

Environment and Health in Flanders: 40 Years of Institutional Struggle

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Environment and Health in Flanders: 40 Years of Institutional Struggle

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from Radboud University Nijmegen
on the authority of the Rector Magnificus
prof. dr. S.C.J.J. Kortmann,
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to be defended in public on Monday, July 2, 2012 at 13.30 hours
by

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Samenvatting

Milieu en Gezondheid in Vlaanderen: Een Proces van 40 Jaar Hard Labeur.

Hoewel de milieugezondheidskunde een relatief jong beleids- en onderzoeksveld is, zijn de grondslagen reeds vele decennia geleden ontstaan in de domeinen milieuhygiëne en arbeidsveiligheid. Milieuhygiëne heeft haar roots in de postindustriële revolutiejaren (19^{de} eeuw). Ten gevolge van de industrialisatie en verstedelijking, en de daarmee samenhangende epidemieën namen de bezorgdheden over de gezondheidseffecten toe. Het wetenschappelijk onderzoek en het beleid richtten zich op het bevorderen van de volksgezondheid door het verbeteren van de voedsel- en waterkwaliteit, de woonomstandigheden, een goede hygiëne, vaccinatieprogramma's en afvalberging. In de 20^{ste} eeuw gaven grote milieuproblemen veroorzaakt door menselijke activiteiten, zoals industriële en technologische activiteiten en het vervoer, aanleiding tot het bestuderen van de daaraan gerelateerde gezondheidseffecten. Arbeidsongevallen en beroepsziekten zorgden, parallel daarmee, voor een stroming vanuit de arbeidsgeneeskunde die eveneens de gezondheidseffecten ten gevolge van het gebruik van producten en stoffen bestudeerde.

De doelstelling van dit proefschrift is om het institutionaliseringsproces van het Vlaamse arrangement milieu en gezondheid historisch te reconstrueren en te analyseren. Bijzondere aandacht gaat hierbij naar de veranderingen in de ideeën over complexiteit en de impact daarvan op kennisontwikkeling en besluitvorming. Immers, de laatste twee decennia is het bewustzijn van de epistemologische en sociale complexiteit van milieugezondheidsproblemen sterk toegenomen.

De epistemologische complexiteit verwijst naar het gegeven dat mensen via verschillende kanalen worden blootgesteld aan een cocktail van lage of hoge concentraties van fysische, chemische en biologische agentia in het leefmilieu. De gezondheids- en welzijnseffecten, die vaak het gevolg zijn van een niet-lineair, multi-causaal verband, zijn vaak onzeker, komen pas tot uiting na vele jaren en zijn niet noodzakelijk gebonden in tijd en ruimte. Kenmerkend voor zulke problemen is dat de wetenschap niet tot eenduidige, onomstreden en zekere conclusies kan komen. Onzekerheid wordt m.a.w. beschouwd als een intrinsieke eigenschap van kennisverwerving. Dit soort vraagstukken kunnen niet op een positivistische wijze bestudeerd worden, maar vergen een meer integrale, interdisciplinaire en systeemaanpak met veel aandacht voor onzekerheden en veronderstellingen. De sociale complexiteit betekent dat er meerdere legitieme – maar vaak tegenstrijdige – opinies, perspectieven,

waarden, belangen en veronderstellingen zijn met betrekking tot het milieugezondheidsprobleem. Immers, bij milieugezondheidsproblemen zijn veel - en heel verschillende - actoren betrokken: burgers, het bedrijfsleven, de politiek, deskundigen, maatschappelijke- en milieuorganisaties, actiegroepen, enz. Om met dit soort van complexiteit om te gaan zijn participatieve methoden nodig die dialoog hoog in het vaandel dragen, zowel in kennisproductie- als besluitvormingsprocessen.

Drie verschuivingen kunnen in verband gebracht worden met het toenemend bewustzijn van het complexe karakter van milieugezondheidsrisico's: 1) een epistemologische verschuiving weg van het traditionele positivisme gekenmerkt door rationalisme, wetenschappelijke zekerheid en disciplinair reductionisme; 2) een toenemende behoefte aan beleidsintegratie en participatie; en 3) de organisatorische en methodologische uitdagingen voor de relatie tussen wetenschap en beleid omdat de legitimiteit van wetenschappelijke kennis in vraag gesteld wordt. Samenvattend, het complexe karakter van milieugezondheidsrisico's stelt de wetenschap, het beleid en hun onderlinge relatie voor nieuwe uitdagingen.

De epistemologische verschuiving in het denken over wetenschap en kennisverwerving kan samengevat worden in het begrip Post-Normal Science, verwijzend naar een nieuwe aanpak voor problemen die zich 'beyond normal science' bevinden en dus niet geanalyseerd kunnen worden door de klassieke disciplinaire en positivistische wetenschapsbeoefening. Postnormale wetenschapsbeoefening hecht veel belang aan kwaliteit, adequaat omgaan met en communiceren over onzekerheden en een open dialoog tussen alle betrokkenen, zowel experts uit zeer uiteenlopende disciplines als leken. Gelijkaardige, alternatieve benaderingen in de wetenschappelijke literatuur die beter moeten toelaten om complexe problemen te bestuderen zijn o.m. Transwetenschap (Trans-science) van Weinberg en Mode 2 wetenschap van Gibbons en Nowotny.

Min of meer parallel met de epistemologische discussie over kennisontwikkeling, is in de beleidsliteratuur de evolutie van government naar governance beschreven. Hiermee wordt verwezen naar de verschuiving van een sterke top-down sturing door de overheid naar een meer horizontale vorm van sturing waarbij de overheid niet de enige actor is in het besturen van de maatschappij. Governance verwijst naar sturing en besluitvorming waarin de focus ligt op diverse sturingsniveaus van lokaal tot supranational (ook multi-level governance genoemd), alsmede de grote diversiteit aan publieke en private actoren die betrokken worden bij beleid (of multi-actor governance). Een derde dimensie van governance heeft betrekking op het multi-sector

karakter van complexe vraagstukken. Toegepast op milieugezondheidsrisico's lijkt het vanzelfsprekend dat het milieugezondheidsbeleid wordt ontwikkeld door en afgestemd tussen het milieubeleid enerzijds en volksgezondheid anderzijds, maar deze problemen zijn ook gelinkt aan transport, ruimtelijke ordening, industrie en werkgelegenheid, energie, innovatie, enz. Multi-sector governance verwijst naar de integratie van milieugezondheidsdoelstellingen in alle relevante beleidsdomeinen. Een gecoördineerde aanpak moet voorkomen dat milieugezondheidsmaatregelen van het ene domein conflicteren met de maatregelen van een ander domein.

Als gevolg van de evoluties in kennisontwikkeling en besluitvorming staat ook de traditionele verhouding tussen wetenschap, politiek en maatschappij ter discussie. Immers, de waardegeladenheid van experts en het gegeven dat ze niet met een eenduidig en zeker antwoord kunnen komen op complexe problemen maakt dat hun autoriteit en hun klassieke rol van 'speaking truth to power' in het besluitvormingsproces niet langer vanzelfsprekend zijn. Bovendien komt de zogeheten 'two communities metaphor', waarbij wetenschap en politiek als twee geheel gescheiden actorgroepen met tegengestelde finaliteit en belangen, onder druk te staan. Vanuit een meer operationeel-organisatorisch perspectief heeft Gieryn het begrip grenzenwerk geïntroduceerd, duidend op de idee dat de grens tussen wetenschap en politiek niet zo scherp en éénduidig is in het geval van complexe problemen. Grenzenwerk verwijst naar de wisselwerking en interactie tussen wetenschap en beleid, wat tegelijk ook afbakening en afstemming inhoudt, waardoor gezamenlijk kennis en besluitvorming tot stand komt. Die tendens naar grenzenwerk vereist de ontwikkeling van nieuwe methodologische tools (grensobjecten) en organisatorische voorzieningen (grenzenwerkers en -organisaties). Het empirisch onderzoek m.b.t. grenzenwerk heeft geleid tot een typologie van kennis-en-beleid-arrangementen.

Vanuit een discursief institutioneel perspectief wordt, in dit proefschrift, verondersteld dat deze veranderende ideeën omtrent complexiteit belangrijke drijfveren zijn voor institutionele verandering van het Vlaamse kennis- en beleidsarrangement milieu en gezondheid. Met behulp van documentenanalyse en diepte-interviews worden de ontwikkeling en de institutionalisering van het Vlaamse arrangement historisch gereconstrueerd en geanalyseerd. Ook de internationale en Europese context is bestudeerd om een uitspraak te kunnen doen over de belangrijkste oorzaken voor institutionele continuïteit en verandering. De resultaten van het onderzoek moeten zowel een wetenschappelijke- als een beleidsmeerwaarde genereren. Vanuit wetenschappelijk oogpunt, beoogt de studie een theoretische en empirische bijdrage te leveren aan het debat over 'risk governance', toegepast op het

milieugezondheidsdomein. Tot op vandaag zijn de publicaties in dit domein vooral conceptueel van aard, terwijl het aantal diepgaande empirische studies zeer beperkt is. Zelfs al lijkt een historische analyse niet erg beleidsrelevant, en zelfs al is het Vlaamse arrangement milieu en gezondheid nog steeds in ontwikkeling, toch wordt het arrangement met behulp van een concrete set aan indicatoren onderworpen aan een beleidsrelevante evaluatie. De resultaten van de effectiviteitanalyse vormen de basis voor het formuleren van aanbevelingen om het Vlaamse kennis- en beleidsarrangement milieu en gezondheid te optimaliseren.

Op het internationale en Europese beleidsniveau wordt sinds de jaren negentachtig een pleidooi gevoerd voor een systematisch en proactief milieugezondheidsbeleid gebaseerd op het opstellen, uitvoeren en toepassen van concrete actieplannen (Nationale Actieplannen Milieu en Gezondheid). Uit de historische analyse van het Vlaamse arrangement milieu en gezondheid blijkt echter dat de impact van deze internationale en Europese verdragen en engagementen relatief beperkt is. De ontwikkeling van het Vlaamse kennis- en beleidsarrangement milieu en gezondheid werd vooral beïnvloed door de accumulatie van vier snel op elkaar volgende incidenten die voor een geleidelijke verandering zorgden in de ideeën over milieugezondheidsproblemen zowel bij de wetenschap, de politiek als de samenleving. Deze vier incidenten waren: de loodproblematiek in Hoboken ten gevolge van metallurgie-activiteiten, de cadmiumverontreiniging in de Noorderkempen veroorzaakt door zinkfabrieken, de publieke onrust aangaande mogelijke gezondheidseffecten ten gevolge van dioxine-emissies van twee huisvuilverbrandingsovens in Wilrijk, en de Belgische dioxinecrisis in de voedselketen.

De belangrijkste discursieve vernieuwing m.b.t. kennisproductie die trapsgewijs doorheen de vier casestudies tot uiting kwam, is een beter geïntegreerde en integrale benadering van milieugezondheidsproblemen, zowel op organisatorisch als op methodologisch vlak. Op organisatorisch vlak groeide het bewustzijn van de meerwaarde van inter- en zelfs transdisciplinaire onderzoeksgroepen. In een interdisciplinair onderzoeksteam worden inzichten van experts uit verschillende wetenschappelijke disciplines gecombineerd. In transdisciplinair onderzoek worden kennis en ervaring van verschillende organisaties, zowel wetenschappelijke experts als NGOs, burgers en experts uit het bedrijfsleven, geïntegreerd. Het samenbrengen van uiteenlopende visies is vooral belangrijk voor het bepalen van een goede probleemdefinitie en het beoordelen van het milieugezondheidsrisico. Ook de methode of de manier van onderzoek doen naar milieugezondheidsproblemen moet een meer integraal karakter krijgen. Zo moeten niet alleen fysische,

biologische en chemische processen in rekening gebracht worden, maar ook sociale, psychologische, economische en politieke factoren. Aangezien milieugezondheidsproblemen grens- en tijdsoverschrijdend zijn, moeten ook de temporele en ruimtelijke schalen aangepast worden, enz. Zulke aanpak wordt ook wel een 'integrale beoordeling van milieu en gezondheid' genoemd. Belangrijk hierin is dat er adequaat omgegaan wordt met onzekerheden en veronderstellingen.

De gradueel veranderende opvattingen over besluitvorming hebben betrekking op: 1) het differentiëren van milieukwaliteitsdoelstellingen i.f.v. specifieke doelgroepen; 2) een verregaande coördinatie en integratie van het milieu- en gezondheidsbeleid; 3) de participatie van belanghebbenden in het besluitvormingsproces; en 4) het uitwerken van een efficiënte en effectieve communicatiestrategie omtrent onzekere en complexe milieugezondheidsvraagstukken.

De combinatie van deze nieuwe opvattingen als gevolg van vier opeenvolgende incidenten en de intrede van Agalev in de Vlaamse Regering opende een 'window of opportunity'. Agalev kon tijdens de verkiezingen in juni 1999 immers ten volle profiteren van de publieke onrust, en slaagde erin deel uit te maken van de Vlaamse Regering van 1999 tot 2004. Agalev leverde de Vlaamse ministers voor leefmilieu en volksgezondheid. Gesteund door de Parlementaire Ad Hoc Commissie Milieu en Gezondheid, werden de toenmalige praktijken rond milieu en gezondheid grondig herzien.

Doorheen de jaren zorgden de eerder beschreven nieuwe opvattingen over milieu en gezondheid voor veranderingen in het Vlaamse kennis- en beleidsarrangement milieu en gezondheid, gekenmerkt door nieuwe actoren en organisatorische structuren (bv. het Vlaams Medisch Milieukundig Netwerk bestaande uit medisch milieukundigen, de overheidsdiensten milieu en gezondheid van de Vlaamse milieu- en gezondheidsadministratie en het Steunpunt Milieu en Gezondheid), nieuwe spelregels, wetgeving en beleidskaders (bv. Beleidsnota Risicobeheer, Vlaams decreet betreffende het preventieve gezondheidszorgbeleid, Spelregels risicocommunicatie) en nieuwe tools om de interactie en wisselwerking tussen wetenschap en beleid te verbeteren (bv. Fasenplan, milieugezondheidsindicatoren en het Vlaams Humaan Biomonitoringsprogramma). Volgens de typologie van Hoppe, evolueerde het Vlaamse arrangement van een Verlichtingsmodel en Bureaucratisch model, beide gekenmerkt door een duidelijke scheiding tussen wetenschap en politiek, naar een meer Pleitbezorgersmodel en Leermodel, die beide dialoog veronderstellen tussen wetenschap en politiek.

De prestatie-analyse toont aan dat er een intense uitwisseling en interactie plaatsvindt tussen: 1) diverse beleidsniveaus, van lokaal, regionaal tot federaal en Europees; 2) tussen de ambtenaren van de milieu- en de gezondheidsadministraties; 3) tussen wetenschap en beleid; 4) tussen experts van verschillende disciplines; en 5) tussen burgers en wetenschap/beleid. Het Vlaams Humaan Biomonitoringsprogramma van het Steunpunt Milieu en gezondheid en het lokaal netwerk van medisch milieukundigen slagen er tesamen in om potentiële milieugezondheidsproblemen snel te detecteren en te beheersen met als resultaat dat ongerustheden of incidenten niet uitmondten in een crisis.

Ondanks het goed functionerend netwerk zijn er toch concrete aanbevelingen geformuleerd om het Vlaamse kennis- en beleidsarrangement milieu en gezondheid, zowel inhoudelijk als organisatorisch, te optimaliseren in de toekomst. De inhoudelijke aanbevelingen hebben betrekking op: 1) het ontwikkelen van een geformaliseerde procedure om zorgvuldig om te gaan met onzekerheden; 2) het formuleren van specifieke milieugezondheidsdoelstellingen en de integratie van deze doelstellingen in alle relevante beleidsdomeinen (en niet enkel in de beleidsdomeinen milieu en volksgezondheid); 3) het optimaliseren en versterken van het fasenplan als tool om de interactie tussen wetenschap en beleid te verzekeren; 4) het optimaliseren en operationaliseren van het beleidskader voor het omgaan met onzekere risico's; en 5) het onderzoek en debat heropenen naar het bepalen van "goede" milieugezondheidsindicatoren. De suggesties voor het optimaliseren van het organisatorisch kader hebben betrekking op het ontwikkelen van strategieën om participatie tijdens kennisontwikkeling en besluitvorming te bevorderen en het zoeken naar bijkomende mechanismen om het innovatieve karakter van het Steunpunt Milieu en Gezondheid te faciliteren en te verzekeren in de toekomst.

Tot slot, het Vlaamse kennis- en beleidsarrangement milieu en gezondheid institutionaliseerde langzaam aan, maar zeer vergaand, en groeide uit tot een relatief stabiele en succesvolle institutie. De kracht zit vooral in de intense, maar niet altijd vanzelfsprekende, interactie tussen wetenschap, beleid en samenleving. De kans dat dit goed functionerend en succesvol arrangement zal de-institutionaliseren lijkt eerder klein. In tegendeel, het arrangement is nog steeds in ontwikkeling en moet ook in de toekomst vernieuwend blijven door in te spelen op nieuwe inzichten en ervaringen. De milieugezondheidskunde is immers een snel evoluerend onderzoeks- en beleidsdomein.

Summary

The main objective of this thesis is to reconstruct and analyse the dynamic emergence and the institutionalization of the Flemish environmental health arrangement. More precisely, the impact of new discourses on environmental health and changing thoughts regarding complexity on the institutionalization process is investigated.

Complexity reveals at two levels. Complexity at the level of variables refers to its multi-dimensional character (its embeddedness in a broader physical, social, economic and political context), multi-causality (multiple sources, agents, pathways, exposures, health effects), non-linear behaviours, long delay periods between cause and effect, cross-bordering time and scale, and the unclear sense of all consequences and/or the cumulative impact of collective action. As a consequence, complex problems are intrinsically clouded with uncertainties and imperfect understanding. Second, environmental health problems are complex at the societal level. After all, these problems are interwoven with moral, financial, economic, environmental, socio-cultural, and socio-political norms and values, resulting in a plurality of legitimate – often conflicting and controversial – perspectives. These two key features of complexity – radical uncertainty and a plurality of legitimate perspectives – induce challenges for science, politics, and the science-policy interface. As such, complexity goes parallel with three related shifts:

- 1) beyond the modern positivistic epistemology, characterized by rationality, full knowability and disciplinary reductionism towards Post-Normal Science and co-production of knowledge;
- 2) from traditional, sectoral policy arrangements and levels within government towards multi-actor and multi-sector governance; and
- 3) towards new types of boundary arrangements at the science-policy interface, reconsidering the role of knowledge, as science is no longer the unquestioned source of legitimacy for policy arguments.

From a discursive institutional perspective, the assumption is that new and changing discourses are the driving forces behind institutional dynamics, challenging the development of novel organizational facilities and methodological tools, within the (scientific) knowledge-production as well as the (political) decision-making processes. In order to study the impact of the newly emerging discourses about environmental health and complexity on the institutionalization process of the Flemish environmental health arrangement, a historical analysis was performed, which covered a forty years period, from

the Nineteen Seventies until the first decade of the twenty-first century. The developments within the Flemish environmental health arrangement are studied against the background of the international and European context in order to determine the strongest triggers and drivers for institutional change and continuity. Data were gathered, analysed and interpreted according to a qualitative approach, and using a triangulation of methods (document analysis, in-depth interviews and participated observation) to get a detailed and balanced picture of this institutionalization process.

Although, a historical analysis is in most cases not associated with policy oriented research, and the institutionalization process of the Flemish environmental health arrangement is still on its way, an attempt was made to evaluate the performance of the arrangement. Based on a non-exhaustive list of indicators, concrete recommendations were formulated to optimize the content as well as the organizational structures of the Flemish environmental health arrangement.

The following paragraphs present the main conclusions of this thesis.

The establishment of the Flemish environmental health arrangement is characterized by a process of gradual, but eventually far-reaching institutional transformation. The impact of the top-down approach, characterized by a more systematic, proactive, forward-thinking, and realistic environmental health policy and planning approach, enforced by the European governmental level, was limited. The identified primary triggers for institutional dynamics were the gradual discursive shifts in response to four local environmental health incidents related to: 1) the metallurgic activities in Hoboken, 2) the cadmium pollution in the Northern Kempen, 3) the dioxin deposition by two waste incinerators in Wilrijk near Antwerp, and 4) the Belgian dioxin crisis in the food chain. More precisely, the series of environmental health incidents gradually shifted the discourses of Flemish politicians, scientists, and the population in general, about environmental health risks and uncertainties. This epistemological shift, in turn, led to new scientific organizational and methodological challenges, on the one hand, and changing discourses about the environmental health policy arrangement and the science-policy-society interface, on the other.

Related to the (scientific) knowledge-production, an increased need was determined: 1) to manage uncertainties appropriately, 2) to extend the research team with several scientific disciplines as well as non-scientific forms of expertise, and 3) to shift the research focus from mortality and severe health effects to moderated health effects and negative effects on well-being. To summarize, these discourses altogether require a more integrated approach

of the knowledge-production process, at the organizational (interdisciplinary and trans-disciplinary research teams) as well as methodological (integrated risk assessment) level.

The observed key discursive governmental changes reflect: 1) the need to differentiate various target groups when establishing environmental quality standards, as one realized that some societal groups are more vulnerable; 2) the need to better coordinate and even integrate the environmental and public health policy (multi-sector governance or policy integration); 3) the need to increase stakeholders' participation in order to take into account all types of knowledge, perceptions, values, etc. in the decision-making process (multi-actor governance); and 4) the need to develop efficient and effective communication strategies in response to scientific uncertainty.

These gradually changing epistemological and governmental discourses caused by the accumulation of incidents within a short time period, shortly followed by elections that enabled the Green Party to profit from public concern and ultimately join the newly formed government from 1999 until 2004, created a window of opportunity to rethink the current affairs about environmental health and to achieve institutional change. Through the years, each discursive shift transformed – to a greater or lesser extent – the Flemish environmental health arrangement into a rather stable arrangement. After all, the changing discourses gave the opportunity to new agencies and organizational structures to enter the arena (e.g., Local Environmental Health Officers, Administrative Services on Environment and Health, the interdisciplinary Flemish Centre of Expertise on Environment and Health), establishing new rules, legislation and decision-frameworks (e.g., Guidelines on Risk Communication, Decision-framework for uncertain risks, Flemish Decree on Preventive Health Policy), and developing tools and methods to ameliorate the science-policy interface (e.g., Flemish Programme on human biomonitoring, Phased Action Plan, environmental health indicators).

The institutionalization occurred across the boundaries of science and policy and the increased interaction between science, policy and society is also considered as one of its strengths. Related to the science-policy interface, the Flemish environmental health arrangement evolved from the Enlightenment and Bureaucratic Model, characterized by a strict demarcation between science and politics, towards the Advocacy Model and the Mutual Learning Model in which all stakeholders are involved.

The performance analysis has made it clear that the current Flemish environmental health arrangement succeeds in increasing the exchange of information: 1) between the local, the Flemish, the federal and European

governmental level; 2) between scientists and policymakers; 3) between environmental civil servants and public health civil servants; 4) between the general people and the experts or policymakers. Moreover, the human biomonitoring surveys, in combination with the work of the local environmental health officers, succeed in detecting potential environmental health problems quickly, thus preventing concerns or problems from evolving into crises.

Nevertheless, the analysis also provided insights into some shortcomings and recommendations to ameliorate the content and the organizational structure of the arrangement in the future. The contents' recommendations regard: 1) the development of a formalized procedure to ensure appropriate uncertainty management, 2) the integration of environmental health objectives structurally and explicitly in all relevant policy domains, 3) the optimization and strengthening of the Phased Action Plan as a boundary object, 4) the optimization of the Flemish decision framework for uncertain risks and making it operational in practice, and 5) further research and a socio-political debate about good environmental health indicators. At the organizational level, points of interest in future research relate to: 1) the strategies facilitating co-production of knowledge and multi-actor governance, and 2) mechanisms that facilitate and ensure the innovative capacity of the Flemish Centre of Expertise on Environment and Health in the long run.

List of Abbreviations

µg	Micrograms
Agalev	Flemish Green Political Party, as of 2003: Groen! In Dutch: Anders Gaan Leven
ALARA	As Low as Reasonably Achievable
AMINAL	Administration of Environment, Nature, Land & Watermanagement In Dutch: Administratie Milieu, Natuur, Land- en Waterbeheer
ARAB	General Regulation of Labour Protection In Dutch: Algemeen Reglement op de Arbeidsbescherming
AROL	Administration for Planning and the Environment In Dutch: Administratie voor Ruimtelijke Ordening en Leefmilieu
BBL	Federation for a Better Environment In Dutch: Bond Beter Leefmilieu
BEF	Belgian Francs
BONK	Exposure study regarding heavy metals in Northern Kempen In Dutch: Blootstellingsonderzoek Noorderkempen
BS	The Belgian Official Journal In Dutch: Belgisch Staatsblad
Cadmibel	Cadmium in Belgium, a scientific research project
Cd	Cadmium
CEHAPE	Children's Environment and Health Action Plan for Europe
DABM	Flemish Decree on Environmental Policy In Dutch: Decreet Algemene Bepalingen Milieubeleid
DALYs	Disability Adjusted Life Years
DDE	Dichlorodiphenyldichloroethylene
DG	Directorate-General
DI	Decilitre
DPSIR	Driving forces, Pressure, State, Impact, and Response
E&H	Environment and health
EAP	Environmental Action Programme
EC	European Commission
ECEH	European Centre for Environment and Health
Ecolo	Walloon Green Political Party
EEHC	European Environment and Health Committee
EFSA	European Food Safety Authority
EH	Environmental health
EHAP	European Environment and Health Action Plan
EHAPE	Environmental Health Action Plan for Europe
EHSG	Environment and Health Steering Group
EU	European Union
FLEHS	Flemish Environment and Health Survey
FP	Framework Programme
FWO	Research Foundation Flanders In Dutch: Fonds voor wetenschappelijk Onderzoek Vlaanderen

GMO	Genetically Modified Organism
HCB	Hexachlorobenzene
HEIMTSA	Health and Environment Integrated Methodology and Toolbox for Scenario Assessment
HGR	Superior Health Council In Dutch: Hoge Gezondheidsraad
HIA	Health Impact Assessment
ICRP	International Commission for Radiation Protection
IEHIA	Integrated Environmental Health Impact Assessment
IHE	National Institute for Hygiene and Epidemiology In Dutch: Nationaal Instituut voor Hygiëne en Epidemiologie, later hervormd tot het Wetenschappelijk Instituut Volksgezondheid
IHK	Waste Incinerator in Edegem
IISEH	Integrated Information System on Environment and Health
INTARESE	Integrated Assessment of Health Risks of Environmental Stressors in Europe
IRGC	International Risk Governance Council
ISVAG	Intercommunal cooperation for waste treatment In Dutch: Intercommunale voor slib- en vuilverwijdering
JICEH	Joint Inter-ministerial Conference on Environment and Health
LIN	Department of Infrastructure and Environment In Dutch: Departement Leefmilieu en Infrastructuur
LNE	Environment, Nature and Energy Department of the Flemish Government In Dutch: Departement Leefmilieu, Natuur en Energie
LOGO	Local-Regional Health Consultation and Organizations In Dutch: Lokaal Gezondheidsoverleg
MAC	Maximum Allowable Concentration
MINA	Environment and Nature In Dutch: Milieu en Natuur
MIRA	Flanders Environment Report
MMK	Local Environmental Health Officer In Dutch: Medisch Milieukundige
MRL	Maximum Residual Limit
NEHAP	National Action Plan on Health and the Environment
Ng	Nanogramme
NGO	Non-governmental organization
NIEHS	National Institute of Environmental Health Sciences
Nm ³	Meter cubed under normal pressure and temperature
OCL	Organization that supports the LOGOs (Local-Regional Health Organizations) In Dutch: Ondersteuningscel Logos
OECD	The Organisation for Economic Co-operation and Development
OVAM	Public Waste Agency for Flanders In Dutch: Openbare Vlaamse Afvalstoffen Maatschappij
PAA	Policy Arrangement Approach
Pb	Lead

PBL	Netherlands Environmental Assessment Agency In Dutch: Planbureau voor de Leefomgeving
PCB	Poly-chlorinated biphenyls
PheeCad	Public Health and Environmental Exposure to Cadmium
PIH	Provincial Institute for Hygiene of Antwerp
SCALE	Science, Children, Awareness, Legal instrument and Evaluation
SCK-CEN	Belgian Nuclear Research Centre In Dutch: Studiecentrum voor Kernenergie
SERV	Flanders Social and Economic Council In Dutch: Sociaal-Economische Raad van Vlaanderen
SO ₂	Sulfur Dioxide
SREH	Society for Research on Environment and Health
STS	Science, Technology and Society
TEQ	Toxic Equivalent
TOVO	Division of Public Health Surveillance of the Agency for Care and Health in Flanders In Dutch: Toezicht Volksgezondheid
TWOL	Environmental Scientific Research Programme In Dutch: Toegepast Wetenschappelijk Onderzoek Leefmilieu
UA	University of Antwerp
UN	United Nations
UNECE	United Nations Economic Commission for Europe
VGR	Flemish Health Council In Dutch: Vlaamse Gezondheidsraad
VIG / VIGeZ	Flemish Institute for Health Promotion In Dutch: Vlaams Instituut voor Gezondheidspromotie, hervormd tot het Vlaams Instituut voor Gezondheidspromotie en ziektepreventie (VIGeZ)
VITO	Flemish Institute for Technological Research In Dutch: Vlaams Instituut voor Technologisch Onderzoek
VLAMM	Flemish doctors for the Environment In Dutch: Vlaamse Artsen voor Milieu en Maatschappij
Vlarale	Flemish Council for the Environment In Dutch: Vlaamse Raad voor het Leefmilieu
VMM	Flemish Environment Agency In Dutch: Vlaamse Milieumaatschappij
VUB	Free University of Brussels - Dutch-speaking Free-University in the Brussels Capital Region In Dutch: Vrije Universiteit Brussel
VWZ	Flemish Agency for Water Treatment In Dutch: Vlaamse Waterzuiveringsmaatschappij
WHO	World Health Organization
WHO-Europe	World Health Organization Regional Office for Europe
WIV	Scientific Institute of Public Health In Dutch: Wetenschappelijk Instituut Volksgezondheid
WVG	Department of Welfare, Public Health and Culture In Dutch: Departement Welzijn, Volksgezondheid en Gezin

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Chapter 1: Introduction

During my masters' education in Occupational Health, Safety and Environmental Management, I was confronted with the impact of industrial activities and technological developments on the society, the environment, and public health and welfare. But my interest in this theme has aroused since becoming a young mother. After all, as most other parents, I want my children to be able to grow up healthy in a livable, peaceful, and fair environment. However, due to my educational background, I am aware of the complex and difficult relationship between technological innovation, environmental quality, and public health; I gain further knowledge on this topic from a sociological point of view.

Mobile phones present an illustrative case. The Flemish Government distributed a pamphlet which really triggered me, entitled, "Your child runs / does not run the risk of using a mobile phone - Nobody knows the truth." Let us assume that scientists will confirm within the near future that the radiation of mobile phones is significantly dangerous for children's health and development, as there is already an increased recognition of its potential environmental and public health impacts, is there a way to go back from the wireless community dream? The use of mobile phones has increased during the last decade and has become an integral part of daily life. Wireless communication technology has transformed everyday life, leading to one becoming available anytime and anywhere. Not only do children pressure their parents into giving them a mobile phone to stay in contact with their friends and to achieve social status; parents feel their children are safer having a mobile phone with them, with the assumption that parents can stay in touch with their children. If scientists will find out that the use of mobile phones does not affect human health, will this kind of communication strategy damage the credibility of the Flemish Government as an information supplier?



Illustration 1:
Pamphlet mobile phones
(Flemish Agency for Care
and Health, 2007).

At this moment, technological development outpaces knowledge development on its potential long-term health effects. Is it naïve, considering the option to hamper the release of a new technology and to postpone decision making until it is scientifically proven that there are no negative side-effects on human health, the environment, and future generations, even if this research takes many years? And how should one deal with the diverse stakeholders' opinions on this subject? Concerned citizens demand precautionous behaviour and a strong regulation, while other citizens advocate technological innovation and an increase in the quality of life.

1.1. Environmental Health as an Emerging Field

1.1.1. Setting the Agenda of Environmental Health

Over the last four decades, initiated by the Declaration of the United Nations Conference on the Human Environment in 1972 (UN, 1972), and followed by the European Conferences on Environment and Health of the World Health Organization (WHO-Europe, 1989; 1994a; 1994b; 1999; 2004a; 2004b; 2010a; 2010b), politics as well as science are increasingly dealing with environmental factors that can potentially adversely affect the health of present and future generations. However, it has taken some time to get environmental health explicitly on the political and scientific agenda; the beginnings of increased recognition that the (polluted) environment can negatively affect health can be traced back more than a century (Gochfeld & Goldstein, 1999). After all, during the post-industrial revolution years, when increasing urbanization in combination with open-air sewerage and bad sanitary fittings naturally led to concerns about the safety of food, sanitation, waste, and other aspects that influence human health, the attention for environmental hygiene arose from a public health perspective (Ryan, 2003). This evolution went largely parallel with an increased recognition that polluted workplace environments could harm employers' health and that employers should be protected. Recently published newspaper articles about the first trial on asbestos in Belgium illustrate the latter (Illustration 2)

NV ETERNIT MOET ASBESTSLACHTOFFERS 250.000 EURO AAN SCHADEVERGOEDING BETALEN

David verslaat Goliath

'Mijnwerkers krijgen stoflongen, bakkers de meelziekte en niet iedereen bij Eternit werd ziek'

'Eternit heeft uit winstbejag de wetenschap opzijgeschoven'

Eternit zelf tekent allicht beroep aan tegen de uitspraak. 'Wij blijven ervan overtuigd dat we in het verleden altijd de nodige maatregelen hebben genomen in overeenstemming met de vigerende wetgeving op basis van de toen geldende wetenschappelijke inzichten.' 'Achteraf is gebleken dat het gezondheidsrisico onderschat werd, zowel door de overheid, de medische wereld als de industrie', klonk het gisteren in een persmededeling. (me)

'Die doofpot, dat hadden ze niet mogen doen, ontkennen wat al lang bewezen was: dat je er ziek van werd. Maar daarvoor gaat niemand vervolgd worden. Grote honden bijten elkaar niet.'

