens and Environmental Pollution

In the same year as the WHO study on carcinogens began, Rachel Carson, herald of the environmental movement, published her seminal work *Silent Spring,* in which she described and warned about the dangers of carcinogens accumulating in the environment; namely polycyclic hydrocarbons from pesticides. The book was translated in Finnish in the same year and chapters of it were published in *Helsingin Sanomat*. With strong reference to Wilhelm Hueper, Carson viewed carcinogens as dangerous, even in very low quantities and no matter where they were found in the environment. As Sellers has argued, Carson in fact popularised a view on environmental health that had first been formulated by industrial hygienists.[432] Thus, at the same time as air pollution was coming under closer scrutiny by the FIOH, another offshoot of industrial hygiene drew attention to chemical pesticides and their carcinogens.

429 Stocks 1966, 622.
430 Hakkarainen 2000, 108; Timmerman 2009, 83.
431 Research into Environmental Pollution, Report of Five WHO Scientific Groups 1968, 35.
432 Sellers 1994, 58–59.

In the light of their common topic, it seems odd how little attention the FIOH's carcinogen study received in Finland. Moreover, it is surprising that no parallels were drawn between airborne carcinogens and Carson's concern about pesticides. There are hardly any news reports about the study conducted by the FIOH. It would seem Noro and Laamanen also made little effort to make the issue more visible. The comparative study between Helsinki and Oslo was covered by the press, but it was viewed as a statistical cancer study and no reference was made to air pollution research.[433] Noro was interviewed in an article in *Helsingin Sanomat* in 1963 in which he merely referred to foreign studies that had shown some correlation between polluted urban air and lung cancer. In the same article, it is stated that the situation in Finland is relatively good and that there is "no reason to restrict the use of air as a dumping ground for waste, since this would result in an unnecessary rise of productions costs."[434] As for pesticides, the FIOH toxicologist Jeddi Hasan regarded them as a minor topic in occupational medicine, though he added that their public health significance was harder to evaluate. The heated ongoing debate was, according to Hasan, due to effects in animals rather than humans. He was suspicious of the potential long-term dangers of carcinogens and suggested, naturally, continuous research and observation.[435]

The fact that few parallels were made between Carson and the FIOH study in the early 1960s supports the assertion made by some Finnish environmental historians that *Silent Spring* had limited effect in inspiring Finnish discussion on environmental pollution at the time of its publication and translation. According to Timo Järvikoski and Sirje Nienstedt, the book sparked only minor discussion, as the problems of U.S. agriculture—Carson's primary target—were distant from a Finnish perspective.[436] Tuomas Räsänen has also shown that Carson's initial significance vis-à-vis Finnish discourse was limited, with nature conservationists viewing her concerns as being

433 Keuhkosyöpää enemmän meillä kuin Norjassa. WHOn kehotuksesta tukimus eron syistä, HS 9.2.1962.

434 Syövän vaara ilmassa, HS 29.3.1963.

435 Hasan 1965, 8. Hasan was not dismissive of the effects on animals and regarded the development of pesticides that were also harmless to animals as essential in the future.

436 Järvikoski 1991, 168; Nienstedt 1997, 20. The U.S. historian Chad Montrie has criticised the tendency to represent *Silent Spring* as the beginning of the environmental movement on the grounds that it distorts the history of environmentalism by focusing on the post-war era and the "songbirds and suburbs" canon. In so doing, the long and versatile concerns about environmental pollution that date to the dawn of industrialisation are overlooked. See Chad Montrie, *The Myth of Silent Spring: Rethinking the Origins of American Environmentalism.* University of California Press, Berkeley 2018; Similar arguments have been made in Finnish environmental history by Simo Laakkonen. See Laakkonen 2001.

limited to the United States.[437] Uekötter has also noted that although the ecological message in Carson's book was soon acclaimed in the United States, it received surprisingly little attention in expert agencies.[438] In light of these observations it seems that in spite of the almost mythical status it would later wield, Carson's *Silent Spring* was initially seen in Finland as expressing a specific environmental health concern and did not effectively fuse the different aspects of environmental pollution together. Similarly, rather than merging into a more general threat of environmental pollution, carcinogens in the air remained an isolated environmental health issue that received little attention in Finland in the early 1960s. It seems that the attitude towards air pollution in general, and carcinogens in particular, was markedly different in the early 1960s compared to the latter part of the decade, despite the simultaneous expert attention to carcinogens in the air and in chemicals.

The WHO study was a further step in the appropriation of air pollution research by the FIOH, which began with the Milan conference in 1957. As has been shown in this chapter, the contours of modern, public health-based air pollution research were initially drawn in the United States and subsequently in the WHO. With health effects at the core, the control of air pollution became a question of medical knowledge. This itself became a question of knowledge about the constitution of urban air. Faith in the methods of industrial hygiene as a means of determining safe air ensured that the concept of clean air became redundant. The first air pollution study by the FIOH in 1959, however, showed how the measurement of air pollution was in practice still, in many ways, in the age of smoke. Whereas the fundamental aims of research came from industrial hygiene, the practice of measuring air quality derived from British atmospheric science at the turn of the twentieth century. Nonetheless, this hybrid was quickly embraced by officials in Helsinki, who were under considerable pressure from an increasingly annoyed public. The FIOH study provided objective and specific information that could be compared with other measurements, medical studies and hygienic norms. In short, the FIOH became part of the transnational network of experts that could turn local air quality into numbers. Despite this, the 1950s and early 1960s was still a time of struggle for FIOH air pollution researchers. There was not yet adequate support for the notion that air quality should be monitored and that the problem of bad air quality required the use of a certain way of knowing in order to be solved. This situation would begin to change in the mid-1960s as the Finnish government effectively made the FIOH the official national authority on air pollution, if only for a short period.

437 Räsänen has argued that *Silent Spring* had an indirect effect on the Finnish environmental movement via Sweden, where the book received more attention and excited Swedish marine pollution researchers. See Räsänen 2012.

438 Uekötter 2009, 227–228.

# 4 Air Pollution in the Modern Toxic World

## 4.1 Air Pollution and Finnish Public Health in the 1960s

Notwithstanding the carcinogen study, the early 1960s were still a struggle for the FIOH's nascent air pollution research. However, this decade can be regarded as pioneering and golden era of the new expertise in air pollution in Finland. In the mid-1960s, the Finnish government took action on air pollution and formed a national council of experts to deal with the situation. Air pollution was considered a neglected issue that required more systematic and uniform attention than was possible by municipal health boards alone. This era—from the mid-1960s to the early 1970s—marks the pinnacle of FIOH's role as the foremost body of expertise on air pollution and environmental pollution in general in Finland. At the same time, the FIOH increased its activity on air pollution research producing over a dozen studies on air quality in urban and industrial areas. This was not only the case in Finland. Many countries in Europe and North America created or expanded their networks of measurement while medical research on the effects of air pollution received more resources than ever. International conferences also proliferated, and their ranks swelled with members from different fields. In short, the 1960s saw a considerable increase in research on air pollution and in the number and significance of experts.

Furthermore, this decade has been seen as an era of heightening crisis and conflict in air pollution control, as public indignation continued to grow and embraced new features. According to Uekötter, the 1960s marked a time when attitudes towards bad air quality in the United States shifted from annoyance to down-right fear of the health effects.[439] Similar developments took place in Finland, which were initially beneficial for the FIOH and its air pollution research. Environmental expertise began to be institutionalised within the Finnish government. However, the increased concern, together with a rivalry between the experts, also hindered the FIOH. This ultimately led to its decline as an institution of

[439] Uekötter 2009, 135, 222.

expertise on environmental health. The purpose of this final chapter is to examine the parallel developments that took place in the 1960s. Furthermore, this final chapter will demonstrate how 'the clarification of the air' was seemingly making progress with the accumulation of knowledge. Yet, at the same time these very premisses were questioned by different views on the environment, health and toxicity of the modern world.

## The Ascension of Air Pollution

Looking at the overall picture, the change in attitudes towards air pollution in Finland, and in Helsinki particularly, seems to follow a similar path to that described by Uekötter in relation to the United States. As Schönach has shown, press coverage on air pollution increased considerably in Finland in the mid-1960s, as did the number of complaints about smoke and fumes filed in Helsinki. This increasing discontent had already led to the appointment of a smell nuisance committee by the city of Helsinki in 1960.[440] Some of the causes also seem to have aligned. Uekötter argues that it was partly the success of the often-discredited smoke abatement policies in the United States from the 1950s that had successfully led to the banishment of coal smoke from the air to such an extent that attention was given to other previously neglected and often invisible pollutants.[441]

In Helsinki, the state of the air had also improved, although not because of successful smoke-abatement policies. The gradual increase in the coverage of district heating since the 1950s, developed as a method for efficient energy use, began to considerably reduce the amount of smoke from domestic furnaces. This development was changing the usual sensescape of the city, as the smoke from domestic wood burning ceased to be the norm in many districts. Better air quality lowered people's tolerance of invasive fumes and led to an increase in complaints to public health officials. The use of centralised energy production also created point sources of pollution that were not tolerated by people in the same way as domestic emissions had been.[442] Paradoxically, the improvement in the normal state of air created an environment in which fumes and smoke seemed increasingly invasive and unreasonable.

The rise in the overall standard of living in Finland from the late 1950s probably had an impact on the issue. After all, the rise of post-material values through an increasing standard of living has been seen as one of the factors behind rising environmental concerns in the late 1960s. However, this idea has also been

440 Schönach 2008, 181,182.
441 Uekötter 2009, 226, 263.
442 Schönach 2008, 129–136.

criticised.[443] Uekötter argues that a shift in values was not the reason for the concern about air pollution, but may have changed the nature of what was an already existing concern as it was incorporated into environmentalism.[444] Some Finnish environmental historians have argued that as the loose wartime attitudes towards environmental conditions began to erode in the late 1950s, the public no longer tolerated nuisances caused by waste and filth.[445] Others have argued that the ban on atmospheric nuclear tests in 1963 directed attention away from radioactive fallouts to more mundane forms of pollution.[446] Whatever its effects on people's values, economic growth certainly changed the fabric of Finnish society in the 1960s. Whilst the rise in living standards had been relatively meagre during the post-war years, due to fluctuating economic growth, war indemnities and other repercussions, the economy began to grow steadily in the late 1950s. Along with economic growth, migration from agrarian communities to urban and industrial centres increased and finally exploded in the 1960s.[447] The most striking demonstration of the rising prosperity in Finland was the increasing number of cars, which produced a new form of air pollution problem, especially in Helsinki. In other words, it seems that the Finnish public began to express indignation in the 1960s, which one U.S. expert regarded as a trend that would fundamentally change air pollution control:

> A free citizen, now enjoying an otherwise miraculous standard of living, cannot, will not, and should not be forced to undergo the exquisite tortures inflicted upon him constantly by metropolitan living.[448]

In addition to the discrepancy between the state of air and standards of living, another explanation given for the change in the 1960s relates to the much-debated notion of an epidemiological transition. According to the traditional narrative of medical

443 This idea was most famously articulated by the political scientist Ronald Inglehart in the 1970s as part of his modernisation theory. See Ronald F. Inglehart, *Cultural Evolution: People's Motivations are Changing, and Reshaping the World.* Cambridge University Press, Cambridge 2018. Though it is often accepted as a partial cause of environmental awakening, it has also been criticised for neglecting older concerns about environmental degradation and for the apparent arbitrariness of the standard of living, which supposedly causes the change in values. For an early critique of this theory, see Mary Douglas & Aron Wildawsky, *Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers.* University of California Press, Berkeley 1983.

444 Uekötter 2009, 118.

445 Lahtinen & Vuorisalo 2004, 685–690; Laakkonen & Vuorisalo 2019, 277–282.

446 Mattson 2001, 189.

447 Hoffman 2019, 150–152.

448 Kennedy 1957, 140.

history, the combined strength of sanitation, prosperity and advances in medical science in the mid-twentieth century resulted in the banishment of epidemic diseases that had been the primary menace of societies. Due to this victory, the focus of public health and medicine turned to less acute issues. Chronic diseases were the new enemy, some of them old but previously neglected, such as rheumatism and cancer. Some appeared to be new conditions that had emerged as a result of affluence and the modern way of life, such as diabetes, cardiovascular diseases and lung cancer. In short, the diminishing threat of microbes paved the way for non-bacteriological environmental health concerns.[449] Uekötter, for example, argued this general shift in disease patterns as a probable cause for the heightened fears over the health effects of air pollution in the 1960s in the United States.[450]

The history of public health initiatives in Finland seems to support this traditional narrative. In the 1960s, the Finnish public health system was reformed and more resources were directed to the treatment of chronic diseases. According to Minna Harjula, more comprehensive decisions on health were also taken in the 1960s in Finland, and it became more common to quote the WHO's wide-ranging definition of health in public health policies.[451] The rising concern and government attention towards air pollution seem to fit easily into this development. It was, after all, in parliamentary discussions on new public health laws that the inadequacy of air pollution legislation was first taken up in 1962. Furthermore, other countries saw an increase in funding for air pollution research and for reforming public health systems. Among Nordic countries, Sweden was notable for its major contributions to air pollution research in the 1960s.[452] In the United States, the growing concern over chronic diseases and environmental health led to the reorganisation of the Public Health Service in the mid-1960s.[453] In other words, it would seem appropriate to explain the increasing concern for air pollution and its health effects as part of a more general shift towards the examination of chronic diseases and their environmental causes in modern public health and medicine.

However, the effects of the so-called epidemiological transition and the shift in public health in terms of views on air pollution need to be examined more closely.

449 The theory of epidemiological transition from infectious to chronic diseases was first made by Abdel Omran in 1971, and it has been much-debated ever since. See, for example, Joshua A. Salomon & Christopher J. L. Murray, The Epidemiologic Transition Revisited: Compositional Models for Causes of Death by Age and Sex. *Population and Development Review* 28(2): 205–228, 2002.

450 Uekötter 2009, 226. See also Patterson 1987.

451 Harjula 2007, 104.

452 On Nordic air pollution research, see, for example, Rapport från första nordiska luftvårdssymposiet, Stockholm den 12–14 oktober 1965. Copenhagen: Nordforsk 1965.

453 Uekötter 2009, 210–259.

Most of the debate on the so-called epidemiological transition has revolved around public health statistics and the reasons behind the presumed decline in epidemics.[454] From a different perspective, the sociologist David Armstrong has argued that the change of focus to chronic diseases formed part of a wider move towards surveillance medicine, in which aspects of life are analysed by medical experts in the name of prevention.[455] Although Armstrong's view has been criticised for unfairly perceiving medical inclusion as medicalisation, it serves to show the political and social levels at play in the concept of chronic disease.[456] This notion has been developed further by the historian of medicine Georg Weisz, who has examined the evolution of the concept of chronic disease in the twentieth century. According to Weisz, the reason behind the change in policies and attitudes was not solely due to the perceived defeat of epidemics. Rather, it was the construction and use of the idea of chronic disease that was used to answer specific social and political issues. This development varied between countries as different groups took up the idea of chronic disease to serve their goals.[457] The argument Weisz makes can be used to see the difference between what happened in Finland as opposed to the United States and other countries in the supposed rise of chronic diseases in public health.

In this light, the relationship between Finnish public health in 1960s and the concern for air pollution has a different appearance. By the 1960s, the disease pattern among Finns had changed and childhood mortality rates, for example, had decreased considerably, as was common in many countries at the time. In addition, Finnish medicine experienced a therapeutical turn in the 1950s, as antibiotics and other pharmaceuticals with unseen efficiency began to be administered widely. This trend further enhanced the curative aspects of the medical profession and education.[458] However, despite these advances Finns were far from healthy as was pointed out by the sociologist Pekka Kuusi, one of the most influential Finnish intellectuals of the 1960s and one of the central the architects of the new public health and social policy system that was developed in the 1960s Finland.

Through age-adjusted mortality statistics Kuusi demonstrated that despite the progress made in medical treatment and public health, the state of adult health in

454 The historian Jason Szabo, for example, has argued that chronic diseases in nineteenth-century France were, in fact, perceived as more dangerous than contagious disease epidemics and that public health statistics supported this view. See Jason Szabo, *Incurable and Intolerable: Chronic Disease and Slow Death in Nineteenth-Century France.* Rutgers University Press, New Brunswick 2009.

455 Armstrong 2014, *et passim*.

456 For criticism, see, for example, Chris Gilleard & Paul Higgs, Revisionist or Simply Wrong? A response to Armstrong's Article on Chronic Illness. *Sociology of Health and Illness*, 36:7, 1111–1115, 2014.

457 Weisz 2014*, et passim*.

458 Aalto 2016, 318–324.

Finland was horrid when compared to other European countries. With little regard to lifestyle or the living environment, Kuusi saw the reason behind this state of affairs as stemming from poor access to medical treatment, especially in rural areas. This resulted in the neglect of chronic diseases that slowly impacted the working-age population.[459] To remedy this situation Kuusi proposed a more extensive network of clinics and stronger subsidies for treatment, so that subtle chronic diseases could be diagnosed and treated early. In light of these problems, reform of social policy and the municipal doctor system became the core of Finnish public health policy in the 1960s, as chronically sick adults gradually became a new focus group of public health.[460]

It is safe to say that this concern about chronic diseases had little in common with public anxiety about cancer in the United States. Neither did it resemble the path taken in France and Great Britain, where, as Weisz has shown, chronic diseases came to be linked with old-age and better medical care for the elderly.[461] Whilst this examination offers no conclusive view on how chronic diseases were seen in Finnish society, it does indicate that the problem that was attempting to be addressed by the Finnish public health reform concerned the issue of underdevelopment and disparity in access to health care. This reform of public health and the treatment of chronic diseases was part of a Keynesian vision that aimed to utilise social policies for the benefit of the national economy. Chronic diseases left untreated were a threat to the economy, as they turned working-age adults into patients in need of long-term treatment.[462] The concern about subtle illnesses resembles those of Finnish hygienists of the early twentieth century, who warned about the "creeping illnesses" that threatened factory workers. Yet, whereas the hygienists called for a cleaner environment, for example, Kuusi and other reformers in the 1960s sought more inclusive medical intervention, supported by the power of modern medicine and Keynesian social politics.

The point here is to show that the transition from infectious epidemics to chronic diseases was not a deterministic development that focused the attention of the public health and the medical profession on new environmental health issues. In the United States, the fear of cancer and other incurable diseases fuelled public health reform, thereby supporting Uekötter's argument about the significance of the epidemiological transition.[463] But in Finland the relationship of the air pollution

459 Kuusi 1961, 252–287.
460 Harjula 2007, 103–104; Harjula 2015, 256–271.
461 Weisz 2014, 101–127, 198–203, 224–232.
462 Kuusi 1961, 263–267.
463 As Weisz argues, the fear of cancer had been growing in the United States since the early twentieth century.

problem to public health is less clear. The reform itself had little to do with air pollution, or any aspect of environmental health for that matter. In fact, the lack of environmental health aspects was precisely why Finnish public health reform was criticised in the early 1970s, on the grounds that it failed to intervene in order to tackle the very conditions that caused the illnesses.[464] The rising concern about air pollution and the reform of public health to fight chronic diseases were two separate developments that became entangled in many respects. Both were fuelled by increasing standards of living and the changing fabric of society. In other words, Finnish public health attitudes still viewed air pollution as mainly a nuisance in the 1960s, rather than an acute hazard. Yet, its presence was now felt more strongly in the politics and administration of public health. The importance of expert also grew.

## The Appropriation of Air Pollution as a Public Health Issue

As seen in the previous chapter, FIOH researchers attached little acute public health significance to the levels of air pollution in Finland after the 1959 study. If anything, Noro arguably downplayed concern for air pollution compared to cigarette smoking. Despite this lack of immediate concern, Noro and Laamanen began to bring air pollution problems to the fore and wrote popular articles on the subject that were published in a wide variety of magazines in the early 1960s. These writings were moderate in tone in regards to the state of ambient air. The overall situation in Finland is stated to have been good due to low population density and geographical advantages. Even in the most polluted areas there was no cause for concern, while indoor cigarette smoking was regarded as being the main polluter of the air.[465]

As for the health effects, Laamanen described them as "an interesting question" since many of the substances found in the air were known, through laboratory tests, to have negative effects. However, the quantities in the air were so small that the question of health effects was left "more than unanswered". Writing in *Kotiliesi*, one of Finland's most popular women's magazines, Laamanen stated that "the impurities in urban air are so varied that it is naturally possible that urban air is unequal to rural air in matters of health, but no general rule can be asserted with a specific numerical value, because of the effects of multiple factors."[466] The negative effects of air pollution were predominantly evident in dirtiness and in the death of trees, especially coniferous trees that were damaged by sulphur in the air. Laamanen stated that maintenance officials in Helsinki had had to cut down hundreds of large trees in

464 Harjula 2006, 105–106.
465 Laamanen 1960, 1298–1299, 1348–1360; Noro & Niemioja 1963, 316; Laamanen 1964, 7; Laamanen 1966a, 6–7; Noro & Laamanen 1966, 66–76.
466 Laamanen 1960, 1351.

recent years that had been damaged by "unfavourable" air.[467] In other words, expert opinions in the early years of the 1960s in Finland show little change in attitudes towards the potential health effects of air pollution. The writings repeat the same message that Noro and Laamanen first outlined in their 1958 medical journal article: namely, there was no cause for concern and that research and control should be continued to avoid the fate of other, more industrialised countries.