Illustration 2: Headlines published in the Flemish Newspaper *De Standaard* about the first Belgian trial on asbestos.

As such, the agenda setting was caused by new experiences on the environment and health in the occupational as well as urban context, which resulted into changing thoughts and ideas - also called discourses - on environment and health. These new discourses, in turn, resulted into a rethought of the scientific and political affairs related to environmental health. The pre-existing ministries as well as the knowledge-production process needed to be revised in order to integrate two pre-existing policy domains/scientific disciplines, environment and health. However, the degree of institutionalization goes further than a mere reorganization and integration of environmental health as a research discipline and policy field at the organizational level.

At least one important aspect has also influenced the institutionalization process: the increased recognition of the complexity of the environment and health system. The environment and health system is characterized by, "a complex web of many-to-many relationships: multiple sources, multiple agents, multiple pathways and media, multiple exposures, and multiple health effects," which can transcend time axes across generations and geographic scales (Briggs, 1999). Although the environment and health system has always been complex in its nature, the attention and consciousness of it increased over the last two decades due to more powerful technologies and increased knowledge production about the known but also about the unknown (Briggs, 2008). Using the words of Martuzzi and Tickner (2004), "Although

understanding of environmental and health risks has advanced greatly, so has the complexity of the factors that can affect health.” The next section firstly elucidates the concept of complexity, focusing on the complicated non-linear variables, on the one hand, and the plurality of legitimate perspectives, disputing values, interests, and perceptions, on the other. Secondly, the next section describes the challenges related to the complex character of the environmental health system for knowledge production and decision making.

1.1.2. Complex Environmental Health System

Because environmental health problems are embedded in a broader social, financial, political, and economic context, these problems are characterized by complexity at the level of variables, on the one hand, and at the societal level, on the other. Complexity at the level of variables refers to the multi-dimensional (physical, social, economic, political) character of environmental health problems; the many different, interlinked and non-linear cause-effect relationships; the long delay periods between cause and effect; the long-term health effects due to cumulative exposure to different (low dose) agents; and the unrestrictive nature of time and/or scale (e.g., the effect on future generations) (Knol et al., 2010). As a consequence, complex problems are intrinsically clouded with partly irreducible, largely unquantifiable uncertainties, knowledge gaps, and imperfect understanding (Van der Sluijs, 2007). The societal complexity refers to the associated moral, financial, economic, environmental, socio-cultural, and socio-political values, interests and perceptions which are often conflicting and controversial but equally legitimate (Funtowicz et al., 1999). In other words, there is no unique, privileged perspective on the system among those who have an interest in the issue and a commitment to its solution (Funtowicz & Ravetz, s.d.). To summarize, the two key properties of complexity are radical uncertainty and a plurality of legitimate perspectives or stakes (Funtowicz et al., 1999).

These two key features of complexity are used by Hisschemöller and Hoppe (1996) to typify policy problems. According to their typology (Table 1), problems are labelled complex or unstructured when there is: 1) lack of certainty concerning the knowledge about the problem; and 2) lack of consensus on ethical values and relevant norms. On the contrary, a problem is structured when there is a high degree of consensus and certainty. A problem is moderately structured when one dimension scores positive and the other negative; when there is consensus about values but uncertainty about the structure of problem solving or the opposite.

Table 1: Typology of policy problems (Hisschemöller & Hoppe, 1996).

		Certainty about Relevant Knowledge	
		+	-
Consensus on Relevant Norms and Values	+	Structured Problem	Moderately Structured Problem
	-	Moderately Structured Problem	Unstructured Problem

Other synonyms of complex problems are: *wicked*, *messy*, and *systemic* problems (Hisschemöller & Hoppe, 1996; Renn, 2005). *Wicked* indicates the opposite to tame problems, referring to clusters of problems which cannot be solved in isolation from one another due to their interdependencies. As a consequence, wicked problems are clouded with scientific uncertainty about the consequences and/or the cumulative impact of collective action and socio-political and moral controversies, thus hampering one from being able to reach consensus on solutions (Turnpenny et al., 2009). *Messy problems* refer to a complex set of issues which do not yet have a well-defined form or structure. Renn (2005) prefers, in this context, the term *systemic risk*, referring to, "the embeddedness of any risk to human health and the environment in a larger context of social, financial, and economic consequences and increased interdependencies both across risks and between their various backgrounds." Klinke and Renn (2006) identified four major characteristics of systemic risks: complexity, uncertainty, ambiguity, and ripple effect. *Complexity* refers to the difficulty of identifying and quantifying cause-effect relationships due to feedback loops, long delay periods, inter-individual variation, etc. Due to this complexity, scientific knowledge is missing or imperfect and *uncertainty* arises. *Ambiguity* refers to the variability of legitimate interpretations which exists on the ground of differences in values and norms. *Ripple effects* denote the time- and space-less dimension. Systemic risks exceed the borders of regions and policy fields, and they can influence future generations.

Despite this diversity in terminology, the common characteristics of wicked, messy, unstructured, systemic, or complex problems are related to the trans-disciplinary character of those problems, indicating that they are embedded in a broader system. As a consequence, those problems are ill-defined, clouded with uncertainty, and influenced by conflicting and contradictory values.

The consequences of the complex character of the environmental health system are threefold. First, it challenges the production and organization of scientific knowledge as the traditional, modern, and positivistic epistemology

searching for the universal truth and full scientific knowledge based on linear, causal, reductionist, and analytical approaches. These approaches become too limited with regard to complexity, because there is an unclear sense of all consequences and/or the cumulative impact of a collective action (Van Asselt, 2000; Kraye von Krauss, 2005).

Second, the complex character of environmental health problems makes stakeholders' approaches simultaneously inevitable and difficult, thus posing challenges to the decision-making process. Policymakers must therefore search for more integrated and participative approaches to policy that are, "broad in scope, more inclusive in content and more collaborative in nature" (Knol et al., 2010). As such, the institutionalization process of environmental health can be linked to the more encompassing shift from government to governance, arguing for increased policy integration between different policy sectors, at different policy levels, and the involvement of stakeholders in the decision-making process.

Third, as a consequence of the scientific and political developments, the science-policy interface will have to change too; science cannot provide objective, universal, and certain truth to politicians' power and a strict separation between the function of the expert and the politician is no longer defensible. In other words, referring to the work of Habermas (1969), the Technocratic (science dominates and displaces politics) nor the Decisionist Model (politics dominates and steers science) will gain legitimate, socially accepted solutions when dealing with complex problems. Habermas describes a new pragmatic model, characterized by interdependence and mutual communication between experts and politicians. Moreover, if the traditional credibility and legitimacy of science can no longer be assumed, science can no longer be the primary provider of knowledge for the decision-making process, and other stakeholders will need to be involved as well. Consequently, the interaction between science and politics and the role of scientific knowledge in the decision-making process has been reconsidered.

A final remark, the insights into complexity and its challenges are not as recent as they would appear to be. By the early Nineteen Seventies, Weinberg (1972) recognized the limits of science and the ordinary distinction between science and policy in the field of Technology Assessment by introducing the concept Trans-science. According to Weinberg, complex issues at the interface between science and politics can be stated in scientific language, but are beyond the proficiency of science to answer and therefore, transcend science. Issues are categorized as trans-scientific if: 1) the existing scientific knowledge cannot answer the question; 2) new research cannot be carried-out

reasonably rapidly without disproportionate expense and manpower; and 3) moral and ethical judgments are involved. As a consequence, trans-science is associated with scientific uncertainty, value-laden knowledge, political pressure, and the dilemma between usability and accuracy of scientific results (Halfmann & Hoppe, s.d.). Weinberg introduced Trans-science as a challenge to the modern epistemology and recognized its scientific and political-organizational consequences, in the sense that the role of science in the decision-making process must be revisited.

To conclude, environmental health problems are intrinsically complex, characterized by irreducible uncertainties and a plurality of conflicting, legitimate perspectives. Consequently, these types of problems need a different approach or strategy to be studied and managed, contrary to simple problems (Hisschemöller et al., 1996; Funtowicz et al., 1999; Kraye von Krauss, 2005). Since Weinberg launched the concept of Trans-science, a whole literature has developed dealing with knowledge development as well as decision making in the case of complex problems. In order to comprehend, structure, and study the challenges related to complex environmental health risks more precisely, a comparable triptych is used as the outline for the literature review presented in Chapter 2. The review elucidates the challenges which go parallel with complexity:

- a shift in scientific knowledge production and organization beyond the modern positivistic epistemology;
- a shift in political decision making from a traditional, sectoral government towards governance; and
- a shift towards new interactions in the science-policy interface as science is no longer the unquestioned source of legitimacy for policy arguments.

1.2. The Dynamic Emergence of the Flemish Environmental Health Arrangement: Research Objectives and Strategy

The main objective of this thesis is to reconstruct and analyse the dynamic emergence and the institutionalization of the Flemish environmental health arrangement in order to investigate to what extent the new thoughts and discourses regarding complexity, have influenced the institutionalization process.

More precisely, the knowledge-production and policy-making processes of the Flemish environmental health arrangement are studied, determining the impact of:

- the epistemological shift from the modern, Positivistic Model towards Post-Normal Science and its related organizational and methodological challenges for knowledge development;
- the governmental shift from government to governance emphasizing the importance of integrated and participative decision making;
- the changing thoughts on the role of (scientific) knowledge in decision making and the science-policy-society interactions.

The developments within the Flemish environmental health arrangement are studied against the background of the international and European context in order to determine the strongest triggers and drivers for institutional change and continuity.

The historical analysis provides in an increased understanding of the stability and dynamism of the Flemish environmental health arrangement. The ultimate goal of this understanding is twofold. Scientifically, the results make a valuable contribution to the theoretical and empirical debate on (environmental health) risk governance when dealing with complex risks. After all, to date, the publications about environmental health risk governance are mainly conceptual of nature, whereas the empirical evaluations are rather scarce (Runhaar, Driessen & Van der Sluijs, 2009). Socially and politically, the results of the historical analysis gain insight into the level and mode of cooperation between science and policy which is necessary to successfully manage complex environmental health risks today and in the future. Based upon these insights, the performance of the current Flemish environmental health arrangement can be assessed and recommendations can be deduced to ameliorate this arrangement in the future.

The historical reconstruction of the Flemish environmental health arrangement is based on a discursive point of view. The scientific and political challenges as well as the changes at the science-policy interface are considered to be the result of discursive shifts in response to the increased recognition of complexity. The assumption of this thesis is that new and changing discourses have the potential to be the driving force behind institutional dynamics influencing the organizational practices, policy contents, financial and personal resources, etc. From a discursive perspective, Discursive Institutionalism and the Policy Arrangement Approach are selected as the appropriate analytic framework. The analytical framework and research methodology are described in more detail in Chapter 3.

1.3. Outline of the Thesis

This chapter, Chapter 1, provides a general introduction to the content, focusing on the complexity of the environment and health system, the research objectives and the research strategy of this thesis.

Chapter 2 presents a theoretical review of the scholarly literature related to the scientific and political challenges while studying and managing complex environmental health risks. More precisely, Chapter 2 deals with: 1) the shift in scientific knowledge production and organization beyond the modern positivistic epistemology; 2) the shift in political decision making from a traditional, sectoral governmental approach towards (risk) governance; and 3) changes at the interactions between the scientific and the political sphere.

Chapter 3 initially provides an account of Discursive Institutionalism and the Policy Arrangement Approach as the appropriate analytical framework. Then the qualitative methodological approach for data gathering, analysis and interpretation is accounted for. Chapter 3 concludes with a definition and demarcation of the scope of the research project and a reflection on its validity and reliability.

In Chapter 4, the international and European agenda setting of environmental health is described. The second part of Chapter 4 provides an overview of the empirical developments at the international and European level for dealing with complex environmental health risks. The most common Integrated Environmental Health Risk Assessment frameworks are presented. Related to policy developments, the Analytical Framework for Risk Governance of the IRGC and the empirical studies on environmental health risk governance arrangements are discussed.

Chapter 5, Chapter 6, and Chapter 7 reconstruct and analyse the development and dynamics of the Flemish environmental health arrangement over a period of forty years. The division in three chapters follows three consecutive phases, characterized by gradually changing discourses and knowledge about environment and health, resulting into new organizational structures, new actors, resources, and rules of the game. It must be noted, however, that this separation into three periods is not strict and evolutions may overlap different time periods.

The last chapter, Chapter 8, firstly presents conclusions regarding: 1) the strongest triggers and drivers for institutional dynamics (or the lack thereof) in the Flemish environmental health arrangement; and 2) the impact of novel discourses towards risk governance when dealing with complexity. Secondly,

an assessment of the performance of the current Flemish environmental health arrangement is elucidated. Based upon the lessons learnt from that evaluation, recommendations for the future direction of the arrangement are proposed. Chapter 8 ends with a reflection on the theoretical, analytical, and methodological limitations of the study and recommendations for future research.

Chapter 2: A Theoretical Account in Threefold

As illustrated in Chapter 1, the emergence of environmental health and its institutionalization as a new research topic and policy field are not only driven by changing discourses on environment and health, but they are also influenced by gradually changing thoughts in response to complexity on a more generic level. After all, environmental health risks are epistemological and societal complex, challenging the limited capacity of our “modern” institutions, first and foremost those of science and politics, and the science-policy interaction (Leroy, Driessen and Van Vierssen, 2010a). In order to comprehend, structure, and study these three challenges more precisely, Chapter 2 is outlined according to a comparable triptych, which the title of this chapter “A theoretical account in threefold” refers to. First, the challenges related to scientific knowledge production are elucidated. Second, the shift in political decision making from a traditional, sectoral government towards governance is clarified. Third, new forms of interaction between science, politics, and society are described; as science is no longer the unquestioned source of legitimacy for policy arguments.

Section 2.1. presents a theoretical review of the changes in scientific knowledge production when studying complex, in our case environmental health, problems. First, the section focuses on the epistemological shift from the modern, Positivistic Model towards Post-Normal Science (Section 2.1.1.). Second, the organizational challenges for knowledge development towards extended participation and co-production frameworks are highlighted to (re)-legitimize scientific knowledge and to guarantee scientific quality, accountability, and its social robustness (Section 2.1.2.). Third, the methodological challenges related to integrated risk assessment methods are conceptually described in Section 2.1.3. Their empirical developments at the international and European level are presented in Chapter 4, while the specific Flemish aspects thereof are described in Chapter 6 and Chapter 7.

Section 2.2. reviews the governmental developments when it comes to managing complex (environmental health) risks. First, the shift from government to governance is elucidated (Section 2.2.1.). This shift encompasses the cooperation between and integration of different policy fields (multi-sector governance) at different policy levels (multi-level governance), described in Section 2.2.2., and the trend towards an increased participation of stakeholders in the decision-making process, also called multi-actor governance (Section 2.2.3.). The concept of Risk Governance was introduced

by Renn (2005), implementing the core principles of governance when dealing with complex (environmental health) risk-related decision making. The theoretical and conceptual developments towards risk governance are presented in Section 2.2.4., while its empirical developments are described in the empirical Chapters 4 through 7 of this thesis.

Challenging science and politics, notably the science-policy interface, is also reconsidered. After all, in the case of complex problems, science can no longer provide objective, universal, and certain truth to the politicians' power and a strict separation between the function of the expert and the politician is no longer defensible. In other words, the traditional, indisputable borderlines and task divisions between these actors' groups are blurred. The multiple perspectives on the changing relationship between science, politics and society towards a more reflexive and participative model of interaction, taking into account all stakeholders' knowledge, opinions and experiences, are already conceptually elaborated in Section 2.1. After all, these changing perspectives have their roots in the new strategies to (re)-legitimize scientific knowledge production when studying complex problems. Section 2.3. particularly focuses on the concept of Boundary Work, introduced by Gieryn in 1983, in order to draw attention to the boundaries and transactions between science and policy to make complex problems governable.

2.1. Changes in Knowledge Production in Response to Complexity

This section presents a theoretical review of the changes in the scientific knowledge-production process when studying complexity, in this case environmental health risks, focussing on 1) the epistemological shift towards Post-Normal Science; 2) the organizational challenges related to co-production of knowledge; and 3) the methodological challenges related to integrated risk assessment.

2.1.1. Epistemological Shift in Response to Complexity

The concepts of distinction and dichotomy (i.e., as those between facts and values; science and non-science; knowledge and action; and expert and lay people), which characterize the traditional modern epistemology become too simple as science, politics, and society grow closer and more intertwined when dealing with complexity (Strand & Cañellas-Boltà, 2006). To understand the epistemological shift in response to complexity, first, the Modern (Positivist)

Model used to solve structured problems is described in more detail. Second, the revision of the Modern Model and the epistemological shift towards Post-Normal Science in case of complex problems is elucidated. Uncertainty management is elaborated in more detail because it is considered by different groups of authors as an important issue to re-legitimize the scientific knowledge-production process. This section concludes by applying the epistemological shift to the concept of risk.

- **The Modern or Positivistic Model**

Following the Enlightenment movement and its ideals of objectivity and reason, science and policy are developed as two separated institutions characterized by different norms, values, motives, missions, and ambitions. These institutions are characterized by fixed boundaries corresponding to objective facts and subjective opinions. To emphasize the distinction between science and policy, Caplan (1979) introduced the “two communities metaphor”. Whereas science is driven by its interest-free quest for truth, policy is inspired by self-interested, normative, and subjective issues. From a positivistic point of view, science claims to produce privileged and authoritative knowledge characterized as perspective-free, objective, value-free, uncontested, legitimate, independent, reliable, certain, and controllable. Non-scientific knowledge is considered as inferior. Hoppe (2005) and Van der Sluijs (2007) refer to Merton’s Communalism, Universalism, Disinterestedness, and Organized Scepticism (CUDOS) to evaluate and assess scientific practice and distinguish science from non-science (Merton, 1942). Politics however, is looking for feasible, acceptable, and short-term solutions supported by society (Leroy, 2007). As such, science distinguishes itself from politics which are concerned with values, normative questions, subjective opinions, decisions, etc.

According to enlightenment theologies, science and policy are connected in a linear way without explicit interaction. Scientists produce objective and universal knowledge about the natural world driven by curiosity, and independent from politicians’ problems, and have “to speak truth to power” (Funtowicz, 2006). Policy making, on the other hand, is “a matter of becoming informed by science and then, in a second step, to sort out diverse values and preferences in order to formulate the correct and rational policy” (Funtowicz & Strand, 2007). If and how scientific knowledge is used in the decision-making process is the responsibility of politicians. However, the conviction is that politics must be based on scientific knowledge to be effective, to gain credibility and legitimacy, and to improve the society

(European Commission, 2004a). Nevertheless, politics do not intervene in the knowledge-production process and there is no explicit interaction between science and policy other than the linear way that science informs policy (Figure 1). The assumption is that knowledge eventually infiltrates society through journals, media, etc. To conclude, the “two communities’ metaphor” is not only developed to stress the inherent and cultural differences of science and policy, but also to stress the hampered communication, interaction, and utilization of knowledge between these two spheres due to the differences in their nature.

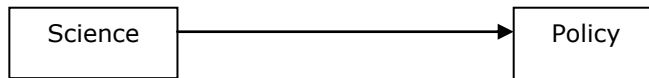


Figure 1: Science and Policy: The Strong Positivistic Model.

In a more moderate point of view, science and policy are still separate institutions characterized by their own *modus operandi*, but there is some interaction and harmony. In this context, it is assumed that politicians pose questions to scientists and those scientists, in return, inform policymakers by producing objective, valid, and reliable knowledge. In practice, it is the role of intermediaries to bridge the gap between science and policy (Figure 2). These intermediaries have to translate policy issues into research questions and have to translate scientific results into policy measures. Intermediaries – later referred to as ‘boundary people’ and ‘boundary organisations’ (Section 2.3) - connect science and policy, but also strengthen the idea of a stringent division between the two (Turnhout & Leroy, 2004).

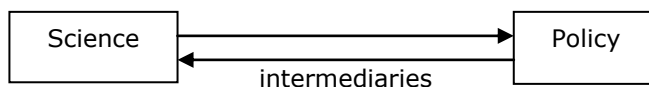


Figure 2: Science and Policy: The Modern Model.

The Modern Model is characterized by a reductionist, technocratic, and positivistic vision (Kramer von Krauss, 2005). Reductionism means that the world is understandable in terms of its component parts. “The initially complex and intermingled problems of the real day-to-day life become economic, medical, agricultural, social, safety issues and problems” (European Commission, 2004a). Technocratic refers to the vision that the world can be technically redesigned in ways that make it more efficient and controllable. In

other words, problem solving can be reduced to inserting technical solutions into different social contexts, therefore it is framed as having a significant technical inclination (Souren, Poppen, Groenewegen & Van Straalen, 2007). In a technocratic approach, science is perceived as the reducer of technical uncertainty, providing a solution to the policy problem (Souren et al., 2007). The Modern Model can also be characterized as positivistic; claiming a separation of facts and values, and viewing uncertainty as a temporary and resolvable certainty deficit.

The Modern Model assumes that: 1) the available scientific information is objective, valid, and reliable; 2) uncertainty can be eliminated or controlled; and 3) there is only one correct and complete description of the system provided by science because the system and the problem are not complex (Funtowicz, 2007; Funtowicz & Strand, 2007). These assumptions simultaneously represent the limitations of the Modern Model. The Modern Model is not useful when scientists disagree or scientists are themselves stakeholders (i.e., science is deeply involved in technology, such as nanotechnology or nuclear technology), which implies that the traditional trust can no longer be assumed (Funtowicz, 2006). The Modern Model is also limited with regard to complexity and irreducible uncertainties. After all, uncertainty is an intrinsic characteristic of complex problems which cannot be described correctly and completely because of the many cause-and-effect relationships across various dimensions. From a more philosophical point of view, the Modern Model is criticized because scientific knowledge is not objective and value-free; researchers have their own framework and mind-set.

▪ **The Modern Model Revised**

Although there are still some who imagine science as being valued independently and essentially driven by curiosity, this view now carries little credibility (Ravetz, 1999). Funtowicz (2006, 2007) revises the modern positivistic epistemology and distinguishes three accommodated conceptual models: 1) the Precautionary Model; 2) the Model of Framing; and 3) the Model of Demarcation, attempting, "to rescue the Modern Model from the problems that challenged it: scientific uncertainty, indeterminacy, multiple framings, social controversy about the underlying values, and conflict of interests" (Van der Sluijs, 2010). However, the core philosophy of the Modern Model - the assumption of perfect science and the idea that science speaks truth to the politicians' power - were unaddressed by the three accommodated models (Funtowicz, 2006).

In response to the growing realization that scientific facts are not fully certain, nor can science give a single, objective solution to the complex problems policy must address, the Precautionary Principle was launched. Because of the imperfect nature of science, an extra and normative element was added to policy decisions, namely precaution, which both protects and legitimizes decisions. The Precautionary Principle was first recognized in the *World Charter for Nature* in 1982. It was subsequently incorporated into various international conventions on the protection of the environment. For instance, Principle 15 in the *Rio Declaration* states that, "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (UN, 1992b). In other words, the lack of scientific certainty may not be used as a reason to delay political decision making. In the *Communication of the European Commission on the Precautionary Principle* (2000) it becomes clear that the normative principle of the Precautionary Model is still framed and expressed in terms of modern rationality, "Recourse to the Precautionary Principle presupposes that potentially dangerous effects deriving from a phenomenon, product or process have been identified, and that scientific evaluation does not allow the risk to be determined with sufficient certainty." As such, the Precautionary Principle is adopted when scientists have specific indications that dangerous effects exist but the scientific evidence is not yet conclusive according to the positivistic standards (usually 95% confidence interval in the case of statistical uncertainty). The Precautionary Model meets limitations when confronted with uncertainty of the type, "We do not know what kind of surprises this technology may lead to," because according to the Precautionary Principle, this type of uncertainty is considered as unscientific (Funtowicz, 2007; Funtowicz & Strand, 2007).

Due to different perspectives and values, a multitude of alternative problem framings are justifiable. However, the way in which problems are framed determines how they are studied and managed. In response to potential expert disagreement and bias in the Modern Model, the Model of Framing strives for the involvement of stakeholders and citizens in the framing process in order to assemble a diversity of viewpoints resulting from, "differences in scientific approach, different types of expertise, different institutional affiliations, or contrasting opinions over the fundamental assumptions underlying the issue" (European Commission, 2002). Because there is no conclusive scientific basis for the choice of framework, everybody has to accept that the choice is arbitrary or social and not objective. However, it is important to describe the values which have become incorporated in the framework and to make values in the experts' system explicit. The Model of

Framing is recommended when the problem being framed is one of bias in order to end partiality. However, the modern ideal of certain scientific knowledge still remains unchanged (Funtowicz, 2006, 2007).

The Demarcation Model also acknowledges expert disagreement and bias caused by the characteristics of the research institution and the research agenda of the scientist. As a consequence, scientific information and advice cannot be guaranteed as objective and neutral. Because science can be abused in a policy process, a clear demarcation between the institutions that provide science and those where it is used, is advocated to ensure that political accountability rests with policymakers and is not shifted, inappropriately, to the scientists. In other words, scientists must be protected from political interference. Nevertheless, it is important to design the right form of demarcation. When the separation is too great, science and policy can become estranged resulting in policy-irrelevant investigations.

To conclude, the Precautionary Model, the Model of Framing and the Model of Demarcation adjusted the Modern Model in order to address the epistemological challenges related to complexity – i.e., uncertain information, arbitrariness of choices, and the possibility to abuse science - without ignoring the core philosophy of Positivism (Funtowicz, 2006; 2007). Those three models are characterized respectively by: 1) the modification of policy by precaution; 2) problem framing by stakeholders; and 3) the protection of scientific knowledge production from political interference. However, according to Van der Sluijs (2007), all modifications of the Modern Model fail in the case of complex problems because the truth cannot be known. As a result, the search for innovative and radical alternatives of the Modern Model, which redefine scientific knowledge as well as governance, has been proposed, “Knowledge is not only produced by science, and governance is more than deducing action from facts and preferences” (Funtowicz and Strand, 2007). This rethought of the modern epistemology towards Post-Normal Science is described in more detail below.

▪ **Towards Post-Normal Science**

The increased awareness of complexity has been challenging the modern conception of knowledge. Society faces problems characterized by radical uncertainties, disputed values, high stakes, etc. (Ravetz, 1999), whereas traditional/Modern Sciences focus on regularity, simplicity, and certainty. As a consequence, “Science is an essential but incomplete knowledge system for many of the risks facing the world” (Rosa, 1998). These changes in our understanding of the world have triggered the complete rethinking of the

modern epistemological approach in order to (re-)legitimize knowledge in the decision-making process and to give science a new, relevant, and useful role in society within its inherent limits.

Funtowicz and Ravetz (1990, 1993) launched the concept Post-Normal Science, which goes behind the modern epistemology and disputes its core activity. Going beyond the traditional assumptions that science is certain and value-free, Post-Normal Science emphasizes the uncertainties and value loading of policy-related science when studying or analysing complex problems. Figure 3 gives a schematic overview of the relation of Post-Normal Science to the more traditional complementary strategies. The diagram has two dimensions "Systems Uncertainties" and "Decision Stakes." When both dimensions are low, the modern epistemology is effective. In the policy-relevant fields of science it is called "Applied Science." The intermediate category "Professional Consultancy" refers to professionals who must be trained in the relevant science, "but there is more to the job than just applying the science (...) the professional must always be prepared to cope with the unexpected" (Funtowicz & Ravetz, 2008). Post-Normal Science must be applied when facts are uncertain and/or disputed and decision stakes are high (Funtowicz & Strand, 2007). After all, when uncertainties and value loadings cannot be denied, routine expertise is totally inadequate, and the best professional knowledge and judgment are insufficient (Funtowicz & Ravetz, 2008).

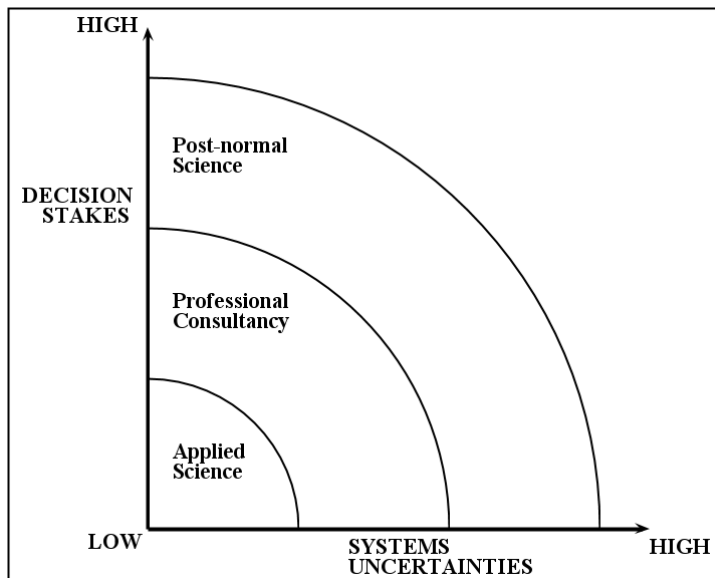


Figure 3: Post-Normal Science (Funtowicz & Ravetz, 1993).

Given the acknowledged imperfections of science, Post-Normal Science legitimizes the plurality of knowledge and emphasizes the importance of appropriate uncertainty management, in order to ensure quality of the processes as much as to the product (Funtowicz, 2006). Uncertainty management is elucidated in more detail in the next section. The acceptance of a plurality of complementary, legitimate perspectives implies extended peer communities instead of disciplinary, collegial peer review communities, which was the dominated strategy within the Modern Model (Ravetz & Funtowicz, 1999). Science is considered as just one part – the internal extension - of the review process (De Marchi & Ravetz, 1999). Stakeholders are the other part – the external extension - of the extended peer community, participating in an open dialogue on the strength and relevance of evidence (Ravetz, 1999; Funtowicz, 2006). To ameliorate the quality-assurance process, stakeholders should be allowed to criticize scientific knowledge as well as the knowledge-production process, and scientists need to be able to express their values (Funtowicz & Strand, 2007).

- **Appropriate Uncertainty Management to Legitimize Scientific Knowledge**

In literature, there is little consensus on how uncertainty should be defined, nor is there a consistent, interdisciplinary framework to address it. This reflects the complex nature of uncertainty, the different epistemic frameworks used, and the diversity of disciplines in which uncertainty is researched. The different thoughts on uncertainty are described using the two most extreme competing paradigms: Positivism and Social Constructivism. Table 2 presents a schematic overview of the ontology, epistemology, and methodology of both paradigms. Special attention is given to their different attitudes to uncertainty.

The positivistic and constructivist epistemology are the two dominant and most extreme competing paradigms. A more moderate perspective is expressed by Walker et al. (2003), who defines uncertainty as, “any deviation from the unachievable ideal of completely deterministic knowledge of the relevant system.” A similar definition of uncertainty is given by Christensen et al. (2003), “Imperfect knowledge about the individual aspects of a system as well as the overall inaccuracy of the output determined by the system.”

Table 2: Ontology, epistemology, methodology and attitude towards uncertainty of Positivism and Social Constructivism.

	Positivism	Constructivism
Ontology	<p>(Naïve) Realism³, Objectivism⁵</p> <ul style="list-style-type: none"> - Reality is real, objective and apprehendable, driven by immutable natural laws^{1,3} - Time- and context-free generalizations - External world independent of human existence⁶ - World can be known although not perfectly⁵ - Classic dichotomy facts ↔ values 	<p>Relativist³</p> <ul style="list-style-type: none"> - Reality is an intangible mental construction (local, specific, socially based, experientially based, dependent on individual/groups) - No object exists outside of our mentally state², world only exists through mind & spirit⁵ - Multiple (conflicting) realities - No separation between reality and perception⁵
Epistemology	<p>Dualist & Objectivist^{1,3}</p> <ul style="list-style-type: none"> - Clear separation between object and investigator → research with no influence in either direction³ - Positivists separate themselves from the world they study → uninvolved and detached - Science is the way to get the universal truth → replicable findings are true: “how things really are, how they really work” (facts) 	<p>Transactional & Subjectivist^{2,3}</p> <ul style="list-style-type: none"> - Object and investigator are interactively linked³, interlocked¹; their relation is indivisible² - Scientific knowledge is socially constructed and negotiated⁴ - Findings are literally created, created in interaction and value mediated^{1,3} - Production of science = social process⁴
Methodology	<p>Experimental & Manipulative³</p> <ul style="list-style-type: none"> - Verification of hypotheses → deductive reasoning, observing, measuring, empirical test¹ - Confounding conditions must be controlled - Methods are chiefly quantitative¹ - Reductionism & determinism - Systematic investigation⁴ 	<p>Hermeneutical & Dialectical³</p> <ul style="list-style-type: none"> - Interaction between investigator and respondents - Interpreted using hermeneutical techniques - Compared and contrasted through dialectical interchange³ - Aim: distill consensus construction - Social factors play a role in the direction of research, drawing of boundaries, ...⁴
Uncertainty	<ul style="list-style-type: none"> - Strong positivism: Uncertainty = unscientific - Moderate positivism: statistical conventions to reject or accept hypotheses (5% SI) 	<ul style="list-style-type: none"> - Scientific knowledge is inherently imperfect - More knowledge does not imply less uncertainty and vice versa - Reduction of uncertainty is limited⁴

¹ Krauss, 2005; ² Morris, 1999; ³ Guba & Lincoln, 1994; ⁴ Van Asselt, 2000; ⁵ Rosa, 1998

According to Walker et al. (2003), better understanding of the different dimensions of uncertainty and their implications for policy choices are likely: 1) to lead to more trust in support for scientific decisions and, ultimately, to better policy; and 2) to help identify and prioritize effective and efficient research and development activities for decision making support. Van Asselt (2000), as well as Walker et al. (2003), developed a typology of uncertainties that may be relevant and useful in the context of policy-relevant science. Both frameworks are quite similar. Van Asselt distinguishes sources and types of uncertainty which correspond to the level and location dimensions of Walker’s typology, respectively. The level or source of uncertainty refers to the degree of severity and expresses the scale of the uncertainty from perfect knowledge to irreducible ignorance (Table 3). The location or type of uncertainty identifies where uncertainty manifests itself (Table 4). Each type or location implies different levels of uncertainty.