Perhaps more essential in these writings is how air as an environment was depicted to public. As noted, textbooks on hygiene had viewed air as complex environmental element with vague empirical relation to health. In contrast, the writings of Noro and Laamanen in the early 1960s usually begin by describing air in the manner of atmospheric chemistry, that is, as a mixture of different basic gases. These basic gases formed pure air and any deviations from this should be regarded as impurities. The result of this view was that clean air was a more or less theoretical construct found practically nowhere in nature, except perhaps above the oceans. In practice, as Noro and Laamanen argued, the air people breathed was always a complex mixture of things that could be regarded as impurities. They provided lists of the various substances, man-made or natural, that may be found in urban air and outlined the sources from which these substances might derive. As Noro explained, in practice air could not be reduced to a simple chemical formula, such as $H_2O$, and therefore could not be evaluated as being clean or dirty in the same way as water. Air could be considered as being polluted when the level of impurities reached a level that caused a nuisance. The unravelling of the effects of this complex mixture constituted a time-consuming endeavour undertaken by scientists in many countries.[468] Thus, through these writings Noro and Laamanen presented the air quality problem for the public in the form in which it was constructed by expert communities in the 1950s and as had been presented in U.S. textbooks since the mid-1950s. Viewed as a chemical mixture, with no clean or natural state, ambient air appeared not fundamentally different from industrial air. It too had to be managed through measurements, analysis and controls, through which harmful dosage levels could be removed.

Another subtle but important development in the early 1960s was the gradual introduction of air pollution control into the teaching of hygiene and environmental sanitation. As shown in the first chapter, air had maintained its status in hygiene books both as a positive environmental element and as a vector of primarily occupational diseases. However, the impurities of outside air had received little attention and were viewed as being a nuisance connected with smoke and dust. This clearly changed in the 1960s, as is seen from Noro's textbook *Hygienia*, published

467 Laamanen 1960, 1350.
468 Laamanen 1960, 1298–1299; Noro 1960; Noro & Niemioja 1963, 316.

in 1966, and from a compilation of lectures delivered to engineers in the same year. Noro, Laamanen and their colleagues presented air pollution as a complex but established field of environmental sanitation, which was based on the measurement of air quality. Extensive knowledge about impurities in air, the methods of their measurement, their effects and their sources would be needed to address the issue of air pollution. In other words, air pollution control required experts that were able to wield the chemical-engineer skills of industrial hygiene as well as the wider public health perspective of a hygienist.[469] Rather than a minor aspect of urban hygiene, the quality of air was now a field of research on its own and a viable option for engineers and hygienists to specialise in.

According to Stephen Mosley, air became a public health issue comparable to water in Great Britain after the 1952 London Smog.[470] This was, in essence, what happened in Finland during the 1960s. The point is not that air attracted the same level of attention as water. Water pollution remained the most important environmental health issue in Finnish public health for the entire decade, as was the case in many other countries. The point is rather that air pollution became an autonomous part of hygiene and public health in the same way water pollution had been since the early twentieth century. Noro and Laamanen continued to use the English term 'air pollution' in tandem with the Finnish equivalent, signifying both the strong U.S. influence and the novelty in viewing air as an element similar to water. The institutionalisation of studies on air pollution had begun in the United States in the 1950s, in the form of handbooks and textbooks that aimed to present the complex problem of smoke, gases, smells and chemicals in the air as a united issue called air pollution, with a specific field of research behind it. This expertise on air pollution was incorporated into Finnish attitudes towards public health, hygiene and engineering during the first half of the 1960s.

## The Rise of Air Pollution Expertise

It seems the rising status of air pollution both as a problem and as a field of expertise in Finland had little to do with any new conceptions about its effects on health. According to Schönach, public health officials in Helsinki in the 1960s were more

469 Noro 1966a, 28–44. The institutionalisation of different autonomous disciplines and fields of research had been a growing trend in science and medicine since the nineteenth century. Handbooks, textbooks and specific journals became the standard way to manifest the cohesion of the disciplines and the proliferation of the field into curriculums and decision-making. See, for example, George Weisz, *Divide and Conquer: A Comparative History of Medical Specialization.* Oxford University Press, Oxford 2006.

470 Mosley 2014, 143–169.

concerned than in the past about the health aspects of air pollution and regularly complained about the lack of knowledge on potential health effects.[471] However, the reason for this seems not to be in any fundamentally different view on the health effects of air pollution. When considering the Smell Nuisance Committee of the city of Helsinki, for example, there is little new on display vis-à-vis attitudes towards air pollution as witnessed by the report they published in 1966. The report took the usual stance towards fumes and smoke: they were a nuisance and should be dealt with, but were deemed not to be a danger to health.[472] Perhaps a more notable feature of the report, which has a certain portentous feel as regards air pollution control, was the emphasis it placed on scientific measurements and the reports published by the FIOH. Objective knowledge was deemed vital as a means of further safeguarding the inhabitants of the city from pollution and to effectively handle the sources of nuisance. Consequently, the report encouraged health officials to commission more surveys from the FIOH and its air pollution experts. As a solution to the specific nuisance problem caused by the rubbish incinerators the report recommended that sufficiently high temperatures be enforced that could be controlled by measurements.[473]

As Schönach has noted, this was the first time air pollution was partially controlled by human practice through specific numerical standards. Public health officials could measure the temperature at which the incinerator burned refuse.[474] Yet, in essence, there was little new in this report compared to the one published in 1958 in relation to the death of trees in North Haaga. Public discontent and a call for action were answered with a call for objective knowledge regarding the issue. As discontent about the state of air grew in Helsinki, so did the city officials' enthusiasm for expert evaluations. In other words, there was a change in how public health officials regarded the problem of air pollution. However, this change seems to have originated more from public pressure, combined with the need for objective knowledge, rather than from a fundamentally new view on the health effects of air pollution.

Along with its general encouragement of air pollution research, the Nuisance Committee supported the proposition made by Noro in 1963 that recommended a second investigation of the air in Helsinki. Noro had indeed proposed such a study, which he thought would be topical, as he believed the composition of air in Helsinki would have most likely altered due to changes in industrial activity, private car use

471 Schönach 2008, 157–158.
472 Report of the Smell Nuisance Committee to Helsinki City Council 23.9.1966, AFIOH.
473 Report of the Smell Nuisance Committee to Helsinki City Council 23.9.1966, AFIOH.
474 Schönach 2008, 144. Schönach has also shown that the measures suggested by the committee were rather ineffective at reducing emissions.

and heating systems. In his proposal to the city administrators, Noro also emphasised the need for a more detailed investigation as the 1959 study had merely measured seasonal changes. According to Noro, it was now "also timely in Helsinki to measure monthly and daily variations and also to carry out a more specific analysis of pollution in a foreign manner."[475] Thus, not only was there an increasing demand for objective facts about the state of air generated by the city officials, there was also ready supply from the industrial hygiene department of the FIOH. The FIOH had been struggling to find demand for its new air pollution expertise since the late 1950s but the tide was turning in the mid 1960s. Extensive and subtle analysis of air quality was more and more viewed as the logical first step in air pollution control.

The second investigation on air pollution in Helsinki by the FIOH began in 1964 and although it was apparently never published and received little attention, it marked a step in the FIOH's ascent towards air pollution expertise. Further attempts to promote air pollution research increased in the mid-1960s. The most prominent example was the booklet considering the general protection of outside air. In 1965, six hundred copies of this booklet were sent to individuals, members of parliament and governmental and municipal institutions. Written by Noro and Laamanen, this booklet was probably the FIOH publication that was most read by those in power.[476] This glossary-like, technical piece of writing presented air pollution as a public health issue in the same form as previously described. In addition, however, Noro and Laamanen called for urgent action from the government and municipalities in order to control the air pollution problem before the continuing trends of industrialisation and urban migration exacerbated the problem to unmanageable levels. They proposed that the Finnish government should establish an expert advisory body, which would be able to issue statements and conduct research on the state of the air.[477] The FIOH booklet does not, however, indicate any marked change in the views of its authors towards air pollution's impact on health. Far from being a warning about the subtle chronic health effects of air pollution, the booklet repeats the same disclaimers as seen before: genuine adverse health effects have not been experienced in any locales. Air pollution was a nuisance, but even as such it posed a serious issue for public health, not to mention the future prospect of smog-filled cities.[478]

The fact that air pollution was regarded as a nuisance, rather than as a health hazard does not mean that the FIOH still lingered in the age of black smoke. The plan for a governmental body of experts shows quite clearly that research on air

475 Noro's letter to the real estate office of the city of Helsinki 10.10.1963, AFIOH.
476 Schönach 2008, 187.
477 Noro & Laamanen 1966, *et passim*.
478 Noro & Laamanen 1966, 26–29.

pollution was becoming more sophisticated and more attuned to the links between health and pollution. A detailed plan of the expert body can be found in a letter Noro sent to the Ministry of Internal Affairs a few months after the booklet was published. He wished to offer a solution to the air pollution problem discussed in parliament. Noro proposed to form an expert council, in the same manner as had been assembled for water pollution and offered the expertise of the FIOH in the management of air pollution. To further the research into air pollution he requested 200,000 Finnish Marks for additional equipment, such as a spectrograph and multiple continuous air analysers. Noro highlighted again the fact that the FIOH had already spent 100,000 Finnish Marks on air pollution research equipment for the WHO carcinogen study.[479] Thus, it was not only through textbooks and teaching that the FIOH tried to promote air pollution as an aspect of public health management. They also attempted to encourage governmental action, and, with it, their role as experts in understanding ambient air. It could be said that there was a mutual interest between FIOH and the government to increase research into air pollution amidst increasing public indignation.

Soon after the publication of the booklet and Noro's letter, the Ministry of Internal Affairs established a Government Council for Air Pollution Control and Noise Abatement, imitating the action it had already taken in regards to water pollution and what had been enacted in Sweden at the time vis-à-vis air pollution. As the title shows, noise was lumped together with air pollution. The reasoning behind this combination is somewhat ambiguous, other than that they were both problematic aspects of modern urban life that required technical expertise in order to be solved.[480] The FIOH's influence in the establishment of this expert body is unclear, since air pollution was already receiving increasing attention. In 1965, for example, even the national parliament issued a resolution for the government to act regarding the problem. Whatever the causes, the outcome was the foundation of an expert advisory board dominated by FIOH personnel. Noro was chosen to head the entire board, while his staff members, Arvo Laamanen and Jorma Lehtinen, oversaw the air and noise divisions. Through this expert board the FIOH strengthened its status as a national authority on air pollution. Moreover, Arvo Laamanen came to be regarded as the nation's foremost air pollution researcher.[481]

479 A letter from Noro to Chief Secretary A. Hannus. 4.6.1965, ISMET domestic correspondence, NAF.

480 The council did not have official title in English. The title used here is also used by Leo Noro in his correspondence. Finnish abbreviation of the council, ISMET, is used when referring to the documents of the council.

481 Schönach 2008, 186–187. Other members were from the meteorological institution and various industrial organisations.

The expansion of Finnish air pollution research can be seen as part of a wider development. The increasing demand for air pollution monitoring that had begun in the 1950s expanded in many countries in the 1960s. The idea gained prominence that a network of standardised measurements was needed in order to effectively control the problem.[482] Noro and Laamanen, too, had a vision to establish a survey covering multiple places of varying size and economic structure, combined with sophisticated analysis on the content of air. Unfortunately, the grand visions Noro had for research into air pollution in Finland did not materialise, even with newfound support from the government. The board of experts only received meagre resources that were far below the amount needed to conduct surveys, let alone buy new equipment.[483] Noro complained that Sweden, for example, had invested huge sums in research in comparison to Finland.[484] Combined with the chronically-tight budget of the FIOH, this lack of resources set in place severe practical limits to the national air pollution expertise in Finland. This disparity became visible when the organisation for Nordic co-operation in scientific and technological research, Nordforsk, began to operate and held the first Nordic symposium on air pollution. Sweden had by far the largest resources for research, whereas Norway had highly-developed legislation.[485] As an FIOH junior researcher, Risto Lahdes later remarked that Finnish experts were largely bystanders at these gatherings.[486] In short, budget constraints prevented once again FIOH from keeping up with developments elsewhere.

Despite limited resources, the years from 1965 to the early 1970s became the most productive time for air pollution research at the FIOH. Large networks were beyond its reach, but instead the FIOH worked with municipal authorities that showed increasing interest in air pollution measurements. In addition to Helsinki, where most of the FIOH's measurements were carried out, many smaller towns and industrial communities requested measurements to be taken on the state of their air in the late 1960s and early 1970s, in order to chart the state of the air and plan possible control measures.[487] The view of air pollution as a problem that needed to be understood via careful expert measurement and analysis was gaining ground. The

482 For a summary of the development of air pollution monitoring networks see, Insights from a Chronology of the Development of Atmospheric Composition Monitoring Networks Since the 1800s. Christopher S. Malley, Mathew R. Heal and Christine F. Braban. 2016, *Atmosphere* 2016, 7(12), 160. See also Mosley 2009.

483 Schönach 2008, 186–187.

484 Noro's letter to the Ministry of Internal Affairs 4.6.1965, AFIOH.

485 See Rapport från första nordiska luftvårdssymposiet, Stockholm den 12–14 oktober 1965.

486 Interview with Risto Lahdes by Paula Schönach, 26.8.2004.

487 The towns and cities were Turku (1966), Lappeenranta-Lauritsala (1967), Pori (1967–68), Kokkola (1966–67 and 1970–71), Rauma (1971), Tampere (1971), Valkeakoski (1971–72), Kuusankoski (1971–72), Karhula (1971), Mänttä (1971–72)

council of experts also began to publish bulletins and issued statements related to air pollution problems in connection with planned factories. In short, from 1966 until the early 1970s the Government Council for Air Pollution Control and Noise Abatement became the official voice on air pollution questions in Finland.

The rise of air pollution expertise in Finland was one feature in the process well-known in environmental history, namely, the scientific management of environmental resources in a modern society. As Stephen Bocking has emphasised, the rise of scientific expertise in societal planning and control did not arise merely from the power of methods, but also from an alliance with institutions that utilised this knowledge. In other words, the increasing management of the environment has been a joint venture between bureaucratic and scientific expertise. Bocking's arguments resonate with those made by Theodore Porter; namely that bureaucratic institutions need specific and objective numbers in order to compensate for their lack of power.[488] One the chief examples of this rise of environmental management was the so-called conquest of water in the nineteenth century. This changed water from being thought of as a natural element to a product that was provided by public administrations.[489] It could be said that urban air in the 1960s was becoming part of this growing sphere of expert management. The methods and principles utilised to manage occupational environments were now united with the government's need to control air as a resource in a modern society. In other words, air needed to be managed in the same manner as water, soil or even milk had been for some time.[490] The principles for attempting to manage environmental aspects, such as the air, were essentially the same as had been used in the management of the industrial environment in the early twentieth century. As Desrosieres has argued, this effectively entailed a subtle alignment between the authority and legitimacy of government and the authority and legitimacy of science.[491]

As the Finnish example demonstrates, the proliferation of air pollution management happened in a simultaneous manner in many countries despite the great differences in the actual intensity of the problem. Noro and Laamanen often complained about the backwardness of the Finnish situation and the lack of resources, but it should be noted that even in highly industrialised nations the legislation and measurement networks were being expanded and upgraded only in the 1960s.[492] Metropolises, such as London and Los Angeles, should be seen as

488 Porter 1996, 8–11.

489 Bocking 2004, 53. See also Jean-Pierre Goubert, *The Conquest of Water: The Advent of Health in the Industrial Age*. Princeton University Press, Princeton 1989.

490 See Kendra Smith-Howard, *Pure and Modern Milk: An Environmental History Since 1900*. Oxford University Press, Oxford 2013.

491 Desrosieres 1998, 334.

492 See Uekötter 2009 and Charvolin *et al.* 2015.

exceptions to the rule, rather than relevant points of comparison. Unfortunately, the conquest of the air proved to be a difficult task in practice. Air pollution was appropriated into public health teaching and the FIOH's measurements on air quality were gradually expanding. Yet, there was something that was still missing if urban air was to become a modern product of technical management akin to the treatment of water and milk.

## The Puzzle of Health Effects

As discussed above, textbooks and other teaching materials are a particularly good source to examine what was regarded as being known at the time. The historian of medicine John C. Burnham has, for example, stated that medical textbooks in the early twentieth century contained a lot of information about diagnosis, but very little about cures. This reflected the unbalanced progress of the discipline at the time.[493] In a similar manner, the textbooks that discussed air pollution in the 1960s Finland show a disparity between knowing how to analyse air and the ability to describe its quantitative and qualitative content, as opposed to knowing what such analysis means in terms of health and wellbeing. A striking feature in all of the Finnish teaching materials is the relatively low attention afforded to health effects in comparison to other aspects of air pollution. The bulk of information, even in the sections labelled as air pollution and health, consider the sources of various pollutants, categories of pollution, or effects on non-human environments. Tables of different substances and their specific effects on health, which were the core of occupational health textbooks, were missing or reduced to a short discussion of the few hazards of industrial air. The famous smog episodes in London and Donora are referred to as proof of the danger air pollution poses in high amounts for the sick and elderly. Little is disclosed of the chronic effects except possible connections to bronchitis and lung cancer.[494] This view of the health effects stemming from air pollution provides a succinct illustration, in many ways, of the general state of the field.

The disparity between the means to analyse air and to understand the significance of the results was already noted in the late 1950s by U.S. researchers. In 1959, a group of top U.S. air pollution experts described the handicaps of analysing air quality in an article that appeared in *JAPCA*, but concluded with the following statement:

493 Burnham 2005, 115.
494 Noro 1966b, 35–45; Laamanen 1966b, 1–7; Noro 1966a, 1–14.

> Even though our ability to identify and measure pollutants is not as far advanced as we believe it should be, it is much further along than our knowledge of the significance of these measurements as they affect the health and comfort of man.[495]

Little over a year after this statement, the Deputy Surgeon General of the U.S. Public Health Service, John Porterfield, delivered a speech at an annual ACPA convention, in which he eloquently praised the progress of scientific knowledge. He applauded not only the material benefits and comfort gained from the accumulation of knowledge and know-how, but also the positive global changes ushered in by science, which had turned the attention of man towards the stars. However, Porterfield also regretted that in this enthusiasm the living conditions on the ground needed more attention:

> But with all this probing of outer space and piercing of inner space, we tend to neglect the mundane, prosaic middle ground in which we live and breathe. As a matter of cold, hard fact, we are closer to putting a man on the moon than we are to creating a thoroughly healthy and pleasant environment on this Earth for man to live in—closer in know-how, closer in time, closer in probability of achievement. A visitor from another planet might find this one of the most perplexing features of our perplexing world—unless, of course, he had become a space visitor because he could no longer tolerate the air on his own planet.[496]

Porterfield suggested the reason for this imbalance was because unlike atomic scientists and space scientists, public health professionals carried the burden of tradition. This steered them towards fighting yesterday's battles. As he noted, it would be nice to fight against relatively simple infectious diseases, "but, while these jobs are never quite done, we are being forced by circumstances beyond our control into the strange, complex, and mysterious world of chronic diseases and toxic environmental hazards. The frontiers of health have moved, and we must move with them."[497] Unfortunately, this movement had achieved limited success by the mid-1960s.

In a summary of the present state of medical knowledge on air pollution in 1966, Harry Heiman, of the U.S. Public Health Service, admitted that despite years of accumulated knowledge and much better understanding of the composition of urban air, it was still extremely difficult to prove the causality between air pollutants and

495 Haage-Smit, McKee, Stern 1959, 44.
496 Porterfield 1961, 175.
497 Porterfield 1961, 175.

illness. Even though there was an indication that cities were in some sense less healthy environments than rural areas, it was hard to separate the effects of air pollution from other aspects of urban life. Epidemiological studies found that high levels of air pollution correlated with increased levels of chronic bronchitis and other respiratory and heart diseases. However, there was no certainty on the specific impurities in the air that led to these illnesses. Heiman regarded sulphur dioxide as a probable cause, but he believed that it was unlikely that it acted alone. As for lung cancer, Heiman argued that there seemed to be strong reasons to suspect air pollution as one cause, but that there was still no uniformity on the issue. The principal difficulty was that cigarette smoking, a common habit that impacted health in a similar manner to air pollution, greatly handicapped the results of epidemiological studies.[498] Thus, in the case of lung cancer, it was possible only to show "an urban factor", without any specific role for air pollution.[499]As another evaluation of the existing research argued, it was easy to make air pollution look bad, but instead of research this was mere "promotion" and "producing a horror picture".[500] According to Heiman's summary, the puzzle, in Kuhnian terms, which was framed in the 1950s as the core focus of air pollution research, was still very much unsolved in the mid-1960s.

Historical studies on air pollution sometimes view the measurement of sulphur dioxide as an early shift away from regarding air pollution as a mere nuisance to more serious attempts to evaluate its health effects. Mosley, for example, demonstrates that $SO_2$ was already suspected of having deleterious health effects in the late nineteenth century and that it subsequently became the focus of British air pollution monitoring in the 1960s.[501] A similar account is given by Charvolin *et al*. in their social history of air pollution in France.[502] This development can be seen as part of a longer trend in the redefinition of air pollution itself, in which air pollution began to be defined as something that was breathed-in rather than something that was seen.[503] What needs to be added to these historical accounts is how quickly $SO_2$ came to be viewed as an inadequate answer to the hazards of air pollution.

As argued in the present work, sulphur dioxide, along with suspended particles, were regarded as the most important object of measurement in the late 1950s. At the same time, dust fall was considered to be mostly of local aesthetic interest. What should be noted, however, is the purpose and significance of these measurements as

498 Heiman 1967, 488–499.
499 Gross 1965, 160–161.
500 McCabe, Machle, Barnes 1964, 107–109.
501 Mosley 2009, 282–287.
502 Charvolin *et al*., 16–21.
503 See Gugliotta 2003.

air pollution research progressed. As one expert noted in a WHO conference in the mid-1960s, it was an easy mistake by a casual observer to regard $SO_2$ as the main culprit in air pollution research. In truth, the scientists who measured it mostly considered it as an index of general air pollution, rather than as a cause of health issues in itself.[504] Similarly, the U.S. public health expert Eric Cassel argued in *JAPCA* that the measurements do not measure $SO_2$ directly, but were more correctly an index of many things, such as weather, fuel use, level of industrialisation and socio-economical standards. Cassel noted that when his team wrote about the measurements they refer to them as "whatever is represented by the measurement of sulphur dioxide". Nonetheless, people citing their research refer simply to $SO_2$.[505]

In other words, for air pollution researchers $SO_2$ signified the general degree of pollution in the ambient atmosphere. The specific significance of $SO_2$ was, however, unclear. The reason for not regarding $SO_2$ as the culprit was the same as with most substances in the air: it was not supported by evidence stemming from toxicology, occupational health and clinical experiments. In fact, in 1967 Mary Amdur, the prominent U.S. toxicologist, concluded that $SO_2$ alone was not the reason why air pollution caused respiratory diseases and that too much attention had been given to it in research. Amdur suggested that research should be focused on combinations of substances and especially on microscopic particles that she suggested were the key to the puzzle.[506] According to the traditional view, as in Noro's textbooks, for example, very large and very small particles were seen as harmless, while it was those of moderate size that were able to penetrate the lungs. In other words, the significance of $SO_2$, along with most pollutants in the air, in the mid-1960s remained largely unknown.

In a way, the situation with urban air pollution in the 1960s resembled studies of indoor air in the 1940s. Carbon dioxide content had been used as an index of fresh air, and $SO_2$ content was analysed as an index of pollution, even though it was clear that the causes and mechanisms were more complex in both cases. Both were used as an index because, on the whole, they were relatively easy to measure and correlated, up to a point, with the deleterious effects. A notable difference is that at

504 Lawther 1968, 24–29.

505 Cassel 1969, 799–802.

506 Amdur 1969, 638–643. In retrospect it appears that Amdur was right. The measurement of microscopic particles (PM2.5) increased from the 1970s. In the late 1980s and early 1990s several studies found a correlation between particulate matter and the age-adjusted death rate in U.S. cities. The issue was controversial, but the significance of PM2.5 was sanctioned by a WHO group of experts in 2003 and has subsequently become the most essential part of air pollution control. It should be added, however, that PM2.5 was only a partial answer to the original puzzle since it was still unclear what substance caused the health effects. On the PM controversy, see Robert F. Phalen, *The Particulate Air Pollution Controversy.* Springer, Boston 2002.

least in Finland, there was no 'Pettenkoffer's figure' experts could use as a precise tool for evaluation and control of $SO_2$. The unknowns in air pollution research can be seen in the difference between air quality control and water quality control. For an engineering or public health official charged with maintaining the state of water supplies, Noro's book *Hygienia,* or any other book on hygiene for that matter, would offer precise instructions, criteria and guides on the quality of water. There were methods to test for known microbes, and even WHO guidelines for the quantity of different chemicals.[507] In other words, there was a more or less standard view on what constituted pure or optimal water and how it should be determined. This standard water was derived from the long fight against water-borne diseases and the overall systematisation of water in modern society, described by Jean-Pierre Goubert as "the conquest of water".[508]

For someone charged with maintaining the quality of outside air, the situation was rather different. For a person tasked with such a job, *Hygienia* would provide a list of known substances found in the air, and vague descriptions of their significance, such as "quite harmless" or "a mild nuisance". This does not mean there were no potential dangers. As Noro stated, U.S. researchers had identified over eighty different gaseous substances in urban air, many of which were known to be carcinogenic. When this was added to the metals and trace elements found in the air in Helsinki, and in urban environments in general, air pollution presented a bewildering mix of things of which little was known in terms of matters of health and wellbeing.[509] It could be said that analysis as a way of knowing was being overwhelmed by its own efficiency. Despite the reduction of air into its chemical components, there was no clear idea about what air as a human environment should be like.

While the puzzle remained unsolved, new substances found in air further complicated matters. Exhaust emissions from motor vehicles were growing due to increasing use of private cars. These emissions were no less of a controversial issue than other aspects of air pollution. This was not due to the topic receiving little attention, nor even the novelty of the issue. It is sometimes argued that consistent attention to car exhaust emissions began in Los Angeles, where the idea of photochemical smog was invented in the 1940s.[510] However, the statements on the matter in both WHO reports and in the reports of the FIOH do not support this notion.

507 Noro 1966b, 54–61.
508 See, Jean-Pierre Goubert, *The Conquest of Water*. Polity Press, Oxford 1986. See also, David Blackbourn, *The Conquest of Nature: Water, Landscape, and the Making of Modern Germany.* Pimlico, London 2007.
509 Noro 1966b, 37–40.
510 Uekötter 2009, 209.

First, although the Los Angeles photochemical smog was well known, it was regarded as a unique problem occurring in a specific topographical setting that was thought to be rare in Europe. Furthermore, the health effects of LA smog were seen as being relatively mild, with symptoms including eye irritation.[511] Similar to the disasters in Donora and London, the Los Angeles Smog was seen as a special case and not the most acute concern even with regards to private car use.

For WHO experts and for the experts at the FIOH in the mid 1960s, the most important potential threats in vehicle exhaust emissions were CO, carcinogens and lead. Of these three, CO was deemed to be the most ominous, since it was rather abundant in exhaust emissions from petrol engines. Moreover, concentrations of carbon monoxide were sometimes even formed in urban streets at higher levels than those allowed in industry.[512] Carcinogens were instead regarded with suspicion rather than simply being viewed as hazardous. As stated in the 1967 WHO report on the health effects of air pollution, the connection between air pollution and lung cancer was "a matter of considerable doubt".[513] Rather than viewing the attention given to the health effects deriving from vehicle exhaust emissions as a novelty stemming from research on photochemical smog, it should be viewed as a continuum: the dangers perceived to stem from CO poisoning gradually evolved from being largely considered an occupational health issue into a problem of public health as the use of private cars proliferated. As seen in the first chapters, CO from wood gas generators was the first major issue studied by Leo Noro and other would-be employees of the FIOH. Moreover, in the air pollution studies they conducted in the 1960s, CO was the element they studied most in car exhaust emissions. It was also one of the few substances that was studied in regards to its effects on health, as the CO content of blood could relatively easily be measured.[514] In other words, the old problem of CO poisoning had returned with private car use and was incorporated into air pollution research that was struggling with pollutants and their effects on health.

Lead content was a new potential hazard in the air in the 1960s and was caused by an increase in the consumption of leaded fuel. Since lead was a known occupational health hazard, the use of tetraethyllead as an anti-knock agent had already been viewed with suspicion by the medical community before the Second World War. However, studies carried out in the United States showed no signs of

511 The Health Effects of Air Pollution 1968, 33–56.

512 Hasan & Nurminen 1965, 20–27. The study concluded that the levels of CO in Helsinki were not a danger to health and did not exceed the amount of CO received from cigarette smoking.

513 The Health Effects of Air Pollution 1968**,** 39.

514 CO content in the blood of traffic policemen was the usual "yardstick" in these studies. This mode of research had already been devised in the 1940s.

lead poisoning in persons continuously exposed to limited amounts of tetraethyllead, and consequently these suspicions gradually receded Hence, economic incentives began to take hold and the use of tetraethyllead proliferated in the United States initially and later in other countries.[515] The historian Christian Warren has shown how the idea of lead being harmless in low doses was based on what he calls the Kettering Paradigm, which was upheld most prominently by the U.S. toxicologist Robert Kehoe. Warren divided this paradigm into four basic principles: lead is endemic in nature, humans have mechanisms to absorb and remove lead, lead has a safety threshold and people's exposure to lead is far below this threshold.[516] As in air pollution research in general, the principles from industrial hygiene and toxicology were fundamental in evaluating the thread posed by lead in air.

In Finland, Esso requested that the FIOH issue a statement about the potential dangers of leaded petrol in 1960. In this report, Noro and the FIOH toxicologist Jeddi Hasan concluded that neither evidence in Finland nor in other countries indicated that lead had harmful, toxic effects at the levels of exposure that were prevalent at the time. Yet, since knowledge on the matter was still scarce, it was also not possible to determine safe levels for lead in petrol. According to Noro and Hasan, the present limit set by the Finnish government for the percentage of lead in petrol had no basis in science. They further added that experience had shown that the feelings people held towards lead were of more significance to symptoms than the actual amount of lead in their environment. This indicated the need for some public education regarding the matter.[517] The statement Noro and Hasan issued clearly reflects the Kettering Paradigm's ideas on the danger of lead. Harry Heiman also viewed lead in petrol as suspicious in his summary and argued that it needed to be monitored. However, he also admitted that hitherto there had been no conclusive evidence of its effects on health in low doses.[518] As had been the case with factory emissions, people's common-sense concern for poisoning could not be verified by medical studies. Hence, the experts such as Noro and Laamanen viewed the concern as being an irrational anxiety that could be cured by educating the public.

Uekötter refers to the "increasingly precise picture of the health effects of air pollution by post war medical science" as one reason behind the rising concern in the 1960s. Yet, it seems that the air pollution experts at the FIOH, the World Health Organisation or the USPHS did not share this view. The research and knowledge had increased and much was known about urban air and its health effects compared to

515 Uekötter 2004, 125–128. See also Warren 2001.
516 Warren 2019, 115–120.
517 Etylisoidun moottoripolttoaineen myrkyllisyys. Lausunto Esso Oy Ab:lle Helsingissä 26.2.1960, AFIOH.
518 Heiman 1967, 488–499.

the previous decade. Even so, the causal proof about the effects of specific air pollutants had proven to be a tough nut to crack. Thus, the plan to clarify air by recognising and removing the harmful quantities had not yet materialised into Finnish public health education. Looking at the overall picture of 1960s debate on environmental pollution, these experts appear to belong to the conservative side, which emphasised the lack of knowledge on the health effects of pollution. These views were increasingly challenged, especially in the United States, by the newer breed of experts who emphasised different aspects of the problem, such as the complexity of the causes and the potential danger from long term exposure on low doses.[519] These debates would also spill into Finnish public discussion later in the decade, challenging the FIOH's expertise on environmental health. Before that, however, the debate on what was known and what needed to be known about air pollution became essential in the effort to manage urban air by scientific standards. This effort increased in the 1960s as the public health officials, industrialists and the general public all saw the need for objective norms for urban air.

519 Nash 2006, 127–150.

## 4.2 The Conquest of Air: Importing Standards for Normal Air

By the mid-1960s, air pollution researchers were able to answer questions relating to the state of the air, how it has changed and the sources that affected its quality. However, whilst representing ambient air through atmospheric chemistry, clean air became a mere theoretical concept, or, at best, a rarity with little practical significance. In other words, the objective basis provided by atmospheric chemistry seemed to give little guidance on the question, that is, the optimal state of air. In the 1960s, this question became increasingly important as air pollution gained momentum as a public health issue and as the expertise in its measurement and control began to be institutionalised into the apparatus of municipal and national regulatory authorities. The purpose of this chapter is to examine how so-called normal ambient air became an object of quantification and expert evaluation. Experts from the FIOH and their foreign counterparts had established their methods of measurement and analysis as objective views on the state of ambient air. However, it was only through air quality norms that this analysis was also able to solve the issue of what constituted the most desirable quality of air. In short, the development of air quality norms provided a means to evaluate and standardise clean air.

### From Reasonability to Numbers

There was a long tradition of evaluating and controlling the state of air in towns and cities in Europe and the United States since the nineteenth century.[520] Although the norms underpinning smoke control varied, the legal basis of these norms could be lumped together under the umbrella term of "nuisance laws". In essence, these laws were based on the concept of reasonability. This idea of reasonability was a two-way construct: it was unreasonable to pollute someone's air, but it was unreasonable to demand completely unpolluted air in industrial or urban areas, for example, that used coal as a source of fuel. The obvious difficulty inherent in this form of regulation was to determine the level at which pollution was deemed to be either reasonable or unreasonable. An understanding of what was meant by reasonable was one of the essential problems of smoke abatement in the nineteenth century. Thus, the optimal state of air not only remained a matter of judicial interpretation, but also a complex socio-political and cultural question.[521] As historical works on air pollution abatement in the nineteenth century and early twentieth century demonstrate, behind

520 See, for example, Uekötter 2005.

521 See, for example, Robert Jütte 2018. For a more general view on the changing ideas of acceptable smells in the urban environment see Alain Corbin, *The Foul & the Fragrant: Odour and the Social Imagination.* Harvard University Press, Cambridge (MA) 1986.

the problem of air quality were a plethora of contested issues, such as ideas of economic development and prosperity, class politics, ideas of cleanliness and comfort, expectations of future technical progress, ideas of urban areas as distinctive spaces, views on the limits of natural resources, ideas on human evolution and also ideas on what constitutes a healthy environment.[522] In short, the state of air was a complex and diverse question of values and ideas, not a matter of simple measurement.

The general idea seems to be that the nuisance laws of the nineteenth century and early twentieth century were vague, open to interpretation and therefore inadequate in controlling air pollution and especially its health effects. This view is shared both by historians and those who were concerned with the issue in the mid-twentieth century. The recurring theme in the history of air pollution control is the inability of local health officials and nuisance legislation to control the vague effects of air quality.[523] The need for more precise legislation was already evident to those who participated in the first conferences on air pollution in the U.S. and Europe in the 1950s. The most enthusiastic industrial hygienists and also insurance experts sometimes proposed the use of modified Maximum Allowable Concentration levels as objective, medically-based numerical guides to provide a basis for air pollution control. Despite the general acceptance of the principles of industrial hygiene, these ideas were quickly turned down on the grounds that the working population and the general population were fundamentally different and could not be protected by similar regulatory concepts.[524] However, the idea of objective numerical norms was compelling and it was seen as the long-term solution that would lead to the clarification of the air. Through this idea air pollution control could potentially utilise objective numerical norms based on medical research, rather than vague notions of reasonability and nuisance.[525]

In the early 1960s the discussion about the need for such norms and their development intensified in Europe and North America. As the of the status of air pollution as a public health nuisance also grew in Finland in the 1960s, so did the demands for more precise legislation. One of the first comments on the vagueness of the air pollution legislation in Finland came from a committee evaluating the proposal for new public health law in 1962. The committee paid attention to the vague legal status of air pollution and noise, which the new law did not broach upon.

522 See Stradling 1999; Thorsheim 2006; Uekötter 2009; Mosley 2004.
523 Melosi 2004 (1981),16; Sellers 1994, 68; Schönach 2008, 155.
524 Tabershaw 1952, 468–471; Phair 1956, 7–8; Giovanardi 1957, 37–55.
525 An early exception in this regard was the Italian professor of hygiene Giovanardi, who asserted at the Milan conference that even the principle of threshold values for ambient air was fundamentally flawed. See Giovanardi 1957.

It demanded "a thorough examination and the setting down of necessary provisions to prevent those health-related nuisances that are increasingly caused by air pollution and noise."[526] Despite the committee's remark, the legal status of air pollution, or noise for that matter, did not change in the new public health law enacted in 1965. In the same year, however, the National Medical Council approached Leo Noro vis-à-vis consultation on the state of air pollution control in Finnish urban areas. This concern did not arise in the council itself, but was brought to its attention by the Association of Finnish Cities. As with the public health committee, the Association of Finnish Cities doubted whether the public health law would be adequate to protect citizens from air pollution. Noro agreed with the association, stating that it was at present difficult, or even impossible, to apply the law against air pollution, since there were no precise norms to which emissions could be compared. He emphasised the need for special legislation and air quality norms if people were to be protected efficiently. Naturally, this would also require more investment from the government for air pollution research. With this in mind, the Finnish Institution of Occupational Health would be at the council's disposal.[527]

Noro also pointed out that the desire for norms came not only from those concerned for air pollution, but also from within industry as well.[528] Indeed, in the meeting between manufacturing industry experts and the newly founded Government Council for Air Conservation and Noise Abatement, the need for specific norms for air quality turned out to be the central topic. The manufacturing-industry experts welcomed norms as providing common and clear ground rules, but they also emphasised the economic cost of adjusting emissions. One representative even suggested that the institution providing the norms should also provide the means to reach them.[529] Whereas those concerned about air pollution demanded norms for securing better legal means to control air pollution, the industry welcomed norms as they provided stable and specific guidelines for development if economic realities were taken into consideration. The lack of norms was also stated as the most immediate problem by the representative of the country's largest industrial consultation firm, which specialised in measurements of efficiency and emissions in industrial processes. They were forced to use foreign standards in order to have some

526 Komiteamietintö (Report of the Public Health Law Committee) 1962:89, 3.
527 Noro's letter to the National Medical Council. 4.6.1965, ISMET Domestic Correspondence, NAF.
528 Noro's letter to the National Medical Council. 4.6.1965, ISMET Domestic Correspondence, NAF.
529 Records of the air pollution division 6/1968, ISMET Official Records 1966–1968, NAF.

specific reference for their measurements.[530] This view on industry and air pollution norms supports the arguments put forward by Schönach; namely, that everyone involved in the discussion about air pollution in Finland during the 1960s wanted the government to introduce official norms.[531] In short, there was a broad consensus in Finnish discussions about air pollution that effective air pollution control required more specific legislation and norms than was then provided by the nuisance law and public health law.

In historical studies on air pollution abatement and politics, there is a tendency to see the development and imposition of air quality standards as a progressive step in environmental and public health legislation.[532] It can be said that this progress has not been seen merely in the standards themselves, but also in their gradual enactment in national legislation in many countries during the 1960s. This tendency relates to the common way of depicting new laws as milestones in the protection of the environment and health. The status of the British Clean Air Act of 1956 is a case in point.[533] However, the point here is not simply to examine the development of air quality norms as a battle for cleaner air. Although the struggles, limitations and compromises in environmental and public health protection are important themes in the history of environmental poisons, this kind of view tends to emphasise political conflict and interests at the expense of the ways in which the environment and health are depicted and evaluated.[534]

The purpose, therefore, is to examine the aspiration for better evaluation of air quality from a specific point of view: as a development and proliferation of norms to solve the problem of agreeing on a common yardstick for polluting air. In a sense it was the old problem of reasonability with all its attendant complexities. Yet, unlike in previous eras, the 1960s saw a growing network of experts with the ability to present air pollution and its effects through the apparent objectivity of science and medicine. As had been the case in industrial hygiene and the MAC levels, the air quality norms could provide, at least in principle, a rational means to manage air without any complex moral question. This transnational network of experts became the forum through which the standards of clean air were adopted in Finland.

530 Records of the air pollution division 5/1968, ISMET Official Records 1966–1968, NAF.

531 Schönach 2008, 208.

532 In the case of Finnish air pollution legislation, see Nienstedt 1997.

533 See, for example, Mosley 2014.

534 For example, Scott Dewey: *Don't Breathe the Air: Air Pollution and U.S. Environmental Politics, 1945–1970.* Texas A&M University Press, College Station 2000; Gerald Markowitz and David Rosner: *Deceit and Denial: The Deadly Politics of Industrial Pollution,* University of California Press, Berkeley 2013; Susanna Rankin Bohme: *Toxic Injustice: A Transnational History of Exposure and Struggle.* University of California Press, Berkeley 2014.