Table 3: Sources or levels of uncertainty (Van Asselt, 2000; Walker et al., 2003).

		Van Asselt (2000)		Walker et al. (2003)	
				Determinism	Perfect knowledge
Unreliability	Inexactness	We roughly know	Statistical uncertainty	Known outcomes; Known probabilities	
	Lack of observations /measurements	We could have known			
	Practically immeasurable	We know what we do not know			
Structural or Systematic Uncertainty	Conflicting evidence	We do not know what we know	Scenario uncertainty	Known outcomes; Unknown probabilities	
	Reducible ignorance	We do not know what we do not know	Ignorance	Unknown outcomes; Unknowns Probabilities	
	Indeterminacy	We will never know			
	Irreducible ignorance	We cannot know	Total ignorance	Nothing is known	

Table 4: Types or locations of uncertainty (Van Asselt, 2000; Walker et al., 2003).

	Van Asselt (2000)	Walker et al. (2003)
Uncertainty about model completeness / adequacy	Epistemological uncertainties (Does the description relates to the real world?)	Context (problem framing)
Uncertainty about model form, structure, functional relationships	Methodological uncertainties (the degree of reliable methodologies used)	Model uncertainty (assumptions, structure)
Uncertainties in model quantities	Technical uncertainties (lack of data, poor quality or appropriateness of data, accuracy)	Input or data
		Parameter
		Model outcome

The appropriate management of uncertainties was considered as an intrinsic and key asset of a greater process of quality control within Post-Normal Science (Kramer von Krauss, 2005). Appropriate uncertainty management refers to the importance of treating all types and sources of uncertainty as a key aspect during all phases in the knowledge-production and decision-making processes. It requires a complementary use of quantitative uncertainty analyses, expressing uncertainties in probabilistic ranges and error bars, and qualitative uncertainty-analysis methods to provide transparency regarding the limits of knowledge, the underlying assumptions, frame-dependent choices, and value loadings (Craye et al., 2005). Stakeholders' participation should be used consciously in uncertainty management in order to highlight the multiple perceptions (Van Asselt, 2000). The ultimate aim of uncertainty management is, according to Van Asselt (2000), "to facilitate the search for the most robust alternative. Robust implies that the identified strategy is one that appears to trigger a favourable future, seems to avoid highly undesirable ones, and is flexible enough to be changed or reversed if new insights emerge." Good management of uncertainty shifts its focus from analysing the impact of uncertainty on the findings, to treating uncertainty as a key feature of complex problems in order to ensure the legitimacy of the knowledge-development process as well as the decision-making process.

Different management strategies were developed to deal adequately with different types and sources of uncertainties. However, it is out the scope of this research project to give a detailed overview. Good overviews are already published by Rotmans and Van Asselt (2001) and Van der Sluijs et al. (2004).

▪ **The Epistemological Shift Adopted to the Concept of Risk**

The risk debate is closely interconnected with the earlier described shift from Modern to Post-Normal Science and the broader uncertainty debate. The interpretation of the concept of risk depends on the school of thoughts. In addition to Table 2, Table 5 presents the different attitudes to risks between the most extreme competing paradigms: Positivism and Social Constructivism.

Table 5: Attitude to risks from a Positivism and Social Constructivism point of view (based on Rosa, 1998; Van Asselt, 2000).

	Positivism	Constructivism
Attitude to Risk	<ul style="list-style-type: none"> - Risk is an objective, real and measurable hazard, free of bias, ethics or sociological shaping - Objective versus perceived risk <ul style="list-style-type: none"> ▪ Objective = true, scientific calculated risk in terms of probability times consequence ▪ Perceived = subjective, valueladeness, non-scientific (lay persons) - Strict distinction between scientific risk assessment (facts) and risk management (values) 	<ul style="list-style-type: none"> - Risk is a social and cultural construction, characterized by plural but equally valid interpretations - Risks only exists when they are perceived - No distinction between risk and risk perception - No distinction between risk assessment and risk management

Due to these conflicting points of view, and recognizing the shortcomings of both risk paradigms, some scientists have been searching for new concepts and frameworks to find a compromise. Rosa (1998), for instance, developed a framework Reconstructed Realism that combines the best features of the competing paradigms. Rosa’s definition of risk is based on Ontological Realism (versus Relativism or Constructivism), “a situation or event where something of human value has been put at stake and where the outcome is uncertain.” This definition is based on the foundation that certain states of the world, which are possible and not yet predetermined, can objectively be defined as risk, independent of our perceptions and our knowledge claims. However, this definition goes beyond the rather naïve conception of an objective and calculable risk in strong positivistic thoughts for mainly two reasons: 1) it takes into account the issue of scientific uncertainty, either about probabilities or about impacts; and 2) it makes clear that conceiving and handling risks always implies a human value. Rosa’s epistemology is based on the concept of Epistemological Hierarchy, an intermediary between the epistemological continuum, ranging from Realism/Objectivism to Relativism/Subjectivism. Rosa argues that human knowledge is limited and can only approximate the

world, so it is impossible to generate perfect knowledge (in contrast with Positivism). Rosa also rejects the strong constructivist point of view that all knowledge claims are equally fallible (versus Constructivism). A hierarchy of risk judgment can be made, based on ostensible criteria (inter-subjective agreement) and repeatability. This concept restates the fundamental demands of Positivistic Science while leaving the door open to other knowledge systems as well as participatory approaches when the evidence becomes increasingly weak. As a consequence, Rosa's risk paradigm addresses debates on uncertainty management as well as the need for more participatory and reflexive risk approaches.

2.1.2. Organizational Challenges for Knowledge Production: Towards Extended Participation

The epistemological shift, as described in Section 2.1.1., goes largely parallel with the increased conscious, in different scientific fields and by different groups of authors, of more fundamental changes in the organizational context of the knowledge-production process. More precisely, an organizational shift has taken place from a disciplinary, reductionist, fragmented organization of science towards one in which science transcends disciplinary boundaries and knowledge is created in heterogeneous communities (i.e., not only scientific ones). In this section, Trans-disciplinary knowledge production and Mode 2 knowledge production are further elaborated. Both conceptualizations acknowledge the intrinsic uncertainties, the disputed values, the limited capacity of (multi-) and (inter-) disciplinary scientific knowledge production and have a common plea to extended participation in knowledge production in order to identify, formulate, and solve complex problems (Regeer & Bunders, 2007).

▪ Trans-disciplinary Knowledge Production

Trans-disciplinary knowledge development goes further than multidisciplinary and interdisciplinary research. Multidisciplinary research studies an issue, "from the perceptions of a range of disciplines but each discipline works in a self-contained manner with little cross-fertilisation among disciplines of synergy in the outcomes" (Hirsch Hadorn et al., 2008). In other words, multidisciplinary knowledge production means that one or more aspects of a subject are studied from different angles, without crossing the boundaries of each scientific disciplinary field (Van den Besselaar & Heimeriks, 2001). Interdisciplinary research emphasizes the need for interaction, migration, and collaboration of different scientific disciplines in order to integrate theoretical

concepts, methodological aspects and tools, empirical findings, etc. in a coherent way for the sake of understanding a problem and finding a solution (Hirsch Hadorn et al., 2008). However, interdisciplinary research still maintains relative autonomy and sovereignty in academic disciplines (Elzinga, 2008). Trans-disciplinary research is rooted in the idea that knowledge also exists and is produced in societal fields other than science; and knowledge is needed to respond adequately to complex problems characterized by factual uncertainties, value loads, and societal stakes (Wiesmann et al., 2008). As such, Klein et al. (2001) define trans-disciplinary as, "a new form of learning and problem solving involving cooperation among different parts of society and academia in order to meet complex challenges of society." The core idea is that different academic disciplines work together with practitioners to solve real-world problems (Klein et al., 2001). The terms: learning, problem solving, and cooperation refer to the non-linear relationship between science and policy and recognize that science alone cannot solve complex issues (Regeer & Bunders, 2007). A similar definition is given by Wiesmann et al. (2008), "Trans-disciplinary research is research that includes cooperation within the scientific community and a debate between research and the society at large. Trans-disciplinary research therefore transgresses boundaries between scientific disciplines and between science and other societal fields, and it includes deliberation about facts, practices and values."

▪ **Mode 2 Knowledge Production**

Gibbons, Nowotny and colleagues (1994) were rather empirically driven to explore and observe changes in the organization of knowledge production. Gibbons and Nowotny introduced the term Mode 2 and contrasted it with Mode 1, the latter corresponds to the Modern or Positivistic Model as described in Section 2.1.1. Mode 1 Science is characterized by investigator-initiated, disciplinary-based, and theoretically- and experimentally-driven knowledge production. Quality must be ensured by internal peer review. In contrast, Mode 2 knowledge production is characterized by: 1) context-driven or problem-focused; 2) trans-disciplinarity; 3) heterogeneous networks of knowledge production; 4) multiple and social accountability; and 5) novel forms of quality control (Nowotny et al., 2003).

The first characteristic of Mode 2 is that knowledge is generated within the context of application, in contrast to theoretical and experimentally-driven science. Mode 2 Science gives more attention to the social context within which knowledge is produced and judged (Souren, 2006). This implies that a variety of interests must be taken into account.

As a consequence, the second feature of Mode 2 refers to trans-disciplinary knowledge production, mobilizing a multi- or inter-disciplinary team of scientists in cooperation with new kinds of knowledge organizations such as consultants, market agencies, activist groups, or other stakeholder groups to join the knowledge-production process.

The third characteristic, the organizational challenge due to trans-disciplinary, describes the production of knowledge that is carried out in heterogeneous, non-hierarchical, and less firmly institutionalized consortia (Souren, 2006). Knowledge production takes place within temporary joint ventures or research communities which constantly change over time. These heterogeneous networks of knowledge production are facilitated through the modern communication technology.

The fourth feature is the shift from, "a culture of autonomy to a culture of accountability" (Nowotny, Scott & Gibbons, 2006). Mode 2 Science deals more frequently than Mode 1 Science with reflexive activities and intense dialogue processes. As a result, the traditional notions of accountability have to be radically revised, also taking into account social accountability.

The last distinction refers to the emerging of novel forms of quality control, because the traditional, discipline-based, peer review system is not sufficient anymore. Additional criteria of quality are added, incorporating a diverse range of social, economic, or political issues such as social robustness, relevance, acceptance, and social desirability (Leroy, 2007).

The dichotomy of Gibbons and Nowotny's model has evoked discussions. Leroy (2009) distinguishes three items of criticism. First, is the dichotomy considered as a historical shift, or do these two modes of knowledge production exist side-by-side? The second criticism is related to whether the indistinctness of the dichotomy must be seen as an analytical or a normative framework. The third remark is that the authors pay less attention to the macro-societal context wherein knowledge is produced. Stressing the contextualization and the societal changes taking place, Nowotny, Scott, and Gibbons published in 2001 their second book *Re-thinking Science: Knowledge and the Public in an Age of Uncertainty*. The authors distinguish three trends that have been transforming the research process: 1) the steering of research priorities; 2) the evolution to more 'engaged' research; and 3) the accountability of science, particularly regarding the assessment of its quality and effectiveness (Nowotny et al., 2003). It is in this changing context that the taxonomy Mode 2 Science emerges. Next to the increased attention given to the changing research environment and the societal context, the authors stress the idea of blurring boundaries between science, society, and policy,

“politicians and civil servants struggling to create better mechanisms to link science with innovation; researchers in professional disciplines such as management, struggling to wriggle out from under the condescension of more established, and more ‘academic’, disciplines...” (Nowotny et al., 2003). As such, Mode 2 Science can be related to the concept of Boundary Work (see Section 2.3.).

- **Conclusion: Towards Co-production of Knowledge**

Although Trans-disciplinary knowledge production and Mode 2 Science are developed from different starting points by different groups of authors, their key-features are quite similar: complex issues require extended participation and the integration of different types of knowledge and values from the scientific and the non-scientific world to ensure an integral, holistic approach and to generate socially robust knowledge (Leroy, 2007). At a more operational level, scientific criteria must be expanded to include social accountability, relevance, acceptance, applicability, contextual adequacy, and social desirability in order to facilitate consensus building, capacity building for governance, and legitimized decision making (Leroy, 2007; Regeer & Bunders, 2007; Scholz, 2010). It must be noted that the availability of potential key actors, the willing to participate in temporary heterogeneous networks, the rules of the game during the mutual learning process, and the novel forms of quality criteria are prerequisites for a successful, mutual learning process (Scholz, 2010; Nowotny et al., 2003).

In this context, Wynne (1992, 1996) uses the term “lay-knowledge” or “layman’s knowledge”, referring to contextual, situated, local, specific, experience-based knowledge, produced by non-governmental organizations, industrialists, policymakers, market agencies, activist/stakeholder groups, citizens, etc. In the case of uncertainty and controversy, Wynne (1992, 1996) acknowledges that the integration of lay, public knowledge can be useful to frame and define the analytical boundaries in socially relevant ways, to articulate uncertainty, to question the underlying values or assumptions, and to reveal inconsistencies. Interaction between citizens and experts requires new forms of participation.

Emphasizing the mutual relationship between science and society in knowledge production, Jasanoff (2004) uses the term “co-production”. Co-production refers to the idea that both, scientific knowledge and lay knowledge, are important to solve complex problems (Regeer & Bunders, 2007), implying a constructivist perspective in the sense that scientific knowledge is not necessarily truer or better than lay knowledge.

As a consequence, science, politics, and society are interwoven; knowledge development and problem solving are no longer strictly separated fields. Pielke (2010) emphasizes the importance of the institutionalization of the science-policy interface to stimulate this interaction, assuring that relevant knowledge is co-produced which is useful in the decision-making process. Examples of science-policy institutions include: government agencies, legislative committees, executive offices, non-governmental advisory groups, etc. (Pielke, 2010). It must be noted that institutionalization not only refers to the gradual sedimentation of (actors') social practices, yet also relates to expertise, funding, and others (resources), to discourses (ideas and norms), and to rules of the game (reporting requirements, public participation, and other decision rules). These four issues together correspond to the four dimensions of the Policy Arrangement Approach, as described in Section 3.1.3. Within these institutions, the traditional, modern boundaries between science, politics, and society blur. Moreover, temporary communities or networks in which different actors are unified can be established. Section 2.3. introduces the concept of Boundary Work, emphasizing the interwoven character between science, politics, and society.

2.1.3. Methodological Challenges Related to Complex Risks: Towards Integrated Risk Assessment

Taking into account the epistemological challenges and reflections in response to complexity (Section 2.1.1.) and the organizational suggestions towards co-production of knowledge (Section 2.1.2.), this section reviews the methodological challenges in order to put the epistemological and organizational shift into practice. More precisely, it describes the conceptual shift from sectoral to integrated risk assessment, aiming at presenting all relevant knowledge and values in a balanced, integrated and holistic way in order to better support the decision-making process.

During the past several decades, risk assessment has been developed as a scientific tool to tackle the uncertain consequences of human activities by summarizing, organizing, interpreting, evaluating, integrating, and presenting scientific information and evidence in order to estimate the risk, with the intention of informed decision making (Eeckley et al., 2001; Van der Sluijs, 2002). The three core components of traditional risk assessment are: 1) identification of hazards and their estimation in terms of dose-response; 2) exposure and vulnerability assessment; and 3) the estimation of the risk in terms of likelihood and severity of the consequences (Renn, 2005).

Initially, based on Positivism, risk assessment has its twin roots in mathematical theories of probability and in scientific methods for identifying causal links between adverse health effects and different types of hazardous activities. In its original form, risk assessment uses a, "chemical-by-chemical approach, focusing on a single media, a single source, and a single toxic endpoint" (WHO, 2001). Over the years, a plethora of technical risk assessment methodologies have been developed for a variety of sectors: environmental assessment, social assessment, health assessment, etc.

Related to new ways of thinking about risks, generally referred to as Constructivism here (see Table 2), the technical, probabilistic risk assessment methodology has been criticized (Renn, 1998). First, from a relativistic perspective, risk assessment could not be regarded as value free and context independent. Second, due to the underlying assumptions, probabilistic risk assessment can only provide, "aggregate data over large segments of the population and long-time duration," while each individual faces different degrees of risk (Renn, 1998).

As a consequence, since the end of the 1970s more attention has been given to risk perception and the sociological or cultural concepts of risk (e.g., Fischhoff et al., 1978; Douglas and Wildavsky, 1982). Risk perception research reveals public concerns, values, and preferences, in addition to studying the mental processing of risk information and the unique coping mechanisms that people use when dealing with uncertainties. Without going into detail, two theories, studying the factors that affect risk perception dominate the scholarly literature: the Psychometric Paradigm, and Cultural Theory. Based on a cognitive perspective, the Psychometric Paradigm, developed by Fischhoff, Slovic, Lichtenstein, Read and Combs in 1978, identifies nine dimensions that affect lay people's risk perception: dread, (in)voluntariness, controllability, lack of knowledge to those exposed, knowledge about the risk in science, the chronic or catastrophic potential, the immediacy of effect, severity of consequences, and the novelty of the risk. Based on factor analysis, Fischhoff et al. (1978) concluded that the perceived level of risk could be well explained by dread and novelty of the risks. The Cultural Theory, launched by Douglas and Wildavsky (1982) from a sociological perspective, emphasizes the impact of the cultural adherence and social learning of how people perceive and understand risks. In other words, the social context and the interaction between people, determined by the grid-group typology, will affect risk perception. The group dimension refers to whether an individual is a member of bonded social units, and how absorbing the group's activities affect on the individual. Grid refers to what degree of social context is regulated and restrictive in regard to the individuals'

behaviour (Olstedal, Moen, Klempe & Rundmo, 2004). Additional to both theories, Slovic (1993) and Wynne (1996) stress the importance of the amount of trust people have in the competence and expertise of individuals or organisations that are responsible for risk management for the understanding of risk perception. The concept of the Social Amplification of Risk tries to integrate the psychological, sociological, and cultural perspectives of risk perception (Kasperson et al., 1988). According to the framework, the social experience of risk, people's behaviour, the appropriate risk, and the communication strategy are determined by the information processes, institutional structures, social-group behaviour, and individual responses.

Social and cultural sciences enrich risk analyses by explaining the context of risk-taking situations, identifying cultural meanings, and helping to articulate other objectives of risk policies besides risk minimization, like fairness and institutional trust. Together, the psychological perspective and socio-cultural assessment of risks help to design risk communication strategies, to create a more comprehensive set of decision options, and to provide additional knowledge and normative criteria to evaluate them. Initially, the technical, psychological, and socio-cultural assessment of a risk are done separately.

Influenced by the epistemological and organizational shifts in knowledge production in response to complexity, the ambition has increased to develop risk assessment methods inclusively dealing with a variety of sectors and disciplines. After all, sectoral risk assessment is challenged by the state, and quality, of knowledge available regarding complex risks (Renn, 2005) and fails to handle these because of its too narrow and unitary approach (Briggs, 2008). Citing Krayer von Krauss (2005), "A number of different experts, each from a different discipline, may produce a number of different analyses of a complex system. While each of these analyses may be a correct partial description, they fall short of a holistic grasp of the system. Although a truly holistic grasp will always remain unachievable, policy-relevant science must strive to integrate partial views into a richer view of the whole." Moreover, risks cannot be confined to perceptions, social constructions, or technical approaches alone (Renn, 1998). Another driver to promote integrated risk assessment is the need for careful utilization of scarce resources, greater consistency and transparency, and more harmonization (Bridges, 2003) in order to increase the quality of the assessment process and its output, in the sense of coherent and consistent decision support (Süter, 2001). According to Schonwalder and Olden (2003), the consciousness that uncertainty in risk assessments can be very costly, "either in terms of unnecessarily strict regulations or in terms of health consequences, disease treatment costs, and lost productivity from underestimating or not being aware of health hazards to

humans” has increased since the Nineteen Nineties. To summarize, integrated assessment is emphasized, not only to examine the overall impacts of the combination of human health and environmental assessment studies, but also to stimulate the contribution of different disciplines within the risk assessment process, taking into account the individual, social, institutional, and cultural context (Bridges, 2003).

The meaning of integration is threefold. First, integration refers to the consideration of all relevant aspects of a problem simultaneously (Shlyakhter et al., 1995), also called holism: multiple agents; multiple contaminants; multiple exposure routes; multiple (health) endpoints; multiple receptors; multiple scales in time, space or place; and socioeconomic processes (Van Asselt, 2000). Second, integration means the combination of different knowledge domains which can contribute to the risk assessment process in order to support decision making in an interdisciplinary way (Bridges, 2003; Rotmans & Van Asselt, 1996). A third meaning of integration is the involvement of stakeholders in a participatory process (Van Asselt, 2000). Integration should extend all phases in a risk assessment process.

It must be noted that a variety of terminology is available in scientific literature, all of which refer to an interdisciplinary and participatory process of combining, structuring, interpreting, and communicating all relevant knowledge and aspects in their mutual coherence to allow a better understanding of complex phenomena and to support the decision-making process (Rotmans, 1999; Rotmans & Van Asselt, 2002). They all imply that the whole of integrated assessment should have added value compared to single disciplinary assessments (Van der Sluijs, 2002). Some examples of such terminology are: Integrated Assessment, Integrated Risk Assessment, Integrated Environmental Assessment, and Sustainability Assessment.

2.1.4. Changes in Science in Response to Complexity: Conclusions

Although knowledge production in the case of complex problems is challenged at different levels – epistemological, organizational and methodological – the key features are, “societal participation, mutual learning, and opening up pre-existing organizational and institutional boundaries” to ensure a more responsible, more legitimate, and more effective jointly produced knowledge outcome (Leroy, Driessen & Van Vierssen, 2010b). From the epistemological point of view, “Science would have to relinquish its modernistic claims to truth, and along with them its monopolistic presumptions. Scientific processes must

be opened up, allowing insight into their workings and made transparent; scientists and their organizations must be made to bear social and political responsibility; the scientific system must be more closely bound to other subsystems of civil society” (Leroy et al., 2010a). As a consequence, epistemological procedures are required, emphasizing the importance of uncertainty management and additional criteria of quality assurance such as social robustness and relevance. That, in turn, implies co-production of knowledge at the organizational level, referring to the creation of knowledge in a process characterized by joint, mutual learning including all relevant actors (non-governmental organizations, industrialists, activists groups, citizens, etc.). At the methodological level, a shift towards integrated risk assessment is determined in order to present the outcome of the knowledge-production process (i.e., all types of knowledge as well as values and norms) in an integrated, holistic, balanced, and transparent way to support the decision-making process.

2.2. Policy Developments in Response to Complexity

Although they unfolded in quite different scientific domains, the epistemological debate on complexity and its organizational and methodological challenges, as described in Section 2.1., occurred parallel to a debate about governance. Whereas the former unfolded primarily around science, technology, society (STS) and related disciplines, the second regards social and political sciences, public administration, and such. This section reviews the new concepts and theories that have been elaborated regarding the steering and management of contemporary society in general and complex issues, in this case environmental health problems, in particular.

In brief, the literature supposes a shift from government to governance (Section 2.2.1.), referring to the limited capacity of a central-steering government, on the one hand, and the voluntarism of both market and civil society representatives, on the other. This broader shift encompasses three important evolutions: 1) an increased demand for cooperation between and even integration of different policy sectors (Multi-sector governance); 2) a similar demand for exchange and cooperation between different levels of policy making (Multi-level governance); and 3) an increased appeal for participatory approaches in the decision-making process (Multi-actor governance).

Because the empirical analysis mainly focuses on the institutionalization of the Flemish environmental health arrangement, most attention is given to the elucidation of multi-sector governance (Section 2.2.2.) and multi-actor governance (Section 2.2.3.). The trend towards multi-level governance is less important for this research. Combining the epistemological changes related to the concept of (complex) risks and the shifts in governance in order to manage them, Renn (2005) introduced the concept Risk Governance which is elaborated on in Section 2.2.4.

2.2.1. From Government to Governance

Since the late Nineteen Seventies, the scholarly literature has described the limited central role and steering capacity of governments. Scharpf (1978) emphasizes the need to increase cooperation between governments and other institutions and organizations. Citing Scharpf, "It is unlikely, if not impossible, that public policy of any significance could result from the choice process of any single unified actor. Policy formation and policy implementation are inevitably the result of interactions among a plurality of separate actors with separate interests, goals and strategies." The transformation of traditional, state-based government to governance, characterized by the cooperation of different governmental and non-governmental actors at various levels of policy making, was driven by technological change, internationalization, Europeanization, and modernization in response to complex social life risks (Van Kersbergen & Van Waarden, 2001). As a consequence of these drivers, the (perceived) effectiveness of a central government is questioned and the plea for more direct democracy has increased (Runhaar et al., 2009).

During the last two decades, governance has received increased attention in a variety of scientific disciplines, including: political science, law, sociology, public and business administration, etc. resulting in various meanings and conceptualizations. In their literature review, Van Kersbergen and Van Waarden (2001, 2004) distinguish good governance, global governance, bottom-up self-governance, economic governance, corporate governance, new public management, network governance, and multi-level governance. Van Bommel (2008) and Hajer and Wagenaar (2003) also added public-private partnerships, multi-actor governance, deliberative governance, and social-political governance. Despite various understandings, Van Kersbergen and Van Waarden (2004) identify two commonalities: 1) all meanings discuss shifts in governance as a response to the decreased ability of central governments to regulate society; 2) all conceptualizations have a common concern about accountability, responsibility, and legitimacy.

In response to the first commonality, the different authors describe and analyse one of more crucial shifts in governance. In general, a shift in governance refers to a new range of practices that has emerged, "between institutional layers of the state and between state institutions and societal organizations" (Hajer & Wagenaar, 2003). As such, shifts in governance can occur in two dimensions: vertically and horizontally. Multi-level governance captures the upward vertical shifts from national to international institutions (internationalization and Europeanization) and the downward vertical shift from (inter)national to regional and local levels (decentralization). In other words, multi-level governance defines the political arena, which ranges from the local to the global level (Renn, 2008a). Multi-actor governance refers to the horizontal shift in governance. Multi-actor governance includes all relevant actors within a community, region, nation, or continent in the decision-making process (Section 2.2.3.). This transformation implies a shift from public to semi-public or to private forms of governance, as well as a shift from government to business (Van Kersbergen & Van Waarden, 2001). Referring to Van der Zouwen (2006), "Policy processes and interactions between actors are increasingly located outside the classical institutions of the nation state and inside informal settings, and more ad-hoc and temporary." Multi-sector governance refers to the horizontal integration between different policy sectors (Section 2.2.2). In other words, since complex problems tend to transcend traditional policy borders, the convergence and the coordination between different policy fields are necessary in order to manage these problems. Finally, there are various kinds of mixed vertical-horizontal shifts resulting in complicated networks encompassing supra-national, national, and sub-national actors in private, semi-private, and public spheres (Van Kersbergen & Van Waarden, 2004).

The second commonality is related to accountability and legitimacy. After all, the earlier described shifts in governance create common responsibilities of agencies from two or three sub-spheres of state, market, and civil society but initially exist in an institutional void, "There are no pre-given rules that determine who is responsible, who has authority over whom, what sort of accountability is to be expected" (Hajer & Wagenaar, 2003). Accountability refers to the system of checks and balances to control the exercise of power in order to prevent abuse and to protect citizens against powerful actors and organizations (Van Kersbergen & Van Waarden, 2001; 2004). Legitimacy is defined by Schmitter (2001, In: Van Kersbergen & Van Waarden, 2001) as, "a shared expectation among actors in an arrangement of asymmetric power, such that the actions of those who rule are accepted voluntarily by those who are ruled because the latter are convinced that the actions of the former

conform to pre-established norms. Put simply, legitimacy converts power into authority.” New principles of accountability and legitimacy must be developed because the traditional checks and balances are less effective, or even obsolete, when shifts in governance occur.

Soer and colleagues (2009) illustrate that these shifts in governance also affect the environmental health policy domain. As will be elucidated in more detail in Section 4.2.2., Soer and colleagues recognize a shift to more participative approaches taking into account different stakeholders (multi-actor governance) and an increased integration of environmental health objectives in other policy sectors (multi-sector governance). According to Arts and Leroy (2006), it even seems that the environmental (health) domain has been and still is the laboratory of institutional innovations, such as common responsibility, stakeholder involvement, etc.

2.2.2. Multi-Sector Governance: Towards Policy Integration

Complex environmental health problems are unprecedented in their rates and scope and do not respect the traditional segmented policy-making structure (Briggs, 2008). This fragmented construction, characterized by central steering, autonomous policy developments for specific domains and a hierarchical set of relations at multiple levels of government (Geerlings & Stead, 2003), was set up to ensure greater focus, specialization, and efficiency in government operations. By definition, it is obvious that environmental health problems transcend the sectoral environment and public health policy fields. However, to realize environmental health objectives efficiently and effectively, these objectives must also be integrated in non-environmental and non-public health policy domains. After all, a wide variety of sectoral policies influence whether environmental health objectives are achieved, such as energy, transportation, agriculture, and the economy. Coordination between all relevant policy fields is crucial to ensure complementary and coherent policies, rather than single conflicting measures.

Consequently, policy integration is proposed from a normative as well as a rational point of view (Persson, 2004). From a normative point of view, integration includes the prioritization of the objectives of one policy field over the objectives of other policy fields (Bauer & Rametsteiner, 2007), or it ensures that the objectives of one policy area get higher priority in other sectors’ policy-making processes (Persson, 2004). Related to environmental health in particular, policy integration is recognized as a normative principle to

achieve sustainable development, to protect public health and to prevent environmental damage. For instance, related to environmental health, the transport policy field must take into account environmental health objectives. After all, the transport sector is responsible for various types of pollution (e.g., air and noise) which have adverse effects on public health including cardiovascular diseases and respiratory diseases (Stead, 2008). In recognition of these strong links between transport and environment and health policy, integrated policies are required. Taking a more extreme position, environmental health objectives should outweigh sectoral policy objectives, such as economic and technological progress. For instance, is it socially acceptable to invest blindly in wireless communication technology, nanotechnology, or genetically modified food although they have some potential – although not currently scientifically proven – environmental and public health impacts?

From a rational point of view, integration provides efficiency, effectiveness, an optimal use of public resources, and coherence in the decision-making process and its output by removing contradictions, reducing energy spent on defending territories, and realizing mutual benefits and solutions (European Environmental Agency, 2005a). The increased number of actors involved in the process makes policy integration increasingly more difficult, but they also make it more compelling to achieve (Geerlings & Stead, 2003).

Multi-sector governance refers to the horizontal integration of objectives between different policy fields. As a consequence, in this thesis, multi-sector governance and policy integration are considered to be synonyms. The next sections focus on the definition of policy integration and the strategies used to realize integrated policy-making or multi-sector governance.

▪ **Definition of Policy Integration**

In public policy and public administration literature, multiple interpretations are given to the concept of policy integration. A variety of other terms are used in relation with or as synonyms for policy integration, such as: policy coordination, policy consistency, policy coherence, cross-cutting policy-making, joined-up government, holistic government, etc. (Meijers & Stead, 2004).

Meijers and Stead (2004) define policy integration as, “the management of cross-cutting issues in policy making that transcend the boundaries of established policy fields, and which do not correspond to the institutional responsibilities of individual departments.” Policy integration is seen as the

development of a joint new policy related to existing policy fields. Other conceptualizations of policy integration found in literature are: 1) the incorporation of the concerns of one policy area into another; and 2) the process and output of linking and coordinating actors and organizations across sector boundaries (Bauer & Rametsteiner, 2007). These different conceptualizations of integration demonstrate that an integration process can occur at different levels and that integration can mean both unifying several parts into a (new) whole or incorporating one into a larger (existing) unit (Persson, 2004). Figure 4 gives a schematic overview of these pluralistic conceptualizations of integration.