## The Normal Air of the Modern Environment

As the role of the air pollution researcher became more firmly grounded at the Finnish Institute of Occupational Health during the 1960s, the work they undertook was also increasingly connected to that undertaken by their U.S. counterparts. U.S. research was already the most prominent in the field, but the connection to the U.S. strengthened further after Arvo Laamanen, the leading Finnish air pollution expert, completed a study trip to the public health research centre at Cincinnati in 1965. During this study trip Laamanen became further acquainted with U.S. air pollution control and research, which had a strong emphasis in public health.[535] According to a long-time colleague of Laamanen, this versatile public health view had a lasting impact on how Laamanen perceived air pollution research.[536]

U.S. dominance can also be seen by examining the references in the FIOH studies conducted in the mid-1960s. German research published in the journal *Staub* was also deemed important, but the references in FIOH publications indicate the predominance of U.S. research. *JAPCA* became the most important channel of information for research and the manuals Laamanen brought from Cincinnati were often used as guides to evaluate air pollution and its public health significance.[537] According to a junior researcher, Arthur Stern's monograph, entitled *Air Pollution*, became the Bible of Finnish air pollution research.[538] This U.S. dominance can be seen as a continuation of the post-war dominance of the United States in air pollution research described by Uekötter.[539] Due to its general dominance and visibility, U.S. research became the central reference point in the development of air quality norms.

The need for improved public health legislation received political support in the in the United States during the 1960s, which furthered the development of air quality norms. In fact, the House of Representatives had given almost unanimous support to the development of national air quality standards. The 1963 Air Quality Act further enhanced interest in the topic by facilitating more resources for research and outlining the need for federal standards for motor vehicle exhausts. The nation's leading air pollution organisation, the Air Pollution Control Association (APCA), also took an interest in the issues and established a working group on air quality

535 The Environmental Protection Agency (EPA), which included air pollution issues under the umbrella of environmental protection, was not established until 1970.
536 Email from Matti Jantunen 9.6.2020.
537 Laamanen & Noro 1966, 39; Laamanen 1966c, 12. Laamanen & Noro 1967, 6,25. The only German work cited in FIOH publications is *Der Atmosphärishce Staub* by Walter Fett. It is introduced as general reading rather than a work that focuses on a specific issue.
538 Lahdes 2006, 59.
539 Uekötter 2009, 147.

standards in 1961.[540] The head of the working group, a prominent California-based air pollution expert, W. L. Faith, described the development of air quality standards as one of the most promising and interesting features in air pollution research. In his speech at the annual meeting of the APCA, Faith stated the need for more research on acceptable levels of air pollution as the most pressing issue in the discipline. As the standards then in use in some locales differed wildly from each other, there was a need for a higher authority on the matter.

It should be noted that for Faith, the need for standards was especially pressing in regards to the health effects of air pollution. He saw little need for national standards in an economic or aesthetic sense, since these should be up to local authorities to decide, as they had done before. He especially endorsed the experience gained from occupational health and industrial hygiene for determining health effects, although these standards could not be applied to outside air as such.[541] Faith's comments show how the idea of medically defined health effects, which could be used in the same manner as in industrial hygiene, came to be seen as the centrepiece in the search for an objective and universal norm for ambient air. In theory, the norms backed by science and medicine would provide an unbiased basis for air quality evaluation when compared to earlier efforts that sought to define the reasonable amidst contested and conflicting evaluations and moral arguments.

Although the legalised medical standards for air had apparently univocal endorsement in U.S. politics and they were also endorsed by many air pollution experts, some experts regarded the adoption of such standards to be a difficult issue. The discussion on standards increased in *JAPCA*, which featured many theoretical pieces on the nature and applicability of air quality standards. Many of these articles were pessimistic or even critical of the idea. Perhaps the most common critical view on the issue was the one held by Robert Kehoe, the nation's leading expert on lead poisoning and industrial toxicology. For Kehoe, the reason why standards could not as yet be applied was simple: ignorance. All issues relating to the matter could, at least in theory, be solved with more knowledge and therefore more research. In practice, however, the understanding of the health effects of air pollution was so limited and the significance of industrial production so overwhelming that any dream of a completely risk-free environment through air quality standards was utterly unrealistic. For Kehoe, the discussions about clean air by many opponents of pollution were little more than a nostalgic yearning with no practical meaning in modern society:

[540] The 1960s also saw a considerable increase in the APCA's membership, which had stayed relatively stable since its formation. See, Sixty Years of Service, *JAPCA* 1967, vol. 17, no. 6, 371–373.

[541] Faith 1962, 315.

> This, like the nostalgic wish to return to the simple life, to the “good old days," to the “horse and buggy days," tugs at the heartstrings of all but the young in years and spirit, who are in search of adventure, rather than peace and quiet. It is, however, errant nonsense. There is no such thing as clean air, and the concept of clean air has never been valid.[542]

For Kehoe, the risks from environmental pollution were part of modern life and standards should be both necessary and feasible, since controlling pollution would always have economic consequences.[543] Though Kehoe has sometimes been depicted as a compromised scholar, with rather relaxed views on pollution and close ties to industry, it should be noted that his opinions on health in modern society differ little from those voiced at the very first WHO conferences on air pollution in the 1950s. As discussed in Chapter 3, promoters of health and wellbeing in the mid-twentieth century viewed industrialisation as the preventive measure par excellence, despite the pollution it caused. On the other hand, Kehoe stands as the primary example of the value laden debate on environmental regulation in the 1960s United States. Kehoe can be seen as one of the leading figures of the older generation of experts, deriving from industrial hygiene, who emphasised the benefits of industrial production and the innocuousness of low levels of pollution. This view was increasingly challenged by experts from other disciplines such as pharmacology, ecology and medical research on chronic diseases where the subtle and complex effects of environmental pollution were studied.[544] Thus, the air quality standards became part of the wider debate about the hazards of environmental pollution and the critique of the traditional experts.

On the other hand, the air quality standards were also criticised for embracing a narrow etiological viewpoint, with its gaze fixed on the specific substances and their specific effects. One of the most famous critics on the plausibility of this etiological view in the health issues of modern society was the microbiologist and author Rene Dubos, who advocated for a less reductionist approach. As one medical doctor argued in *JAPCA*:

542 Kehoe 1964, 16.
543 Kehoe 1964, 16–18.
544 Sellers 1997, 206–225; Stoff & Travis 2019, 152–163.

> Rene Dubos may be correct: the search for the cause may be a hopeless pursuit because most disease states are the indirect outcome of a constellation of circumstances rather than the direct result of single determinant factors.[545]

In other words, it could be futile to try to manage air pollution by creating standards for individual substances in air when it seemed clear that their effects were more complex. In a sense it was the old problem of defining the health effects of chemical substances in the same manner as had been the custom with biological causes of diseases. These problems had previously been recognised in air pollution research, but the development of standards based on objective knowledge in the 1960s made these issues more relevant than ever. As one expert stated in his critique, "these research difficulties are not blocks to the revelation of the truth, they are a part of the truth itself and they cannot be disregarded in the search for rational air pollution control".[546] He pointed out that the general public had already accepted that air pollution was unhealthy, as such, without the need to specify the danger.[547]

Thus, the air quality standards were questioned on the same premises that the biomedical expertise was criticised by the new environmentally oriented experts, namely, the narrow idea of specific etiology. It could be said that the standards for urban air were at the same time viewed as unnecessary and premature by the likes of Kehoe, but could also be seen insufficient and flawed by those embracing the complexity of the problem. As the director of air pollution control at the Pennsylvania Department of Health argued, air quality guides provided an illusion of progress and that they were hastily produced as a fashionable response backed by the federal government.[548]

Another form of criticism pointed out the moral questions that were inherent in the air quality standards despite their apparent rationality. As the head of the United States Public Health Service's air pollution division stated in the mid-1960s, the standards had a strong appeal since they had been depicted as a rational means to deal with air pollution and seemed thus immune to objections. As such they had nearly universal acceptance in society. This universal acceptance would, however, not necessarily be sufficient since "the fact that everyone is in favor of air quality standards will not in itself ensure their development."[549] Like Kehoe, he doubted whether there would ever be enough knowledge to be sure about the health effects.

545 Prindle 1964, 123–125. The quote he uses is from Rene Dubos' book *Mirage of Health: Utopias, Progress and Biological Change,* Rutgers University Press, New Brunswick 1959.
546 Cassel 1969, 799–802.
547 Cassel 1969, 799–802.
548 Sussman 1969, 73.
549 Mackenzie 1964, 19.

However, he also argued that the trust placed in science and medicine in this idea was misplaced. The development of standards for urban air would also require political decisions about what risks are acceptable in a society and what kind of knowledge is accepted as evidence of a hazard.[550] In a similar vein, even the optimistic W. L. Faith noted with regards to $SO_2$ thresholds that it was a question of what effects should be prevented: *"*Is it the threshold for odor detection, alteration of optical chronaxy, damage to vegetation, bronchoconstriction in sensitive human subjects, or some other effect*?*"[551] Despite the appearance of rationality and objectivity, the scientific standards for urban air could not entirely escape the complex socio-political and moral questions that had plagued air pollution control since the nineteenth century.

As these critical remarks show, although air quality standards became increasingly important in U.S. air pollution research from the early 1960s and enjoyed widespread acceptance, their limits and inherent arbitrariness were also noted by the experts themselves. Rather than a simple scientific puzzle, air quality standards were also a value laden socio-political matter. As such they were part of the overall debate on environmental pollution and its regulation in a modern society. Furthermore, the criticism of the standards highlights the administrative need for such objective norms. This bureaucratic side of air pollution knowledge can be seen as part of a more general development within environmental health research. As Karen Rader has shown, the way to regulate radiation was not discovered as a direct result of animal tests, but via an approach that served the principles of the post-war U.S. administrative style that was grounded in objective science.[552] Theodore Porter has also specifically associated the need for quantification to U.S. culture, in which the need of government officials for objective knowledge was greater than in France or Great Britain.[553] The need for air quality standards fits into this picture, for, as U.S. congressman Emilio Daddario stated, experts need to provide facts for the management of the environment because "we will use the environment as never before, to maintain our national strength and leadership and elevate the living standards of the whole world".[554]

It should be noted that the U.S. discussion on air quality standards in *JAPCA* contains many of the elements central to the field known as the Cultural Study of Risk. This field became known through the works of Mary Douglas, Aron

550 Mackenzie 1964, 19–21.
551 Faith 1962, 318.
552 Rader 2004, 248.
553 Porter 1996, 195.
554 Quoted in Report from the Symposium on Air Quality Criteria. *JAPCA*. Vol. 18, no. 7 1967, 443–447.

Wildawsky and Ulrich Beck in the 1980s. Mary Douglas, in particular, criticised the tendency to see risks and dangers through objective knowledge with little regard to their moral qualities. For Douglas, this was one of the manifestations of the modern obsession with objectivity, derived from our fragmented world of experience and made possible by complex social structures.[555] The fact that this criticism was also visible in the discussions in the 1960s is an example of how the development of air quality standards was a project of modern society deriving from the seemingly self-evident need for standardisation as a rational tool for administrative control. The fact that the idea seemed immune to objections emphasises the appeal of standardisation and quantification in modern society. As some of the critics noted, however, there was still the need to decide what was an undesirable effect. The difficulty to objectively define this fundamental concept can be seen by examining the examining the difference between the U.S. and Soviet criteria in the development of these standards.

## The Question of Undesirable Effect: Between the Soviet and U.S. Norms

As noted, the difference between Soviet and U.S standards had been a notable part of industrial hygiene discussions since the 1950s, when the Soviet norms for industrial hygiene were introduced to experts from the U.S. and Western Europe. Along with the development of their own industrial hygiene norms, the Soviets were also quick to turn the same concept for outdoor air. These air quality norms were made known outside the USSR by the several works written by Vladimir Ryazanov, leading expert of environmental sanitation in the country, which were translated into English since the late 1950s.[556] The air quality norms promoted by Ryazanov were developed according to a similar, extremely sensitive, method as had been the case with the Soviet industrial hygiene norms. Ryazanov and his colleagues emphasised subtle irritating effects, aesthetic nuisances and effects that were only felt by the most sensitive individuals. They also outlined that there were normal levels of substances in the human body and regarded any deviation from this norm as problematic. According to this Soviet hygienic ideal, air quality norms should be determined at a very low level so as to prevent even the most subtle sensory effects, such as smells. As Ryazanov stated about odour thresholds in a U.S. environmental health journal:

555 Douglas 2000 (1966) 137–151. Also see Dougals & Wildavsky 1982.

556 *Limits of Allowable Concentrations of Atmospheric Pollutants*. Volumes 1–3. Ed by V.A. Ryazanov. Translated by Benjamin. S. Levine. U. S. Department of Commerce, Office of Technical Services, Washington 1960. Soviet literature on air pollution had been translated in the United States since 1957 by Benjamin Levine. Levine's work continued into the 1960s and he ultimately helped to produce the series *USSR Literature on Air Pollution and Related Occupational Diseases* that totalled in eighteen volumes.

> We support the point of view that the ambient air should not contain odors to be imposed on a population against its wishes. The human being uses the olfactory excitation, for instance, perfume, in those cases when he desires to do so. He does not want to stand for breathing air containing any aromatic substances present there against his wishes. Therefore, inhabitants always object strongly to the pollution of the ambient air by extraneous aromatic substances which are discharged by industry, for instance. We must recognize the right of human beings to breathe the type of air which they like. This can be achieved when the air of our cities become free of extraneous odors. These ideas are the compelling reasons for our study of the threshold of odors from various atmospheric pollutants.[557]

The result of this kind of view was that the Soviet numerical norms for air quality were usually considerably lower compared to U.S. norms, or any others for that matter. The criteria behind the norms used in the United States in the 1960s were also implemented in order to prevent nuisances and health hazards. However, they usually allowed subtle, unpleasant effects or effects only felt by sensitive individuals.[558] In addition to sensory effects, Soviet norms also indicated toxic effects that could be found in quantities way below what was considered safe in the United States. The poisonous attributes of atmospheric lead, for example, were viewed very differently by Soviet and U.S. experts. According to Ryazanov, it had already become evident at the Prague Symposium in 1959 that Soviet scientists "consider lead much more toxic than our American colleagues consider it".[559] In short, due to the influence of Pavlovian physiology and a comprehensive view of hygiene, Soviet air quality norms in the mid-1960s were the strictest and most comprehensive, covering many substances not included in the quality norms of other countries.

In the United States, the response to the Soviet norms seems to have been somewhat mixed. They were sometimes utilised as a reference in order to emphasise the poor quality of air due to their strict attention to subtle effects and subjective nuisances.[560] Nonetheless, these same qualities made the norms unrealistic and implausible in the eyes of many U.S. experts. Reliable measurement of the subtle physiological reactions was deemed to be scientifically difficult and there was no basis on which to evaluate the significance of these reactions. In addition, even if

557 Ryazanov 1962, 481.
558 Laamanen 1966b, 14.
559 Ryazanov 1962, 493.
560 For example, D. M. Anderson, J. Lieben, and V. H. Sussman, Pure Air for Pennsylvania. Pennsylvania Department of Health and U.S.P.H.S., 1961.

one accepted that the effects the Soviets claimed to observe were undesirable and should be avoided, this did not seem to be practical. As some critics pointed out, the air pollution levels in the USSR were no better than those in the United States in spite of the strict norms.[561] In other words, the Soviet norms seemed unrealistic, even if they were deemed necessary. This was, in fact, the same criticism that had been directed at Soviet industrial hygiene norms in the 1950s.

When faced with this criticism, Ryazanov pointed out the different role air quality norms had in the USSR compared to the United States. Instead of strict legal limits that needed to be immediately followed, as in the case of Californian air quality standards, Ryazanov argued that the Soviet norms should be viewed as a future objective that provided a benchmark for clean air, despite being unattainable at the present. As Ryazanov stated to U.S. experts:

> If our standards, as we developed them, corresponded to the standards that could be practically used at this moment-today-now-if this were the case, there would be no need for studying the methods of bringing about better cleanliness and prevention of atmospheric pollution, and the industry would not have to be under tremendous pressure from the scientific community to bring about reduction of atmospheric pollution. Hygienic standards must also be ahead of present technical developments, otherwise they would be applying a brake to our progress, because they would be serving as sanctions for what the industry is presently doing with reference to atmospheric pollution.[562]

This view of norms as a future goal differed somewhat from what was thought to be the aim of the U.S. standards. Strict legal limits were enforced in California and subsequently in the entire country. The Air Quality Act of 1967 required states to adopt air quality standards that were binding and any fluctuation over and above the given values resulted in legal measures being taken by the federal authorities.[563] In other words, the Soviet and U.S. values represented opposites in more than one sense. While the U.S. legal system and air standards sought active and strict control in the here-and-now, the Soviet norms were deliberately higher and were seen as future goals. As Ryazanov argued*: "*Our standards must not be judged by the fact that we have a lot of fines to pay in our country for the breaking of the standards.

561 Tipikin 1957, 227–231; McCabe, Machle, Barnes 1964, 107.
562 Ryazanov 1962, 493.
563 According to Risto Lahdes, who worked at the FIOH air pollution research unit from the late 1960s, the strict legislation adopted in the United States supported the development of extremely accurate measurement apparatus that had to be accompanied with detailed manuals. These manuals were later used as educational material for Finnish researchers. Lahdes 2006, 63.

These standards are for the purpose of use in the future, not today."[564] The difference between Soviet and U.S. methods to determine air quality norms demonstrates how the scientific criteria of norms were, in fact, a matter of perspective. Though they could be based on observational techniques that were seen as objective and on the seemingly ubiquitous discipline of human physiology, there was still the question of what constitutes an undesirable effect?

## Local Pollution and Universal Health

The Soviet and U.S. models can be seen as the two most visible and fundamentally different ways to develop air quality standards, which would frame international discussion on norms for air quality measurement. In contrast to regular communication with researchers in the United States, Arvo Laamanen and the FIOH air pollution research team do not seem to have had much direct contact with colleagues in the USSR. This was despite the view that Soviet research in hygiene and public health was state of the art. The lack of communication could have simply been due to practical reasons; namely, the language barrier. As Soviet experts rarely published in languages other than Russian, their research seems to have disseminated in the FIOH via the United States.[565] Another reason can be seen in the strong U.S. orientation in the methods and equipment utilised by the FIOH's industrial hygiene department since its foundation. This Western orientation was further enhanced by the WHO lung cancer study in the early 1960s, as described earlier. In short, the Soviet research of the effects of air pollution had a negligible influence on the practices employed by the FIOH, as had been the case with Soviet industrial hygiene.

Yet, it is noteworthy that Soviet air quality norms were often referenced by Laamanen and Noro. Although Noro considered Soviet industrial MAC values to be unrealistically sophisticated, he viewed Soviet air quality norms more sympathetically. Since there were no air quality norms whatsoever in Finnish law in the mid-1960s, the FIOH researchers used foreign standards as reference points in their studies and teaching. The Soviet norms were not elevated to any special position, but their high hygienic standard seems to have been in accordance with the ideals Noro and Laamanen shared on air pollution control and public health in general. They were described by Noro and Laamanen to be "in accordance with the principles of hygiene" since they did not allow any effects, even from the most

564 Ryazanov 1962, 493.

565 In 1960 Noro approached the United States Department of Commerce with the intention of buying a copy of *USSR Literature on Air Pollution and Related Occupational Diseases.* Noro's letter to the United States Department of Commerce 14.10.1960, AFIOH.

sensitive individuals. In a similar manner to some U.S. studies, Noro and Laamanen used the Soviet standards as a reference to evaluate the state of air.[566] It seems that despite being rather unrealistic, at least in the short-term, the sensitivity and high hygienic ideal of the Soviet norms made them appealing tools of evaluation for air pollution control.

Despite the use of foreign norms as tools of evaluation, experts in the FIOH expressed similar concern over the use of air quality standards as were voiced in the discussion in the United States. A lukewarm view towards air quality norms is most clearly evident most in the writings of Laamanen. He believed that some standards were necessary for evaluation and control, but in the lectures he delivered to engineers on air pollution control in 1966 Laamanen emphasised the overwhelming complexity of the issue. He presented the existing norms adopted in other countries, but emphasised that they were merely "a kind of qualifying requirement for dirtiness and grounds for preliminary action".[567] He argued that air pollution research should focus on being able to ascertain the basic load of substances that was safe for humans. He stressed, however, that this objective still seemed to be far off in the future. The question itself contained "the field of air pollution research in all its complexity and multiplicity"[568]. According to Laamanen, research still focused on basic monitoring and examination, while little was known about the effects of specific substances.[569] It should be noted that Laamanen viewed the carcinogenic substances in the air as being especially problematic in this regard. As he argued, in his own convoluted style:

> The possibility of carcinogenic (cancer causing) and mutagenic (mutant, erratic variations in individual development causing) substances being able to cause, even in extremely low concentrations, cellular, even molecule level disturbances, which manifest in substantial alterations in specific cells, leads to the conclusion that it is presumably quite impossible to find reliable safe level for these substances.[570]

The scepticism expressed by Laamanen and Noro about the feasibility of achieving safe levels for carcinogens is interesting given the fact that in many prestigious publications the so-called non-threshold idea was depicted as outdated and overtly

566 Noro 1966a, 10–11.
567 Laamanen 1966b, 8.
568 Laamanen 1966b, 5.
569 Laamanen 1966b, 5.
570 Laamanen 1966b, 6.

conservative.[571] In this regard, the statements by Laamanen and Noro seem to contradict the historical interpretation made by the toxicologist Edward Calabrese, in which the non-threshold idea stemmed from radiation studies and only later took root in discussions about chemical carcinogenesis.[572]

Nonetheless, it should be noted that while Laamanen highlighted the problems related to the regulation of carcinogens, the issue does not seem to be at the heart of the question on the air quality standards. In a thematic issue of *JAPCA* on air quality standards, for example, there was not a single article on carcinogens.[573] This observation does not support the argument often made in the history of environmental toxins that the low-dose problem with carcinogens was a central trigger in the move away from the threshold paradigm during the 1960s and 1970s.[574] The fundamental issues with health-based air quality norms centred, rather, on the inherent uncertainty of medical knowledge on air pollution in general. In other words, the so-called 'low-dose debate' about whether or not there is a threshold for carcinogens and the danger of low doses, though extremely important in the history of environmental poisons in general, does not seem to have had a similar place in the discussion of air quality norms.

Laamanen further complicated the issue of air quality norms for his students by arguing that despite the focus of research on health effects, human health should not be seen as the only criterion of evaluation. Air pollution also affects the non-human environment—buildings, animals, plants, trees—some of which could be more sensitive to certain substances than humans. As Laamanen argued:

> In agriculture, the degree of pollution is classified according to agricultural standards; special categories are used for different material damage; smell evaluations are based on special views etc. It is therefore obvious that air quality classification, if undertaken, proposed or published, is based on various basic aspects that represent, relatively broadly, the field of 'air pollution'.[575]

[571] For example, in the WHO report the so-called non-threshold view was seen as too conservative. Research into Environmental Pollution 1968, 69. The same stance was also taken in the textbook *Chemical Carcinogenesis* from 1962. See Clayson 1962, 8.

[572] See, for example, Edward J. Calabrese, From Muller to Mechanism: How LNT Became the Default Model for Cancer Risk Assessment. *Environmental Pollution.* 241, 2018, 289–302.

[573] See *JAPCA* 1964, vol. 14 no. 1.

[574] See, for example, Boudia & Jas 2015, 10; Kirchhelle 2018, 213; Homburg & Vaupel 2019, 14.

[575] Laamanen 1966b, 4.

In short, although health effects were central to research, it was not self-evident to Laamanen that health should be the only criterion by which air quality should be evaluated. Different kinds of situation and conditions required different criteria. Finally, the precision and objectivity of the norm could become a hindrance to securing good air quality. As Noro stated, when he was asked to provide a standard for indoor air quality: "It is unwise to give norms for air other than for medical purposes, since progress should be towards the cleanest air possible."[576] Similar to the argument made by Ryazanov, Noro emphasised that a level for acceptable air could generate a situation in which no incentive remained to improve the state of air or to preserve the condition of air where it was cleaner. In sum, it can be stated that even though Laamanen and Noro recognised norms as being important and as an essential tool for regulation, they do not seem to have been particularly enthusiastic about air quality norms that were calculated by drawing on expert knowledge of their health effects. As with the knowledge about the health effects of air pollution discussed in the previous chapter, Noro and Laamanen seem to have sided with the older generation of experts represented in the United States by Kehoe and the USPHS.

These questions were discussed also among Nordic experts at the first Nordic air pollution symposium held in Stockholm in 1965. Held under the auspices of Nordforsk, the symposium was attended by scientists from Scandinavia and Finland. Laamanen and Noro attended as Finnish representatives, but all the presentations were delivered by Swedish experts. Once again, they recognised the need for comprehensive air quality norms but were pessimistic about them being developed. Despite the fact that the Swedes had already developed some local air quality guidelines, the experts at the symposium felt that contemporary knowledge was far away from more extensive norms based on health effects.[577] Instead, they suggested local emission norms as a practical tool for air pollution control, despite their inferiority to air quality norms in terms of environmental health.

There was no question that air quality norms, or 'immission' norms as they were called in Finnish and Swedish literature, were the fundamental goal in air quality control. As one Swedish expert noted, trans-European or even international norms were the ideal, in the same manner as U.S. experts aimed to secure federal norms. Thus, there was a desire to develop norms that could be used anywhere.

576 Noro's letter to the Helsinki Municipal Health Committee, AFIOH.

577 The Swedish norms were said to express the specific nature of air pollution problems in Swedish cities; namely, relatively low levels of particulate matter, which "could be looked upon as a safety factor" allowing for greater levels of $SO_2$. See, Rapport 6402 från Statens Luftvårdsnämnd under redaktion av Lars Friberg och Ragnar Rylander. Medicinska rekommendationer röande luftrenhetsnorme. Stockholm 1964.

Unfortunately, this development was seen to be far-off in the future.[578] Consequently, Noro and Laamanen emphasised the need for more research funds in order to develop adequate norms for Finland.[579] In other words, there was no great enthusiasm for air quality standards based on health amongst Finnish and Scandinavian experts. Despite the apparent universality of medical knowledge and human health, air pollution was a complex local matter. Thus, it was left for the WHO to provide universal standards for safe urban air.

## The World Health Organization and Universal Guidelines for Air Quality

The idea of universal air quality norms had already been discussed at the first WHO conferences in the late 1950s. However, at this time experts considered it premature in light of available knowledge.[580] In the early 1960s, at the same time as the ACPA began to show increased interest in air quality standards, the WHO also intensified its efforts to provide international guidelines for air quality. In 1963, a WHO Inter-Regional Symposium was held, which heralded the initiation of the development of international guidelines for air quality. Although the symposium attendees refrained from issuing numerical guidelines, again due to limited knowledge, they stated that such standards were both possible and essential for air pollution control, since the criteria of the national norms varied significantly.[581]

As a preliminary guide, the symposium defined four standard categories by which the level of air pollution could be evaluated.[582] This course of action was further praised by the WHO Expert Committee on Atmospheric Pollutants in the same year. Agreeing with the conclusions of the symposium report, the expert committee urged for more unified medical research on air pollution in order to define international standards for air quality.[583] The categories of pollution developed by the WHO were quickly adopted by Finnish educational approaches to air pollution control, although their significance in practical control and research seems to have

578 Friberg Lars 1965, 22–26; Ulveson 1965, 20 (Planerad Svensk Luftvårdslagstiftning). Emission norms could be used to control the amount of air pollution emitted by factories or furnaces. However, since the effect of emissions on air quality depended on meteorological and topographical factors, these norms were only an indirect tool to control air quality.

579 Noro's letter to the Ministry of Internal Affairs 4.6.1965, AFIOH.

580 Air Pollution 1958, 11.

581 In 1963, numerical standards were used in four countries: Czechoslovakia, the Federal Republic of Germany, the United States of America (in the states of California and Oregon) and the Soviet Union.

582 Criteria For Air Quality and Methods of Measurement 1963, 5.

583 Atmospheric Pollutants 1963, 13–14.

been rather limited.[584] It was none-the-less an early attempt to form international standards for the control of urban air quality.

After international air quality criteria were implemented in 1963, the subject was next discussed at the 1967 Health Effects of Air Pollution Symposium hosted in Prague by the WHO's European office. Laamanen also attended this meeting. The need for international guidelines is stressed in the report of the symposium's proceedings, but it is also emphasised that they should be based strictly on scientific, medical, physiological and toxicological knowledge. It was argued that a lot of poor and misleading studies ended up in official publications and from there to development of air quality standards. Because of this and other difficulties, the norms used in different countries varied wildly. It was argued that the WHO should distance itself from these and base the guidelines only on high quality research. As already noted, the science of toxicology was seen insufficient in finding out the specific health effects of air pollutants already in the late 1950s conferences. In a similar manner, it was argued in the Prague symposium that both physiological and pharmacological research was needed in order to gain more subtle knowledge about the health effects of pollution, while the final deductions should be left for hygienists or epidemiologists. Furthermore, the Soviet methods and the works of Ryazanov were praised as being true to the WHO's definition of health and hygiene principles.[585] In other words, the European representatives at Prague did embrace, at least in principle, the ideals of the Soviet air quality standards. They also embraced the accumulating research on the subtle chronic effects of air pollution, which should be the basis of air quality guidelines.

As in the United States, the necessity of air norms was not univocal among the European participants. Some claimed that the importance of air quality guidelines was being overstated and thought that "under present conditions the need in most cities was for energetic practical action to reduce pollution and, at this stage, the precise composition of what might ultimately be accepted as pure air was of somewhat less importance" 586. Critics also referred to air pollution control in Great Britain, which was based solely on practical emission control without enforcing standards of clean air.[587] These arguments resemble the ones made by Sir Hugh Beaver in the very first air pollution conferences in 1950s, when he emphasized the need for action rather than perfect answers. After all, many of the widely used regulatory means to reduce air pollution, such as zoning, emission control and centralised energy production could be implemented without legal standards for

584 For example, Laamanen 1966b, 1–11.
585 The Health Effects of Air Pollution 1968, 51–58.
586 The Health Effects of Air Pollution 1968, 58.
587 The Health Effects of Air Pollution 1968, 58.

urban air. These critical voices were, however, faced with the more widespread idea that legal standards were necessary for effective management of air pollution. Apparently at the 1960s many countries sought guidance from the WHO in drawing up their air pollution regulations. As the chief of the WHO's environmental pollution division stated: "developing countries and many developed countries have no air quality criteria and many countries do not know if they have a problem; they are looking to WHO for guidance on this matter".[588]

This pressure from individual countries seems to have further increased the need for international guidelines on environmental pollution in general. However, it should also be noted that international guidelines for air pollution fitted well to the WHO's general effort to standardise public health.[589] This standardisation was guided by what has been seen as the common feature of the United Nations' institutions; namely, great trust in science and rational analysis as the universal means to improve societies.[590] As in the case of national air quality standards, the matter was not merely about science and medicine but also about the regulatory ideals. The development of international guidelines for urban air was in a sense part of the post-World War idea of universal standard for development.

Though WHO was eager to provide international numerical guidelines, it was faced with the same problematics as those trying to develop national standards for air quality. When the WHO asked Professor James Whittenberger from the Harvard School of Public Health to review the literature on air quality norms, in preparation for their guidelines, his report in 1966 was rather pessimistic. Highlighting once again the limited knowledge and lack of any medical consensus with regards to most substances, he even doubted whether it was feasible at all to try to create international air quality standards based on scientific and medical criteria. Recognising the need for some kind of standards, he suggested that they be based on cultural norms since every culture most likely has some aesthetic and sanitary ideals.[591] In short, the international standards for air quality were not, at least according to Whittenberger, due to a sometime if one wanted them to be based on scientific consensus.

In 1972, the WHO was finally ready to publish its first numerical guidelines for ambient air. Values were given for carbon monoxide, photochemical oxidants, sulphur dioxide and smoke. Nitrogen oxide was discussed, but knowledge on the

588 Report of a WHO air pollution scientist in consultation on air pollution criteria, 1.11.1971, appendix 1, A 6/87/6.

589 This long tradition can be seen in the reports of the expert committees from the 1940s. See, for example, Expert Committee on Environmental Sanitation. Report on the First Session. WHO Technical Report Series No. 10. WHO, Geneva 1949.

590 Cooper & Packard 1997, 2; Staples 2006, 3; Borowy 2012, *et passim*.

591 Letter from James L. Whittenberger to the WHO's Environmental Health Division, 31.1.1966, a 1, A6/445/3

matter was still deemed insufficient. Despite the numerical guidelines, the report gave even more emphasis to uncertainty and the lack of knowledge in the field. All ways of examination are seen as disadvantageous in some way. Though the experimental studies of Ryazanov are seen as important, their inability to account for sick people, elderly and children limit their use.[592] Epidemiology covered all areas, but it had great trouble in demonstrating causality in the face of a bewildering array of variables. Before introducing the guidelines, the writers of the report wonder whether assessing the effects of air pollution through research will ever be adequate to protect people from its effects:

> Air pollution is an extremely complex matter. The association between a pollutant and illness or death may be accidental rather than causal; the concentrations of many pollutants, some unmeasured or unidentified, often go hand in hand; and any urban population will contain some people in such a precarious state of health they will succumb to any stress from which they could not reasonably be protected.[593]

With all the disclaimers, the report is reminiscent of an expert pressed for an exact figure on a complex issue, rather than a triumph of research. Yet, there seemed to be little choice on the matter. The sense-based approach as suggested by Whittenberger, for example, did not take account of the fact that many pollutants were invisible, odourless and still harmful. In addition, many of the suspected harms caused by air pollution were chronic and subclinical and therefore difficult to detect without sophisticated instruments and methods. With all its uncertainties and disadvantages, scientific and medical research had extended the senses and made visible previously unknown aspects of air pollution. Any standard that did not take account of these aspects would be inadequate in terms of public health. This subtle analysis combined with the objective and rational ethos of scientific knowledge. As Faith stated, there was no logical way to deny the need for air quality norms.

## Imitating the Norms

Although Laamanen and Noro often stated the need for special norms in Finland, they did not directly partake in such an initiative. In contrast to Swedish air pollution

592 Despite this, there was an effort by the WHO officials together with Swedish and Soviet researchers to continue the work of Ryazanov, who had recently passed away, in order to experimentally determine guidelines for some pollutants. See correspondence in WHO A 6/445/3.

593 WHO Air Quality Criteria and Guidelines 1972, 8.

research, for example, there was no Finnish project to study and develop a national norm for air quality. This was partly due to a lack of research resources, which Noro and Laamanen did not fail to highlight when given a chance.[594] Other reasons for Finland's lack of a coordinated research project can be seen in the complexity of the issue and the possibility to benefit from projects undertaken in other countries. As Schönach has argued, the FIOH researchers knew that work was being undertaken abroad vis-à-vis norms and legislation. Hence, they chose to wait in order to see what others would come up with, instead of wasting their own resources.[595] By waiting for results from other countries and from the WHO, the FIOH once again seems to have embraced the idea of imitating common developments as a way to overcome the problem of limited resources. Furthermore, the Finnish example indicates that creating scientific standards for urban air required resources and a research community that were available only in rich countries, as was argued also by the WHO officials.

The first Finnish air quality norms were published by the Government Council of Air Pollution Control and Noise Abatement, a body headed by Noro and Laamanen, in 1969. Along with the categories of air pollution that the WHO had already developed in 1963, the publication presents numerical norms for $SO_2$, carbon monoxide and soot. The values were, in essence, taken from the Swedish air quality norms. Published in the council's own bulletin, the norms presumably had a rather extensive readership among both politicians and industrialists. Since the council was only a consultative body, these norms had at best a quasi-official status based on the council's expertise and could only be used as guidelines in practical emission control. Schönach has argued, in fact, that their value for overall air pollution control policy remained rather limited.[596]

A second set of Finnish air quality standards was issued when the Finnish Medical Council, by then headed by Leo Noro, used the WHO guidelines in 1973 to form its own set of norms that were published in its circular letter. These too were not legally binding, but as with the previous norms adopted by the air pollution control council, they provided an objective and precise basis for evaluation. These values were also incorporated into a new textbook on environmental hygiene by Noro, thus finally giving outside air similar tools for its management as inside air had had for decades.[597]

594 For example, Noro's Letter to the National Medical Council, 4.6.1965/ ISMET Domestic Correspondence, NAF; Laamanen 1966b, 10.

595 Schönach 2008, 207.

596 Schönach 2011, *et passim*.

597 Terveydenhoitolain (469/65) ja -asetuksen (55/67) nojalla annetut ilman epäpuhtauksia koskevat terveydelliset suositukset 1973(Circular of the Medical Council), 17–18; Noro 1978, 32–45.

At the level of air pollution research and control, the new publication series from the United States Health Department, entitled Air Quality Criteria, became the principal work of reference for Finnish researchers. Though not standards as such, these criteria laid the basis for air pollution control with their lists of specific compounds and their effects.[598] As the publications were renewed every five years, with thicker volumes each time, they became a material manifestation of the accumulating knowledge on the health effects of air pollution.

Whilst the air quality norms were few and their applicability was still narrow, they represent an important phase in the institutionalisation of what Uekötter has called a bureaucratic revolution in air pollution control. Uekötter regards the search for precise figures, instead of vague laws, as a general shift in environmental regulation away from expert evaluation and towards bureaucratic control by measurement.[599] Although the air quality standards were different from the MAC values used in industry, they highlight a strong appeal to broaden this rationality to general living environments. In other words, the development of air quality standards, weak as they still were, was in essence a rationalisation of air pollution control by standardising clean air with a new form of 'reasonable' gauge. The examination of the development of air quality standards supports the notion made by Charvolin *et al*. that the increasing technicality and need for measurements in order to assess air pollution since the mid-twentieth century has to be seen in tandem with political motivations.[600] Rather than simply a scientific discovery, standards of air quality formed within a framework of rationalisation, which, as the anthropologist James Scott has famously argued, produces a section of a reality that is easy to manage.[601] With regards to urban air, the section was determined by the methods of air pollution research and the need for numbers in the management of modern environment.

The development of air quality norms can therefore be seen as one aspect of the more general process of controlling environmental pollution via thresholds, which has been criticized for being practically unfeasible and a narrow point of view based on toxicological concepts.[602] The criticism of the standards shows how the experts who developed them were well aware of the inherent arbitrariness of such standards. Furthermore, the difference between Soviet and U.S. values demonstrated how even physiology and medicine were unable to provide any objective grounds to determine acceptable levels of pollution. The development of air quality norms indicates, again

598 Email from Matti Jantunen 9.6.2020.
599 Uekötter 2008, 180.
600 Charvolin *et al*. 2005, 69–91.
601 Scott 1998, 3.
602 Sellers 1997, 237; Nash 2008, 656.

that perhaps too much blame has been attached to toxicology in historical studies on environmental pollution. The prevailing momentum was not the ability of toxicologists to determine at what point air becomes poisonous, but society's appeal for such a determination.

While MAC levels were tools for rationalisation and scientific management in the early twentieth century, rather than discoveries, the air quality norms were a continuum of this management into the realm of outside air. Rather than perceiving toxicology or modern biomedicine in general as the leading cause, the roots of this bureaucratic revolution can be seen in the general rise of rule-based rationality in the latter half of the twentieth century. As the historian of science Lorraine Daston has argued, it was during the Cold War era that a form of rationality based on common rules rather than on reason and judgement proliferated from factories into society at large.[603] Air quality norms based on science and medicine could, at least in theory, be used as common rules and were capable of eliminating the need for judgement, even though in practice their creation could not be separated from moral questions and political differences in a society.

The air quality standards were also not as easily appropriated as MAC levels had been. The first attempt in Finland to form new air pollution legislation, was made in the early 1970s. The committee evaluating the law saw legal numerical norms as an essential way of controlling pollution. Hence, the proposed law gave the Government Council the power to define legally-binding norms.[604] However, a considerable number of dissenting opinions were left on the report. Arvo Laamanen's dissenting opinion emphasised the complexity of the problem of air pollution. He pointed out that although norms were important, they could not be used without expert knowledge and know-how. He proposed that the legislation should proceed with more limited practical solutions, such as buffer zones around factories, despite their obvious limitations in the long run.[605]

In the same vein, Sten Finne, the head of the Finnish Industrial Union, criticised the norms as being too rigid and a simplistic solution to a complex problem. He referred to the experience in Sweden, where the use of air quality norms had not been successful due to a lack of know-how by the civil servants. As Finne argued: "it is my opinion, that appropriate air pollution control cannot be carried out by comparing the pollution measurements with numbers in a table of norms, but that it requires

603 Daston 2010, record of a lecture. See also *How Reason Almost Lost Its Mind: The Strange Career of Cold War Rationality*, ed. by Lorraine Daston and Thomas Sturm. University of Chicago Press, Chicago 2013.