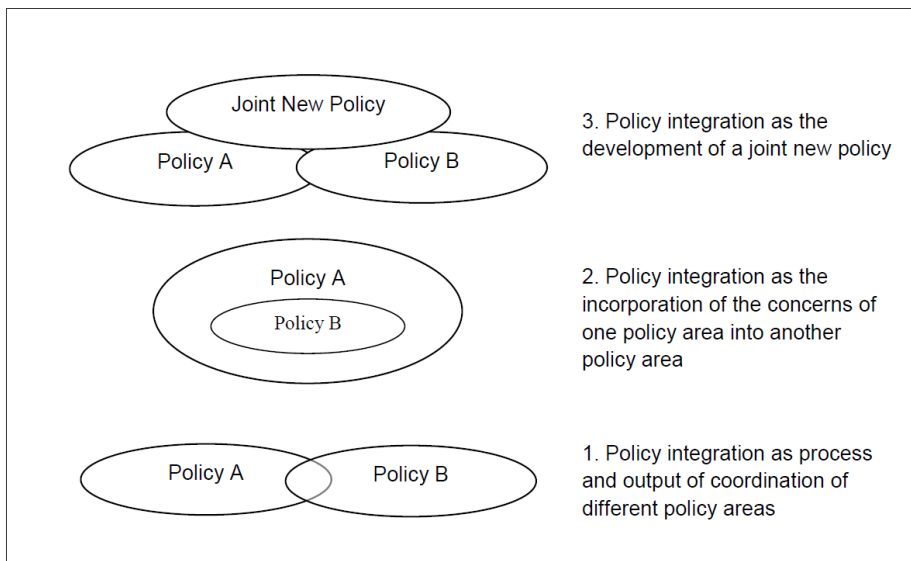


Figure 4: Three understandings of policy integration (Bauer & Rametsteiner, 2007).

The idea of a joint, new policy distinguishes integration from coordination and co-operation (Figure 5). The latter is less far reaching on interaction, interdependency, compatibility, and accessibility (Meijers & Stead, 2004). Policy cooperation simply implies dialogue and information exchange to realize more efficient sectoral policies and to avoid gaps in services. Policy coordination implies a more formal cooperation, transparency, increased interdependency, and some attempt to avoid policy conflicts by adjusting actions in order to create a greater coherence and to ensure consistency between various aspects of a single policy (Bauer & Rametsteiner, 2007). Policy integration results in one joint policy for the sectors involved. According to Bauer and Rametsteiner (2007), co-operation and coordination are part of the processes of policy integration.

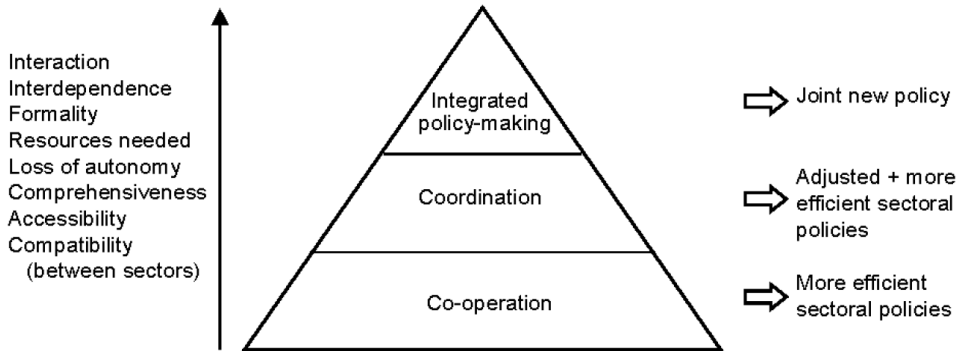


Figure 5: Integrated policy-making, policy co-ordination, and co-operation (Meijers & Stead, 2004).

Moreover, Bauer and Rametsteiner (2007), inspired by Metcalfe (1994), go a step further by distinguishing an eight-level scale to determine the degree of policy integration ranging from independent decision making to establishing and achieving common government priorities (Table 6).

Table 6: The Metcalfe Scale of coordination (Bauer & Rametsteiner, 2007).

1	Independence
2	Communication
3	Consultation
4	Avoiding divergence in policy
5	Seeking consensus
6	Conciliation – mediation
7	Limiting autonomy
8	Establishing and achieving common priorities

Meijers and Stead (2004), as well as Persson (2004) identify three requirements for policies to be qualified as integrated: comprehensiveness, aggregation and consistency. Comprehensiveness recognizes the broader scope of the input stage in terms of time, scale, actors, and issues. Aggregation refers to an overall evaluation of policy measures from different perspectives. Consistency implies that all components of the policy issue are in agreement across different policy levels (vertical dimension) and all

government agencies at a certain level (horizontal dimension). This refers to the difference between horizontal and vertical integration (Geerlings & Stead, 2003; Persson, 2004). Vertical policy integration is integration between different levels of government (i.e., local, regional, national, European, and international level) or between different stages in a policy process (from policy goal to the evaluation of measures). As such, vertical policy integration comes close to what is meant by multi-level governance. Horizontal integration is integration between different sectors or policy fields, also called multi-sector governance. Bauer and Rametsteiner (2007) conclude that horizontal and vertical policy integration are mutually dependent, "horizontal policy integration cannot become successful if it only occurs on the nation state level but is not implemented by subordinated levels and agencies."

- **Realizing Integrated Policy Making**

The integration process is complex and the strategy to realize a certain level of policy integration depends on a large variety of factors. This section reviews the strategies, the underlying factors, the barriers, and the facilitators that govern policy integration processes.

In scholarly literature, different strategies for the achievement of policy integration are listed. Persson (2004) distinguishes two complementary approaches: the toolbox approach and the policy reformation approach. The former involves the implementation of concrete measures in the short to medium-term, while the latter requires a long-term strategy to fundamentally change government structures. The European Environmental Agency (2005a) identifies two approaches to ensure environmental policy integration at the administration level. A top-down approach assumes that interventions at the highest levels in government, included in legislation, rules, or commitments will trickle down and generate strong incentives to influence daily internal practices and cultures of organizations. Examples of top-down actions include the introduction of strategic departments to coordinate activities, regular planning and exercises. Bottom-up approaches refer to informal communication, in-house-training, and personal guidance to encourage, guide, and support individuals. Persuaded by the values of policy integration, individuals can influence higher hierarchical levels. A concrete example of bottom-up action is the introduction of suitable management regimes within individual departments and the coordination mechanisms between departments. Both approaches have their strengths and weaknesses, but together they can ensure a gradual process of change towards policy integration.

The success of the policy integration process is critically influenced by a large variety of factors: organizational, behavioural or individual, political, economic or financial, process-related or instrumental, and contextual factors (Geerlings and Stead, 2003). Persson (2004) selected three categories to describe in more detail: normative, organizational, and procedural factors. Normative factors which influence policy integration are political commitment (national strategies, action programs, and framework strategies), administrative culture and policy tradition. Organizational or institutional factors include: resource allocation, government architecture (the possibility to restructure/reorient existing departments or develop cross-governmental structures), interaction with stakeholders, coordination, and communication mechanisms. Procedural factors include: mechanisms, tools, and rules for decision making.

It must be noted that frameworks for evaluating progress with policy integration or criteria for assessing policy integration are also available in scholarly literature (for instance, Persson, 2004; European Environmental Agency, 2005b). These issues are not further elaborated because neither the level of integration nor the level of institutional change caused by merging policy sectors are analysed in the empirical chapters.

2.2.3. Multi-Actor Governance: Towards Stakeholders' Participation in the Decision-Making Process

Multi-actor governance refers to the increased participation of all relevant stakeholders, including the interaction between governmental and non-governmental actors, in network-like structures during the decision-making process. This transformation implies a shift from hierarchical top-down decision making by a central-steering government in classical state institutions, to a mode of steering characterized by bottom-up facilitation of horizontal cooperation involving all actors who have a particular interest in the decision in more decentralized, informal, temporary, and ad-hoc settings (Van der Zouwen, 2006; Van Bommel, 2008). A non-exhaustive list of possible stakeholders involved in environmental health problems are: industry associations, trade unions, employers' organisations, academic and research institutions, the media, non-governmental organizations, and local citizens.

Stakeholders' participation in the decision-making process can be organized in many different ways depending on the reason of participation, the subject of participation, the number of stakeholders that must be involved, and the desired level of participation (Hage & Leroy, 2007).

A first distinction is made between direct and indirect participation (Bachus, 2005). Direct participation means that every individual has the opportunity to participate. With respect for the environmental health policy field, this can imply major practical problems when all affected citizens would want to be involved. Indirect participation refers to the participation through representation, for instance NGOs or trade unions.

Another distinction is made between formal and informal (e.g., lobbying) participation. In a democratic regime, preference is given to formal participation because informal participation does not guarantee being considered, and it seldom represents all societal groups (Bachus, 2005).

A third typology distinguishes input and output participation (Bachus, 2005), "Input participation is the extent to which organisations are admitted to take part in policy and governance processes and allowed to express their opinion. Output participation is the degree to which the participation process allows stakeholders to actually change the output and outcome of the processes they are participating in."

Similar typologies are presented by Pellizzoni (2001) and Van Asselt and Rijkens-Klomp (2002). Pellizzoni's typology (Table 7) is based on two dimensions: the purpose of participation, referring to deliberation- or decision-oriented, and the top-down or bottom-up agenda setting. For instance, participation by referenda is an example of a decision-oriented, top-down approach, while consensus conferences can be used in case of discussion-oriented, bottom-up approaches. The typology of Van Asselt and Rijkens-Klomp (Table 8) categorizes the available participatory methods according to the desired output of the participation process (mapping out diversity versus reaching consensus) and the motivation for participation (process as a goal versus process as a means).

Table 7: Typology of participatory decision making according to Pellizzoni (2001; In: Turnhout & Leroy, 2004).

	Top Down	Bottom Up
Discussion Oriented	e.g., citizen advisory committees	e.g., consensus conferences
Decision Oriented	e.g., referenda	e.g., citizen bills

Table 8: Typology of participation according to Van Asselt & Rijkens-Klomp (2002; In: Turnhout & Leroy, 2004).

	Consensus	Mapping out Diversity
Process as End	e.g., participatory planning	
Process as Means	e.g., citizen’s juries, consensus conferences	e.g., focus groups, scenario analyses, policy exercises, participatory modeling

2.2.4. Risk Governance

The conceptual debate on risk governance tries to apply the core principles of governance in the context of complex, risk-related decision making (Renn, 2005). As such, the debate on risk governance captures the two earlier described shifts: the epistemological shift rethinking knowledge, knowledge production, and knowledge organization in the case of complex and uncertain risks, on the one hand, and the shifts in governance, on the other.

Before turning to risk governance in more detail, it must be noted that Renn developed his conceptual ideas initially on the environmental health domain, emphasizing the idea that the environmental health field has been and still is the laboratory of conceptual and institutional innovations. As pointed out in Chapter 1, the debate on environmental health risk governance thus far is mainly conceptual of nature. Therefore, Chapter 4 till 7 envisage an empirical contribution to this debate.

The International Risk Governance Council (IRGC) defines risk governance as, “applying the principles of good governance to the identification, assessment, management and communication of risks in a broad sense (...) Risk governance includes the totality of actors, rules, conventions, processes and mechanisms and is concerned with how relevant risk information is collected, analysed and communicated, and how management decisions are taken.” (IRGC, s.d.). As a consequence, risk governance includes the three conventionally recognized elements of risk analysis (i.e., risk assessment, risk management, and risk communication) but also requires the consideration of the legal, institutional, social, and economic contexts, as well as stakeholders’ involvement in both assessment and management (Renn, 2008b). As such, risk governance incorporates criteria like accountability, participation, and transparency within the procedures of risk analysis.

Referring to the described risk paradigms in Section 2.1.1., Renn's concept of risk governance is based on a more moderated perspective between Positivism and Subjectivism, trying to avoid, "the naïve realism of risk as a purely objective category as well as the relativistic perspective of making all risk judgments subjective reflections of power and interests," by taking into account both the physical and social dimensions of risk (Renn, 2008a/b). From this perspective, technologic and scientific factors must be extended to public values, concerns, and perceptions of risk in order to assess, characterize, evaluate, and manage risks (Renn, 2008b). The surplus value of considering the social dimensions is that divergent views and experiences about the tolerance of the uncertainty level, the long term impacts, and the inequity will be included in all phases of the risk governance process (Renn, 2008b). As a consequence, risk governance not only includes multifaceted and multi-actor processes but also the consideration of contextual factors (institutional arrangements, regulatory and legal issues, social and economic contexts), political culture, and different risk perceptions (Renn, 2005). As an account of the institutional consequences of shifts towards governance, Renn (2008a) states, "risk governance is of particular importance in, but not restricted to, situations where there is no single authority to take a binding risk management decision, but where, instead, the nature of risk requires the collaboration of, and the coordination between a range of different stakeholders." Briggs (2008) argues the added value of risk governance, emphasizing that risk management is an open, transparent, and shared process amongst all stakeholders taking into account multiple causes, pathways, health effects, etc.

In order to deal in a more balanced, inclusive, and effective way with systemic risks, the International Risk Governance Council has developed a conceptual framework incorporating a set of key principles for sound risk governance when dealing with systemic risks characterized by complexity, inherent uncertainty, and ambiguity. Decision making in the case of these types of risks takes place under considerable time pressure, knowledge deficits, and conflicting values. Such decision making requires good governance and the inclusion of governments, corporate sectors, experts, civil society, etc. The IRGC framework, developed to make the concept of Risk Governance more operational to the environmental health domain, is elucidated in Section 4.2.2.

2.3. Changes in the Science-Policy-Society Interface in Response to Complexity: Towards Boundary Work

Facing science and politics, dealing with complex issues notably challenges the interactions between science, politics, and society. More precisely, the traditional, modern, indisputable borderlines and task divisions between these different actors have been blurred. Section 2.3.1. focuses on the concept Boundary Work in order to draw attention to the boundaries and transactions between the scientific and political sphere to make complex (environmental health) problems governable. The different types of boundary devices are further elaborated in the next sections, focusing on boundary organizations and boundary people (Section 2.3.2.), and boundary tools (Section 2.3.3.). Section 2.3.4. describes six models of boundary arrangements to typify different types of interactions between scientists and policymakers.

2.3.1. Boundary Work Between Science, Politics, and Society

The concept of boundary work is often used to refer to the problem of demarcation between what science is and what non-science is. For years, positivistic scientists have been searching for unique and essential features to characterize science. For instance, Popper (1930s) proposed "falsifiability", and Merton (1942) used the "CUDOS principle" to evaluate and assess scientific practices in order to distinguish science from non-science (Section 2.1.1.). Inspired by a constructivist belief and searching for an explanation for the historically given cognitive authority of science, Gieryn (1983) introduced the concept of Boundary Work to highlight how the legitimacy, credibility, and authority of experts' knowledge are maintained by establishing borders between the scientific and political spheres/cultures. Boundary work is defined by Gieryn as, "the attribution of selected characteristics to the institutions of science (i.e., to its practitioners, methods, stock of knowledge, values, and work organization) for purposes of constructing a social boundary that distinguishes some intellectual activities as non-science." Work implies a, "meaningful and purposeful activity, directed at the creation of a collective product" (Hoppe, 2010a). This work occurs across the boundaries referring to demarcation and separation of different groups by defining characteristics and prescribing proper behaviour for science and policy. Nevertheless, according to Gieryn (1983) and based on Social Constructivism, the demarcation criteria to distinguish science from non-science are not a universal set of

characteristics but rather context dependent, historically changing criteria which change all the time. After all, boundary work is not performed in a cultural and institutional vacuum (Hoppe & Halffman, 2003). The boundary process is influenced by long traditions and routine practices.

Although Gieryn uses boundary work to stress demarcation between science and politics, Halffman (2003) emphasizes that boundaries not only divide and demarcate in order to guarantee the quality of one's own work (Hoppe, 2010a), but simultaneously, boundary work defines proper ways for interaction, productive cooperation, and coordination. Coordination defines how science and policy are related to each other by defining proper mutual conditions of exchange and a division of labour that is more or less accepted by relevant actors (Halffman, 2003; Hoppe, 2010b). Demarcation and coordination are two sides of the same coin, "keeping your distance, while simultaneously staying close enough to be effective is the enduring dilemma" (Hoppe, 2010a). Science and policy are constantly engaging each other and negotiating amongst each other in order to create areas of legitimate authority. As such, "Boundaries are the outcome of - and form the resources for - continuing boundary work, the further articulation reproduction, or modification of the division of labour" (Halffman & Hoppe, 2005). Initially, boundary work is applied to the context of science and policy; nowadays, it also refers to the co-production of knowledge and expertise in collaborative pursuits in which different social communities are involved.

To describe the boundary process in more detail, Halffman (2003) introduces the TOP approach (text, object, people), in which boundary work uses, produces, redefines and adapts boundary devices for demarcating and coordinating practices. The TOP approach is related to the work of Shapin (1992), "Bounding a practice is a way of defining what it is, of protecting it from unwanted interference and excluding unwanted participants, of telling practitioners how it is proper to behave within it and how that behaviour differs from ordinary conduct, and of distributing value across its borders." Boundaries can be institutionalized or materialized in texts, objects, and people. Boundary texts refer to the discourses, concepts or language used to define respective roles. The term boundary objects is derived from Star and Griesemer (1989) and refers to tools and methods (i.e., measurement networks, computer models, testing equipment, indicator systems) which are developed and used at the interface between science and society for producing knowledge and advice in policy settings. Boundary people are people that operate on the boundary of different worlds; they mark boundaries through their positions, and negotiate the exchanges. These different types of boundary devices are further elaborated in Section 2.3.2. and Section 2.3.3.

2.3.2. Boundary Organizations and Boundary People

Boundary organizations refer to organizations, networks, and institutions that try to maintain a productive balance between different social communities (Miller, 2001; Guston, 2001), and bring people on either side of the boundary together to increase mutual understanding, knowledge, and capacities (Franks, 2010; Cutts et al., 2011). The essential function of a boundary organization is to facilitate the creation of mutually beneficial outcomes, also called boundary objects (Cutts et al., 2011). Applied to the context of the science-policy interface, boundary organizations operate in the border area between the scientific and political community, manage, divide and coordinate these two fields (Miller, 2001) and, “facilitate evidence-based and socially beneficial policies and programmes” (Drimie & Quinlan, 2011). Boundary work at the science-policy interface results in usable knowledge, advice, and scientifically-based policy instruments. In other words, boundary organizations at the science-policy interface guarantee the scientific character of the knowledge production, whilst they are able to formulate policy supportive advice also taking into account ethical, social, and political aspects (Health Council of the Netherlands, 2006). Examples of these types of boundary organizations are: expert advisory committees, research management agencies, advisory boards, state-owned knowledge institutions, planning bureaus, policymakers characterized by a scientific background, scientists focusing on policy relevance topics, ad-hoc expert committees, contracted research, networking platforms, etc. (Halffman & Hoppe, 2005).

Guston (2001), Cutts, et al. (2011) and Franks (2010) define key characteristics of a boundary organization. These features can be divided between institutional characteristics, related to the structure of boundary organizations, and the work processes characteristics (Franks, 2010). The institutional structure of boundary organizations involves the collaborative participation of actors from multiple communities (science, politics, professionals, stakeholder groups, etc.) with dual distinct lines of accountability to each of them, the scientific as well as the political and the societal ones (Cutts et al., 2011; Guston, 2001). This means adherence to principles of science, while still supporting governments (Drimie & Quinlan, 2011). Moreover, the structure of boundary organizations needs to be persistent, stable, and durable in order to reinforce transformed social relationships (Franks, 2010) and adopt an informed, supportive, flexible, and adaptive approach (Drimie & Quinlan, 2011). Related to the work process of a boundary organization, the process should convene, translate, collaborate, and mediate (Franks, 2010). Convening refers to the contact, discussion, and

exchange of information between different communities. Translation means that a boundary organization needs to make the information comprehensible and resources available. Collaboration allows mutual understanding and trust, the co-production of knowledge, and the opportunity and incentives to create boundary objects and the agreement about the use of them (Guston, 2001). Mediation is not a necessary condition for boundary organizations, but can sometimes be important in order to ensure fair representation of the various interests of stakeholders.

To conclude, boundary organizations are involved in co-production in two ways, "they facilitate collaboration between scientists and non-scientists, and they create the combined scientific and social order through the generation of boundary objects" (Guston, 2001). People operating in boundary organizations can be considered as boundary people. In a strict sense, boundary people mark boundaries through their positions but also negotiate the exchanges (Halffman, 2003). Boundary people permit the flow of information between different communities which have their own specific norms, knowledge, discourses, practices, priorities, etc. in order to find a common ground (a shared vision, shared goals, shared objectives, and shared approaches), and to co-produce knowledge (Stern & Green, 2005).

2.3.3. Boundary Tools

Boundary objects refer to tools and methods which are developed and used at the interface of different communities to communicate, to translate, and to maintain coherence across communities (Halffman, 2003; Star and Griesemer, 1989). As a result, boundary objects bind different communities, can be used by each of them for specific purposes without losing their own identity and facilitate their cooperation (Guston, 2001). According to Guston (2001), boundary objects provide stability, "however, they do so only through the consent of actors on both sides of the boundary."

Carlile (2002) identifies three characteristics of effective boundary objects. First, boundary objects must create a common language between two communities to deal with the boundary. Second, boundary objects need to provide a concrete means for individuals to specify and learn about their differences and dependencies across a given boundary. And third, the boundary object must facilitate a process where individuals can jointly transform their knowledge. Turnhout (2009) adds that boundary objects can only be effective if the social worlds that are to be connected have shared values and preferences. This does not mean that these two communities

cannot differ substantially in terms of their daily activities or responsibilities, but they have to be rooted in a common culture. Consequently, boundary objects are flexible enough to have meaning in both social worlds in the sense that they are scientifically valid and policy relevant at the same time, and they are stable enough to travel back and forth between them.

According to the interpretation of boundary work as a coordination process and the concept of Post-Normal Science, the environmental health risk characterization process – estimating and evaluating health risks from exposure to environmental pollution – can be considered as a boundary object on the condition that societal aspects and identified uncertainties are included in addition to the ‘pure’ scientific data (Health Council of the Netherlands, 2006).

2.3.4. Boundary Arrangements

In practice, boundary work is manifested in very different styles and shapes, depending on the various types of policy problems, the degree of scientific and societal complexity of these problems, and the level of perspective evolving from concrete project level to the policy-domain level (Hoppe, 2010a/2010b). As the empirical survey deals with the institutionalization of the Flemish environmental health arrangement, only the policy-domain level is further elaborated.

Inspired by the knowledge-utilization literature, on the one hand, and the science, technology, and society (STS) literature, on the other, Hoppe (2005) distinguishes six models of interactions between scientists and policymakers. Hoppe’s typology is constructed along two axes. The first axis, borrowed from Habermas (1969), concerning “relative primacy” refers to the influence, control, and authority of science in relation to policy. The two extremes are science (technocracy), on the one hand, and politics (decisionism), on the other. If neither science nor politics has a clear priority, there is some form of dialogue between them (pragmatism). The second axis is borrowed from Wittrock and refers to the convergence or divergence between the operational codes and the way of working between science and politics (Hoppe, 2009). Divergence refers to incompatible ways of life between science and politics (either/or). Science and politics are strictly separated. Convergence refers to a relational logic in which science and politics are cooperating, negotiating, searching for consensus, and collective action. Based on these two axes, Hoppe (2002, 2005) indicates six models of science/politics boundary arrangements (Figure 6).

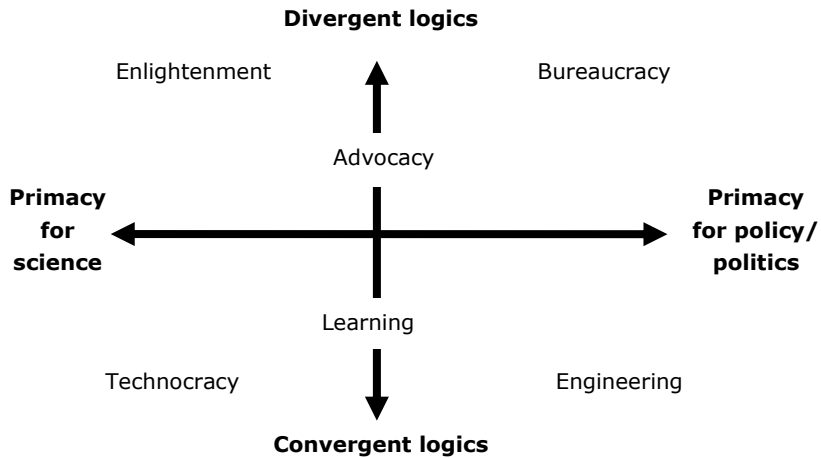


Figure 6: Types of boundary arrangements (Hoppe, 2005).

When politics and science are strictly separated and science has relative primacy, the Enlightenment Model appears. This model corresponds to the Modern or Positivistic Model, as described in Section 2.1.1. Scientific knowledge-production is not focused on converging with policy, but rather it is based on curiosity to gain the objective truth. Science has nothing to do with the use of knowledge in policy making and distinguishes itself from politics because the latter is concerned with values, normative questions, and subjective opinions. Knowledge transfers slowly to the political domain as a result of the work of scientific journalists and popularizing scholars. Scientists themselves reject any responsibility for knowledge transfer and knowledge utilization. It is the task of politicians and administrators to use or neglect scientific knowledge. Because the tasks and responsibilities of science and politics are too divergent, institutional contacts are limited.

In the Technocracy Model, science is given prime importance in the conviction that theoretical scientific insights are necessary for practical operations, such as policymaking, while layman knowledge and normative opinions are considered as inferior importance. As a consequence, "scientists are invited to introduce their arguments to the policymaking process and therefore hold a dominant position in the science-policy interaction process" (Health Council of the Netherlands, 2006). Moreover, science and politics are believed to be convergent. Because their societal functions are the same, scientists gain access to vital positions in policy-making authorities (i.e., policymakers or administrators). As such, scientists intentionally steer the policy-making process in a certain direction as they dictate the input of scientific knowledge in the decision-making process (Health Council of the Netherlands, 2006).

Depoliticizing the policy-process and “scientization of politics” (Habermas, 1971) are key features of the Technocratic Model, in the sense that science displaces politics. “Good policy is spoiled by politics”, is the technocrat’s adage (Hoppe, 2005).

When politics have the primacy and the initiating party in the science-policy interaction process and politics and science are diverged, the Bureaucratic Model takes place. Policymakers request inputs from particular scientific actors, whose contribution they feel is appropriate to achieve their policy goals, and scientists act as data suppliers (Health Council of the Netherlands, 2006). The Bureaucratic Model is characterized by the politics-administration dichotomy. Specialist and policy-relevant knowledge is produced in state-owned research institutions in response to goals defined by politics, then it is mobilized and recruited in the administration by those who have political power. In other words, the input of scientific knowledge is strictly regulated in formalized procedures (Health Council of the Netherlands, 2006).

In the case of the Engineering Model, there is also an idea of mobilizing knowledge at the service of the state, but it is out of the question to incorporate experts and scientists in state-owned administrations. Contrary to the Technocracy Model in which scientists enter into positions of policymakers, politics remain dominant and scientists can be considered as knowledge recruiters. Political leaders pose questions about knowledge, determine the content and priorities of instrumental knowledge, and fund research programmes. The “scientists-as-engineers” apply existing knowledge to solve local problems. Because government only consults and contracts with independent, external knowledge-institutions to deliver detailed orders, it cannot be accused of manipulating research.

If neither science nor politics has clear priority, there is some form of dialogue or entanglement between them. For instance, “scientific experts are able to criticize problem statements of policymakers, to reframe policy beliefs, to suggest alternative policy strategies, to interpret policies, to provide critical reflection and to mediate in policy controversies” (Health Council of the Netherlands, 2006). If there is a strong focus on convergence and consensus, Hoppe proposes a learning discourse. If there is a moderate form of divergence, an advocate’s discourse is suggested. The essential characteristic of Advocacy Models is that each voice in the political arena is considered to be an advocating plea in favour of or against positions defended by other political actors. Each divergent political stance is looking for scientific expertise that harnesses and legitimizes their position. In Learning Models, politics is not constructed as an arena for struggle, but as a forum for debate. Science is

considered to be one actor which will be engaged in the social, mutual learning process together with the other stakeholders in order to find a solution by means of deliberations.

Hoppe (2005) notices that boundary arrangements must not be interpreted and studied as static arrangements as they can evolve from one model into another depending on context, policy field, policy topic, etc. Moreover, Hoppe only presents a typology, no pure form exists and, in reality, intermediate arrangements can operate.

Turnhout, Hisschemöller, and Eijsackers (2008) link the models of boundary arrangements with the typology of the policy problems of Hisschemöller and Hoppe (1996) in Table 9. The latter was introduced in Chapter 1. The way in which a problem is structured determines the science-policy interaction and the role of science in the decision-making process. In the case of structured problems, the problem is well-defined and undisputable. Decision making follows routine procedures; decisionmakers formulate the knowledge question, scientists take on the role of problem solvers, and the decisionmakers implement the uncontroversial solution. As such, primacy is given to politics and there is no opposition to the leading role of expertise. Unstructured problems are characterized by a plurality of goals and means, social and political controversy, and scientific uncertainty. As a consequence, the decision-making process requires a high level of stakeholders' participation during a learning process to create, "a dialogue where actors develop and reflect upon conflicting perspectives" (Turnhout et al., 2008). Science often takes on the role of problem recognizer and signaller. Moderately structured problems are characterized by well-defined norms and values but also by controversial management strategies. The decision-making process is characterized by negotiation, the formation of majorities, and struggles between different advocacy coalitions. As such, the interaction between science and politics is related to the Advocacy Model.

Table 9: Science-policy typology: the relation between problem structure and the role of science/knowledge (based on Turnhout et al., 2008).

Policy Problem	Well structured	Unstructured	Moderately structured
Policy Process	Rule	Learning	Negotiation
Role of Scientist	Problem solver	Problem signaling	Advocacy
Boundary Arrangement	Bureaucracy	Learning	Advocacy

2.3.5. Conclusion on Boundary Work

Although the concept of boundary work is initially formulated to demarcate science from non-science, Guston (2001) argues that the idea of blurring boundaries between the sub-spheres of state, market, and civil society can lead to more productive policy making. Consequently, the theory of boundary work can be linked to the shifts in governance as described in Section 2.2.: the traditional boundaries between the sub-spheres of state, market, and civil society, on the one hand, and the traditional boundaries between different policy fields and policy levels, on the other, are blurred (Pestman & Van Tatenhove, 1998). As shown by Hoppe (2005) boundary work and the idea that science and politics increasingly interact can be beneficial for stimulating mutual learning, "Scientists are learning about aspects relevant for policy and policymakers are learning to see things in a new, different perspective. The dialogue between scientists and policymakers may result in discourse coalition that shares the usage of a particular set of story lines over a particular period of time. Such coalitions are institutional vehicles for change" (Kemp & Rotmans, 2009). The impact of discourses and discourse coalitions on institutional change and preservation is discussed in Section 3.1.

2.4. Conclusion: Towards an evaluation framework to assess the Flemish Environmental Health Arrangement

Chapter 2 gives a clear understanding of the theoretical concepts and developments in response to complexity within three scientific domains: 1) the epistemological debate on knowledge unfolded around STS and related disciplines; 2) the shift from government to governance unfolded in social and political sciences; and 3) the changing interactions between science, politics, and society. Together, they supply a sufficient theoretical background to analyse the dynamic emergence and institutionalization of the Flemish environmental health arrangement. The empirical study, in turn, gains insight on how these theoretical concepts are put into practice and how these changing theoretical discourses in response to complexity have influenced the institutionalization process. The analytical account for assuming that changing discourses can affect institutional change and preservation is discussed in more detail in Section 3.1.

Moreover, at a more operational level, the theoretical concepts and developments can be translated into a non-exhaustive list of concrete

indicators in order to assess the performance of the Flemish environmental health arrangement and to derive recommendations for the future. According to Runhaar et al. (2009; 2010), an effective environmental health arrangement ensures that the region or country progresses in meeting its environmental health objectives and succeeds in reducing environmental health risks to levels that are acceptable to decisionmakers, the public, scientists, and other stakeholders. Table 10 presents a new evaluation framework for assessing the performance of the Flemish environmental health arrangement. The set of criteria and indicators is based on: 1) the literature review as presented earlier in this chapter, 2) the checklist of criteria for evaluating environmental policy integration (European Environmental Agency, 2005b), and 3) the analytical framework for evaluating environmental health risk governance regimes (Runhaar et al., 2009; 2010).

Table 10: A set of criteria and concrete indicators to evaluate the performance of the Flemish environmental health arrangement.

Criteria	Indicators
Political commitment, vision & leadership	<ul style="list-style-type: none"> • Is there an overarching EH-strategy? • Is there political leadership for EH so that the public and administrations are continually encouraged to deepen their EH thinking? • Is the political commitment expressed in legal texts or public statements and is this commitment sustained? • Are there long and medium-term EH objectives?
Policy integration at the governmental level: administrative culture and practices	<ul style="list-style-type: none"> • Three requirements for policies to qualify as integrated: comprehensiveness, aggregation and consistency • Is there a strategic department/unit/committee in charge of coordinating EH across sectors? • Are EH objectives integrated in other related policies? • Are there mechanisms for cooperation with higher or lower levels of governance (international and European network)? • Are the resources (in terms of budget and staff) adequate? • Is policy integration expressed in legislation and decision-frameworks?
Knowledge development for decision making	<ul style="list-style-type: none"> • Is the scientific work of the Flemish Centre of Expertise on Environment and Health appreciated by the scientific world? • Is the scientific work of the Flemish Centre of Expertise useful for and used to inform policymakers? • Does the Flemish Centre of Expertise give sufficient attention to uncertainty management and the plurality of legitimate perspectives?

	<ul style="list-style-type: none"> • Is there a process for ex-ante environmental health assessment for proposed policies or programmes?
Science-Policy interaction	<ul style="list-style-type: none"> • Boundary organizations (Guston, 2001; Cutts et al., 2011; Franks, 2010): <ul style="list-style-type: none"> ○ Do boundary organizations facilitate participation with accountability to each community? ○ Are boundary organizations persistent, stable, and durable and in the same time flexible and adaptive? ○ Do boundary organizations convene, translate, and collaborate? • Boundary objects (Carlile, 2002): <ul style="list-style-type: none"> ○ Do boundary objects create a common language between two communities? ○ Do boundary objects specify and learn about differences and dependencies between two communities? ○ Do boundary objects facilitate jointly transforming knowledge production? ○ Are boundary objects scientifically valid and policy relevant at the same time (Turnhout, 2009)?
Participation of stakeholders	<ul style="list-style-type: none"> • Are stakeholders involved in the knowledge-production? • Are stakeholders involved in the decision-making processes? • Is participation characterized by: <ul style="list-style-type: none"> ○ Direct or indirect participation? ○ Formal or informal participation? ○ Output (decision-oriented, reaching consensus) or input (deliberative, mapping out diversity) participation?
Outcome of the arrangement and monitoring the outcome	<ul style="list-style-type: none"> • Does the arrangement succeed in detecting EH problems early and setting them on the political and scientific agenda? • Does the arrangement succeed in reducing EH-risks to levels that are acceptable to decisionmakers, the public, scientists, and other stakeholders? • Does the arrangement succeed in increasing social basis of environmental health policy? • Is the arrangement legitimated by all stakeholders? • Is the Flemish environmental health arrangement a source of inspiration for other regions, countries and Europe? • Is there a systematic process to monitor and evaluate the EH objectives and targets (e.g., EH indicators)?

Chapter 3: Analytical and Methodological Account

As theoretically described in Chapter 2 and empirically demonstrated in the next chapters (Chapter 4, Chapter 5, Chapter 6 and Chapter 7), the recognition of the complexity of environmental health risks has been increasing over the last four decades. This discursive shift went largely parallel with a more encompassing date about governance in general, emphasizing the need to involve stakeholders in the decision-making process, on the one hand, and to integrate different policy sectors, on the other. The epistemological and governmental shifts have both influenced the institutionalization process of the environmental health field. After all, according to Hajer (1995), discourses can evolve into successful story lines, influencing organizational practices, policy contents, financial and personal resources, etc. In other words, discourses are the driving force behind institutional dynamics.

Section 3.1. positions Discursive Institutionalism and the Policy Arrangement Approach (PAA) as an appropriate analytical framework vis-à-vis to Historical and Sociological Institutionalism and distances it from Rational Choice approaches. In order to study the impact of these newly emerging discourses on the institutionalization process of the Flemish environmental health arrangement, a historical analysis was set up, covering the past 40 years. Data were gathered, analysed and interpreted according to a qualitative approach, and using a triangulation of methods to get a detailed and balanced picture of this institutionalization process. Section 3.2. depicts the variety of methods used: document analysis (Section 3.2.2.) and in-depth interviews (Section 3.2.3.). Chapter 3 also emphasizes the scope of the research project (Section 3.2.1.) and reflects on the validity and reliability of the historical analysis (Section 3.2.4.).

3.1. Discursive Institutionalism and the Policy Arrangement Approach

The main aim of the study is to historically analyse the institutionalization process of the Flemish environmental health arrangement over the last forty years. This process is characterized by stability and changes which are analysed taking into account a discursive perspective. Compared with other approaches within New Institutionalism (Rational Choice, Historical and

Sociological Institutionalism), Discursive Institutionalism assumes: 1) the important role of discourses in influencing actors' preferences, interests and behaviour; and 2) the role of discourses in assuring institutional stability, while simultaneously triggering and legitimizing institutional change (Scott, 2001). The impact of discourses on institutional processes is described in Section 3.1.1, while Discursive Institutionalism as one of the four approaches within New Institutionalism is depicted in Section 3.1.2. In Section 3.1.3., the Policy Arrangement Approach is discussed as the appropriate analytical framework to make Discursive Institutionalism applicable.

3.1.1. Discourses as Driving Force Behind Institutional Dynamics

Discourses are defined by Hajer and Versteeg (2005) as, "an ensemble of ideas, concepts and categories through which meaning is given to social and physical phenomena, and which is produced and reproduced through an identifiable set of practices." More precisely, discourses refer to ideas or text (what is said), to the context (where, when, how, and why it was said), and to the interactions (who said what to whom) (Schmidt, 2008). Through discourses, agencies express their ideas and ideals, their conception of societal issues, and the way in which these could (or should) be dealt with in politics and policies. The former are labelled as "substantial", the latter as "governance" discourses (Lieverink, 2006). Policy or governance discourses are more precisely defined by Arts et al. (2000) as, "dominant interpretative schemes, ranging from formal policy concepts to popular storylines, by which meaning is given to a policy domain." Through interaction, agencies exchange discourses, merge into discursive coalitions or split-up into discursive oppositions, depending on shared or conflicting definitions, beliefs, concepts, assumptions, social choices, narratives and ideas which can vary over the years (Phillips, Lawrence & Hardy, 2004; Arts, 2006). Hajer (1993, 1995, 2000) links the concept of discourse coalition to three elements: 1) a set of storylines; 2) actors that utter these storylines; and 3) practices within which the discursive production takes place. Discourses solidify into institutional arrangements when successful storylines, used by many people (discourse coalition), find their way into policy programmes, measures, practices, budgets, responsibilities, competencies, structures, and rules. Thus, as Hajer (2006) states, "language has the capacity to make politics, to create signs and symbols that can shift power balances and that can impact on institutions and policy-making." This approach to understanding the productivity of discourses draws on the work of Berger and Luckmann (1966, cited in Phillips et al.,

2004) who suggest that an institution is a social construction produced through discourses which are in turn generated by the actors' interactions as they come to a shared definition through linguistic as well as social processes. In other words, discourses are the driving force behind institutional preservation and change and the study of discursive practices is necessary to explain institutional stability and dynamics (Padt, 2007).

Related to the institutionalization of the Flemish environmental health arrangement, the hypothesis is that the new insights related to the increased recognition of complexity, as described in Chapter 2, are most determined for the institutional stability and dynamics of the past forty years. More precisely, the changing epistemological discourses about complex risks, the political discourses about multi-sector governance (policy integration), and the new discourses related to the science-policy-society interface focusing on the participation of stakeholders in response to controversial and scientific uncertain risks are considered as the driving forces behind the institutional developments of the Flemish environmental health arrangement. In the following, empirical chapters is analysed to what extent this is the case for Flanders.

3.1.2. Discursive Institutionalism

In order to analyse the dynamic emergence of the Flemish environmental health arrangement over the last forty years, an institutional perspective is preferred. Taking into account one perspective excludes the use of other perspectives to study (environmental) policy, such as the Rational Choice Theory and the Policy Network Theory (Driessen & Leroy, 2007). It is out of scope of this research project to describe and compare the different ways of theorizing political science in full detail. Good overviews have been published by Marsh and Stoker (2002), and Abma and in't Veld (2001).

Institutionalism has a long history in sociology, but the emergence of New Institutionalism in the Nineteen Eighties has "refuelled the debate recently" (Leroy and Arts, 2006). The notion of New Institutionalism was introduced by March and Olson in the mid Nineteen Eighties in response to an overemphasis on agency without structure (Schmidt, 2008) and referring to a revival and innovation of the Old Institutionalism (Meijerink & Van Tatenhove, 2007). However, New Institutionalism is characterized by a broader definition of institutions (March & Olson, 1989 cited by Freidenvall and Krook, 2007) and focuses on explanation and theory building (Schmidt, 2006) instead of on describing formal features of political systems. New Institutionalism refers to

the increased intention given to structures and sets of rules that guide and constrain the individual behaviour of actors, both formal and informal (Lowndes, 2002). Institutions are understood as the, "informal rules of the game, organizational patterns of political behaviour, and organizational structures" (Immergut & Anderson, 2008). Another definition states: "widely accepted rules and roles, both formal and informal, both visible and latent, which enable some human behaviours and constrain others" (Arts, 2006). New Institutionalism also considers institutions as a result of processes which can change over time while the traditional perspective defines institutions as stable constructs (Lowndes, 2002). One last difference, new institutionalists study the embeddedness of political institutions in a particular context in stead of considering institutions as independent structures (Lowndes, 2002).

New Institutionalism is a broad perspective, emphasizing that the broader institutional context determines the continuity and change of policy processes (Meijerink & Van Tatenhove, 2007). As a consequence, one can study institutions taking into account four different approaches: 1) Rational Choice (RI); 2) Historical (HI); 3) Sociological or Organization (SI); and 4) Discursive Institutionalism (DI) (Schmidt, 2006; Freidenvall and Krook, 2007; Meijerink & Van Tatenhove, 2007). A detailed overview of these different approaches is beyond the scope of this study. A schematic overview is given by Schmidt (2010) and presented in Table 11.

In order to analyse the impact of newly emerging discourses in response to complexity, as described in Chapter 2, on the institutionalization process of the Flemish environmental health arrangement, the discursive institutional perspective was preferred. After all, compared with other approaches within New Institutionalism, Discursive Institutionalism: 1) has come with the discursive term in social sciences emphasizing the important role of discourses in influencing actors' preferences, interests and behaviour (Hajer, 1995); and 2) focuses on the role of discourses for explaining institutional continuity and change (Scott, 2001). In this perspective, discourses are understood to be socially constitutive and hence essential to understanding institutional dynamics. The other three perspectives of New Institutionalism more focus on institutional continuity instead on its dynamics. These perspectives explain institutional robustness by fixed rationalist preferences based on the functionality and the benefits of existing institutions, self-reinforcing historical paths dependency and the importance of choices in the past or institutional persistence, and the consolidation process of all-defining cultural norms and values, respectively (Hall & Taylor, 1996; Schmidt, 2008/2010, Crabbé, 2008).

Table 11: A comparison of the four New Institutionalisms (Schmidt, 2010).

	Rational Choice Institutionalism (RI)	Historical Institutionalism (HI)	Sociological Institutionalism (SI)	Discursive Institutionalism (DI)
Object of explanation	Behaviour of rational actors	Structures and practices	Norms and culture of social agents	Ideas and discourse of sentient agents
Logic of explanation	Calculation	Path-dependency	Appropriateness	Communication
Definition of institutions	Incentive structures	Macro-historical structures and regularities	Cultural norms and frames	Meaning structures and constructs
Approach to change	Static – continuity through fixed preferences, stable institutions	Static – continuity through path dependency interrupted by critical junctures	Static-continuity through cultural norms and rules	Dynamic-change (and continuity) through ideas and discursive interaction
Explanation of change	Exogenous shock	Exogenous shock	Exogenous shock	Endogenous process through background ideational and foreground discursive abilities
Recent innovations to explain change	Endogenous ascription of interest shifts through RI political coalitions or HI self-reinforcing or self-undermining processes	Endogenous description of incremental change through layering, drift, conversion	Endogenous construction (merge with DI)	Endogenous construction through reframing, recasting, collective memories and narratives through epistemic communities, advocacy coalitions, communicative action, deliberation

The strong anchored character of most institutions over time and space is emphasized by Arts (2006). To realize institutional change, Discursive Institutionalism refers to the interaction of actors trying to succeed in convincing other actors to accept their discourse. Whether discourse coalitions result in institutional change depends on the circumstances: power and resources of the actors, on the one hand, and the willingness to change the current rules, on the other (Crabbé, 2008). According to Schmidt (2010), power and position do matter, "Where Discursive Institutionalism can go wrong is when it considers ideas and discourse to the exclusion of issues of power (read RI instrumental rationality) and position (read HI institutional structures), when it assumes that DI deliberation necessarily trumps RI manipulation, or when it over-determines the role of ideas and discourse by forgetting that 'stuff happens' or that historical institutions and cultural frames affect the ways in which ideas are expressed and discourse conveyed." Contrary to the other perspectives within New Institutionalism, Discursive Institutionalism is characterized by: 1) more subjective interests rather than objective or material ones; 2) a more dynamic, agent-centred approach rather than static path-dependent structures; and 3) dealing with norms in more dynamic constructs rather than static ones (Schmidt, 2008). As such, Discursive Institutionalism is the best perspective for this study aiming to analyse the impact of newly emerging discourses on the dynamics of institutional change within the Flemish environmental health arrangement.

Discursive Institutionalism combines two perspectives, Moderated Institutionalism and Constructivism or discourse analysis, in order to find a balance between voluntarism and determinism on the one hand, and materialism and idealism on the other (Arts, 2006). Determinism maintains that human action is shaped unilaterally by rules and roles, external to and independent of human behaviour; also called the structured, institutionalized or rule-directed character. Voluntarism takes the opposite stance, arguing that humans can shape their environments to achieve their interests and goals. As such, Discursive Institutionalism tries to combine the actor-structure duality (Leroy & Arts, 2006). The duality between materialism and idealism refers to the focus on either material circumstances, physical contexts and variables that drive human action (organization) or human factors such as language, desires, ideologies, beliefs, or values and norms (substance) to explain social stability and change (Leroy & Arts, 2006). Consequently, Discursive Institutionalism focuses on the ways in which values within society are constructed, negotiated, and folded into the policy framework, and how beliefs are fixed within society. As a result, institutions can shape the values and fix the beliefs of individuals, as well as the structures within which nations

come to operate when bringing new concepts into the policy arena. Using the words of Arts (2006), "Institutions are social-historical constructs that are 'internalized' in human conduct and memory (...), make the action repertoire of people rather stable and predictable (...). At the same time, it is assumed that rules and roles are continuously 'monitored' by people (...) from which a desire for institutional change might develop."

To conclude, discourses help to explain the dynamic process of institutional change (Schmidt, 2010). After all, institutions are distilled discourses that also have the ability to function as discourses that can change institutions (Meijerink & Van Tatenhove, 2007). To understand why discourses gain dominance while other understandings are discredited and to explain why institutions change or stay persistent, an analytical framework is needed to make Discursive Institutionalism operational.

3.1.3. Policy Arrangement Approach

Other social scientists, studying environmental health risk governance arrangements, have already developed an analytical framework for characterizing, explaining, and evaluating environmental health risk governance regimes (Runhaar et al., 2009). This framework, presented in Figure 7, can be used to analyse trends in environmental health governance at macro (general shifts) and micro (particular shifts in particular countries and time periods) level. Using the term regime, the authors emphasize the judicial approach of the framework, primary focusing on rules of the game and on procedures.

Because, 1) environmental health is a new emerging field without pre-existing rules and procedures yet, 2) my interest in the impact of discourses on institutional dynamics, and 3) the visual presentation of the framework is unnecessary complex in my opinion, it was advisable to look for a more appropriate analytical framework that would make Discursive Institutionalism operational and applicable.

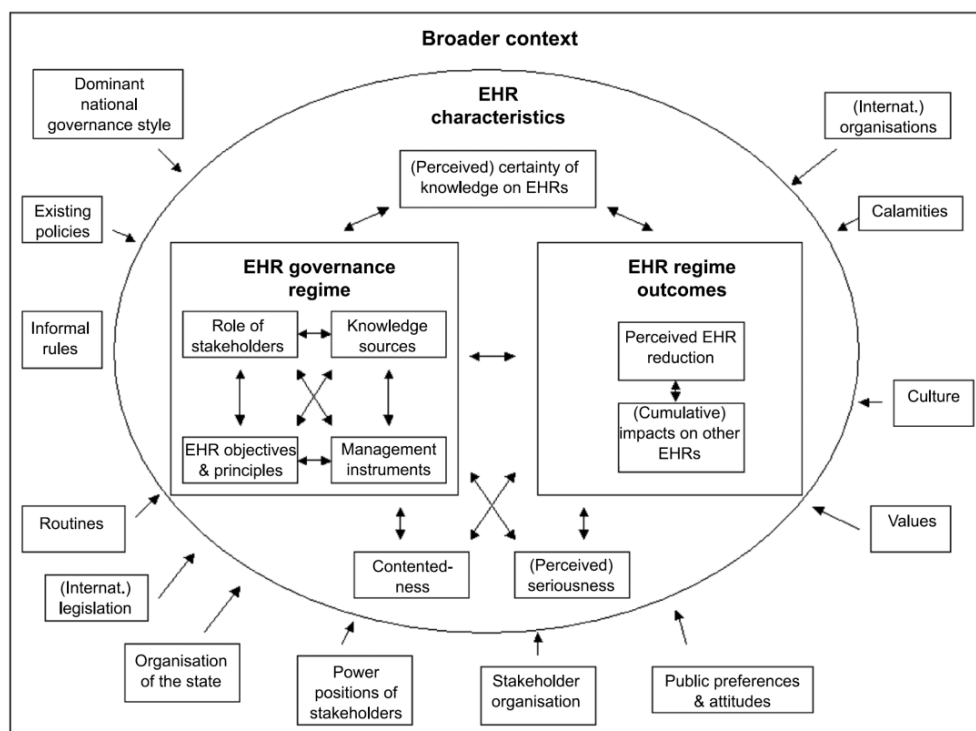


Figure 7: Framework for characterizing, explaining and evaluating environmental health risk governance regimes (Runhaar et al., 2010).

Arts (2006) recommends the Policy Arrangement Approach (PAA), developed to empirically analyse change and stability within particular policy arrangements. Whereas the essence of the PAA and the analytical framework of Runhaar et al. (2009) are very similar, the PAA considers discourses more as independent variables, whereas the framework of Runhaar emphasizes the role of rules of the game and procedures. As a consequence, the PAA fits better in Discursive Institutionalism. After all, the PAA tries, in correspondence with Discursive Institutionalism, “to find a middle-road between actors and structure, on the one hand, and idealism and materialism, on the other, but at a ‘lower’ discipline-specific level of theorizing” (Arts, 2006). A policy arrangement is defined by Leroy & Arts (2006) as, “the temporary stabilization of the content and organization of a particular policy domain at a certain policy level or over several policy levels in case of multi-level governance.” These processes of temporary stabilizations are often referred to as “ongoing processes of institutionalization” (Liefferink, 2006).

The PAA aims: 1) to focus on intentions, motives, discourses, and beliefs of actors as well as on regulatory roles and organizational structures; and 2) to take into account long-term processes that characterize contemporary society (Arts & Leroy, 2006). This framework has been tested in a series of research endeavours in the environmental domain, resulting in scientific articles and dissertations.

While studying institutional change (or the lack thereof), the PAA distinguishes four interwoven dimensions of any policy arrangement, presented by a tetrahedron in Figure 8. The tetrahedron emphasizes that, “change in one dimension seldom stands alone and tends to have an impact on one or more of the other dimensions” (Liefferink, 2006).

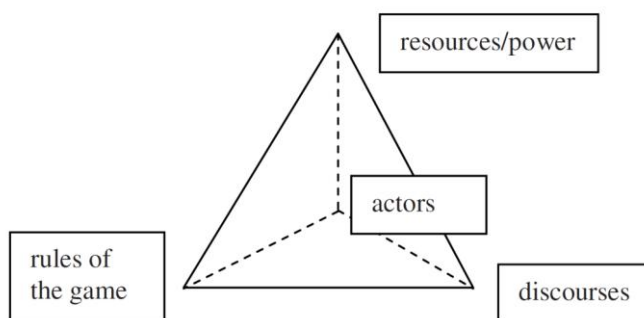


Figure 8: The tetrahedron, symbolising the interconnectedness of the four dimensions of a policy arrangement (Liefferink, 2006).

The dimension “Actors and coalitions” refers to agencies (experts, NGOs, civilians, private sector, civil servants, politicians, etc.) and their coalitions involved in the policy domain. These coalitions or interaction patterns can change over time (Veenman, Liefferink & Arts, 2009). The second dimension “Resources and Power” refers to the allocation of resources and the differences in power that result from this distribution (i.e., financial resources, access to media, knowledge, technology, expertise, etc.). The third dimension “Rules of the game” refer either to formal and informal procedures of decision making (such as legislation and regulation) or to routines of interaction defining the possibilities and constraints for policy agents to act within that domain (who has access?, who advises?, who gathers data?, who interprets the data?, who decides how agendas are made, policies formulated, and decisions made?). In other words, “the rules of the game define the way the game should be played and within which boundaries” (Arts, 2006). Finally, the dimension “Discourses” entails the norms and values, problem definitions, and solution strategies of those involved and varies from formal policy-concepts to popular storylines through which meaning is given to a policy domain.

The first three dimensions refer to the organizational aspects of policy (procedures, instruments, task division) and the latter dimension refers to the substantial aspects of policy (objectives, content, and principles) (Lieberink, 2006).

Each of the four dimensions has the potential to evoke change, as well as prevent change and preserve institutional stability. For instance, based on Discursive Institutionalism, in this research project the analysis started from the discourse corner of the tetrahedron, assuming that discursive shifts will influence the actors and coalitions, the rules of the game, and the available resources. Discourse refers to general exogenous ideas exceeding specific policy sectors and the organization of society, particularly the relationship between state, market, and the civil society, as well as concrete endogenous ideas about a specific policy problem at stake (Lieberink, 2006; Veenman et al., 2009). For example, the empirical chapters (Chapter 5, Chapter 6 and Chapter 7) describe how the increased recognition of complexity in general and the series of environmental health incidents in particular gradually resulted in new organizational structures (actors), new forms of interaction between science, politics, and society (rules of the game), new methods for knowledge production (resources), etc.

3.2. Methodological Account: Qualitative Data Collection, Analysis, and Interpretation

A historical analysis of the dynamic emergence of the Flemish environmental health arrangement over the last forty years requires a clear methodology of data collection, analysis, and interpretation. The scope of the study is defined in Section 3.2.1. In order to get a detailed and balanced picture of the stability and the changes within the Flemish environmental health policy-making and knowledge-production processes along the four dimensions of the Policy Arrangement Approach, data are gathered, analysed and interpreted based on a qualitative approach using a triangulation of complementary methods: document analysis (Section 3.2.2.) and in-depth interviews (Section 3.2.3.). To illustrate their complementary character, the document analysis for instance lays the foundation for the development of a chronological time table (reconstruction of formal discourses, rules of the game, and resources) and actor maps (reconstruction of the key actors). These tools are used as an input for the in-depth interviews to ensure well-documented and focused preparations. The interviews are necessary to validate the information from the document analysis and to gain additional information. After all, most

documents (e.g., meeting reports, policy letters) tend to only describe the reached compromise and rarely the discussions behind it, which give an indication of the different meanings, perceptions, discourses, and actor coalitions. Also informal rules can be mainly reconstructed on the basis of interviews. As such, methodological triangulation is necessary in order to increase the credibility and validity of the research results (Section 3.2.4.).

The methodological approach is described according to the chronology of the empirical chapters. Chapter 4 reviews the empirical developments related to environmental health decision making and knowledge development at the international and European level. Also the Belgian National Environment and Health Action Plan (NEHAP), which was developed in response to European commitments, is discussed. The three latter chapters chronologically analyse the institutional dynamics of the Flemish environmental health arrangement over a period of forty years. The three chapters correspond to three phases which can overlap specific time periods. The first phase refers to the institutionalization and differentiation of industrial safety, public health, and, in later years, the environment as fragmented policy arrangements (Chapter 5). The second phase is characterized by adding environmental health to the political and scientific agenda as a result of a series of environmental health related incidents (Chapter 6). The last phase refers to the institutionalization of a Flemish environmental health policy arrangement (Chapter 7).

It must be noted that the empirical survey, in practice, worked out along different lines and that each empirical chapter is the result of different methodological approaches. For instance, Chapter 5 and Chapter 7 describe more general, long-term developments based on new discourses about environment and health. The dynamics of the Flemish environmental health arrangement become noticeable in Chapter 6 in which the impact of four specific environmental health incidents on the institutionalization of the Flemish environmental health arrangement is discussed. If relevant, the methodological differences for the analysis of the three phases are emphasized in the next sections.

3.2.1. Scope of the Historical Analysis

This study analyses the historical developments of the dynamic emergence of the environmental health arrangement in Flanders (the northern region of Belgium) over a period of forty years. In this section, the demarcation in time and scale is further elaborated.

- **Demarcation in Time**

The Flemish environmental health decision-making and knowledge-production processes are studied over the last four decades, from the Nineteen Seventies until the first decade of the twenty-first century. Nineteen Seventy is chosen as reference point, because it corresponds with the beginning of the scientific and political agenda setting of environmental issues. However, it must be noted that the roots of the environmental health movement and environmental health research trace back more than a century (Gochfeld & Goldstein, 1999) to the post-industrial revolution years when, "increasing urbanization led naturally to concerns about the safety of food, housing, sanitation, industrial waste and other aspects of public works that influence human health" (Ryan, 2003). As a consequence, the sanitary revolution in the nineteenth and twentieth century is also taken into account.

Although the main focus is on the historical analysis, the information gathered is also used to assess the present performance of the Flemish environmental health arrangement. Referring to Runhaar et al. (2009; 2010), an effective environmental health arrangement ensures that a region progresses in meeting its environmental health objectives and succeeds in reducing environmental health risks to levels that are acceptable to decisionmakers, the public, scientists, and other stakeholders. The indicators presented in Table 10, Section 2.4., are used to evaluate the Flemish arrangement. Based upon that assessment, recommendations are derived to ameliorate the performance of the arrangement in the future.

- **Demarcation in Scale**

The historical analysis focuses on the institutional dynamics of the environmental health arrangement in Flanders. The number of empirical studies dealing with the daily practice of environmental health risk governance is still low. Hence, robust empirical evidence is lacking. Two exceptions are the quick-scan survey of Soer et al. (2009) and the follow-up study of Runhaar et al. (2010) in order to characterize, explain and evaluate shifts in environmental health risk governance at a meta-level. However, both studies only focus on the main characteristics of the environmental health risk governance arrangement of 12 different countries and do not pretend to be comprehensive, in-depth and detailed. The latter can be considered as the added value of studying the historical analysis of the Flemish environmental health risk governance arrangement.

Since the constitutional reforms of the Belgian State in the Nineteen Seventies and Nineteen Eighties, the Regions (i.e., the Brussels-Capital Region, the Flemish Region, and the Walloon Region) and Communities (i.e., the Dutch-speaking Community, the French-speaking Community, and the German-speaking Community) have gained political authority on almost all environmental and preventive health policies, respectively. However, the foundations of the Flemish environmental health arrangement date from the period before the constitutional reforms of the Belgian State. As a result of these political evolutions, the historical analysis focuses primarily on Flanders, but also takes into account the Belgian federal level for the historical analysis of the period before the constitutional reforms or if relevant such as related to cooperation agreements between the different governments in Belgium. Also, the international and European policy context is taken into account, as the Flemish environmental health arrangement does not operate in a vacuum, in order to determine the strongest triggers and drivers for institutional change and continuity. The demarcation in scale means concretely that the international and European developments are discussed briefly in Chapter 4, as well as the developments at the federal level. The main focus is on the institutionalization process of the environmental health arrangement in Flanders, elaborated in Chapter 5, Chapter 6 and Chapter 7.

3.2.2. Content-Analysis of Written Documents

The main aim of the document analysis is to provide a first reading and to construct an initial chronology of the developments and evolutions in the environmental health policy and research field at the Flemish, Belgian, European and international level. The analysis of the legislation and policy documents provides an overview of the establishment of the environmental health policy, the way it is formally recorded. The analysis of documents gives some initial indications about the key events, discourses, and actors in the field and a first impression of the stability or change within the environmental health domain at the different authority levels.

The document analysis results in a first draft of a chronological overview and actor maps. The chronological overview of the environmental health policy process takes into account a multi-level perspective to draw attention to the role of different governance activities, actors, discourses, rules and their interplay across a range of geographical-administrative scales (supranational, national, regional and local). The actor maps give a schematic overview of the actors involved into the environmental health governance arrangement, their roles, relationships, and interdependencies over the last four decades of

environmental health history at the different political levels. Each actor map distinguishes governmental, private, societal, and scientific agencies, and those particularly responsible for the interaction between them, for example, advisory boards. While the chronological overview and actor maps are merely heuristic instruments that do not claim to be exhaustive, they do identify key events, discourses, agencies, and the primary interaction forums. Both tools are helpful to detect and analyse the institutional persistence and changes over the last four decades of environmental health governance.

In order to analyse the international and European developments related to environmental health policy making (Chapter 4), policy documents originating from the United Nations, the WHO-Europe and the European Commission are studied. At the international level, international agreements of the United Nations are reviewed including those from the UN Conference on the Human Environment 1972, the UN Conference on Environment and Development 1992, the WHO Health Charters (1978, 1986, 1988, 1991, 1997, 2000, 2005), and the WHO Environmental Health Criteria Programme. Related to the WHO-Europe, special attention was given to the documents related to the *Ministerial Conferences on Environment and Health* (1989, 1994, 1999, 2004, 2010). Related to the European Commission, policy documents were analysed such as: *The European Environment and Health Strategy*, the *European Environment & Health Action Plan 2004-2010*, and the *Children's Environment and Health Action Plan for Europe*. In practice, those international and European policy documents are screened for the phrase "environmental health" and the meaning or interpretation of it. In response to the European commitment at the second WHO-Europe ministerial conference on Environment and Health, the Belgian Government engaged to develop a national environment and health action plan (NEHAP). The development process of the Belgian NEHAP, the NEHAP itself, its related projects and outcomes, and official evaluation studies are consulted at its official website: www.nehap.be.

For the analysis of the institutionalization and differentiation of industrial safety, public health, and in later years, the environment as fragmented policy arrangements in Belgium (Chapter 5), primary sources are scarcely available or difficult to access (for instance, the archive of the Environment and Health Initiative - *Initiatiefgroep Leefmilieu en Gezondheid* - is not open to the general public). Consequently, the use of secondary sources is unavoidable. Examples of secondary sources are publications related to jubilee volumes of environment and health organizations (i.e., 150 years Superior Health Council in Belgium (Bruyneel, 2009), 100 years Provincial Institute of Public Health (Claes et al., 1997), 30 years BBL (BBL, 2001)), and historical reviews of the

Belgian environment and/or health policy (e.g., De Swaan, 1989, Leroy & De Geest, 1985, Van De Kerckhove, 1987, Velle, 1990).

For Chapter 6, analysing the impact of four specific environmental health incidents on the institutionalization of the Flemish environmental health arrangement, primary and secondary sources are studied depending on the date of incidence occurrence. For the incidents that happened before 1985, primary sources are scarcely available or difficult to access. These incidents are analysed using secondary sources (e.g., Gijssels, 1979, Merckx, 2008). The latter incidents are primarily studied based on research papers and (doctoral) dissertations. Additionally, the Flemish newspapers are screened in order to determine important actors, measures, and events, but also different stakeholders' opinions and to verify the historical description of each incident. The newspapers are screened using Mediargus, an online press database covering all Flemish newspapers from 1988. As a consequence, the lead incident in Hoboken that occurred in the early Nineteen Seventies cannot be reconstructed using Mediargus. For the other three incidents, the following key words were used: "cadmium Noorderkempen", "dioxins verbandingsovens" and/or "ISVAG", "dioxine voedselketen".

Related to Chapter 7, analysing the institutionalization process of the Flemish environmental health arrangement since the end of the Nineteen Nineties, mainly primary sources are studied, such as policy documents, legislation, annual reports, and advisory reports. These sources are mostly digital available. The selection of appropriate policy documents at the Flemish level is conducted by identifying the key agencies involved in drafting, ratifying, and implementing environmental health legislation, as well as those involved in the actual implementation thereof. Flemish policy documents and legislation are gathered from the search engine of the Flemish Parliament (www.vlaamsparlament.be). Annual reports, advisory reports, and recommendations are downloaded from the websites of the Flemish public health and environmental administrations (TOVO, LNE, VMM), advisory bodies (VGR, Mina-Council), and scientific networks (www.milieu-en-gezondheid.be). In practice, these documents are screened for the phrase "environmental health" and the meaning or interpretation of it.

To describe the developments and evolutions in environmental health knowledge production, international, Belgian, and Flemish scientific review articles, papers, and reports are consulted. In addition, the website of the Flemish Centre of Expertise on Environment and Health (www.milieu-en-gezondheid.be) provides an abundance of information.

3.2.3. In-Depth Interviews

The interviews occur in two phases. The first phase, the exploratory phase, aims to develop a global comprehensive of the Flemish environmental health arrangement. The main aims of the second series of in-depth interviews are to validate the information from the document analysis and to gain additional information about the different meanings, perceptions, discourses, and actor coalitions behind legislation, agreements or decisions. After all, documents, such as meeting reports and policy documents, tend to only describe the reached compromise and rarely the discussions behind. Also the informal rules are mainly reconstructed on the basis of interviews.

▪ Exploratory Phase

At the start of the research project, five informants have been interviewed to develop a global comprehensive of the environmental health field in Flanders. The respondents are selected based on their long-term experience in the field and in heterogeneous manner (scientists as well as policymakers), to get a broad, multi-perspective overview. An overview of the interviewees is presented in Table 12.

Table 12: List of interviewees during the exploratory phase.

Name	Function/Expertise
Prof. Dr. G. Schoeters	Programme manager at VITO, responsible for the environmental health research programmes focusing on the development of biomarkers and their application in human biomonitoring. Member of the Flemish Centre of Expertise on Environment and Health.
Prof. Dr. Ilse Loots	Professor at the University of Antwerp, specialized in environmental sociology and policy evaluation. Member of the Flemish Centre of Expertise on Environment and Health.
Prof. Dr. Luc Hens	Professor of Human Ecology at the Vrije Universiteit Brussel.
Prof. Dr. G. Eggermont	Research experience in radiation protection, dosimetry, nuclear safety, environment, nuclear waste management, science and technology assessment, and integration of social science and technology. Member of the Belgian Health Council.
J. Malcorps	Member of the Flemish Green Party (Groen!) Chairman of the ad hoc Commission for Environment and Health of the Flemish Parliament 2000-2001.

The aim of these helicopter interviews is twofold. Firstly, complementary to the document analysis, the interviews give the opportunity for the interviewer to become acquainted with the Flemish environmental health field. After all, it is an opportunity for the interviewer to make herself and her research topic known to these key players. Secondly, the interviews, taking place in the exploratory phase, are used as a learning process for the interviewer. Through learning by doing, the interviewer learns which themes and terms operate well or not, etc.