604 Komiteamietintö 1973:6, 92, 189.

605 Komiteamietintö 1973:6. Dissenting opinion by Arvo Laamanen, 1–16.

active, in some sense creative, work that guides progress."[606] Finne and Laamanen both saw the norms as valuable guidelines, but thought that their legal implementation was premature and counterproductive. The dissenting voices ensured that the air pollution legislation in Finland only came into law in the 1980s. In this sense, the appropriation of air quality norms in Finland fell short as they remained mere guidelines for over a decade. While the MAC values for industry had been adopted from the United States fairly easily, air quality norms represented a political question of a different kind. Even with the international guidelines from WHO, the complex issue of urban air pollution was not easily reduced to simple numbers.

The dissenting voices over the proposed air pollution legislation represented, however, more than simple disagreement over air quality norms. Since the late 1960s, the discussion about air pollution in Finland began to heat up. While air quality guidelines further institutionalised the expertise of air pollution measurements into society, the increasingly irritated public, fuelled by the rising popularity of environmental thinking, challenged the traditional expertise on environmental health. At the same time, many began to harbour doubts about whether the FIOH was the right institute to be the nation's preeminent authority on air pollution. This peculiar conflict, in which divergent views about the environment and health clashed, can be seen as a local manifestation of a wider phenomenon; namely a change in expertise over the environment.

606 Komiteamietintö 1973:6. Dissenting opinion by Sten Finne, 5–6.

## 4.3 Environmentalists and Meteorologists: Contesting the Expertise of Air Pollution

The late 1960s and early 1970s were contradictory times for the Finnish Institute of Occupational Health and its air pollution research team. On the one hand, rising public indignation over pollution, together with the overall rise of environmental issues, ensured increasing resources from the government and municipalities for air pollution research. In the early 1970s, in particular, the air pollution laboratory in the FIOH grew considerably. At its height, it employed twenty researchers under the leadership of Laamanen. On the other hand, the rising public concern for pollution brought with it an increasing critique of the FIOH and its authority over environmental health. Experts in fields including biology, veterinary medicine and ecology challenged the view of the health effects of air pollution that were espoused in the FIOH. At the same time, a rivalry over environmental expertise broke out within research into air pollution in Finland as the Finnish Meteorological Institute sought to strengthen its position in the expanding field of environmental research. In other words, just as air pollution research began to stand on firm ground within FIOH, its authority was challenged from various directions. The purpose of this last chapter is to examine the air pollution conundrum in the late 1960s and early 1970s in Finland as a contest of expertise over health and the environment; an issue that became increasingly important at this time. Rather than seeing the contest merely as a local phenomenon, it is possible to perceive them as manifestations of a wider development, that is, heightened environmental concerns and demand for environmental expertise.

Schönach has described the late 1960s as marking a crisis in Finnish air pollution discussions, as public opinion became increasingly critical of the government and municipal policies as well as of expert evaluations. This public indignation culminated in 1969, when the first mass protest against air pollution took place in Helsinki.[607] This change can be seen as part of a broader and well-known phenomenon in Western Europe and the United States, in which concern for the environment and a critique of the Western way of life gained considerable momentum.

On the other hand, some historians have aimed to lower the scale of this rejection of the status quo, and instead have emphasised continuity. As Uekötter has argued, it is hard to pinpoint a specific time when public sentiment changed. He argues that the concern for air pollution in United States grew gradually from the 1950s, as the U.S. public became ever more fearful of the potential health hazards of pollution and increasingly critical towards industry. According to Uekötter, a rhetorical change

607 Schönach 2008, 167–181.

occurred in the late 1960s, which emphasised health, fear, globality, invisible pollutants and the connection of air pollution to other environmental problems.[608] Caitlin Murdock has also defended the notion of continuity in the overall pessimism and fear of industrialisation and technological progress. In the case of Germany, for example, she shows how fear and anxiety already existed in the 1950s and coexisted with a sense of economic optimism that is usually seen as being prevalent in this decade. She emphasises the long continuity in demands for a healthy environment rather than a sudden revolution in the late 1960s.[609] Similarly, Simo Laakkonen and Timo Vuorisalo depict the change in the 1960s Finland as a slow evolution rather than a sudden revolution.[610] These accounts support the observations made in the present study; namely that people living in Finland in the 1940s and 1950s were concerned about an unhealthy environment caused by air pollution. These attitudes were prevalent despite lukewarm attitudes from within the medical sphere.

Along with a longer perspective over time, the changes in the late 1960s should be granted a more nuanced geographical perspective. As Christopher Rootes has argued, the connection between environmental thinking and the cultural radicalism of the late 1960s, for example, differed greatly between countries. He sees the connection as being strongest in the Nordic zone, where the 'spirit of the sixties' supported the combination of environmental concerns, such as air pollution, into a whole-hearted critique of Western consumerism.[611] Uekötter has also shown how the quarrel between the public and industry over air pollution issues did not develop a similar scope in West Germany as it did in the United States.[612]

Thus, rather than seeing the environmental revolution as the explanation behind the change in attitudes towards air pollution, it should be seen as a multiform phenomenon deriving from longer historical processes with obvious transnational elements as well as local characteristics. This expansion of the air pollution problem into part of a more general societal and environmental critique in the case of Finland can be most clearly examined by concentrating on the phenomenon that united the ideas of counterculture, environmentalism and fear of chronic poisoning; namely, the increase in private car use.

608 Uekötter 2009, 208–210, 258–262.
609 Murdock 2019, 45–64.
610 Laakkonen & Vuorisalo 2019, 285–286.
611 Rootes 2008, 295.
612 Uekötter 2004, 247–252.

## The Polluting Golden Calf

> **Air Pollution from motor vehicles is not dangerous to health** – a nuisance maybe, but not a hazard says a group of World Health Organization (WHO) experts. The surprising statement flies in the face of much other published data and opinion, but the WHO panel makes a strong case. .... Statements to the contrary, continued the experts, stem from faculty research or emotional reaction to dense clouds of annoying black diesel exhaust.[613]

This brief article in the journal *Chemical Engineering* in 1967 was picked up by Uolevi Raade, a noted Finnish industrialist and president of the Neste Oil Corporation. Seemingly delighted by his discovery, Raade sent a Xerox copy of the article to city councillor Carl-Gustaf Londen, who was known for his attempts to draw attention to air pollution in Helsinki. Londen, for his part, described the statement as "strange at best, but more like clear-cut wrong," and forwarded the copy to Laamanen, hoping for "the means for a sharp reply".[614] Unfortunately for Londen, Laamanen was unable to provide a contrasting viewpoint. Instead, he promised to look at the report and stated that there were plans to discuss the issue at the Finnish government's expert committee with the representatives of the oil industry. He then forwarded the statement to the World Health Organization and requested the original report, stating that he had been approached by multiple parties to comment on the issue.[615] As this correspondence attests, air pollution, and particularly the health effects of motor vehicle exhaust emissions, was becoming an increasingly contested issue in the late 1960s, and both sides looked for support from medical and scientific experts. The fact that Londen responded to the news about the WHO report with utter disbelief emphasises the strong views that had been formed around the issue at a time when the increase in private car use in Helsinki was dividing opinion.

The considerable increase in private car use during the 1960s in Finland can be seen as the focal point of a growing critique of the effects of air pollution. This critique was in large measure a result of the actual decrease in air quality, particularly in Helsinki. Historical records have shown that the air in Helsinki, in all likelihood, was at its worst in the late 1960s, and that this development was mainly due to motor vehicle exhaust emissions.[616] The number of private cars had tripled after import

613 *Chemical Engineering* 28.8.1967.
614 Carl-Gustaf Londen's letter to Arvo Laamanen 27.11.1967, ISMET Domestic correspondence, NAF.
615 Laamanen's letter to Carl Gustaf Londen 1.12.1967, ISMET Domestic correspondence, NAF; Laamanen's letter to G. Ponghis 30.11.1967, ISMET Foreign correspondence, NAF.
616 Mattila 2001, 64–76.

restrictions were lifted in 1963 and, due to the geographical restrictions of the city, the streets of Helsinki were overwhelmed by the volume of traffic.[617]

The smoke, noise and hazards caused by this development gave rise to a heated discussion and a citizens' movement that aimed to protect the rights of the majority against the car-driving minority.[618] But perhaps more fundamentally, the critique against cars combined with air pollution abatement to offer up a wider critique against the Western way of life in general. The private car was in many ways a symbol of a society that was considered to be individualistic, overtly technological and obsessed with consumerism and high standards of living. As one hygienist argued, after examining the pollution caused by the increase in motor vehicles: "The private car, however, is a golden calf of sorts; a symbol of our high standard of living and extremely hard to intervene against".[619] In other words, after being a secondary issue for a long time, the increasing use of cars made air pollution a key societal issue in Helsinki.

Private cars also posed a problem for the regulation of air pollution. In Europe and North America, air pollution was usually considered a local matter that should be controlled by local officials, but the proliferation of private cars that were manufactured in one place and used in another posed a problem in terms of emission control. As Uekötter has shown, this was one reason behind the federal legislation on air pollution that began to be adopted in the USA in the early 1960s.[620] In addition, the exhaust emissions from motor vehicles posed a different kind of threat to health and wellbeing. Not only were they a more complex mix of chemical substances than could be found in traditional coal smoke, but they were also emitted at the ground level and in places in which people lived. In this way, the discussion of motor vehicle exhaust emissions underlined the two trends that were becoming prevalent in air pollution discussions more generally; namely, an emphasis on health effects and the inclusion of air pollution within the overall problem of the chemical pollution of the environment.[621]

617 Central Helsinki is surrounded by sea on three sides, making any expansion of traffic difficult to manage.

618 Schönach 2008, 173–181.

619 Taka 1968, 124–126. The most famous detail in this regard was the so-called Smith & Polvinen Scheme that was published in the late 1960s, in which a futuristic vision of Helsinki was designed as a small version of Los Angeles. Although it has been depicted as an example of the private car mania of the 1960s, some have suggested that the plan was actually meant as a provocation in support of public transport. See, for example, Henrik Meinander 2019, 350–356.

620 Uekötter 2009, 208–209.

621 This trend in air pollution research was noted, for example, in Research into Environmental Pollution. Report of Five WHO Scientific Groups. World Health Organization, Geneva 1968.

Noro and Laamanen were also aware of the new and increasing threat to ambient air posed by private car use. In a 1967 survey on the sources of air pollution in Helsinki they argued that the increase in pollution was to a significant degree due to increased car use. Consequently, they proposed action to lessen vehicle emissions and traffic congestion in order to improve air quality.[622] Despite this, Laamanen and Noro did not perceive air quality in Helsinki, or in any other locale in Finland for that matter, to be dangerous to health. The amounts of lead, carcinogens and even CO were deemed to be too low to be of concern, even though it was advisable to keep the amount of these substances as low as possible. In addition, the visible smoke from diesel buses—a common topic of complaint—was deemed to be a nuisance by the FIOH experts, since it did not contain the potentially dangerous substances found in petrol exhausts.[623] These views differed markedly from the ones held by those advocating for a cleaner environment in the late 1960s.

## Poison is Always a Poison

The hardening critique against air pollution found a new medium in the late 1960s; namely, books and pamphlets criticising the degradation of the environment. Whilst many classic texts of this genre had already been translated into Finnish, it was only in the late 1960s that environmental books written by Finns began to appear more frequently. Various publications appeared from 1968 that criticised the pollution of the environment, the destruction of natural habitats and the overall degradation that stemmed from the modern way of life. In these works, air pollution generally formed only one aspect of a wider problem and usually not the most important. However, these works offer a concrete example of how the specific issue of air pollution, particularly the dangers of motor vehicle exhaust emissions, became incorporated into a generalised anxiety about environmental degradation. The specific indignation and even fear of air pollution on the streets of Helsinki that was promoted by The Majority, a citizen organisation established to curb the increase in traffic in Helsinki, was published in the same pamphlet series as the fears of a future without birds and meadows that were inspired by Rachel Carson.[624]

At the same time, the traditionally mild-mannered Finnish Society for Nature Conservation, the most important nature conservation organisation in Finland, transformed into an active and radical critic of modern society. In 1967, the society's

622 Laamanen & Noro 1967, 14–17.
623 Laamanen & Noro 1967, 16.
624 See *Alas auton pakkovalta*. Toim. Leena Manula. Huutomerkkisarja Tammi, Helsinki 1969; *Minne kukat kadonneet*. Toim Jukka Pakkanen. Huutomerkkisarja. Tammi, Helsinki 1970. See also Valtiala 1969.

new chairman, the biologist Pekka Nuorteva, stated the following: "It is clear that the protection of nature cannot in this situation focus simply on forming nature reserves or on the protection of single animal and plant species. Nature conservation must more efficiently widen its scope to cover the protection of man itself from all the dangers that relate to the misuse of natural resources and the pollution of nature."[625] The society shifted its focus in the late 1960s into general environmental protection and air pollution came to be seen as one of the features of environmental pollution.The main culprit of the pollution of the air was no longer perceived as stemming from the foul-smelling emissions of the pulp industry, but the petrol industry that supplied fuel for motor vehicles and heating plants. From this perspective, air pollution was fundamentally caused by the same destructive use of resources which was responsible, for example, for the oil tanker accidents that threatened the Baltic Sea.[626] In short, the long-held public indignation regarding air pollution in the late 1960s was combined with a wider critique and fears about health and environmental contamination.

The issues that worried the new critics of environmental pollution were much the same things that had concerned air pollution researchers: lead, carbon monoxide, sulphur dioxide and carcinogens. These worries, however, were mostly focused on the problem of increasing private car use. The epitome of the critique of air pollution and motor vehicles can be seen in the mass protest known as Pollution Week that took place on the streets of Helsinki in 1969. It was organised by the veterinary students together with other parties that were against the increasing use of private cars in urban centres. This event was the first environmental mass protest in Finland, but it has remained relatively unknown and has not retained a significant position in the self-image of the Finnish environmental movement.[627]

For contemporaries, however, the protest was quite visible on the streets of Helsinki and in the media reporting of the event. Indeed, the week-long protest seems to have subsequently inspired school teachers to focus on the pollution of the environment.[628] The Pollution Week protest included many demonstrations and participants wore gas masks, as well as carrying out the ceremonial destruction of a

625 Nuorteva 1967, 41.

626 For the significance of oil tanker accidents on Finnish environmentalism, see Räsänen 2015.

627 The Finnish environmental movement in the twenty-first century seems to view its history as protection of pristine nature and wildlife, whereas less notice is given to the long-term efforts for a clean urban environment. See, for example, *Laulujoutsenen perintö. Suomalaisen ympäristöliikkeen taival.* Suomen luonnonsuojeluliitto ja WSOY, Porvoo 2008.

628 Luonnonsuojelu on vielä vieras asia kouluissamme, HS 27.4.1969.

car and providing an oxygen bar for passersby.[629] These theatrical acts of protest seem to have been influenced by activism in the United States, where so-called pollution weeks had been regular occurrences since the early 1960s The use of gas masks to depict so-called horror scenarios, for example, had been common in the U.S.[630] This imitation further highlights how the concern for clean air was appropriated into a broader societal and environmental critique in the late 1960s.

Uekötter has seen this development in the United States as a rhetorical change, in which air pollution was united with the concerns of health and global environmental degradation.[631] Similarly, the new activist concern can be highlighted in their rhetoric about poisons and the overall toxicity of modern society. Studies on public health and industrial hygiene rarely described substances as poisons, since their effects were also dependant on dosage and the form of exposure. According to this tradition, the essential concepts were poisoning or intoxication, dosage, exposure, symptoms, mortality and morbidity. That is, the effects caused by exposure to a substance, rather than the quality of the substance as such.

In contrast, the new critics focused predominantly on the qualities of the substances. The hazards of lead and carcinogens in the environment are emphasised by describing the potential harmful effects these substances have. In short, CO is a poison that kills by supplanting oxygen in the blood; lead is a poison that accumulates in the body causing various health effects; carcinogens are poisons that have the ability to cause cancer.[632] As stated in a pamphlet criticising private car use: "Even in Finland, cars and especially petrol-powered cars produce tens of thousands of tons of substances in the air that are, as such, well-known poisons. To this are to be added poisons the effects of which are as yet unknown."[633] In a similar style another pamphlet states that "the poison levels in the air of Helsinki have risen 18%".[634] Likewise, the posters of the Pollution Week demonstrators in Helsinki stated that "Lead Kills Slowly!" and "Lead and Sulphur Explode Our Organs!".[635] Uncertainty about the veracity of knowledge about the health effects of pollution are

629 Kaasunaamariajelu ympäri Helsinkiä, HS 24.24.1969.
630 Uekötter 2018, 43. The Pollution Week was not alone in this regard. Demonstrations in the United States were used as a model in the leftist societal critique in general, especially in the tumultuous year of 1968. Meinander 2019, 330–356.
631 Uekötter 2008, 261.
632 Valtiala 1969, 18–35; Manula 1969, 42–61; Nordberg, 1970, 91–94; Nalle Valtiala, Hiipivän lyijymyrkytyksen uhka, HS, 12.3.1969.
633 Manula 1969, 42.
634 Nordberg 1970, 91.
635 Kaasunaamariajelu ympäri Helsinkiä, HS 24.24.1969.

interpreted as a "danger that it has not yet been able to prove", as was stated in one anti-car pamphlet.[636]

The FIOH, and Noro especially, held a markedly different view on communication about the hazards to health. As had transpired on several occasions, it was important for Noro not to cause unnecessary fear and anxiety. Whilst he always saw "propaganda" as being essential in the fight against occupational hazards and the deleterious effects of modern society in general, he was careful to keep it within strict boundaries. This can be seen in his critique against "the wrong kind of propaganda" in hygiene education in the 1940s, which had caused needless anxiety about bacteria and in his concern in the early 1960s that "a lung disease psychosis" occurred in workplaces due to over-enthusiastic attention to dust.[637] Also, as seen in the previous chapter, he even downplayed the potential health effects of smoking as criticism against cigarettes became increasingly fierce in the early 1960s. This relaxed attitude towards the harmful effects of tobacco came in spite of Noro expressing strong anti-smoking views in the 1950s. Thus, the rhetoric of the new critics of environmental pollution was judged by Noro to be the wrong kind of propaganda. As he later argued: "It has been horrifying, how, in recent years the 'environmentalists', who lack any medical-toxicological expertise and training, have interpreted the dangers of mercury, lead, asbestos, pesticides etc."[638]

There were also, however, more fundamental differences between the FIOH and the new critics that went beyond mere rhetoric about poisons. In many ways, the FIOH represented the old generation of experts whose knowledge was based primarily on occupational health disciplines. As noted earlier, this expertise was challenged in the United States by experts from different fields, such as ecology, biochemistry and medical research on cancer. These experts emphasised the accumulation of chemicals in the environment and their often unpredictable

636 Manula 1969, 42. The different views on potential dangers have sometimes been explained as the difference between lay and expert notions of risk. See, for example, Mary Douglas & Aron Wildawsky, *Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers.* University of California Press, Berkeley 1983. However, the historian Sylvia Tesh has criticised the whole idea of different risk perceptions between lay people and experts on the grounds that the former often use experts of their own or at least knowledge produced by experts. See Sylvia Noble Tesh, *Uncertain Hazards. Environmental Activists and Scientific Proof.* Cornell University Press, Ithaca 2000.

637 Tri Leo Noro: Työpaikkahygienia, Myllykosken Paperitehdas Oy:n henkilökuntalehti 4/1954; Noro 1960, 64.

638 Noro 1978, 131; Pääjohtaja Leo Noro: Ympäristötekijät tautien synnyssä − 2. Kansainväinen yhteistyö ainoa tie, HS 13.11.1973.

effects.[639] Similarly, the continuous exposure to low doses of pollution was viewed with increasing suspicion. Research from biochemistry and molecular biology emphasised the carcinogenic potential of substances even in minute amounts. This idea was most famously put forward by the U.S. biochemist Bruce Ames, stating even a single molecule could theoretically cause cancer.

In the history of environmental toxins, this low dose debate represents a turning point in regulation, when the so-called threshold paradigm began to lose its power.[640] As Uekötter has argued, in the late 1960s United States thresholds for pollutants were increasingly implemented as a precaution, with less stringent requirements for knowledge and consensus.[641] This change in attitudes would also become evident within the FIOH in the 1970s, as a new generation of researchers laid more emphasis on low doses and especially carcinogens.[642] As one former employee of the FIOH remarked, the institution's approach towards toxins and chemical contamination changed rather dramatically after the new generation took charge in the late 1970s.[643] However, in the late 1960s the FIOH represented an oppositional force to the environmental critics who had embraced the new views on the hazards of environmental pollution.