The exploratory interviews are semi-structured based on interview guidance. The questions focus on the development and evolutions of the environmental health policy and/or science domain, the institutional context, the role interviewees and other actors play, the perceived interaction between science and policy, and their discourses on complexity and uncertainty. The interviewees are challenged to take a helicopter perspective, a more general point of view. All interviews are taped, with the approval of the interviewees, and transcribed.

- **Second Phase**

In the second phase, 25 respondents are interviewed. The respondents are selected based on their role and position, distracted from the chronological overview and actor maps, which resulted from the document analysis. In order to get a well-balanced picture of the environmental health arrangement and to achieve a representative study, it is necessary to select the respondents carefully. The main criteria are: a well-balanced number of scientists and policymakers, a well-balanced number of respondents from the environment and the health perspective, and a well-balanced number of respondents within the three different time periods of the Flemish institutionalization process. However, related to the last condition, it is obvious that it is a difficulty to find appropriate interviewees for the first age of differentiation. After all, most public servants, politicians, and scientists of that time period are already retired (e.g., Denteneer, Thiers and De Wel) or have even deceased (e.g., Prof. Clara). An overview of the interviewees is presented in Table 13. For each interviewee, his/her function is shortly described and an indication is given of the person's perspective (environment or health and science or policy).

All interviews are semi-structured. The interview guide is based on the results of the document analysis and the outcome of earlier interviews. The interview guide is adapted to the role, function and activities of each respondent. The questions focus, for instance, on the agenda setting of environmental health,

the development and evolutions of the environmental health policy and/or science domain, the institutional context, the impact of different crises like the incineration crisis, the role different actors played, the relationship between different actors, the perceived interaction between science and policy, the use of environmental health indicators, biomonitoring, their discourses on complexity and uncertainty, some concrete questions about the content of policy documents or legislation, a strength weakness analysis of the Flemish environmental health network, etc.

All interviews are taped, with the approval of the interviewees, and transcribed in a Word 2007 document. The interviews' transcripts are imported into NVivo software. NVivo is a computer programme designed to help in qualitative data analysis. The raw interview data are coded or categorized. The codes are created based on the a-priori and induction methods. The a-priori method is created prior to the fieldwork and is derived from the conceptual, analytical, and methodological frameworks. While doing the qualitative analysis and the examination of the data, it is useful to create some specific codes to refine the a-priori selected codes. These codes are called inductive codes. An overview of the created a-priori and inductive codes is schematically presented as a tree nodes structure in Figure 9. In order to make a difference between the a-priori created and inductive codes, the inductive codes are put in *Italic*. The NVivo software is only used to gather all information efficiently derived by the interviews related to a specific subject and to deduce overviews fast.

Table 13: Overview interviewees to control representativeness.

(S = scientist; P = politician or civil servant; E = environmental perspective; H = health perspective).

Time Period	Respondent	Function	S	P	E	H
Age of Differentiation	August Denteneer	Civil servant, Flemish Environmental Administration, early 1980s		X	X	
	Godfried Thiers	Manager, Scientific Institute of Public Health, 1980s and 1990s	X			X
	Guy Magnus	VLAMM (Flemish Doctors for the Environment), WVMG (Flemish Scientific Organization for Environment and Health)	X			X
	Herman De Wel	Civil servant, Flemish Environmental Administration, 1980s-mid 1990s		X	X	
Series of Environmental Health Incidents	Wivina Demeester	Flemish Minister of Health, 1995-1999		X		X
	Theo Kelchtermans	Flemish Minister of Environment, 1988-1992; 1995-1999		X	X	
	Mieke Vogels	Flemish Minister of Health, 1999-2003		X		X
	Vera Dua	Flemish Minister of Environment, 1999-2003		X	X	
	Rudi Daems	Principle Private Secretary of the Flemish Minister of Environment, 1999-2003		X	X	
	Pierre Biot	Civil servant, Federal Public Service Health, Food Chain Safety and Environment		X	X	
	Bob Vlietinck	Professor, Genetic Epidemiology	X			X
	Francis Noyen	Environment and Nature Council of Flanders		X	X	
	Nik Van Larebeke	Professor, Cancer Prevention	X			X
	Jan Staessen	Professor, Molecular and Cardiovascular Research	X			X
	Dominique Aerts	Civil servant, Flemish Environmental Administration, late 1990s			X	X
Dirk Wildemeersch	Civil servant, Flemish Health Administration			X	X	

Institutionalization of the Environmental Health Arrangement	Jan Verheeke	Principle Private Secretary of the Flemish Minister of Environment, 2004-2009		X	X	
	Karen Van Campenhout	Civil Servant, Flemish Environmental Administration		X	X	
	Hans Reynders	Civil Servant, Flemish Environmental Administration		X	X	
	Hana Chovanova	Civil Servant, Flemish Health Administration		X		X
	Hans Keune	Sociologist	X			
	Vera Nelen	Provincial Institute for Hygiene of Antwerp	X			X
	Marleen Van Steertegem	State of the Environment Report of the Flemish Region of Belgium		X	X	
	Mart Verlaek	Civil Servant, Flemish Health Administration		X		X
Willy Baeyens	Professor Environmental Chemistry; coordinator Flemish Centre of Expertise on Environment and Health	X		X		

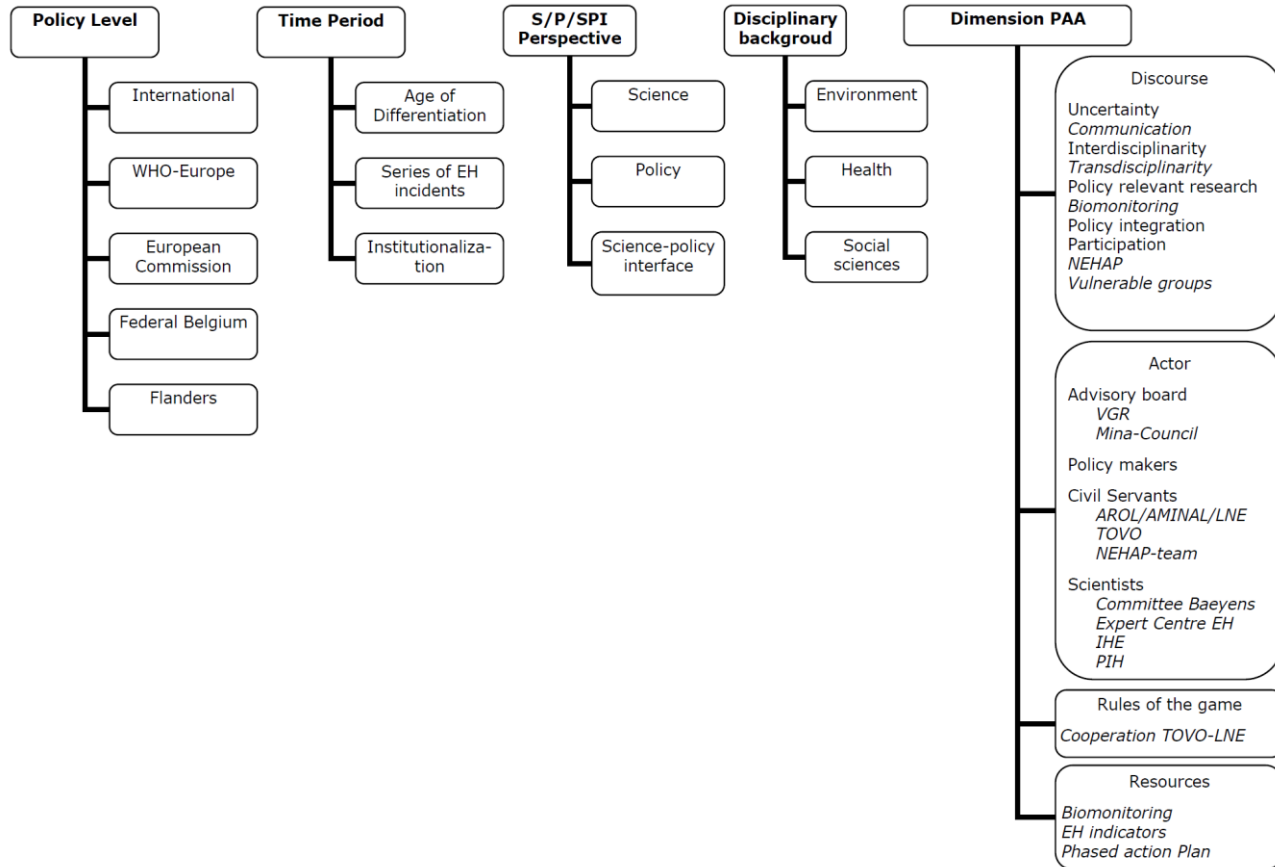


Figure 9: The tree nodes structure of the a-priori and inductive created (Italic) codes.

3.2.4. Validity and Reliability

In this research project, the impact of newly emerging epistemological discourses about complexity of environmental health risks, the political discourses about governance, and the new thoughts about science-policy-society interaction on the institutionalization process of the Flemish environmental health arrangement is studied over a period of forty years. The strength of the historical analysis approach, based on a combination of several research methods, is its internal validity. To ensure completeness of findings and to confirm findings, the technique of data and methods triangulation is employed. Data triangulation refers to the collection of data from more than one level of persons. In this research strategy, thirty key persons involved in the Flemish environmental health policy-making and knowledge-production processes are selected, considering a balance between policymakers, public servants, and scientists; as well a balance between those from an environmental perspective and those from a health perspective. As such, data from one level of persons is used to validate data from the other levels, but it is also useful to discover additional data to reconcile the incongruence. Methodological triangulation refers to the technique of using more than one method to gather data. In this research strategy, content analysis and in-depth interviews are used to answer the same research question and to look for convergence in research findings. More precisely, in-depth interviews are used to verify conclusions from the document analysis and to gather information that goes behind the written document, as such, discussions and discourses lagging behind the formal agreement which was written down. On the other hand, document analysis is used to double-check the answers of respondents and to have impressions or expressions gathered from the interviews clarified. In order to verify the correctness and completeness of the historical and current analysis, ir. Rudi Torfs (VITO) and dr. Roel Smolders (VITO) have reviewed the empirical chapters. By using triangulation, a more detailed and balanced picture of the Flemish environmental health policy and knowledge arrangement is gathered, and the credibility and validity of the results increase.

Contrary to the internal validity, the external validity of the results of the historical analysis bridging 40 years of environmental health institutionalization in Flanders is rather limited because every case is rather unique. The limited external validity is not a problem because this research project not intended to be generalized.

Another important criterion to judge scientific research is reliability. Guba and Lincoln (1994) prefer to use the term "dependability" in the case of qualitative

research because the assumption of repeatability is under discussion. To increase the reliability of this research, the selection of documents and respondents, as well as the interpretation process and the account of choices, are written down as clearly and explicitly as possible. Transparency is considered of paramount importance. Referring to Guba and Lincoln, the account for the ever-changing context within which research occurs is reported.

Chapter 4: International and European Developments: Towards Risk Governance

In Chapter 2, the recently emerged concept Risk Governance (Renn, 2005) is introduced to deal systemically with environmental health risks, which are embedded in a larger social, financial, and economic context and characterized by complexity, uncertainty, and ambiguity. Risk governance reflects the substantial changes related to: 1) the epistemological discourse about the concept of risk itself (Section 2.1.1.), 2) the scientific knowledge development process in response to complexity at the organizational level towards extended participation (Section 2.1.2.) as well as at the methodological level towards integrated risk assessment (Section 2.1.3.), and 3) decision making encompassing shifts in governance in order to manage these complex risks (Section 2.2.1.). Taking into account the theoretical and conceptual developments towards Risk Governance as described in Section 2.2.4., this chapter reviews its empirical developments at the international and European level.

First, the emergence and agenda setting of environmental health at the international and European level is described (Section 4.1.). The environmental health discourse and policy framework in Europe are explicated by the *Environment and Health Process for Europe*, initiated by the WHO-Europe. In response to the increased need to institutionalize environmental health as a policy domain and to the need for closer cooperation between health and the environment, on the one hand, and between different political levels, on the other, the *Environmental Health Action Plan for Europe* (EHAPE) and *National Action Plans on Health and the Environment* (NEHAP) have been established (Section 4.1.1.). Because the Belgian Environmental Health Action Plan has been developed in response to the European development, the action plan, its strengths and weaknesses are described in more detail in Section 4.1.2. To conclude this first part, the future directions of environmental health at the international and European policy level are put in a nutshell (Section 4.1.3.).

Second, the empirical challenges for dealing with complex environmental health risks are identified (Section 4.2.) Related to knowledge developments, an overview is presented of the most common Integrated Environmental Health Risk Assessment frameworks (Section 4.2.1.). Related to policy developments, the analytical framework for risk governance and the empirical

studies on environmental health risk governance arrangements are discussed (Section 4.2.2.).

This chapter is a further elaboration of earlier published work by Stassen, Gislason and Leroy in the international peer-reviewed journal *Public Health* in 2010: "Impact of environmental discourses on public health policy arrangements: A comparative study in the UK and Flanders (Belgium)."

4.1. Agenda Setting of Environmental Health: Towards Environmental Health Action Plans

This section primarily looks at the successful launch of key sensitizing environmental health concepts and related discourses at international and European levels. A schematic overview of the most important events related to the emergence and agenda setting of the environmental health discourse at these levels is presented in Figure 10. As the schematic overview presents, the Environment and Health Process for Europe, initiated by the WHO-Europe, played an important role. For instance, based on the debates during the Ministerial Conferences on Environment and Health in 1994, the *Environmental Health Action Plan for Europe* (WHO-Europe, 1994a) was established. The second part focuses on the development process, the strengths and weaknesses of the *Belgian Environmental Health Action Plan* (NEHAP, 2003), which was drawn up in response to a European commitment in 1994 (WHO-Europe, 1994b). The last part reflects on what the near future will bring at the international and European level related to environmental health.

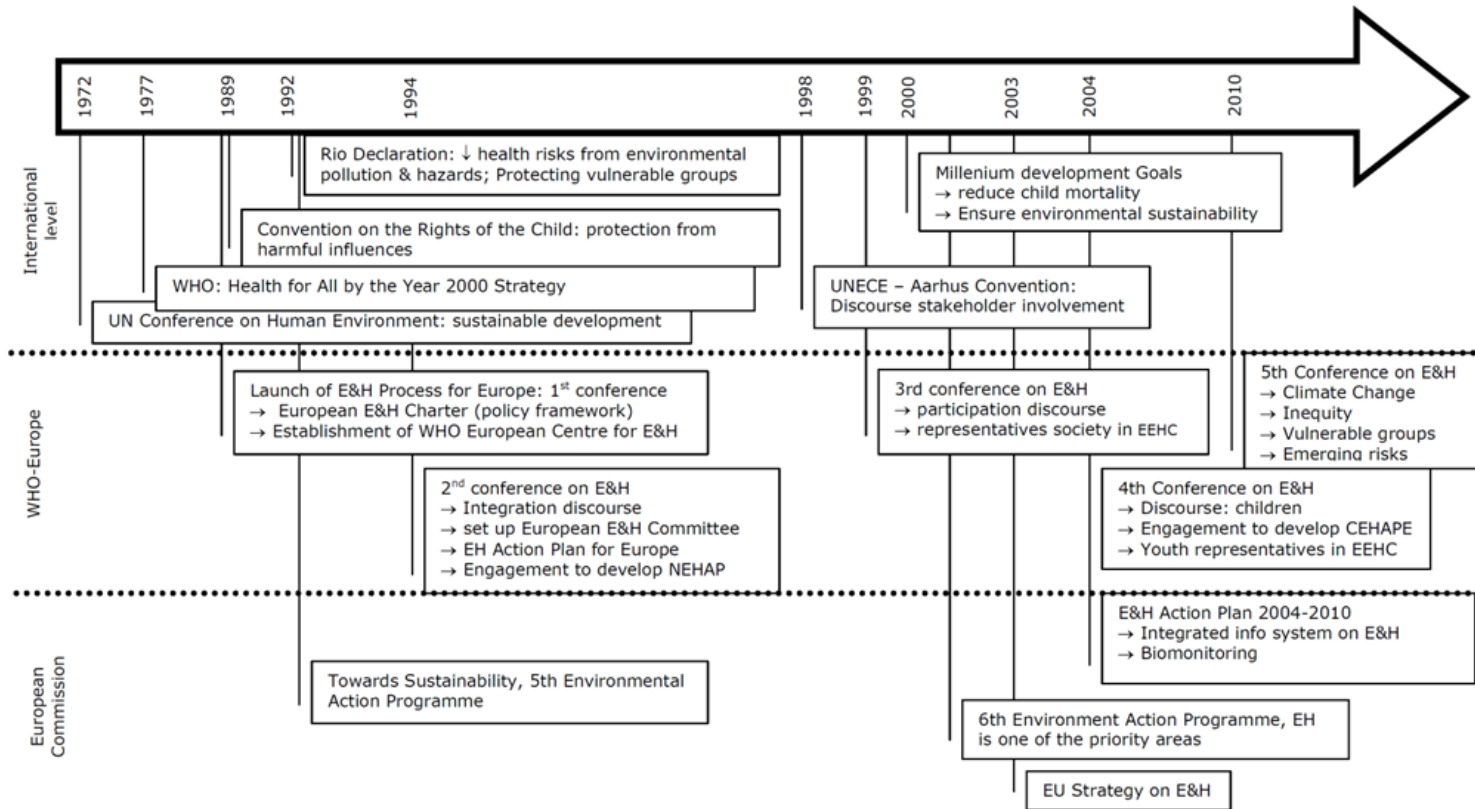


Figure 10: Schematic overview of the key events in environmental health policy at the international and EU-levels (Based on Stassen, Gislason & Leroy, 2010).

4.1.1. The Emergence of Environmental Health at the International and European Level: Towards Action Plans

The environmental health discourse has been developed over time as an increasingly important issue for sustainable development. Sustainable development was set on the international, political agenda by the *Declaration of the United Nations on Human Environment* (UN, 1972), which emphasizes the interrelationship of human activities and their impacts on the biosphere and, in turn, the interdependence of human beings and the environment. The Declaration highlights that an environment of a quality that permits good health and well-being is a human right for the present and the future generations. Good health and well-being are not only important for individuals themselves, but also for the wider economic and social benefits. As a consequence, the human population bears a solemn responsibility to protect and improve the environment. As such, international and European environmental policies have been driven by health considerations from the beginning.

The World Health Organization (WHO) have played an important role in placing environmental health risks on the international agenda. Already in 1977, the WHO launched the *Health for All by the Year 2000 Strategy* with the intention to attain for all citizens of the world a level of health, by the year 2000, that will permit them to lead a socially and economically productive life (WHO, 1981). Recognizing the dependence of human health on a wide range of environmental factors, environmental health was defined as a priority area and eight environmental health targets were set in 1984 by the European Union Member States within the *European Health for All Policy* (WHO-Europe, 1984).

The environmental health discourse and policy framework in Europe have been made explicit by WHO-Europe. Central to this initiative is the *Environment and Health Process for Europe* launched by WHO-Europe in 1989 and marked by a series of ministerial conferences held every five years intended to shape European and national agendas on health and environment, as well as to strengthen collaboration on a variety of scales (Perlstadt, 2002). At the first Conference in 1989, the ministers endorsed the *European Charter on Environment and Health* in which they recognized the dependence of human health on a wide range of environmental factors and agreed upon the basic principles, mechanisms, and priorities at work within this phenomenon (WHO-Europe, 1989). This charter comprises the backbone of the European Government's approach to environmental health. The charter has also been influential at the international level, for instance, during the 1992 Rio Summit

which resulted in *Agenda 21* (UN, 1992a). At the Second Ministerial Conference (WHO-Europe, 1994b), the integration discourse was set, acknowledging: a) the need for closer cooperation between health-related, environmental, and research areas in order to develop a community system that integrates information on the state of the environment, ecosystems, and human health; b) the importance of institutionalizing environmental health as a policy domain; and c) the intent to improve cooperation between the European-, national-, and local-level processes. The established *Environmental Health Action Plan for Europe* (EHAPE; WHO-Europe, 1994a) aims at giving purpose and direction to environmental health activities within countries by ensuring coordinated actions designed to make the best use of the limited resources and to avoid the duplication of efforts (WHO-Europe, 1994a). The member states also committed to develop *National Action Plans on Health and the Environment* (NEHAP) by 1997. Inspired by the Aarhus Conference on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (UNECE, 1998), the discourse of stakeholder involvement was emphasized as important to environmental health matters at the Third Ministerial Conference (WHO-Europe, 1999). This discourse reflects the call for: 1) effective public access to information; 2) an improvement of communication and public participation; and 3) access to justice for the public with regard to environment and health matters. At the Fourth Ministerial Conference (WHO-Europe, 2004a), the particular vulnerability of children and reproductive health to environmental threats was made explicit. International agreements highlighting the protection of vulnerable groups (e.g., children) from harmful (environmental) influences, such as the *Convention on the Rights of the Child* (UN, 1989), the *Rio Declaration* (UN, 1992b) and the *Millennium Development Goals* (UN, 2000) were reinforced. More recently, the discourse of environment, health and children has been integrated into the *Children's Environment and Health Action Plan for Europe* (CEHAPE) (WHO-Europe, 2004b). At the fifth and last conference the need to more vigorously protect the health of children and other vulnerable groups was reconfirmed (WHO-Europe, 2010b). In addition, more attention has been given to socioeconomic and gender inequalities as well as to the environmental health impacts of climate change and other emerging risks such as nanoparticles.

Inspired by the international agreements on sustainable development and the WHO-Europe initiatives on environmental health, the European Union and the European Commission have more focused on environmental health issues. In order to implement initiatives such as *Agenda 21*, the European Union adopted *Towards Sustainability*, a programme of policy and action in relation to the

environment and sustainable development, better known as the *Fifth EC Environmental Action Programme* (European Community, 1993). This programme was among others linked to the *European Environmental Health Action Plan* (WHO-Europe, 1994a). In the *Sixth Environment Action Programme of the European Community (EAP)*, environmental health was identified as one of the four priority areas (European Community, 2002). Through the 6th EAP resources were provided to finance environmental health research and human biomonitoring projects. In light of these efforts, the high number of reported environment-related diseases and the increased recognition of the intrinsic complexity of most environmental health issues, the European Commission felt the need to launch a new approach to better tackle ongoing and emerging environmental health issues. After all, the early environmental health actions focused on single pollutants in single environmental compounds, while it became more and more obvious that policy responses needed to integrate different sources and stressors across different policy domains in order to effectively address the multi-causality of the issues at stake.

The *Strategy on Environment and Health* (EC, 2003), adopted in 2003, recognizes the complexity of environmental health problems, in particularly with respect to the chronic exposure to low doses of pollutants' cocktails and their cumulative health effects. This policy framework, also called the *SCALE initiative*, aims to scale up efforts and capacity for policy making and to achieve a better understanding of the complex interactions between the environmental threats and human health in order to reduce the impact of environmental factors on human health. As the acronym SCALE indicates (Science, Children, Awareness, Legal instrument and Evaluation), the strategy is based on science, focuses on children as a particularly susceptible population group, aims at raising awareness across the general audience, uses legal instruments and includes continuous evaluation. Reflecting the integration discourse, the *SCALE Strategy* proposes closer co-operation between the health, environment, and research communities and promotes the development of a community system that integrates data on the state of the environment, ecosystems, and human health. During its first cycle (2004-2010) the strategy focused on the link between environmental factors and childhood respiratory diseases, neurodevelopment disorders, childhood cancer, and disruption of the endocrine system. During the implementation process of this first cycle, full stakeholder involvement was realized by setting up technical working groups, a consultative group on environment and health and a major stakeholder conference in spring 2004.

Because European policy seeks to be based on scientific evidence, the EU funds environmental health research in their *Framework Programme for Research and Technological Development* in order to fill in the knowledge gaps regarding the link between the environment and health. Referring to the Aarhus Convention, the European policy framework also promotes the integration of all stakeholders by drawing together knowledge from a wide range of actor networks in order to ensure the efficient implementation of the Strategy.

The EU Strategy was followed by the *European Environment and Health Action Plan 2004-2010* (EHAP) which proposes: 1) to develop an Integrated Information System on Environment and Health (IISEH) in order to understand the links between sources of pollutants and health effects and referring to a coordinated approach to human biomonitoring; 2) to fill the knowledge gaps by strengthening research and identifying emerging issues; 3) to review policies and to improve communication (EC, 2004b). The Mid-Term Review of the EHAP, made by the European Parliament's Council on Environment and Health in 2007, emphasizes the need for a preventive policy, a sufficient funding for human biological monitoring, increased public awareness of environmental health, the considerations for vulnerable groups, and more attention to mental health, indoor pollution, nanoparticles and electromagnetic fields (EC, 2007).

To conclude, when these various international and European initiatives are analysed comparatively, three central environmental health discourses can be distinguished, which have an overall impact on the European arrangement and a particular constitutive impact on environmental health research and policy making. The first discourse, the integration discourse, refers to the cooperation between environment and health within policy and research, on the one hand, and the importance of coordination between different policy levels, on the other. Second, the discourse of stakeholder involvement refers to the public access to information and the participation of stakeholders in different stages of the decision-making process. Third, vulnerable groups, especially children, must be better protected.

These novel environmental health discourses have greatly affected the involved actors at the European level. For instance, in the European Environment and Health Committee, representatives of civil society, specifically youth, are included. Another illustration is the establishment of the European Centre for Environment and Health, and the Consultative Group on Environment and Health to ensure science-based decision making, on the one hand, and stakeholder involvement, on the other. In the *SCALE strategy* as

well as in the *European Environmental health Action Plan*, human biomonitoring is emphasized as a tool to better understand the link between environmental quality and long-term health effects and to improve policy-making.

Finally, these international and European developments have boosted environmental health research and policy making over the last decade and have made health effects of environmental exposure a trans-boundary issue, cutting across many diverse policy areas including, but not limited to: transport, climate change, housing, socio-economic (in)equality, and sustainable development. However, the science-policy interface and the integration of research results in environmental health policy making could be better according to a progress report on the implementation of the European Environment and Health Action Plan of the European Commission (SEC, 2010), "The results of the many environment and health research projects funded under FP5, FP6 and FP7 and of other information gathering efforts could be better exploited at policy level. An efficient mechanism to ensure the science-policy interface should be identified." The future directions of the environmental health arrangement at the international and European level are further elaborated in Section 4.1.3.

To conclude this section, Figure 11 presents a schematic overview of the actor groups involved at the European level in 2009.

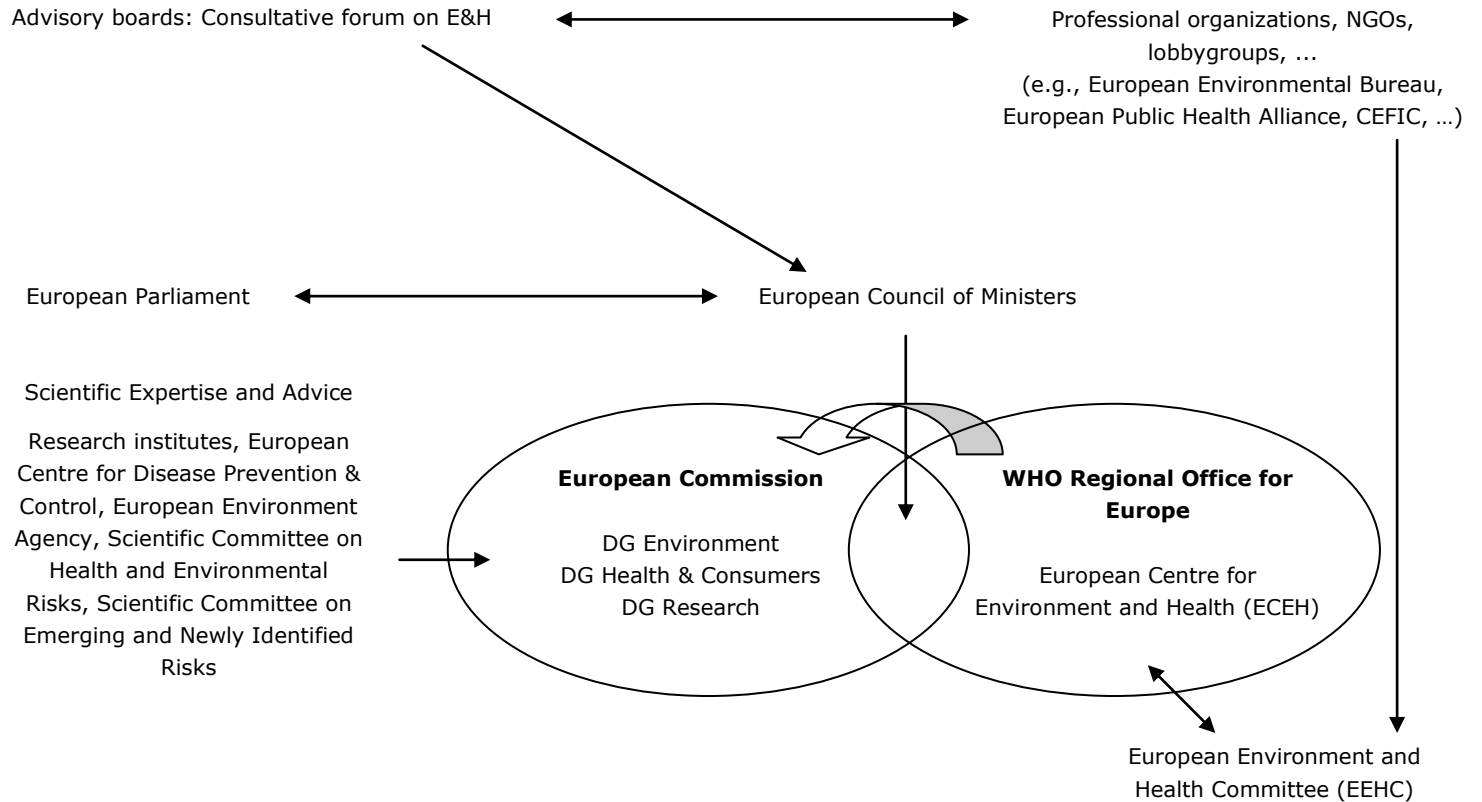


Figure 11: Actor map of the EU-level in the year 2009.

4.1.2. The Belgian Environmental Health Action Plan

The institutionalization of the environmental health policy field at the federal level is limited to the Belgian Environmental Health Action Plan in response to a European Commitment at the Second Ministerial Environment and Health Conference (WHO-Europe, 1994b) to develop National Action Plans on Health and the Environment (NEHAP). The first section reconstructs the main phases in the development process and the main characteristics of the Belgian NEHAP taking into account the four dimensions of the Policy Arrangement Approach (Actors, resources, rules of the game and discourses). In the second section, the NEHAP is evaluated through the eyes of the stakeholders, based on the interviews and the analysis of official governmental documents. A distinction is made between the content of the NEHAP, which reflects its priorities and most important discourses, and its organizational structure.

- **Towards a Belgian National Action Plan on Health and the Environment**

At the Second Ministerial Conference on Environment and Health, organized by the WHO-Europe in 1994, the importance of institutionalizing environmental health as a policy domain was recognized. As a consequence, the Member States committed themselves to develop National Action Plans on Health and the Environment (NEHAP) by 1997. These action plans are considered to integrate environment and health issues into existing policies (agriculture, energy, industry, transport, etc.). The National Action Plans should be closely linked with the European Action Plan in order to improve cooperation and coordination between the European and national processes (WHO-Europe, 1994b).

Although the Belgian Government already committed itself to develop a NEHAP in 1994, it was just beginning the discussions in 1998, a short-time span before the National Action Plans should be presented at the Third Ministerial Conference on Environment and Health in 1999. As a result of the late start-up, the Belgian Government could only present the Table of Contents (Wildemeersch, personal communication, March 30, 2010). The interviewees identified two main reasons for this late start-up. First, there was limited political interest in environmental health issues at the federal level before the dioxin crisis in the food chain, which is described in more detail in Section 6.4. (Vogels, personal communication, March 19, 2010; Magnus, personal communication, March 25, 2010; Aerts and Biot, personal communication, May 28, 2010). Second, the NEHAP concept was not adapted to the specific

characteristics of a federal country like Belgium in which environmental policies and preventive health issues are authorized to Regions and Communities, respectively (Wildemeersch, personal communication, March 30, 2010). As a consequence, in the early Nineties was hardly any competence at the federal level about environment and health issues. Moreover, there was no formal organizational structure yet for the environmental health debate between the different governmental levels in Belgium (Aerts and Biot, personal communication, May 28, 2010). As a solution to the federal organizational void, the Environment and Health Steering Group (EHSG) was established in 1998 in order to develop the Belgian NEHAP. This steering group brought together representatives of all the ministries in the fields of environment and health in Belgium.

Eventually, the *Belgian Environmental Health Action Plan* was launched in 2003 (NEHAP, 2003), consisting of three complementary documents. The first document provides an inventory of all actors involved in the environment and health, their actions, and measures taken. The second document summarizes the first document and adds some conclusions. The third document contains seven recommendations, which must be used as a frame of reference for the thinking and decision making of all ministers responsible for the environment and health in Belgium, concerning:

- a functional cooperation between existing structures of the environment and health, in order to facilitate horizontal decision making;
- the development of databases concerning all the aspects of environment and health (pollutants, pathologies, exposure, perception, wellbeing);
- the determination of priorities for environmental health research based on an interdisciplinary approach, in order to deal with uncertain risks;
- the development of a preventive environmental health policy, with explicit attention given to vulnerable groups;
- two-way communication on environment and health issues: considering the concerns of the population and disseminating information to individuals;
- courses and trainings on the relationships between the environment and health;
- the increase of people's awareness and education about environment and health issues in order the change production and consumption methods.

The recommendations are broken down into 36 practical measures to be carried out in the short-, medium-, and long-term (www.nehap.be, September 7, 2011). These actions are complementary to the projects conducted directly by the partners.

One of the main aims of NEHAP is to develop a framework for an integrated environmental health approach in Belgium and to increase the cooperation between the existing environment and health organizations at the crossroads of the two fields and of the various levels of power (NEHAP, 2003). In other words, NEHAP emphasizes the importance of integrated decision making and risk management. More precisely, environment and health problems should be incorporated into all other policies (horizontal integration), and coordinated across different policy levels (vertical integration).

To implement the actions mentioned in the NEHAP, a cooperation agreement was signed on December 10, 2003 by the Federal Government, the Regions, and the Communities (BS, 2004a). This agreement establishes the rules for collaboration, provides a framework for joint action, facilitates a multi-disciplinary approach, and determines the financial support for NEHAP projects and actions. The Joint Inter-ministerial Conference on Environment and Health (JICEH), established in 2001, brings together all of the competent ministers (federal, community, and regional) in the fields of the environment and health. The main intent of the Conference is to determine the NEHAP priorities and to monitor the implementation of NEHAP (www.nehap.be, September 2, 2011). The Joint-Inter-ministerial Conference is assisted by the Cell Environment-Health (consisting of representatives from all ministries for the environment and health in Belgium and their governmental departments), and its federal secretariat in order to prepare the activities of JICEH and to implement the Belgian NEHAP (www.nehap.be, September 2, 2011).

Although the financial budget of NEHAP is rather low (120,000 Euros/year), it finances some research projects in areas where many uncertainties exist or that would help to develop effective political tools that could prevent/ensure appropriate managing of environmental health problems. Examples of NEHAP projects are: 1) the inventory and selection of environmental health indicators to pinpoint and evaluate the Belgian policy on environment and health; 2) the comparison and evaluation of product policies of various countries world wide, regarding the protection of the indoor environments; 3) the evaluation of measures adopted at various levels in order to limit high ozone concentrations during heat waves; and 4) the investigation of the applicability of the European Apheis (Air Pollution and Health – A European Information System)

methodology to monitor the effects of air pollution on health in three Belgian cities (www.nehap.be; July 18, 2011; Snoy et d'Oppuers, 2007).

In response to the European commitment to develop national Children's Environment and Health Action Plan (CEHAP) in 2004, at the Fourth Ministerial Conference on Environment and Health, the members of the Joint Inter-ministerial Conference on Environment and Health (JICEH) in Belgium decided to integrate actions aimed at children within the existing NEHAP structure. This decision was taken based on the limited financial and personal resources (Aerts and Biot, personal communication, May 28, 2010) and the conviction that vulnerable groups, like the children and the elderly, needed continuous attention in the decision-making process (Van Campenhout and Reynders, personal communication, March 29, 2010; Vlaams Parlement, 2010). The financed CEHAP projects are related to international concerns and research projects, such as: the participation in two European projects on human biomonitoring, a feasibility study to establish a registration system used to investigate the relationship between child cancer and the environment, the participation in a WHO project to investigate the concentration level of persistent organic pollutants in breast milk, and the investigation of the indoor air quality of nurseries and schools (Snoy et d'Oppuers, 2007; NEHAP, 2008).

In 2008, the JICEH decided to draft a follow-up NEHAP. The second action plan consists of two complementary parts. The first part refers to the recommendations of the first NEHAP, which have been changed and/or adapted when necessary. The second part is the operational report including an enumeration of all past activities as well as a résumé of future activities. For the period 2009-2013, the NEHAP activities and environmental health projects focus on reducing the incidence of respiratory problems, especially as far as children are concerned. For instance, during the current NEHAP (2009-2013), the project on environmental health indicators is restricted to respiratory diseases in children as a result of indoor and outdoor exposure.

- **Strengths and Weaknesses of the Belgian NEHAP Evaluated by the Stakeholders**

In this section, the Belgian Action Plan on Health and the Environment is evaluated through the eyes of the stakeholders, based on data collected during the interviews (primary data), as well as information gathered from official governmental documents and research reports (secondary data). The strengths and weaknesses related to the NEHAP's content and its organizational structure are discussed.

Related to the NEHAP's content, the first document, which gives an overview of all actors involved in the environment and health process in Belgium, is considered useful in the sense that it stimulates the exchange of experiences, knowledge, etc. After all, the document presents a list of the responsible persons and persons or organizations that can be contacted if different scenarios or problems occur (Aerts and Biot, personal communication, May 28, 2010). Contrary, the recommendations defined in the third document are not sufficient geared to the international and European initiatives (Callebaut et al., 2007) or the *Federal Plan for Sustainable Development* (MINA-raad, 2003). Moreover, they are too broadly defined to be useful (Callebaut et al., 2007), and an operational action plan characterized by concrete deadlines, actions, resources, and responsibilities is lacking (VGR, 2003; Mina-raad, 2003). The OECD (2007) recommends analyzing the costs and benefits of environmental health policies and supporting environmental health research that is more relevant to policy. Summarizing, using the words of Noyen (personal communication, May 28, 2010, my translation), "Despite all efforts to develop a Belgian National Action Plan on Environment and Health, its development is more driven by the European commitment and less by the conviction to develop a useful instrument resulting in an approach that is too theoretical."

Related to the established organizational structure to implement the Belgian NEHAP, the cooperation agreement on environment and health (December 10, 2003) provides the institutional framework (BS, 2004a). Its main added values are: 1) the establishment of a similar cooperation structure for public health as already existed for the environment, 2) the assembly of representatives of different policy fields and levels to who authority over environmental health issues is allocated, and 3) the possibility to determine a collective opinion related to environmental health issues in response to European and international negotiations (Callebaut et al., 2007; Aerts and Biot, personal communication, May 28, 2010). However, the organizational structure is judged to be inefficient and cumbersome, in which not all governmental actors are equally involved (for instance the local and provincial governments, or representatives from the policy domains transportation, etc.), not to mention that representatives of the general public and scientists are not included at all (Callebaut et al., 2007).

To summarize, the main advantage of NEHAP is the opportunity to bring together the multitude of governmental actors at the federal and regional levels related to environment and health and to establish a formal consultative structure between them. However, the limited annual financial and personnel resources pass over the opportunity to make a difference in environmental health policy (Aerts & Biot, personal communication, May 28, 2010; Daems,

personal communication, May 6, 2010; Malcorps, personal communication, February 29, 2008; Hens, personal communication, June 13, 2008). If the resources remain limited in the future, the function of NEHAP will be reduced to a deliberative body to determine a common Belgian viewpoint (Aerts and Biot, personal communication, May 28, 2010).

Last remark, the impact of NEHAP on the Flemish environmental health policy arrangement was – and still is – rather limited. As illustrated in the following empirical chapters, the institutionalization process in Flanders was driven by a series of environmental health related incidents from the Nineteen Seventies until the Nineteen Nineties (Chapter 6). As a consequence, the environment and health decision-making and knowledge-development processes in Flanders were already well developed, while the other Regions in Belgium fell behind. As a result, the Belgian NEHAP could profit from the Flemish experiences and adopted their lessons learned (cfr. discourses about uncertainty, communication, etc.), as described in Chapter 6 and Chapter 7. The Flemish Health Council was rightly concerned that the NEHAP commitments could hamper a more ambitious regional approach in Flanders (VGR, 2003).

4.1.3. Future Directions at the International and European Level

What will the future bring at the international and European level related to environmental health? In the *Parma Declaration on Environment and Health* (WHO-Europe, 2010b), the Representatives of the Member States in the European Region of the World Health Organization emphasize, “To intensify their efforts to implement the commitments made through previous WHO ministerial conferences, especially those set out in the Children’s Environment and Health Action Plan for Europe.” The selected priority domains are related to climate change, socioeconomic and gender inequalities, non-communicable diseases, endocrine-disrupting chemicals, and (nano)-particles. The member states have committed to increase their efforts to develop, improve, and implement environmental health legislation and environmentally friendly, health-promoting technologies. The European Commission is challenged, “To offer further scientific, political, technical, and financial assistance to help establish effective mechanisms and strengthen capacities to reduce exposures to environmental hazards and the resulting health impact in the Region.” In response to the commitments adopted in the *Declaration of Parma* and the *WHO Regional Committee for Europe Resolution* (WHO-Europe, 2010c), five time-bound environmental health targets (Box 1) have been defined to reduce the harm to children’s health from environmental threats in the next decade

(www.euro.who.int, November 23, 2011). The *Parma Declaration* frames these commitments in a broader perspective, focusing on new challenges, such as climate change and socioeconomic inequalities.

Box 1: The five Parma time-bound environmental health targets to protect childrens' health (www.euro.who.int, 2011).

- By 2020, safe water and sanitation in homes, child care centres, kindergartens, schools, health care institutions and public recreational water settings;
- By 2020, health and safe environments and settings of daily life to walk and cycle and undertake physical activity;
- By 2015, indoor environments free of tobacco smoke in child care facilities, kindergartens, schools and public recreational settings;
- By 2015, environments free of toxic chemicals; and
- By 2015, reduced identifies health risks from carcinogens, mutagens and reproductive toxicants, including radon, ultraviolet radiation, asbestos and endocrine disruptors.

The representatives from the 53 European Member States of the WHO-Europe will meet again at the Sixth Ministerial Conference on Environment and Health in 2016. In the meanwhile, the European Environment and Health Process will continue. An institutional framework will be established in order to ensure political drive and appropriate coordination when implementing the national and international policies (WHO-Europe, 2010a). The European Environment and Health Task Force will include leading officials of the 53 Member States in the WHO European Region who are nominated at the national level as focal points for the European Environmental Health Process. The task force will be the leading international body for the implementation and monitoring of the environment and health process. The European Environment and Health Ministerial Board will be the political face and driving force of international environmental health policies. The Ministerial Board will consist of eight ministers equally representing the health and environment policy domains.

At the EU-level, the European Commission declared in Parma to ensure synergies between actions at the EU level and the Parma conference by implementing the *European Environment and Health Action Plan*. However, the first *Environment and Health Action Plan for Europe* (EHAPE) ended in 2010. During the Belgian presidency of the European Union from July 1, 2010 until December 31, 2010, several environmental health-related conferences and workshops were organized. Moreover, a study was requested by the Belgian Federal Minister of the Environment to review the EHAPE achievements and to identify opportunities for what should come after 2010 (HEAL, 2010).

The conclusions and results of these events lay the foundation for a request to the European Council in order to stimulate the development of a second European Environment and health Action Plan. The key points for a second European Environment and Health Action Plan are listed in Box 2.

Box 2: Key points for a 2nd EHAPE (“Towards a 2nd European Environment and Health Action Plan”, 2010).

Collaboration for better implementation of existing legislation;
Harmonization on methodologies towards more powerful national results;
Increase efficiency of resources dedicated at national and EU level;
Translation of science into policies and opportunities for new policies;
Overarching priority topic: vulnerable groups;
Priority topics to be continued and intensified: indoor air quality, human biomonitoring, integrated information system, disease predictive models;
Emerging topics such as climate change and health or nanotechnology.

The European Council conclusions of the 3061st Environment Council Meeting held in Brussels December 20, 2010, emphasize the development of the Seventh Environmental Action Programme that should focus on “climate change, biodiversity, the efficient and sustainable use of resources, the urban environment, the prevention and reduction of environmental pollution, as well as improving the quality of life and human health.” The Council also invites the European Commission to prepare a second Environment and Health Action Plan. In case of a second European Environment and Health Action Plan, the Health and Environment Alliance (HEAL, 2010) suggests to continue the priority themes of the first EHAPE as well as to include new emerging issues, and “to further develop policy tools to achieve a reduction in the disease burden and greater protection of vulnerable groups.” However, until December 2011, it is rather quiet at the European Union level. It seems that since 2010, as a consequence of the financial crisis, more attention is given to innovation and economic growth. The question is to what extent the European political arrangement will allow to further support and facilitate environmental health in the near future.

4.2. Challenges for Dealing with Environmental Health Risks: Towards Risk Governance

The chronological review of the emergence and agenda setting of environmental health risks at the international and European levels illustrates a variety of challenges for adequate knowledge and policy developments in response to complex environmental health risks. First, the empirical challenges related to knowledge developments are described. Based on the identified knowledge gaps for adequate policy development, an overview is presented of the most common Integrated Environmental Health Risk Assessment frameworks (Section 4.2.1.). Second, the political challenges towards risk governance are empirically presented. The Analytical Framework for Risk Governance of the IRGC and the empirical international and European studies on environmental health risk governance arrangements are discussed (Section 4.2.2.).

4.2.1. Knowledge Developments: Towards Integrated Environmental Health Risk Assessment

At the WHO International Public Health Symposium on Environment and Health Research in 2008 (WHO-Europe, 2008), the knowledge gaps for adequate policy development were identified. First, science needs to rethink its positivistic epistemology and expand its approach to capture the complexity and emergence of environmental health problems. After all, in order to develop and evaluate environmental health policies, decisionmakers need more comprehensive and balanced information to consider all implications of policies, including: 1) the cumulative effects of multiple exposures; 2) the long-term, unintended and trans-boundary effects; 3) the vulnerability of specific population groups; and 4) the multi-factorial nature of problems and the far-reaching effects of policies and other interventions. Second, in order to ensure its legitimacy, uncertainty management must be a key feature during the whole knowledge-production process. As such, uncertainty management should not only incorporate quantitative uncertainty analyses on the conclusions, but also transparency about the limits of knowledge, the underlying assumptions, and the values. Third, an inter- and even trans-disciplinary approach is recommended because neither expert views nor multidisciplinary expertise can grasp the complexity of the concerns of society nor be substituted for the engagement and involvement of the directly concerned stakeholders. As a consequence, social experts as well as stakeholders and the broader public have to participate in the knowledge-

production process to incorporate the multitude of attitudes towards real or perceived environmental health issues and to include different opinions and perceptions of risk and uncertainty.

However, these three knowledge gaps have challenged the development and implementation of more efficient methods and tools in order to facilitate and stimulate the integrated approach, uncertainty management, and the interaction between scientists, policymakers, and the public within the knowledge-production process. The conceptual evolution from sectoral risk assessment towards integrated risk assessment is already described in Chapter 2. Sectoral risk assessment is characterized by, “a chemical-by-chemical approach, focusing on a single media, a single source, and a single toxic endpoint” (WHO, 2001). Integrated risk assessment refers to “the interdisciplinary and participatory process of combining, interpreting, and communicating knowledge to allow a better understanding of complex phenomena” (Rotmans & Van Asselt, 2002), studying multiple agents, multiple exposure routes, multiple contaminants, multiple health endpoints, multiple scales in time, space and place (Süter et al., 2001). In response to the challenges when dealing with complex environment and health risks, assessment frameworks have been empirically developed, in the United States as well as in Europe, in order to improve knowledge development for adequate decision making.

- **The Environmental Health Risk Assessment and Risk Management Framework of the United States**

The United States have played a pivotal role in the conceptualization of risk assessment. Already in 1983, the American National Research Council published an applicable framework for risk assessment in The Red Book in order to present complex, inconsistent and incomplete scientific information in a usable form to risk managers (National Research Council, 1983; 2009). The assessment framework defines four steps in the risk assessment process: hazard identification, dose-response assessment, exposure assessment and risk characterization (Figure 12). Recognizing that the assessment of risks is a value-free and objective activity, free of policy and political influences, the framework is based on a positivistic approach. Nevertheless, the first recommendation of the Red Book emphasizes the well documentation of the assumptions made and the development of interference guidelines containing “an explicit statement of a predetermined choice among alternative inference options” (National Research Council, 1983; 2009).

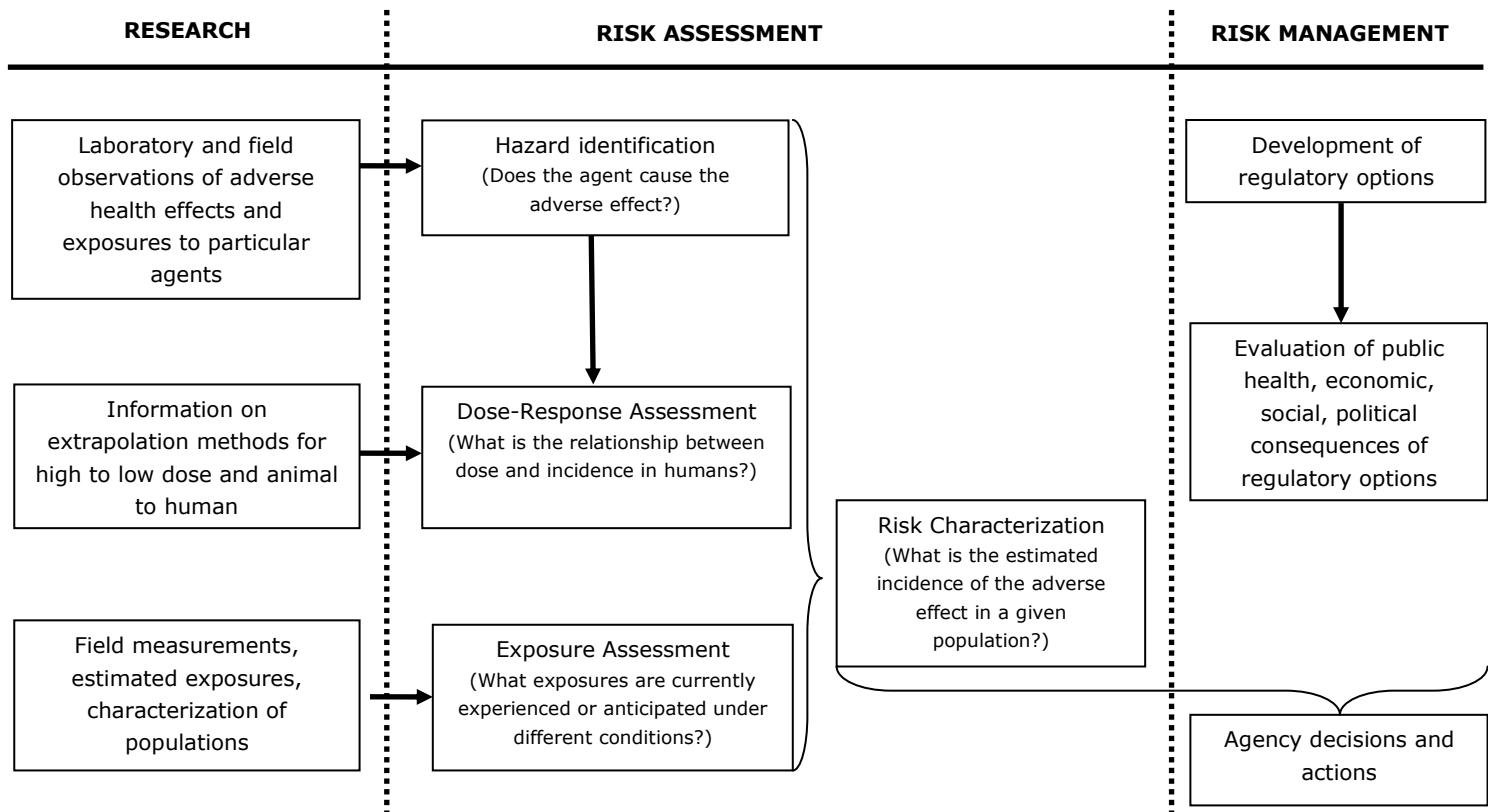


Figure 12: The national Research Council's risk assessment and risk management paradigm (National Research Council, 1983).

Because the American Environmental Protection Agency has been recently challenged by the growing complexity environmental health risks, the original assessment framework of The Red Book has been revised by the National Research Council. After all, the risk assessment framework should taken into account “multiple health and ecologic effects, costs and benefits, and risk-risk trade-offs (...) and to consider the social impacts of risk decisions to ensure that risk assessment is relevant to stakeholder concerns” (National Research Council, 2009). The revised framework (Figure 13) differs from the Red Book paradigm, primarily in its initial and final steps. More attention is given to problem formulation and scoping in order to determine the types of assessments and the required level of scientific depth that are needed to evaluate different management options. The framework also provides a formal process of stakeholder involvement throughout all stages and makes underlying limitations and assumptions more transparent. Related to stakeholder involvement, a balanced participation should be ensured and time constraints are necessary in order to ensure that decisions are made.

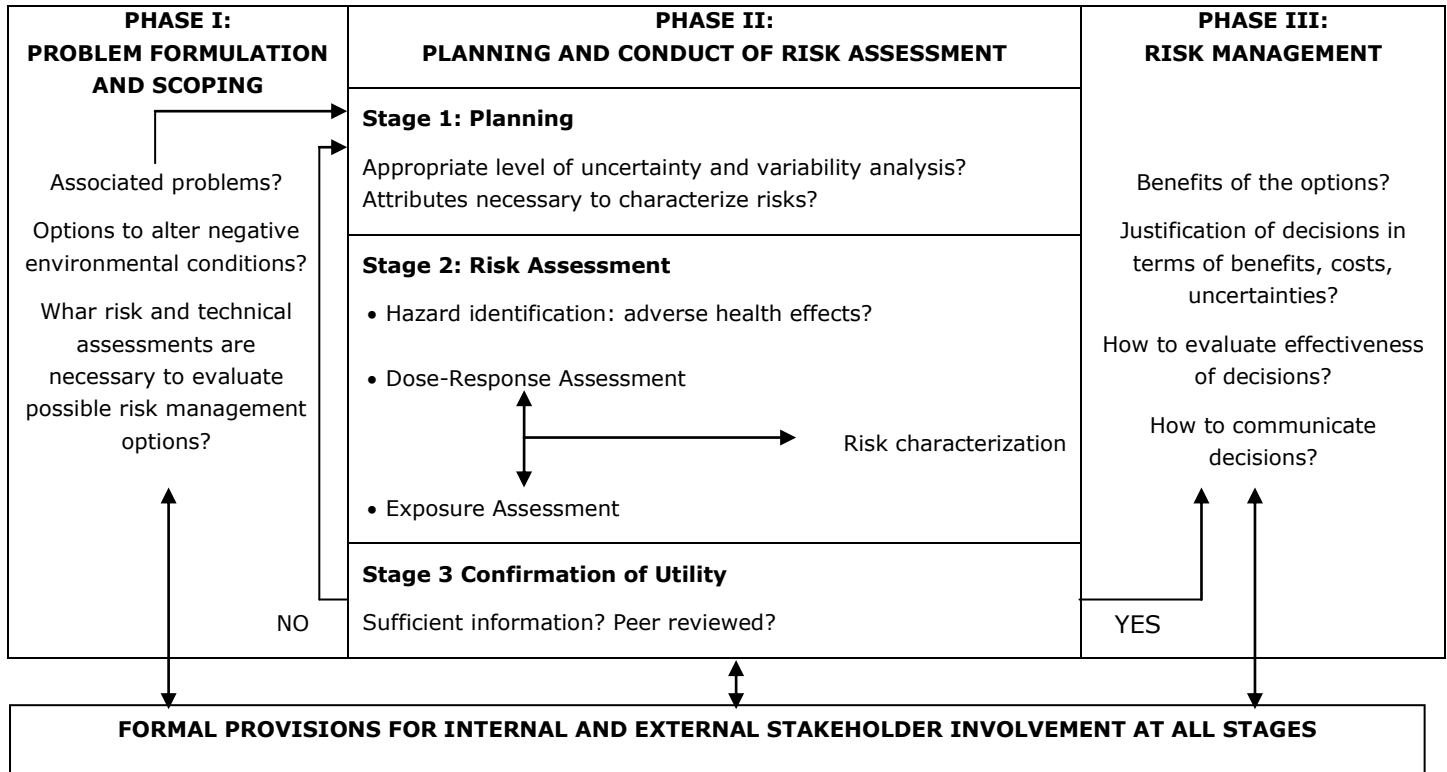


Figure 13: The American framework for risk-based decision making adapted to the complexity of environmental health problems (based on National Research Council, 2009).

▪ **The European Framework for Integrated Environmental Health Impact Assessment**

In response to the need for more inclusive and integrated assessment approaches of complex environmental health risks, and based on the work undertaken in two large European-funded research projects INTARESE (Integrated Assessment of health Risks of Environmental Stressors in Europe) and HEIMTSA (Health and Environment Integrated Methodology and Toolbox for Scenario Assessment), Briggs (2008) presents an analytical framework (Figure 14) at a more concrete and operational level for Integrated Environmental Health Impact Assessment (IEHIA).

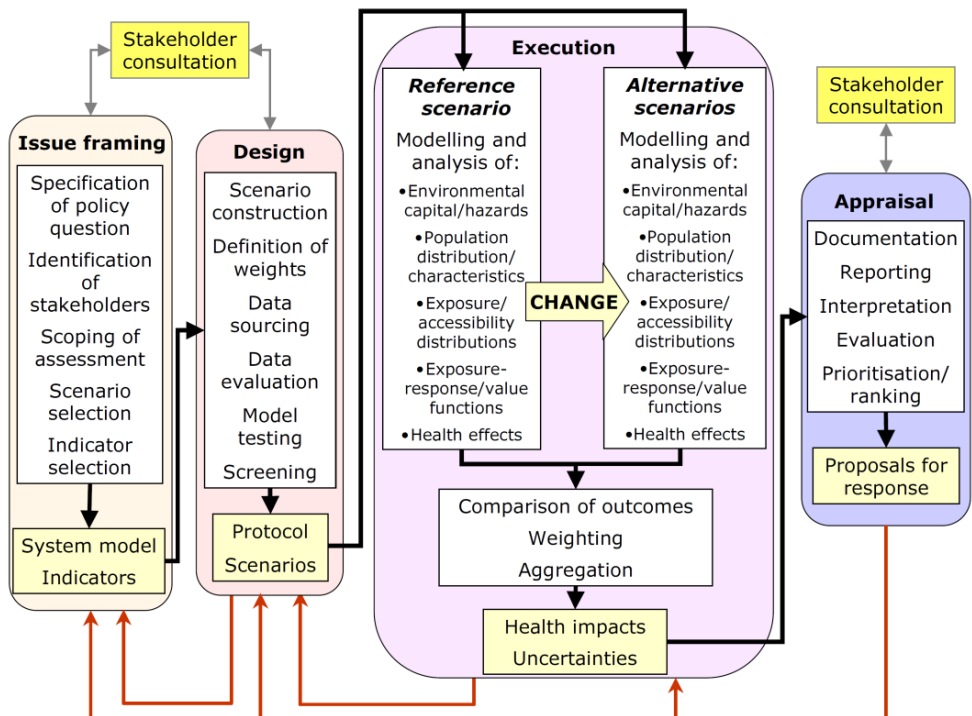


Figure 14: An operational framework for Integrated Environmental Health Impact Assessment (Briggs, 2008).

IEHIA is defined by Briggs (2008) as, "A means of assessing health-related problems deriving from the environment, and health-related impacts of policies and other interventions that affect the environment, in ways that take account of the complexities, interdependencies and uncertainties of the real world." Emphasizing effective stakeholder participation, multi-causality and non-linearity of many of the relationships, uncertainty management and the adaptive and behavioural changes that characterize environmental health systems, the framework aims to challenge the major features of complex environmental health risks. Different types of integration are incorporated into the framework: along the full length of the causal chain from sources to health effects; across different sources, exposure routes, and health outcomes; across different policy fields, scientific disciplines and other types of knowledge by integrating stakeholders; geographically across different regions and spatial scales; and temporally over different time dimensions (Briggs, 2008).

The assessment process of the Integrated Environmental Health Risk Assessment framework is composed of four phases (Briggs, 2008; Knol et al., 2010), which are very similar to the components of traditional risk assessment. However, more attention is given to the earlier stages of the analysis in order to ensure a well-defined problem definition, and the final stage in order to make sure that the involved stakeholders properly understand and accept the interpretation of the risk evaluation.

The first phase, "Issue framing", refers to a discursive, participative, and iterative process to define the problem, set the boundaries, determine the scope, outline the policy scenarios that should be considered, and choose the appropriate assessment form. A tool that can be used to stimulate thinking and discussion among stakeholders in this first stage is a structural framework in which the general context of the environmental health system related to economy, society, culture, etc. is described (Knol et al., 2010; Knol, 2010). This comprehensible model must be refined in a relational framework focusing on the links between different aspects of the system in order to create a chain- or web-like structure.

During the second phase, "Design", the conceptual model is converted into a detailed protocol or methodological approach in order to determine whether, and how, the assessment should proceed. As such, the relational structures are described in more detail and translated into an operational model which represent the subsystems, variables and processes that need to be assessed (Knol et al., 2010).

In the third phase, "Execution", the relevant data are collected and analysed in order to identify hazards, assess exposure, and characterize risks, taking into

account combined effects of exposure to multiple agents operating via different pathways and causing different health outcomes. Within INTARESE, a particular study investigated the potential application of human biomonitoring data - complementary to monitoring, modelling, epidemiology, etc. - to increase the capacity to adequately evaluate exposure to low levels of environmental chemicals for which the traditional epidemiological studies were too limited (Smolders et al., 2009). The main advantages of human biomonitoring data are: 1) its integration over environmental compartments and stressors, 2) its integration in time and space, and 3) its integration of lifestyle and person-specific information (Smolders et al., 2010).

The final phase, "Appraisal", refers to the discursive process with stakeholders, during which the results are reviewed, synthesized, interpreted, communicated, and compared to the original goals defined in the issue-framing phase. As a consequence, Knol (2010) suggests, "It may be appropriate to return to a simpler framework, focusing on the relevant measures of impact, in order to summarise the results of the assessment and help compare, or choose between, the different options available."

▪ **General Conclusion**

Despite the American and European efforts, Integrated Environmental Health Assessment is still in its infancy. The major challenges of IEHIA are related to the difficulties inherent to stakeholder involvement and the complexity of systemic issues (Briggs, 2008). Related to stakeholder involvement, a successful participation of stakeholders requires mutual understanding, equality, and trust like repeated and continuous dialogue. As a consequence, stakeholders' involvement is a time-consuming process. The participation process can be hampered by: different levels of knowledge; power; and social, cultural, and institutional affiliations. Related to complexity, Briggs (2008) identifies dealing with multi-causality, non-linearity and the dynamics, change, and adaptation processes over the short- and long-term as the key difficulties. Moreover, combining qualitative and quantitative information within the assessment also remains a major challenge. As a consequence of this complexity, IEHIA will always be characterized by incomplete, uncertain knowledge and data and it will be very difficult to carry out an IEHIA in practice within the limited resources, time frames and manpower (Knol, 2010). However, Knol (2010) argues that "the societal costs of sub-optimal decisions are also likely to be high." The American and European frameworks include a reflection about the scope of the appropriate form of assessment process that would be useful, efficient, and necessary in a particular context.

Although the intention of IEHIA to combine, interpret and communicate all relevant knowledge to support the policy process, it will not be the exclusive input for decision making. Other elements, “such as the political and social climate, other issues on the political agenda, or the media” will also influence the policy-making process (Knol, 2010).

4.2.2. Policy Developments: Towards Environmental Health Risk Governance Arrangements

The theoretical and conceptual developments towards risk governance are already described in Section 2.2.4. Risk governance, introduced by Renn (2005), deals systemically with complex environmental health risks. The International Risk Governance Council defines risk governance as, “Applying the principles of good governance to the identification, assessment, management and communication of risks in a broad sense (...) Risk governance is concerned with how relevant risk information is collected, analysed and communicated, and how management decisions are taken.” (IRCG, s.d.).

From a theoretical point of view, risk governance reflects the substantial changes related to the concept of risk itself (Section 2.1.1.), the organizational and methodological features of knowledge production (Section 2.1.2. and Section 2.1.3.), and the shift in governance (Section 2.2.). This chapter reviews the empirical developments towards risk governance at the international and European level. In order to deal in a more balanced, inclusive, and effective way with systemic risks, Renn (2005) developed, in cooperation with the International Risk Governance Council, a conceptual framework incorporating a set of key principles for sound risk governance. This framework is described in the first section below. The second section deals with the daily practice of environmental health risk governance by describing the results of empirical international and European studies on environmental health risk governance arrangements.

- **Analytical Framework for Risk Governance (Renn, 2005/2008a/2008b)**

Renn (2005) developed, in cooperation with the International Risk Governance Council, a conceptual framework for sound Risk Governance. After all, decision making in the case of complex (environmental health) risks takes place under considerable time pressure, knowledge deficits, and conflicting values and requires good governance. The framework contains the key

principles for sound risk governance, but does not intend to be a concrete and detailed manual, because of the diverse nature and context of these types of risks. These key principles include: transparency, effectiveness, efficiency, accountability, equity, fairness, respect for the rule of law, and the need for solutions that are politically and legally realizable as well as ethically and publicly acceptable. As a consequence, the framework integrates scientific, economic, social, and cultural aspects and requires the participation of all stakeholders (government, corporate sector, experts, civil society, etc.) during the whole process of risk analysis (i.e., risk assessment, risk management, and risk communication) (Renn, 2008a/b). The Integrated Analytic Framework for Risk Governance is presented in Figure 15.

The risk process itself is a cyclical, iterative, and interlinked process which builds upon four phases: pre-assessment, risk appraisal, characterization and evaluation, and risk management. Risk communication, the fifth phase, must be integrated throughout all phases. Together, those interlinked stages develop a thorough understanding of a complex risk and options for dealing and managing it.