This does not mean that Noro and his colleagues were completely at odds with the environmental concerns of the era. In his own writings in the late 1960s, Noro saw environmental pollution as a serious problem for modern society that would need to be dealt with, noting, for example, the accumulation of chemicals in the food chain.[644] Also, the report from the fifth symposium of the British Ecological Society held in 1964, entitled *Ecology and the Industrial Society*, was referred to in the FIOH's booklet on general air pollution as a foundational text on the subject.[645] Although the report did not have the alarmist tone characteristic of the environmental

639 Perhaps the most famous single event in this critique was the re-evaluation of industrial lead in the environment by the chemist Clair Patterson in the mid-1960s. This was accompanied by the theory that the fall of the Roman Empire was due to lead poisoning from water supplies by the sociologist Colum Gilfillan. The theory became a popular reference in the debate over the increasing amount of lead in the environment. The Finnish critic Nalle Valtiala, for example, referred to Gilfillan's theory, which further boosted his concern about the "degeneration of the race", should pollution continue. See Nalle Valtiala, Hiipivän lyijymyrkytyksen uhka, HS, 12.3.1969

640 Boudia & Jas 2014, 10; Kirchhelle 2018, 213; Homburg & Vaupel 2019, 14.

641 Uekötter 2008, 181–201.

642 Emails from Jouko Tuomisto 15.3.2020, 16.4.2020.

643 Emails from Antero Aitio 23.8.2020, 7.10.2020.

644 Noro 1969, 126–130. In his 1974 book on environmental hygiene, Noro expresses concern about the accumulation of chemicals in the food chain due to the use of pesticides. He refers directly here to Rachel Carson. He noted, however, that little was known about possible chronic effects. Noro 1974, 104.

645 Laamanen & Noro 1966, 39.

movement as a whole, it did highlight the environmental issues of industrialisation as a unified problem affecting all spheres of life: "There is in particular a need for a greater appreciation that these troubles are disorders of a whole complex system, rarely curable by tinkering with parts of it."[646] The FIOH researchers seem to not have been strangers to the idea of understanding these various environmental consequences as a unified, serious ecological problem.

Nonetheless, unlike the critics, Noro emphasised the ability of humans and other animals to adapt to their surroundings. True to the dose makes the poison dictum, he emphasised that poison is a quantitative concept as much as qualitative. In theory, everything has the ability to be toxic, but in practice humans and other animals have significant tolerance of many substances. In Noro's view the task was to find out the optimal level of environmental contamination that does not cause a danger to health, noting that "humanity will gradually adapt to reasonable levels of pollution, but not to unreasonable levels."[647] Although Noro was not dismissive of the potential effects of environmental pollution in low doses, he did not seem to appreciate the way that these theoretical risks from laboratory tests were expressed by some and argued for a more comprehensive medical view on the matter.[648]

Other FIOH experts also often found themselves moderating the concerns raised in the late 1960s, be it the contamination of coastal waters by mercury or lead from car exhausts.[649] The FIOH toxicologist Sven Hernberg provided reassuring words about fears of the potential chronic health effects of lead from gasoline. He pointed to an expert report from 1968, which had not found evidence of chronic effects even in industry.[650] Hernberg saw the immediate dangers of lead as minor and advised that a wait for further studies on the long-term effects was necessary. He regarded that the alarmist statements seemed to serve little purpose, and suggested a halt on public discussion of lead contamination for the time being in order to give scientists time to work.[651] As the philosopher of science Isabella Stengers has argued, this rather arrogant idea of giving scientists the time they needed to come to the right solution on their own terms in relation to complex environmental or societal problems has

646 Clapham 1965, 4.
647 Noro 1969, 126–130.
648 Pääjohtaja Leo Noro: Ympäristötekijät tautien synnyssä −1. Tarvitaan tutkimusta ei pelottelua, HS 21.11.1973.
649 For a closer examination of the mercury pollution scandal, see Räsänen 2015.
650 Sven Hernberg, Lyijy ja kansanterveys, HS 20.3.1969.
651 Sven Hernberg, Lyijy ja kansanterveys, HS 20.3.1969. Hernberg's view on lead seems to fit into the so-called Kettering Paradigm.

been popular amongst scientists.[652] As a direct response to Hernberg, an anti-car pamphlet in Finland in the late 1960s asked the following:

> Should we not discuss the dangers threatening our health at a time when the question of air pollution is one of the most burning topics all over the world? Should we be silent and let 'the scientists have their peaceful working conditions' when at the same time everywhere protest movements have arisen to demand clean air for everyone?[653]

In an atmosphere of environmental concern and fear in the late 1960s, the FIOH's stance on issues, such as air pollution, seemed somewhat lukewarm and dismissive. The chairman of the Finnish Society for Nature Conservation, for example, described the attitudes of the FIOH towards air pollution as "frightening".[654] In addition, the FIOH's status as a semi-private institution, which sold its services to industry, was seen as incompatible with its role as a leading institution of expertise on environmental health. The following was stated in a survey on environmental protection policies in Helsinki: "Present air pollution research is controlled by industry and does not sufficiently serve the needs and benefits of the private citizen. The research of the Occupational Health Institute on air pollution attempts to oversee industry, while in reality it is industry that oversees the research and acts as its employer."[655] Similarly, the radiochemist Elisabeth Helander, who was one of the most ardent critics of the FIOH, accused the institution of being entirely dominated by industry. In her opinion, this led the FIOH to be particularly dismissive of the dangers of air pollution and lead.[656]

There was little new in the accusations of bias towards industry laid against the FIOH. The fact that private industries purchased occupational health services from the FIOH had already aroused suspicion in the 1950s. The chief officials of the FIOH replied, as they had before, by emphasising that the majority of their funding came from the Finnish government and that control of the institution was shared by industry, trade unions and the government.[657]

652 See Isabelle Stengers, *Another Science is Possible. A Manifesto for Slow Science*. Polity, Medford 2018.

653 Manula 1969, 46.

654 Olli Ojala:Ympäristönsuojelukomitea ei näe muuta kuin virkoja, HS 9.6.1970.

655 Launis 1971, 37.

656 Saastetutkimuksen tulokset saatava nopeasti julkisuuteen, Suomen Sosiaalidemokraatti 22.1.1971.

657 Letters from the FIOH director Matti Karvonen to the radiochemist Elisabeth Helander, 21.1.1971 and 29.1.1971, AFIOH. Ironically, it was a lack of funding from industry that had crippled the research efforts of the FIOH since it was founded.

The accusation was not entirely unfounded, as the industry was not only the customer of the FIOH and it also often owned the material that formed the basis of the FIOH's research. This could potentially lead to situations in which the FIOH had to maintain good relations at the expense of research. This is indicated by one case from the early 1960s, when Leo Noro agreed not to publish the results of a certain study on the levels of mercury on workers, as the representatives of the sulphate pulp mill in question feared the conclusions would be misinterpreted in certain circles.[658]

It is unclear whether the relationship with the industry had an effect on the FIOH's air pollution research. The air quality issues in Helsinki, where the criticism was strongest, were, after all, not caused by any particular industry. The main problem was private car use, which Laamanen and Noro readily admitted. Rather than being dominated by the industry, it could be argued that Noro and his colleagues maintained a sympathetic view on industrial production in general. This differed from the environmentalist view of the critics. From this perspective the views of critics seemed clueless to the benefits of industrialisation, as well as the full picture of public health and, the relative significance of environmental toxins. In contrast, from the point of view of the critics, the statements made by Noro and other members of the so-called old guard reflected a narrow view that was anthropocentric, dismissive and biased towards industry and clueless of the intricacies of nature.

It can be said that the critical views on air pollution, and environmental pollution in general, in the 1960s were not only based on harsher rhetoric and/or ecological thinking, but also on different views of poisons and their potential hazardous effects. The critical view has been regarded as environmentalist and stems from works such as Rachel Carson's *Silent Spring*.[659] It should be noted, however, that this idea also had its roots in occupational medicine and industrial hygiene. When Wilhelm Hueper, the principal source for Carson, warned about airborne carcinogens in the early 1950s, his idea was deemed to be premature and unnecessarily alarmist by other experts, but not wrong as such. Even Robert Kehoe recognised Hueper's concern, stating that "the time to protect the public health as well as industrial health, is before the tragedy rather than after. If we do not accept that principle, we are likely to be lost in this modern and complex world."[660] By the late 1960s, support for

658 Letter from Kaarlo Lehtiö to Leo Noro, 30.12.1961; letter from Leo Noro to Kaarlo Lehtiö, 16.1.1962, AFIOH. The results were instead published in a Swiss medical journal.

659 Elisabeth Helander, for example, later regarded *Silent Spring* as an important source of inspiration. Elisabeth Helander: Tieteen ja ympäristön asialla. *Kemia* 6/2018, 39.

660 The discussion section of Hueper 1952, 484. Note also that the theory of the fall of Rome as a result of chronic lead poisoning was published in an occupational medicine journal. See S. C. Gilfillan, Lead Poisoning and the Fall of Rome. *Journal of Occupational Medicine*, vol. 7, issue 2 1965, 53–60.

Hueper's point of view had grown, based on growing evidence and due to the writings of well-known environmentalist, such as Rachel Carson. In other words, Hueper, Carson and the Finnish critics of air pollution in the late 1960s shared a common view, which highlighted the potential effects of chemicals and their possible connection to the abundance of chronic diseases in modern society.

Thus, although the concern for air pollution, along with other forms of environmental pollution, gained currency in the late 1960s in Finnish society, this placed the FIOH and its experts on the defensive. Many of the critics saw an urgent need for a national centre for air pollution research to replace the authority of the FIOH.[661] Though this centre never materialised, the days of the FIOH as the national authority on air pollution problems were numbered. In the late 1960s and early 1970s the Finnish government began to plan the institutionalisation of environmental expertise and management within the bureaucracy of state. This was a development that was taking place in many European countries. It sparked a contest for official expertise about air pollution between the interested parties. However, although the criticism against the FIOH had been grounded on different views on health and the environment, the final challenge to the FIOH's expertise came from a seemingly unlikely discipline; namely, meteorology.

## The Triumph of Meteorology

Meteorological knowledge had been a part of air pollution research and control since the nineteenth century, due to the fact that atmospheric movements and topography affected the dispersal of emissions. Emissions were a source of pollution, but the extent to which they affected people depended to a great extent on the weather. Consequently, it was common to situate industrial areas on the eastern side of urban areas in the northern hemisphere, due to the prevailing westerly winds. Thus, even after the role of weather decreased in public health during the nineteenth century, it remained an integral part of the overall air pollution problem. The disasters in Meuse, Donora and London, for example, were all seen to be caused by extraordinary meteorological circumstances.

Nevertheless, despite the standard place of meteorology in air pollution research, the latter was not a significant part of the former until the mid-twentieth century. When the national meteorological institutions, or their predecessors, began to be established in the nineteenth century, they were not initially charged with monitoring the quality of the air. This was also the case in Finland, where the national

661 Kaasunaamariajelu ympäri Helsinkiä, HS 24.24.1969; Saastetutkimuksen tulokset saatava nopeasti julkisuuteen, *Suomen Sosiaalidemokraatti* 22.1.1971.

meteorological institute was established in 1881.[662] Things began to change in the mid-twentieth century when meteorologists became better at predicting weather and modelling atmospheric movements at the same time as the trans-boundary movement of pollution received sustained attention.

The historian Paul N. Edwards has shown how the entanglement of research on the atmosphere and nuclear technology enabled a better understanding of global atmospheric movements, as well as the effects a nuclear fallout could have on the global climate. Radioactive particles were deemed objects worthy of monitoring due to their potential danger, but they also provided a way to trace the movements of the atmosphere.[663] It is this same entanglement that first attracted Finnish meteorologists to air pollution research in the 1950s, when the fallout of Soviet nuclear tests was scrutinised by the government. Many institutions were involved in radioactive monitoring in Finland, with the meteorological institution being commissioned to develop a network to measure radioactivity levels in snow and rainfall. The development of this network began in the 1950s and carried on throughout the 1960s. However, according to Rolf Mattson, who worked on the project from its inception, he and his colleagues had little contact with the researchers at the FIOH.[664] It was only when the Government Council on Air Pollution Control and Noise Abatement was founded 1967 that researchers from the FIOH and the Meteorological Institute came into closer contact.

Antti Kulmala was a key figure from the Meteorological Institute, who had distinguished himself by devising a modelling system for monitoring long-range air pollution. His publication from 1966, *Dusty Rains in Finland*, in which he traced the dust fallout in Finland to the Caspian Sea ranks as the first Finnish meteorological study in which atmospheric modelling was presented as a tool to observe environmental pollution.[665] Kulmala was included in the Government Council on Air Pollution Control and Noise Abatement as a representative of the Meteorological Institute. Subsequently, he became an active promotor of meteorological modelling in air pollution control. For example, he proposed a forecasting system in which district heating plants could revert to cleaner fuel when weather conditions were

662 Seppinen 1988, 71. The predecessor of this institution was the Magnetic Observatory founded in 1838. An exception in this regard was the observation of visibility that also considered visible air pollution.

663 Edwards 2012, 28–40.

664 Interview with Rolf Mattson, 24.08.2020. It should be noted that radioactive pollution was often seen as a separate issue ever since air pollution research began to be institutionalised in the 1940s and 1950s. It was dealt with by specialised institutions and scientific disciplines.

665 See Kulmala 1965.

predicted to be unfavourable.[666] The increasing level of attention devoted to trans-boundary pollution and the significance attached to trans-national measurement networks also made meteorology all the more important.

Unfortunately, the harmonious working relationship between Laamanen and Kulmala in the Council did not last for long. At the same time as public discussion about air pollution was on the rise in Finland, a quarrel erupted between the two experts over air pollution research and its future prospects. From the correspondence and internal memos in the archive of the Meteorological Institute it can be seen that Kulmala was unhappy with the state of affairs in the Council. He accused Laamanen of misconduct as the secretary of the Council, as well as of favouring the FIOH in the decision-making process and of withholding relevant literature in the FIOH library. More fundamentally he viewed the studies carried out by the FIOH as having "questionable scientific relevance" and argued that their views on air pollution control, such as the use of buffer zones around factories, were outdated. He also bluntly argued that the Council for Air Pollution Control had failed in its duties and required reorganisation.[667] Thus, at the same time as the environmental critics began to question the FIOH's authority on pollution, the dominance of the institution as the official centre of air pollution expertise was also challenged.

As Schönach has shown, Kulmala was hardly alone in his critique. Although the FIOH published over a dozen studies in the latter part of the 1950s/1960s, the studies that gained the most publicity were the ones that focused on the overall state of air in Helsinki, where the critique against pollution was strongest. However, while the reception of the first study in 1958 had been largely positive and engaged, further inquiries were seen as being more like a substitute for genuine abatement measures. Studies ordered by city officials were now seen as a token gesture from those in power, whilst in reality firm acts of abatement and control were needed. Newspaper journalists complained about the lack of practical advice and called for action instead of endless studies with statistics and ambiguous statements. The slow pace of research was also an issue: one study was designed to take five years in order to produce results on a matter that was arguably clear for everyone.[668]

Schönach has also argued that in spite of the numerous studies undertaken in Helsinki and the seemingly close collaboration by officials and researchers, the FIOH provided little meaningful knowledge or tools for policymakers and city officials. According to Schönach, the statements made in FIOH studies were so

666 Record of the air pollution division 7/1968 30.4.1968, ISMET Official records 1968, NAF.

667 Memorandum from a meeting 24.1.1972, Records of the Administrative College Cb:5 1972, AFMI.

668 Schönach 2008, 191–192.

ambiguous and their style of writing so obscure that no definite conclusions about the state of air could be drawn from them. She emphasises the conflicting style of the studies, which at one and the same time denied that there was any danger from air pollution and also claimed it was a considerable nuisance. The central conclusion continued to be that more resources were needed for additional studies. Due to this indefinite style and lack of practical solutions, the FIOH studies failed to have any meaningful effect in remedying the air pollution problem in Helsinki.[669] It seems then that Kulmala's critique was more than just borne out of rivalry.

There is little reason to doubt the communicative problems described by Schönach. For one thing, there is no denying that Laamanen wrote in a meandering style that sometimes bordered on being incomprehensible. It is also easy to agree with her that the reports usually end up in a statement describing air pollution as being of no danger, yet a considerable nuisance that was worthy of more research. This apparent inconsistency can be seen as deriving from the difference between nuisance and danger, which was clear and essential for medical experts, despite the efforts of the WHO to convince them otherwise. For the general public, as noted, the difference was less meaningful. Describing pollution as a nuisance may have seemed belittling in this context. However, Schönach also shows how the officials and politicians in the city administration, for their part, had little idea about what they actually wanted from these studies, apart from objective facts, and generally attached little priority to the matter.[670] There were also personality issues to consider. Although Laamanen is remembered as a visionary and as a talented scientist, he was also known for his stubbornness, high-handedness and reckless style, which, when added to his convoluted diction made him a difficult co-worker.[671]

Notwithstanding these local and personal circumstances, the quarrel between Kulmala and Laamanen reflects more fundamental disagreement over air pollution research. As noted, the large measurement networks in Europe and United States often focused on few pollutants—usually $SO_2$ and suspended particulates—and aimed to provide a long-term general picture of the state of air, which could be used in regulating emissions. As Stephen Mosley has argued, they formed part of a 'network of trust' between experts, officials and the public.[672] The FIOH research, however, mostly concentrated on specific pollutants in special environments, rather than undertaking general monitoring of air pollution. Studies measuring asbestos, vanadium, carbon monoxide and factory emissions at the ground level and on streets aimed to reveal the source and significance of these special and potentially harmful

669 Schönach 2008, 188–192; Schönach 2011, 133.
670 Schönach 2008, 188–192.
671 Email from Matti Jantunen 9.6.2020; interview with Risto Lahdes 26.8.2004.
672 Mosley 2009, 273–302.

substances.[673] In contrast to these specific measurements in various environments, Kulmala promoted a form of research that was based on modelling the diffusion of a few noted pollutants through atmospheric models and continuous measurement networks.[674] In short, Kulmala and Laamanen had different views on what kind of air quality analysis would best serve the interests of air pollution control. Kulmala's approach embraced extensive models that could be compared to pregiven norms. Laamanen, on the other hand, highlighted the complexity of the problem and emphasized special measurements that could reveal subtle aspects of urban air that were yet unknown.

There was little reason why these two aspects could not have been more complementary than competitive, as is indicated by the fact that Laamanen also wished for more extensive background measurement networks. However, this difference developed into a rivalry between meteorological and medical expertise in Finnish air pollution research, which can be seen in practically every report from the various environmental protection committees held in the late 1960s and early 1970s. When Laamanen was a member of a committee, the report emphasised the complex public health aspects of pollution and the experience gained by the FIOH over the years.[675] These reports were in turn criticised by Kulmala for downplaying the significance of meteorology, transboundary air pollution and knowledge of atmospheric movements. He emphasised the central position of weather as the factor that determined the effects emissions would have on ambient air. Because of this, air pollution differed from water and soil pollution or from noise pollution in regards to the expertise needed in its control. Thus, air pollution research could not be given to the FIOH, or to other institutions, except for the Finnish Meteorological institution, since "atmospheric science requires continuous hourly contact with the state of the atmosphere".[676] In short, as the organisational boundaries of Finnish environmental protection were being designed, Kulmala and Laamanen both promoted their own institutions as the most relevant centres of expertise for the study of air pollution.

Although the first committee reports promote the FIOH as the foremost centre of expertise, the tide turned against Laamanen as the future of the institute itself was debated. At the beginning of the 1970s, not only did Leo Noro, the well-connected

673 The asbestos study was probably the most widely distributed air pollution study undertaken by the FIOH, due to the rise in awareness of the carcinogenicity of asbestos and its unexpected prevalence in ambient air. See, for example, Heiman 1967.

674 Email from Matti Jantunen 9.6.2020.

675 Komiteamietintö 1970:25; Komiteamietintö 1971:15.

676 Comment on the report of the environmental protection committee to the Prime Minister's Office 29.7.1971, Records of the Administrative College 1970–1971. Cb:4, AFMI; Letter to the Prime Minister's Office 14.5.1971, Records of the Administrative College 1970–1971. Cb:4, AFMI.

long-time director of the FIOH, leave to become head of the National Medical Council, but also the contract between the FIOH and the government came to an end. This sparked an official inquiry by a governmental committee to discuss the future of the institution. The most significant conclusion of the inquiry was the suggestion to strip the FIOH of all its activities that were deemed to be outside its core focus on occupational health, including, for example, air pollution research.[677]

The decision to streamline the FIOH was endorsed by the Air Pollution Control and Noise Abatement Committee, which was the most significant inquiry carried out on air pollution research. Although both Laamanen and Kulmala were members of this committee, it was the latter who seems to have prevailed. The report highlights the significance of meteorology and the trans-boundary nature of air pollution. In addition, the report emphasises the importance of institutions, such as the World Meteorological Organization and the OECD, as forums of international research, while the WHO is hardly mentioned. It is argued that since the analysis of pollutants is being done more and more automatically, expertise in air pollution research predominantly entails gaining an understanding of atmospheric movements. As a result, the report proposes to transfer the research from the FIOH to the Meteorological Institute, since it is the only organisation with adequate experience, facilities and international networks.[678] However, those on the losing side viewed this change as detrimental to public health and to air pollution control in general.

In a dissenting opinion added to the report, Laamanen questioned the decision to transfer the research to the Meteorological Institute on the grounds that air pollution is a matter of public health. He argued that the Meteorological Institute had no expertise in this field and that it would be forced to outsource all analysis, which would be expensive. He further argued that there is no example from abroad of a similar organisation being the head of air pollution research. A cursory review of international literature would, according to Laamanen, have revealed the strong public health basis of the research and pointed to the role of the Meteorological Institute to be in "studies considering the transmission of pollutants, which are natural to the institution and important to air pollution control".[679] Most significantly, Laamanen criticises the report for its shallow treatment of the subject. He argues that the extremely complex concepts of polluted and dirty air are reduced to a matter of measurements of community air pollution.[680] Despite the objections made by

677 Komiteamietintö 1973:6, 128–130, 136–137.

678 Komiteamietintö 1973:6, 150–167. For example, the internationality of meteorology is highlighted in the report by referring to the foundation of the World Meteorological Organization's predecessor in 1873.

679 Komiteamientiö 1973:6. Dissenting opinions, Arvo Laamanen, 5.

680 Komiteamietintö 1973:6. Dissenting opinions, Arvo Laamanen, 1–16. Many other dissenting opinions relating to different topics were also left out of the report.

Laamanen, air pollution research was transferred from the FIOH to the Meteorological Institute in the 1970s as part of a streamlining initiative. As a result, the Finnish Meteorological Institute became the nation's leading institution of matters pertaining to air pollution.

Although Laamanen argued that the change in the status of the FIOH was absurd when compared to other countries, it could be seen as part of a wider development in expansion of environmental expertise. As noted, the significance of the OECD in air pollution research grew in the 1960s and 1970s in tandem with an increased focus on long-range pollution and acid rain.[681] This was viewed with some concern by WHO officials already in the early 1960s. As Renato Pavanello, chief of the WHO's air and water pollution division stated, the OECD's strong participation was placing WHO in "the absurd position of supporting the leading work on matters of public health importance to an agency which had a primary role of supporting economic development."[682]

Other international organisations also began to show an interest in air pollution and environmental issues in general. As Frioux has argued the political institutionalisation of the environment in the early 1970s in many countries changed the status of air pollution problems and attracted the interest of new parties, both national and international.[683] Indeed, the number of environmental expert organisations increased significantly in the 1970s.[684] In addition, due to the upcoming Stockholm Conference on the Human Environment, which was convened by the United Nations, many existing international organisations began to take an interest in environmental matters. This, in turn, exerted pressure on the WHO's Environmental Health Division to keep up with the rapid progress of research on the matter.[685] At the conference itself, representatives of the WHO were rather reserved as they were worried about the effects environmental pollution restrictions could have on global health and development.[686] In a way, these new organisations were stepping on the toes of the WHO, the traditional authority on environmental hygiene.

As part of this development, the World Meteorological Organization, previously occupied with its global network on weather data, also began to take an interest in

681 Rothschild 2019, et passim.

682 Memorandum from Pavanello to the Assistant Director General of the WHO, 16.12.1963, A6/343/3, AWHO.

683 Frioux 2019, 232.

684 Kaiser & Meyer 2016, 231.

685 Memorandum from Assistant Director General to the Director General 8.9.1969, appendix 1, H11/225/2, AWHO.

686 Borowy 2012, 456. As noted, the WHO's environmental pollution report highlighted the fact that a third of the world's population still suffered from poor hygiene and infectious diseases.

air pollution research at the late 1960s. In fact, air pollution was added to the global network of the WMO as it obligated its members to also measure local air quality. This obligation was used by Kulmala as one reason to shift research on air pollution in Finland to the Meteorological Institute, along with the fact that experts from meteorological institutes were usually the ones representing countries at OECD meetings about air pollution.[687]

It can be said then that the conflicts that beset Finnish air pollution research in the late 1960s and early 1970s were part of wider phenomenon, in which the political significance of environmental protection increased. This trend brought with it experts from disciplines that had previously had little authority pertaining to environmental pollution, or societal matters in general. This further highlights the change of environmental thought in the late 1960s and early 1970s. Whilst ever smaller amounts of chemicals in nature were seen being regarded as pollution, the nature of the problem was also broadening from the local to the transnational and even to the global. Fear of the long-term health effects of air pollution and concern for the environment as a global phenomenon were both part of what Uekötter regarded as the new environmentalist rhetoric of the 1960s.[688] As developments in Finland show, this new rhetoric had a significant effect on the issue of how the problem should be examined and by whom. It can be said that this institutional change depicts a shift in the way environmental contamination was viewed.

With the FIOH withdrawn from air pollution research and from research on environmental toxins in general, the visible connection between the research of industrial environments and modern environmental concern was lost. In Finnish environmental history, disciplines such as occupational medicine and industrial hygiene have received little attention. The environmental movement itself reveres biologists and atmospheric scientists, but sees no relationship to research on industrial environments.[689]

A vague understanding of this relationship is depicted most vividly by the arguments about why air pollution research was moved from the FIOH and why it was conducted there in the first place. This change has been explained both as a political move and as a rather natural development due to the streamlining of the FIOH's activities. Noro saw the move as a political matter, in which the research

687 A comment on the report of the environmental protection committee to the Prime Minister's Office 29.7.1971, Records of the Administrative College 1970–1971 Cb:4, AFMI.

688 Uekötter 2009, 261.

689 For example, in a history of the Finnish environmental movement compiled by the Finnish Society for Nature Conservation, the air pollution section begins in the 1970s and quickly turns to climate change issues. It makes no mention of the FIOH. Reinikainen 2008, 186–193.

was given to a more suitable candidate in the Meteorological Institute. According to Noro, the streamlining of the FIOH in the early 1970s resulted in occupational health research being put back into the same narrow confines that it had occupied in the 1940s.[690] The former FIOH employee Matti Jantunen also recalls the event as a severe political wrangle, in which two figures with opposite research views clashed, although he admits it can in retrospect be seen as a natural solution.[691]

The general consensus, however, is that the FIOH was a rather odd place for air pollution research to begin in Finland. The overall significance of the FIOH in matters of environmental health has been seen as a special feature in the Finnish history of environmental health.[692] These views reflect the fact that air pollution is easier to regard as part of the history of atmospheric research and public health than that of industrial hygiene and occupational medicine. However, one purpose of this study has been to show that there was nothing amiss in the FIOH being the pioneering centre of Finnish air pollution research and environmental pollution research in general. The FIOH's position merely highlights the fact that the roots of modern environmental knowledge are not only in ecology or atmospheric science, but also to a great extent in the international endeavour to manage the inevitable toxicity of industrial environments.

In short, although Noro and others in the FIOH were superseded by the new experts of the environment in the early 1970s, their significance in appropriating the research of modern environments in Finland should be noted if one wishes to understand the roots of Finnish environmental thinking and the ways of knowing that have shaped the way environmental contamination is viewed. Rather than a local curiosity, the FIOH was part of a transnational quest by experts of industrial environments to maintain safe urban air.

690 Noro 1979, 218.
691 Email from Matti Jantunen 9.6.2020.
692 Vuorinen & Mussalo-Rauhamaa 2020, 245. See also Lahdes 2004.

# 5 Conclusion

The premise of this study was not to view air pollution as a synonym for humanity's air quality problems, but as a specific concept forged into its modern form in the mid-twentieth century. From this premise, the aim of the present work was to examine how air pollution became part of Finnish environmental health expertise. Moreover, this work has sought to highlight the significance of this field of expertise vis-à-vis how the relationship between health and ambient air has been understood. This point of view enabled a more focused examination of the phenomena.

Thus, rather than beginning from the smoke abatement policies and nuisance laws of the nineteenth century, this study begins with the medical and hygienic teachings of the 1940s in Finland, when the would-be pioneers of Finnish air pollution research received their medical training. Rather than tracing the roots of air pollution research from the perspective of famed British atmospheric scientists, such as Robert Angus Smith and John Aitken, this study examines the Finnish physicians who analysed the health problems of industrial environments in the 1940s. Here, air became a central medical concern for the first time since the heyday of miasma theory. This expertise in dust, fumes and smoke became essential when the quality of ambient air became a concern for the local administration in Helsinki in the 1950s.

Finally, rather than examining the places that suffered from heavy pollution, this study has focused on a relatively peripheral country in which air quality problems were never at the forefront of public health concerns. This examination shows how the concept of air pollution, its research and monitoring, were appropriated into Finnish society in an effort to standardise the problem of urban air quality using the methods developed in industrial hygiene. The appropriation of air pollution research was, in other words, part of the transnational development in the mid twentieth century during which the complex problems of modern society were subjected to rational management by objective knowledge and expertise.

This development began with a shift from the vague hygienic idea of clean air to a more precise concept of safe air. The examination of Finnish hygiene teaching in

the 1940s shows that although the war against bacteria dominated public health expertise, clean and fresh air were still regarded as being important for health and wellbeing. It was the growing issue of health and safety in industrial environments that generated a demand for a different kind of medical expertise that focused on dust and fumes in the air. These working environments were riven with hazards, chemicals and dust. The essential factor was, however, the conflict of interest between those who worked in these environments and those who owned and controlled them. This conflict of interest created a demand for objective medical expertise. U.S. industrial hygiene was very influential in this regard. It was a discipline that enabled the expert management of industrial environments by creating safe levels for different substances. The Finnish Institute of Occupational Health became the national embodiment of this transnational network of environmental health expertise.

This expertise in industrial environments did not, however, automatically transform into interest in ambient air quality outside the setting of factories. As this study shows, the experts at the FIOH showed little interest in air quality issues in the 1950s, despite the disasters that took place in Donora and London. In fact, this study suggests the need for a re-evaluation of the (in)famous air pollution disasters as exposers of the health effects of air pollutants. Whilst their significance as dramatic examples of the problem cannot be questioned, it is shown that the events were regarded by the expert community as special cases that occurred in special circumstances and provided little knowledge about the health effects that the experts were most concerned about. Namely, the long-term effects of daily exposure. Similarly, in the less industrialised and sparsely populated Finland these events represented only a distant threat. Instead of these disastrous events, it is argued in this work that an emphasis should be placed on ways of studying human exposure to air impurities that were developed within the spheres of occupational health and industrial hygiene.

Furthermore, it has been shown that the research on the health effects was made possible by public sentiment rather than vice-versa. The initial interest in air quality in Finland stemmed from public fear and indignation about threats to their health. Local administrators responded by devoting expert knowledge to the issue. The same phenomenon seems to have been taking place in many countries in the late 1950s. Hence, the FIOH was part of a wider development in which experts on industrial dust became essential actors in governmental efforts to respond to public criticism and control the quality of air. As had been the case in occupational environments, experts were enlisted to produce objective knowledge and rational solutions amidst complex societal dilemmas.

This work argues that new knowledge about the health effects of air pollution was not the main reason behind the institutionalisation of air quality monitoring in

modern societies. Instead, the process was made possible by public indignation about polluted air combined with a faith in scientific expertise in societal matters, both of which increased in the mid twentieth century. What the experts of industrial environments had to offer in this situation were the methods and concepts derived from industrial hygiene that could be used to provide, at least in theory, a rational solution to the problem of urban air quality. In other words, the control of industrial hazards and diseases not only formed the medical basis for air pollution research, but also reflected the way in which modern environmental problems could be dealt with.

The internationalist ethos of development made it plausible for the WHO to design universal standards and tools that could be used to manage the hazards that threatened society. Similarly, it gave Finland, a small country with limited resources, an incentive to observe, learn and imitate other nations deemed to be ahead along the path to progress. An essential feature of this imitation was the network of research and expertise, represented by the transnational activity of the FIOH. What was essential in both industrial hygiene and air pollution research was the availability of such things as simple and standardised self-products, manuals, procures, textbooks, lecture materials and the vast amount of journal articles that contained detailed descriptions of the methods. Historical research on the proliferation of scientific knowledge has often emphasised the limits, locality and appropriation of knowledge production. In contrast, this study emphasises the standardisation of transnational knowledge production and the seemingly mundane material used to achieve this. In a relatively peripherical country, such as Finland, imitation rather than innovation formed the essential part of research.

In effect, the aim to ‘clarify the air’ shared the basic ideas of Maximum Allowable Concentrations in industrial hygiene. First, clean air was a practically useless concept; second, the accumulation of medical knowledge had the potential to reveal what substances would be dangerous to health and at what quantity. As such, the research agenda served both the interests of expanding research and also the growing degree of bureaucratic regulation related to the environment, which revolved around numbers, facts and rules. Air quality guidelines, which were created in the late 1960s, epitomised this development. The networks for measuring pollution continued to expand during the 1960s and became more sophisticated, along with the statistical tools used to model the changes in pollution and the meteorological tools to model atmospheric movements. As a result, in little over a century, ambient air evolved from the “ultimate sink”, as described by Joel Tarr, into one of most closely-monitored environmental elements, with regular air quality updates for cities becoming as ordinary as weather forecasts. This change has generally been met with approval, as more knowledge is thought to result in better environments.

The last chapter of this study shows how the FIOH lost its position and credibility as the expert body on environmental health in Finland at the height of its status and in the wake of increasing environmental regulation. What this study claims, however, is that despite their eventual demotion, the activities of the FIOH form an essential part of Finnish environmental history and the development of environmental regulation. In short, the history of environmentalism and environmental regulation cannot be understood in Finland without examining the development of occupational medicine and industrial hygiene as expert disciplines of environmental health in modern society. The case of the FIOH should be seen as more than a local curiosity. It formed part of a wider development that essentially came about because of two fundamental changes that are not often considered in environmental history. First, the shift to working outside homes, as a result of the gradual erosion of agrarian society.

Second was the considerable diversification of domestic industrial production in many countries, caused by the crash of the free trade era after the two world wars of the twentieth century. The attempt to control the proliferation of occupational environments in the post-Second World War era, in which a spirit of rational management reigned, created a demand for objective expert knowledge. At the same time, a method of gauging air quality and its health effects was produced that addressed a specific set of questions with specific tools. The case of the expertise of the FIOH vis-à-vis air pollution shows how the way of knowing about air pollution and the questions in need of answering were co-produced by medical and scientific disciplines, alongside the concerns of the public and the regulatory needs of the modern administration. This development led to a need to clarify air through medical research.

## A Puzzle or a Wicked Problem?

The nature of air pollution as a public health and environmental problem did not evolve in ways that were feared by many in the late 1960s. The concern that air pollution would form a part of the general chemical contamination of the environment was downplayed, as many forms of emission were controlled quicker than presumed. The most remarkable achievements at this time were perhaps the ban on lead in petrol and the overall decrease in car exhaust emissions achieved by technical apparatus. District heating and other centralised forms of energy production have improved air quality in wealthy countries by displacing domestic furnaces. Trans-boundary pollution, which also began to receive attention in the late 1960s, was largely eradicated in Europe by the 1980s. This success was accompanied by tighter emission controls for industry in general. However, although many of its most visible and irritating forms declined, if only in the prosperous parts of the globe,

air pollution did not disappear entirely. The polluted air in urban areas still remained an object of criticism, concern and research.

Despite the increase in knowledge and measurements, however, the fundamental question that puzzled air pollution researchers from the early 1950s remained unanswered: how and why is urban air pollution harmful to health? Despite active measurement of various substances in the air, none seemed to explain the excess morbidity and mortality in urban environments. A turning point in this regard has been seen in the so-called Six Cities study of 1993, which revealed a correlation between mortality and the number of small particles in the air.[693] This discovery, and similar studies that followed, caused significant changes to governmental regulations as both the U.S. Environmental Protection Agency and the WHO accepted that control of particulate matter was the most efficient way to protect people from the hazards of air pollution.[694] It seems then that the toxicologist Mary Amdur was right when she suspected in the 1960s that the answer to the puzzle of the health effects of air pollution could be found in the finite particles long thought to be of little consequence. Thus, the so-called particulate matter became the main focus in the attempt to clarify the air.

However, right after this discovery, a controversy arose over the results. The most obvious criticism centred on the fact that particulate matter could not be seen as a toxin, or a specific cause of disease, since it covered everything in the air that appeared in particles of sufficient size. More importantly, the significance of particulate matter to public health was questioned. This was mostly due to the relatively weak correlation shown in epidemiological studies. All in all, the uncertainties and problems associated with the discovery in 2004 were little different to those discussed after the Great Smog in London in 1952:

> The uncertainties and concerns included a lack of information on biological mechanisms, limited information on personal exposures, difficulties in disentangling effects of any single air pollutant in the mix of pollutants, and a

693 See Douglas W. Dockery, C. Arden Pope, Xiping Xu, John D. Spengler, James H. Ware, Martha E. Fay, Benjamin G. Ferris, Jr., and Frank E. Speizer. An Association between Air Pollution and Mortality in Six U.S. Cities. *New England Journal of Medicine* 1993; 329:1753–1759.

694 Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide. Report on a WHO Working Group. Bonn, Germany 13–15 January 2003.

> lack of specificity as to whether or not particle mass is a surrogate for some other particle-related factor such as size, number, or composition.[695]

In other words, the knowledge needed to clarify the air was still incomplete. What occurred was that air pollution and matters of public health garnered headlines that grew in intensity at a level not seen since the 1960s. Amidst this publicity, the particulate matter controversy also highlighted other aspects of air pollution research and control that had been central to the issue since the 1950s. The prevalence of particulate matter in urban environments was deemed to be so great that removing it would require "major unprecedented changes in our culture"[696]. As Philip Drinker noted already in the 1950s, the problem of air pollution is a problem of the ordinary rather than the exceptional.[697] Renewed focus was also brought to the link between indoor and outdoor pollution, as particulate matter is caused by various personal activities. As historian Richard Hamlin has stated, the health effects of air pollution remain a complex and contested issue, and air remains the ultimate commons. In other words, it is easy to use but hard to regulate.[698]

The particulate matter controversy and the enduring problem of air pollution supports the notion that many environmental issues are often complex societal and cultural issues that are difficult to reduce into simple facts. This argument has been made by the geographer Mike Hulme, who states that climate change, for example, it is a so-called wicked problem that cannot be solved simply through better understanding of the climate. Whilst it has been depicted as a scientific puzzle that can be solved by accumulating knowledge and reducing uncertainties, climate change is, according to Hulme, fundamentally a cultural and political problem that does not have the right solutions.[699]

In a similar way, the optimal quality of ambient air may not be a puzzle that has a right answer. This leads to a fundamental question about the relationship between environmental problems and the knowledge produced about them. Ways of knowing are always formed upon a set of ideas about what kind of knowledge is essential and

695 Robert Phalen. The Particulate Air Pollution Controversy. *Nonlinearity In Biology, Toxicology, And Medicine*, 2: 259–292, 2004. See also, Showdown Over Clean Air Science. *Science* vol. 277 25 1997; John F. Gamble. PM2.5 and Mortality in Long-term Prospective Cohort Studies: Cause-Effect or Statistical Associations? *Environmental Health Perspectives,* vol. 106, 9, 1998; James E. Enstrom, Fine Particulate Matter and Total Mortality in Cancer Prevention Study Cohort Reanalysis. *Dose-Response: An International Journal* January-March 2017:1–12.

696 See Robert Phalen, The Particulate Air Pollution Controversy. *Nonlinearity In Biology, Toxicology, And Medicine*, 2: 259–292, 2004.

697 Drinker 1957, 21.

698 Hamlin 2014, 23–30.

699 Hulme 2018, 330–335.

how it is produced. Together these ideas shape the most important part of knowing; namely, ignorance. An essential part of expert power is the ability to determine what needs to be known in order to solve a problem. As the case of the FIOH and air pollution has shown, the formulation and dissemination of these expert ways of knowing are an essential part of environmental history.

# Abbreviations

| | |
|---|---|
| Air Pollution Control Association | APCA |
| Archives of the Finnish Institute of Occupational Health | AFIOH |
| Archives of the Finnish Meteorological Institution | AFMI |
| Archives of World Health Organization | AWHO |
| Finnish Institute of Occupational Health | FIOH |
| Finnish Meteorological Institution | FMI |
| Government Council for Noise Abatement and Air Pollution Control | ISMET |
| *Helsingin Sanomat* | HS |
| Helsinki City Archives | HCA |
| *Journal of Air Pollution Control Association* | JAPCA |
| National Archives of Finland | NAF |
| United States Public Health Service | USPHS |
| World Health Organization European Office | EURO |
| World Health Organization | WHO |
| World Meteorological Organization | WMO |

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