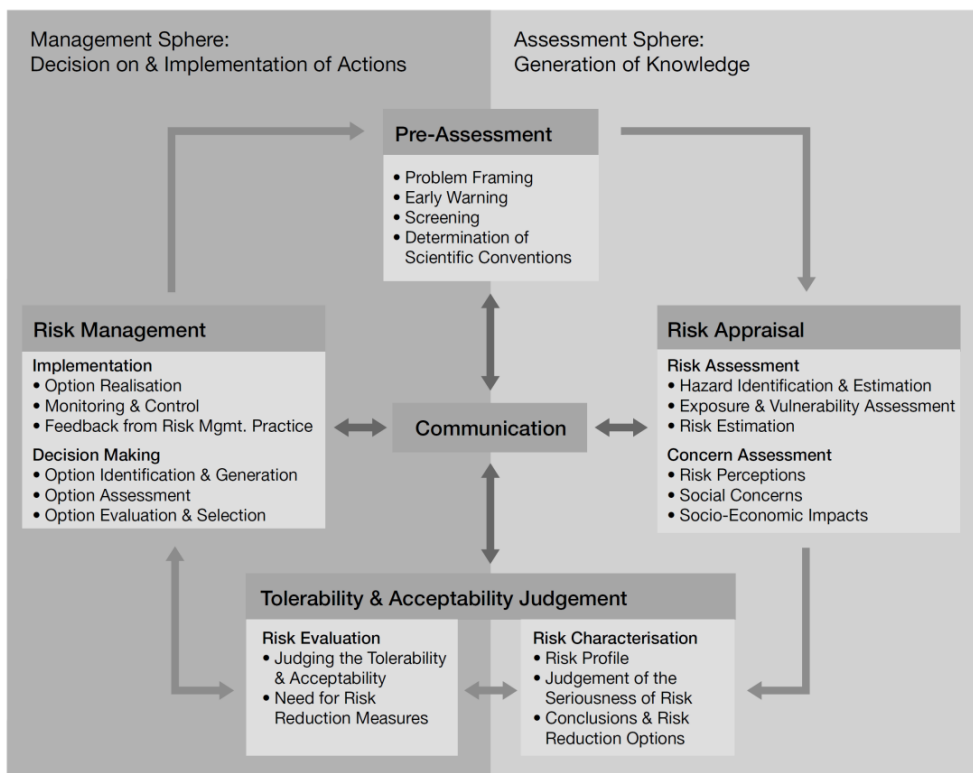


Figure 15: IRGC Risk Governance Framework (Renn, 2005).

The “pre-assessment stage” corresponds with the “issue-framing” stage of the Integrated Environmental Health Impact Assessment Framework or the “problem formulation and scoping” phase of the American Assessment Framework. During the pre-assessment stage, the variety of issues that all stakeholders associate with risk are identified, the problem is framed, the underlying goals are defined, the applicable legal, political, social, and economic conventions are identified, and the relevant risk topics are selected in order to determine an adequate risk assessment and management strategy.

“Risk appraisal” refers to the review of the available (scientific) knowledge for the physical-, economic- and social- related risk issues. Risk appraisal consists of both, a traditional risk assessment based on natural sciences as well as a concern assessment (social and economic implications included) done by social scientists. Concern assessment provides sound insights into risk perceptions, concerns, differences in stakeholders’ objectives and values, inequalities in the distribution of benefits and risks, (controversial) social response to risks, and the role of the media and governance institutions, etc. Insights into these social aspects are important to determine effective communication and management strategies.

The aim of the third phase, the characterization and evaluation of risks, is twofold. First, a balanced, evidence-based judgment must be reached on the (in)tolerability and acceptability of a given risk based on all relevant (technical, environmental, social, economic, political, health, ...) knowledge and uncertainties. The term tolerable is used to describe an activity “that is seen as worth pursuing for the benefit it carries yet it requires additional efforts for risk reduction within reasonable limits.” Intolerable risks should be avoided. Risks are called acceptable if, “the remaining risks are so low that additional efforts for risk reduction are not seen as necessary.” Second, if the tolerability and/or acceptability of the risk is disputed, the risk must be evaluated based on the diverse types of pros and cons taking into account societal values and norms, political priorities, etc. Whereas the US framework favours an organizational combination of characterization and evaluation, the European framework prefers a separation between both processes (Renn, 2005).

The risk management phase refers to the determination of options for risk reduction, the implementation of the chosen measure, and the monitoring of the intended, as well as unintended, consequences (Renn, 2008a). Depending on the outcome of the risk characterization and evaluation phase and contextual factors (such as urgency of decision making, institutional capacity, available resources), different management strategies must be applied. However, the framework is not intended to be a comprehensive manual, to

provide concrete solutions for all types of risks, or to obligate the decisionmaker to a particular course of action (Renn, 2008b).

Risk communication is essential in the whole risk governance process, from the issue-framing to the monitoring of implemented risk management strategies. The communication should be internal as well as external. The internal communication refers to the exchange of information between risk assessors and risk managers as well as between natural and social scientists, etc. External communication occurs between the internal actors and the broader public. The communication should be based on a mutual learning process, and not only considered as a one-way communication to educate and inform the public and to create confidence in the responsible institutions (Renn, 2005). As a consequence, stakeholders should be involved in all phases to make sure, "that decisionmakers have asked all the right questions and thus have the most complete information available with which to make their decisions" (Renn, 2008b). Moreover, stakeholder participation enriches the risk governance process by: creating a social basis of the problem framing; offering practical-knowledge in the risk assessment phase; providing more balanced judgments by assuring that all values and preferences of those who will be affected are made clear in the risk evaluation phase; and by creating higher quality outcomes in terms of effectiveness, efficiency, legitimacy, fairness, transparency, public acceptance, and ethical acceptability (Renn, 2005). Nevertheless, Renn (2008b) is aware of the difficulties and challenges of meaningful stakeholder involvement with regards to the selection of stakeholders, the method to reach consensus, the assurance of the outcome quality, etc. Again, the framework does not provide a concrete manual, the degree and design of stakeholder involvement will depend on the risk characteristics and the context.

To conclude, the Risk Governance Framework of the IRGC is a conceptual framework and not a ready-for-use recipe or concrete manual that can be applied to all types of risks. Moreover, risk governance is not something that takes place in isolation; the legal, political, scientific, social, historic, organizational and economic context is important (Renn, 2008b). Contrary to more traditional approaches, the Risk Governance Framework emphasizes the importance of communication throughout all phases of a risk governance process, focusing more on qualitative forms of information, the integration of societal values and risk perception and stakeholders' involvement to develop a better balanced, more effective and more inclusive governance strategy when dealing with systemic risks (Soer et al., 2009; Renn 2005/2008a/2008b). As such, the framework bears close resemblance to the principles of the Post-Normal Science Epistemology of Funtowicz and Ravetz (1990).

▪ **Environmental Health Risk Governance Arrangements**

In this section, the daily practice of environmental health risk governance is described although the number of empirical research studies is rather rare. While the concept of risk governance was successfully put upon the scientific and political agenda, giving rise to conceptual and normative discussions at scientific conferences, political gatherings, articles, and policy papers, it seems that robust empirical evidence related to environmental health risk governance arrangements is lacking. Relevant empirical questions are: What shifts in environmental health risk governance can empirically be discerned? What mechanisms explain these shifts? What is the performance of these risk governance arrangements in terms of stakeholders' involvement, legitimacy, adequacy, etc? In this section, the results of two empirical studies investigating environmental health risk governance arrangements are presented. Soer et al. (2009) conducted a quick-scan survey to compare trends in environmental health risk governance approaches in 10 European countries, the USA and Australia. In a follow-up study, Runhaar et al. (2010) characterized, explained and evaluated the shifts in environmental health risk governance at a meta-level (i.e., over time and covering health risks in general as dealt with in a large number of countries).

To be perfectly clear, an Environmental Health Risk Governance Arrangement is defined by Runhaar et al. (2010) as, "the complex of institutional geography, rules, practice, and animating ideas that are associated with the regulation of a particular risk or hazard." The aim is to avoid or reduce environmental exposure or to mitigate the negative health and well-being effects of exposure.

Based on an empirical quick-scan survey, Soer et al. (2009) conclude that national governments often have no consistent framework for dealing with similar types of risks in different domains in terms of scientifically proven severity, public concern, or cost-effectiveness (Runhaar et al., 2010). However, a shift from traditional approaches to more societal, integrated and differentiated approaches has been determined.

The traditional way of dealing with environmental health risks is a result of the Enlightenment or modernistic thinking (Section 2.1.1.). Within this perspective, central governments are considered to have a strong and leading role in addressing social problems based on scientific knowledge of the health impacts and hierarchical decision making. The traditional approach is characterized by specialized sector-based risk governance arrangements, equal protection for all, a strict demarcation between disciplinary fields and policy domains, restricted transparency, less attention to cost-benefit

considerations, limited stakeholder participation, little attention for societal perceptions of risks and cumulative impacts, and ad hoc decision making (Soer et al., 2009; Runhaar et al., 2010).

Because of the recognized shortcomings of the traditional approach when dealing with complex risks, and the simultaneous trend towards multi-actor (stakeholder participation) and multi-sector governance (policy integration), the environmental health risk governance arrangements shifted to more societal, integrated and differentiated approaches (Runhaar et al., 2010). The societal dimension refers to the consideration of social aspects in risk governance like perception, values, emotions, communication, etc. However, to date, "No country has suggested a concrete, coherent method that may be used to weigh such qualitative information in light of other scientific data" (Soer et al., 2009). This issue corresponds to the concern assessment aspect of the IRGC Risk Governance Framework. Integration refers to the integration of economic, social, cultural, and other considerations, the involvement of stakeholders, as well as the integration of environmental health objectives in other policy sectors. As a consequence, risk assessment processes and risk management processes are more integrated and stakeholders are involved in order to gain co-responsibility for preventing and reducing environmental health risks. Although in most revised countries the creation of a single environmental agency generated improved transparency, accountability, and cross-sectoral integration, it seems to be insufficient in achieving a coherent risk governance approach. Differentiation refers to differentiated risk approaches, standard setting, and policies based on different risk characteristics or regions (such as area-specific standards, specific standards for vulnerable groups). However, a lack of knowledge, budgetary constraints, insufficient internal and external communication, difficulties to quantify health risks and weigh diverging sectoral ambitions were identified by Soer et al. (2009) as the primary barriers for a differentiated approach.

It must be noted that this shift in risk governance approach does not have the same intensity in all revised countries and are far from institutionalized (Runhaar et al., 2010). Most national environmental health risk governance arrangements are still struggling with how to deal with the lack of knowledge and scientific uncertainty, how to weigh scientific and stakeholder inputs, how to integrate health data and social and economic concerns, etc. Structured and coherent approaches are also still missing in today's environmental health risk governance arrangements.

Although Flanders was included in the study of Soer et al. (2009), the quick scan only focused on the main characteristics. In Chapter 5, Chapter 6 and

Chapter 7, the gradual institutionalization of the Flemish environmental health risk governance arrangement is analysed in detail. The international and European context, as described in this chapter, is taken into account during the analysis of the Flemish environmental health arrangement. After all, Flanders does not operate in a vacuum: international and European discourses, methodologies and agreements might filter through to the national and regional level and, vice versa, local Flemish good practices can force a breakthrough at the European level.

Flemish Environmental Health Risk Governance Arrangement

The next chapters reconstruct the dynamic emergence of the Flemish environmental health arrangement over a period of forty years. Although the Nineteen Nineties are called the “Third Decade of Concern for Environmental Health” by David Rall, former director of the National Institute of Environmental Health Sciences (NIEHS), the roots of the movement can be traced back more than a century (Gochfeld & Goldstein, 1999). Also environmental health research has its roots in the post-industrial revolution years when, “increasing urbanization led naturally to concerns about the safety of food, housing, sanitation, industrial waste and other aspects of public works that influence human health” (Ryan, 2003). As a consequence, the sanitary revolution in the nineteenth and twentieth century is also taken into account.

The development and dynamics of the Flemish environmental health arrangement are chronologically described in three chapters (Chapter 5, Chapter 6, and Chapter 7, respectively) corresponding to three phases which can overlap specific time periods. The first phase refers to the institutionalization and differentiation of industrial safety, public health, and, in later years, the environment as fragmented policy arrangements in Belgium (Flanders had no political authority yet). The second phase is characterized by adding environmental health to the political and scientific agenda as a result of a quick succession of environmental health related incidents that occurred in Flanders between the Nineteen Seventies till the Nineteen Nineties. The last phase refers to the institutionalization of a Flemish environmental health policy arrangement. While this periodisation is not quite strict and evolutions may overlap different time periods, yet their distinction represents different discourses and knowledge about environment and health (e.g., children as vulnerable group), new organizational structures for dealing with the environmental health problems (e.g., Policy Research Centre of Expertise on Environment and Health), new actors (e.g., Local Environmental Health Officers), resources (e.g., structural financial support for environmental health research), and rules of the game (e.g., amendments to the constitution). However, it must be noted that not all new discourses cause institutional change as a result of path dependency.

As to the approach, for each phase, the historical developments are firstly factually reconstructed. Neither a detailed historical description of all institutions and organizations related to the environment or public health domain, nor a detailed list of all legislation, Royal Decrees, Ministerial Orders,

etc. is within the scope of this research. The aim is to sketch the main developments within the emerging Flemish environmental health arrangement in a broad outline. A historical reconstruction of the policy-making processes and production of knowledge in regards to environmental health in Flanders is useful, because: 1) it clarifies the evolution of environmental health discourses and the historical motives behind environmental health policy; 2) it identifies the institutional/organizational context which can explain institutional robustness and resistance against change. The results of the historical analysis assist in the understanding of the stability and dynamism that occur in environmental health institutions and policies. Special attention is given to the institutionalization of the science-policy interface and boundary work when dealing with complex risks. Focusing on boundary work and the science-policy interaction, I opted for an integrated description of the policy and knowledge field related to environment and health. When relevant, an explicit link is made to the international and European developments as described in Chapter 4.

Second, while describing the historical reconstruction of the Flemish environmental health arrangement, attention is given to all four dimensions of the Policy Arrangement Approach, taking into account: discourses, actors, resources, and rules of the game. However, it is out of scope to give an endless list of all actors, resources and rules of the game involved. The description and characterization of the policy arrangement allow the understanding of the ongoing processes of institutionalization in terms of changes and temporary stabilizations and the mechanisms behind them (Leroy & Arts, 2006). Based on Discursive Institutionalism new or changing discourses related to environmental health are investigated in order to determine whether and how they have been influencing the other three dimensions – actors, resources/power, and rules of the game – of the Flemish environmental health arrangement.

Third, my own theory-informed interpretation is placed on the dynamics of the emerging environmental health arrangement, taking into account all theories described in the literature review (Chapter 2). The empirical survey is interpreted according to the epistemological literature about complexity, risks, and uncertainties, keeping in mind the theory regarding the science-policy interface and, more precisely, boundary work. Boundary work refers to the continuous process of construction, deconstruction, and reconstruction of the boundaries between science and policy in which boundary objects, boundary people, and boundary organizations are put forward as an institutional solution for the interaction between science and policy (Hage et al., 2010; Huitema & Turnhout, 2009). The typology of boundary arrangements developed by

Hoppe (2005) is used as a heuristic tool to comprehend the dynamics of the Flemish environmental health arrangement. Finally, the literature on policy integration (multi-sector governance) and governmental institutionalization is taken into account. The type and level of policy integration are defined through the years (Bauer & Rametsteiner, 2007; Meijers & Stead, 2004).

Chapter 5: The Age of Differentiation

The phase of differentiation refers to the period in which the attention for environmental hygiene arose from public health concerns, on the one hand, and from industrial safety, on the other.

First, the institutionalization process of public health and industrial safety in differentiated policy arrangements is described (Section 5.1.). Special attention is given to their differences because each policy arrangement has gradually developed its own knowledge infrastructure, advisory boards, rules of the game, etc. In particular, the differences in science-policy interactions, types of boundary work, and the risk management strategies between these two arrangements are studied. Section 5.1. focuses on the impact of the increased environmental hygiene concern on the development and dynamics of both policy arrangements. After all, regarding the Policy Arrangement Approach, new discourses as well as actors, resources and rules of the game can cause changes in policy arrangements.

As a consequence of the increased public concern for the environment, political awareness, and scientific knowledge production in the Nineteen Seventies and Eighties, the content and organization of the environmental field gradually institutionalized into a separated policy arrangement. Section 5.2. describes the structuring and stabilization of the environmental field into policy actors, scientific institutions, taxes, legislation, etc. A distinction is made between the period before and after the constitutional reform of the Belgian State in 1980 towards a federation. After all, since 1980 political authority on almost all environmental issues has been empowered to the Regions.

5.1. The Fragmented Institutionalization of Public Health and Industrial Safety

Due to industrialization and urbanization, fierce industrial competition, and a labour surplus, during the eighteenth and nineteenth century, the living and working conditions were humanly disgraceful: open-air sewerage, bad sanitary fittings, rubbish in the streets, and unhygienic circumstances (De Swaan, 1989, Bruyneel, 2009). Houses were mostly built by factory owners for money and in order to hold on to their staff. Until 1845, as a consequence of the French decrees in 1789 and 1790, public health issues were mainly the affair of local and provincial governments. For instance, main authorities were empowered to the provincial medical committees and the local civil servants

“Commissaire du Service de Santé Civile” (Velle, 1990). However, inspired by liberalism and the idea that the common good will be maximized through the maximization of everyone’s own good, the French Decree of March 2, 1791 promulgated the principle of industrial freedom. In accordance with the right of ownership, which was written down in the Constitution, local authorities denied these objectionable unsanitary housing practices and unsafe industrial conditions and did not intervene (Van De Kerckhove, 1987; Bruyneel, 2009). The industrial freedom and the priority given to the creation of jobs prevailed (Buyst, Lowyck, & Soete, 2011).

5.1.1. The Institutionalization of Public Health Policy

In the mid nineteenth century, Belgium was affected by an economic as well as a food crisis as a result of poor grain harvests and a potato blight. As a consequence, quick successions of epidemics and infectious diseases, such as cholera and typhoid fever, occurred. In 1855, John Snow discovered that cholera is a waterborne infectious disease caused by a multiplying living organism although he could not identify the specific causal agent. This discovery facilitated the scientific understanding of microbial diseases. The complementary scientific studies of Louis Pasteur and Robert Koch, both considered as the founders of medical bacteriology, are worth mentioning. Pasteur favoured individual vaccination to protect humans against infectious diseases, while Koch stimulated public health measures like sanitary methods to protect populations (Ullmann, 2007). Both scientists searched for universal truth and strongly believed in a convergence between science and politics by devoting their knowledge in service to humanity and emphasizing the industrial and practical applications of their research.

The increased scientific understanding of microbial diseases drastically changed the perception and societal practices, and it laid the foundation for the so-called “Sanitary Revolution” regarding food preparation, human waste disposal, water quality, etc. (Gochfeld and Goldstein, 1999). After all, medical scientists emphasized the need to invest money in waste water drainage and the supply of clean drinking water (Buyst, Lowyck, & Soete, 2011). As a result, the political concerns about public health and environmental hygiene increased and the Belgian Government developed a more centrally-coordinated public health policy within the Ministry of Home Affairs. The Service de Santé Civile et de l’Hygiène was established in 1845, and in 1846 transformed into the Division des Affaires Médicales et de l’Hygiène (Velle, 1990). Between the late Eighteen Eighties and Nineteen Thirties, the Public Health Department and Public Health Inspection were mostly authorized to the Ministry of Agriculture

and Industry instead of the Ministry of Home Affairs (Velle, 1990). The main aim of the Public Health Department was to prevent epidemics and infectious diseases (Leroy & De Geest, 1985), to gather statistical epidemiological data, to coordinate the installation of sewers, and to advise about the permitting of unhealthy and nuisance industries (Velle, 1990). As such, its initial discourse focused on an anti-epidemic policy by investing in sanitary methods, on the one hand, and curative medicine (vaccination), on the other. Referring to Gochfeld & Goldstein (1999), in the nineteenth and early twentieth century, environmental health was almost synonymous with sanitation in order to prevent communicable diseases.

The Royal Academy of Medicine of Belgium, founded 1841, and especially the Superior Health Council, founded 1849, were created as official advisory boards to provide scientific support to the Belgian authorities regarding public health and hygiene (Bruyneel, 2009). For an overview of the most important activities of the Superior Health Council, refer to Velle (1990). At the end of the nineteenth century, the Provincial Governments of Antwerp and Brabant established bacteriological research institutions which were transmuted through the years into the current Provincial Institute for Hygiene of Antwerp (PIH) and the Institute Louis Pasteur (Claes et al., 1997). At the national level, the Laboratory for Bacteriology and Hygiene was founded during the world exhibition in Brussels, 1897, in fear of a new cholera epidemic (Thiers, 2004). The central laboratory (in 1951 transformed into the National Institute for Hygiene and Epidemiology) and the Institute Louis Pasteur merged into the current Scientific Institute of Public Health in 2003.

The establishment of numerous scientific advisory boards and research institutions at the local, provincial as well as the national level illustrates the importance and dominance of scientific influence over political judgment. Moreover, the tasks of the Public Health Department made it likely that scientifically trained persons gained vital positions as civil servants or even policymakers. In other words, the governmental staff became more scientific by appointing more and more physicians (for instance health inspectors). As a consequence, the public health arrangement was originally characterized by an Expert-based Model (Hoppe, 2005). Relative weight was given to science in its relationship to politics; and within the public health arrangement, there was a convergence between science and politics, as both served society. As such, the public health policy arrangement in the nineteenth century is clearly characterized by a Technocracy Model (Hoppe, 2005).

However, the establishment of the Public Health Department within the Ministry of Home Affairs and national and provincial funded research

institutions leads one to suspect that the Belgian State would evolve towards a more Bureaucratic Model characterized by a strong and central-steering government and state-owned research institutions. This occurred in 1936, when the Ministry of Public Health was established in order to discourage the fragmented competences related to public health. After all, until 1936, the public health policy arrangement was characterized by a horizontal and vertical fragmentation of authorities across different governmental departments at different levels (Velle, 1990). In the same time period, the focus of public health intervention shifted increasingly from the population in general to the individual, by means of a boost to curative medicine that accompanied the discovery and implementation of antibiotics to the detriment of preventive medicine and the ecological perspective (Morris et al., 2006). However, the impact was limited because, according to Morris et al. (2006), "the physical environment did not disappear from the portfolio of public health policy, but it was no primary driver of intervention." Perhaps, the new definition of health, adopted by the World Health Organization in 1946, prevented to delete preventive health care from the agenda in a time period wherein the primary drivers for health policy were often concerns to curative and individual medicine. At the International Health Conference in New York (1946), health was defined as, "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 2003). This definition implies that the population must be protected against bacteria and viruses but also against environmental pollution and dangerous substances which can have a negative impact on human health. As a consequence, an increased number of tasks have been covered under the umbrella term of public health and it was necessary to reorganize medicine in order to more fully deal with prevention (Gochfeld & Goldstein, 1999).

In Belgium, the National Institute for Hygiene and Epidemiology (IHE) was established in 1951 in response to the fast scientific and technical evolutions and the need to integrate more expert knowledge within the Ministry of Public Health. The main objective of IHE was to give the public health policy a scientific underpinning. Scientists investigated, among other things: food safety, chemical agents, infectious diseases, and medication (Bruyneel, 2009). The establishment of the National Institute for Hygiene and Epidemiology confirms the evolution towards a more Bureaucratic Model characterized by a central-steering government (cfr. the establishment of a specific dedicated Ministry of Public Health at the national level) that had to establish state-owned research institutions in order to legitimize their power. Experts and physicians were recruited as civil servants in national administration agencies.

5.1.2. The Institutionalization of Industrial Safety and Labour Protection

Initially, the Belgian policy of labour protection and industrial safety followed the philosophy of the Napoleon Decree, promulgated in 1810. This decree can be considered as the first regulation addressing the prevention of industrial risks and pollution caused by the activities of manufacturing establishments deemed dangerous, insalubrious or incommodious (Reynard, 2002). The Napoleon's Decree distinguished three classes of dangerous activities according to the risks they posed and enforced safety distances in order to protect the nearby residential areas. Depending on the category, the central government, the government at the head of a 'département', or the local mayor was authorized to permit industrial activities and a public inquiry was needed (Reynard, 2002). However, Merad and Dechy (s.d.) nuanced: "Given the impossibility, in scientific terms, to assess a generic applicable distance between factories and urban settlements, the decree left this decision and the responsibility to deliver a permit to operate to national (...) and local authorities depending on the 'level of hazard' of the activity." As a consequence, the emphasis of this early scene was on politics. In view of the fact that almost all politicians were industrial employers and powerful priests, their main goal was to ensure the liberal ideologies and industrial interests that dominated the nineteenth century (Reynard, 2002). As such, the main policy priorities were related to the assurance of employment and the prevention of fatal work-related accidents. As a consequence, child labour, the exposure to toxic chemicals, and the operation of unsafe machinery, etc. were not uncommon events.

As a reaction to the humanly disgraceful working conditions, the last two decades of the nineteenth century were characterized by social tension, the formation of trade unions, emergent syndicalism, and the rise of socialist political movements. The labour movement, supported by social occupational physicians, used public health and the prevention of infectious diseases to fight against poverty and to gain more political power (Velle, 1990). The revolution against humanly disgraceful working conditions culminated in the outbreak of the social disturbances in 1886. This was a turning point in the developments of a new institutional arrangement concerning labour protection, characterized by a strong political involvement of employers' and employees' representatives, strong legislation, and an administrative license procedure in order to determine the rules of the game. However, the license procedure, as already described above, was still build on the Napoleon's classification of industrial activities.

In contrast with public health policy, where state and science representatives shared primary roles, the institutionalization process of occupational health and safety was initiated in response to a long history of social disturbances. In other words, the increased political awareness about occupational health and safety was caused by a bottom-up approach. Opposing societal forces, i.e., employers and employees, were at the basis of this process in order to accommodate their conflicts.

An autonomous Ministry of Labour was established in 1894. As a result of the liberal and capitalism ideology in that time period, the role of the Ministry of Labour was restricted to supervision and monitoring. The government primarily played a notary role by adopting laws to formally legitimize the earlier agreed engagements between employers and employees, and by establishing the labour inspection. As a result of the opposing stakes of employers and employees, the Ministry of Labour promulgated very detailed and technical legislation based on (objective) scientific evidence. Science could only do so because of its positivistic ontology at that time. Searching for the universal truth, there was a long time delay between the scientific discovery (early warnings) and the infiltration of scientific knowledge in political thoughts and decisions. Lack of knowledge, call for scientific certainty, prior economic considerations, etc. were all reasons to delay policy action (see also Late lessons from early warnings, Harremoës et al., 2001). The Ministry of Labour was advised by the Council of Labour Protection, established in 1936, composed of civil servants, experts, and equal employee and employer representation. The establishment of the Council is historically important as it reflects mutual agreement between employers and employees (Van De Kerckhove, 1993). Summarizing, the function of the government was limited to the promulgation of laws and inspection, and to the establishment of scientific research institutions while the market was assumed to provide economical growth.

Following the Enlightenment's ontology and epistemology of that time period, the first law of industrial health and safety (July 2, 1899), authorized the King to make regulations for every kind of work-related risk, for which scientific evidence was obvious. The King was authorized to take measures to increase the safety and hygiene of the employees and to fix penalties for violators. Some progressive occupational physicians already used biomonitoring techniques in occupational settings in the late nineteenth century and the early twentieth century, in order to determine chemical substances in human body fluids and to protect the health of exposed workers. For instance, levels of lead, mercury, and benzene metabolites were measured in blood and urine of lead and benzene factory workers in an attempt to determine the level of

acute toxic poisoning (Paustenbach & Galbraith, 2006; Angerer, Ewers & Wilhelm, 2007). As such, occupational physicians were pioneers in investigating the impact of environmental pollutants on human health. They inevitably focused on occupational settings where a direct and biologically plausible toxic, infectious, or allergenic mechanism could be substantiated and studied by reductionist modes of enquiry (Morris et al., 2006). As a consequence, occupational physicians and "dokters van het volk" (community doctors) played an important role in the agenda-setting of environmental health problems "avant la lettre" (Loots, personal communication, 9 July 2008). However, Merckx (2008, my translation) emphasized that just a limited number of physicians really played a proactive role, "Often prevention and early detection of diseases were not the main objectives of labour physicians, ensuring production was given primacy." This was aligned with the principle goal of the Ministry of Labour, in particular to ensure the employment (De Wel, personal communication, March 3, 2010).

According to the positivistic discourse of that time period, all rules of law must be written scientifically precisely, resulting in very detailed and technical legislation primarily oriented to the physical working conditions. The executive power released the General Regulation of Labour Protection (ARAB – "Algemeen Reglement voor de Arbeidsbescherming") in 1946-1947, in order to compile all Royal Decrees related to industrial health and safety and to update those rules to the level of the science and technology evolution (Van De Kerckhove, 1993; Geysen, 1991). The General Regulation of Labour Protection established the conditions of exploitation for industries characterized by unhealthy, unsafe, or nuisance activities. Environmental protection was reduced to an internal administrative procedure, taking into account only the consultation between government and licensee. Other stakeholders were not involved unless they could achieve involvement through lobbying and action (see the representation of trades unions in the Council of Labour Protection; Leroy & De Geest, 1985). This idea was based on the Napoleon's Decree of 1810. The introduction of a strong license-driven policy and the ARAB legislation, characterized by internal administrative procedures between government and license-holders, gave the labour arrangement more features of the Bureaucratic Model. The role of science was limited to occupational medicine investigating serious health effects (such as mortality, lead intoxication, asbestosis) by employees and the people living in the neighbourhood related to short-term exposure to strongly concentrated pollutants due to industrial activities (Merckx, 2008).

5.1.3. Environmental Health Research in the Mid Twentieth Century

Several major disasters in the mid twentieth century provided important lessons for scientific knowledge in general and environmental health research in particular. Many of these events occurred in an occupational setting, although there were important events that exposed whole communities as well (Gochfeld & Goldstein, 1999). Typical examples are: the thousands of pulmonary attacks caused by a smog of industrial fumes which filled the Meuse River Valley in Belgium in 1930, the inorganic mercury bioaccumulation in the aquatic food chain caused by a chemical plant around the Minamata Bay in Japan in the 1950s, which resulted in many deaths as well as profound mental retardation of babies exposed in utero; the Donora smog in 1948, which resulted in respiratory symptoms; and the London smog of 1952, which was credited with 4000 excess deaths (Gochfeld et al., 1999). These disasters, as well as the nuclear attack in Hiroshima and Nagasaki, were an ontological breakthrough towards Post-Positivism. Within a post-positivistic ontology, the objective reality exists, yet it is only imperfectly apprehendable through the human methods of knowing. Moreover, the multitude of post war epidemiological data related to nuclear radiation laid the foundation for the development of the stochastic risk philosophy. After all, in a post-positivistic approach, replicated findings are only probably true and statistics are used to deal with this type of uncertainty. Nevertheless, objectivity remains the ideal, controlled by communities of peers. Another lesson learned by the atomic disasters was that low dose exposure can already lead to stochastic health effects and that those health effects can even occur in the long term (Laes et al., 2004; Eggermont, personal communication, June 25, 2008). As a consequence, the International Commission for Radiation Protection (ICRP) introduced a change of mentality in the Nineteen Fifties by developing the ALARA-concept (As Low as Reasonably Achievable) consistent with the assertion that even low exposure levels can produce detrimental effects like genetic mutations or cancer. To conclude, the nuclear accidents were a breakthrough in knowledge development about the impact of radiation on public health. However, it took years to implement this knowledge on the "classic" environmental problems caused by humans such as water and air pollution (Torfs, personal communication, September 27, 2012).

Related to the public health impact of the "classic" environmental problems, the publication of *Silent Spring* in 1962 by Rachel Carson was revolutionary and laid the foundation for the modern environmental health knowledge (Frumkin, 2005). Carson's publication warned the society of the toxic effects

of industrial chemicals on the environment and their impact on human health. Carson emphasized the multiple exposures to chemicals and their persistent and bio-accumulative characteristics which can cause delayed acute and chronic health effects. According to Frumkin (2005), "In the ensuing decades, environmental health essentially became synonymous with the recognition and control of chemical exposures. Environmental health scientists were toxicologists and epidemiologists, specializing in pesticides, metals, solvents, asbestos, or persistent organic pollutants." The main aim of toxicology is to understand and predict the toxic effects of chemical and physical agents. As Ryan (2003) states, "By conducting controlled experiments in genetically homogeneous animal populations, investigators could control extraneous sources of variability and also boost study power by using higher exposure levels." The expansion of industrial organic chemistry and pesticide production exploited the understanding of toxicology in the post-World War II period (Gochfeld et al., 1999). Epidemiology was commonly used to evaluate the impact of occupational environmental circumstances on human health. Since the Nineteen Sixties, the tools and principles have been applied in the broader environmental context to evaluate health impacts caused by exposure to air pollution, water contaminants, chemical agents like pesticides, heavy metals, and physical agents (Kanarek et al., 2007). In addition to toxicology and epidemiology, biomonitoring was used to assess exposures of the general population to chemicals found in food and drinking water (Paustenbach et al., 2006). In the early Nineteen Sixties, powerful analytical techniques were developed to measure very low concentrations of chemical substances in human fluid caused by environmental exposure (Angerer et al., 2007).

5.1.4. Lessons Learned

Figure 16 presents an overview of the relevant actors during the first phase, characterized by the institutionalization of public health and industrial safety, as separate policy domains in Belgium from Eightien Thirty until the mid twentieth century. The following sections sum up this period, taking into account the theories described in Chapter 2. First, the fragmented institutionalization processes between public health and industrial safety are summarized focusing on the differences in the science-policy interface. Second, the discursive shifts regarding risks and uncertainties towards a post-positivistic epistemology and new methods for knowledge production are described. Third, the differences in thoughts about environmental health risk management approaches by the Ministry of Labour and the Ministry of Public Health are elucidated.

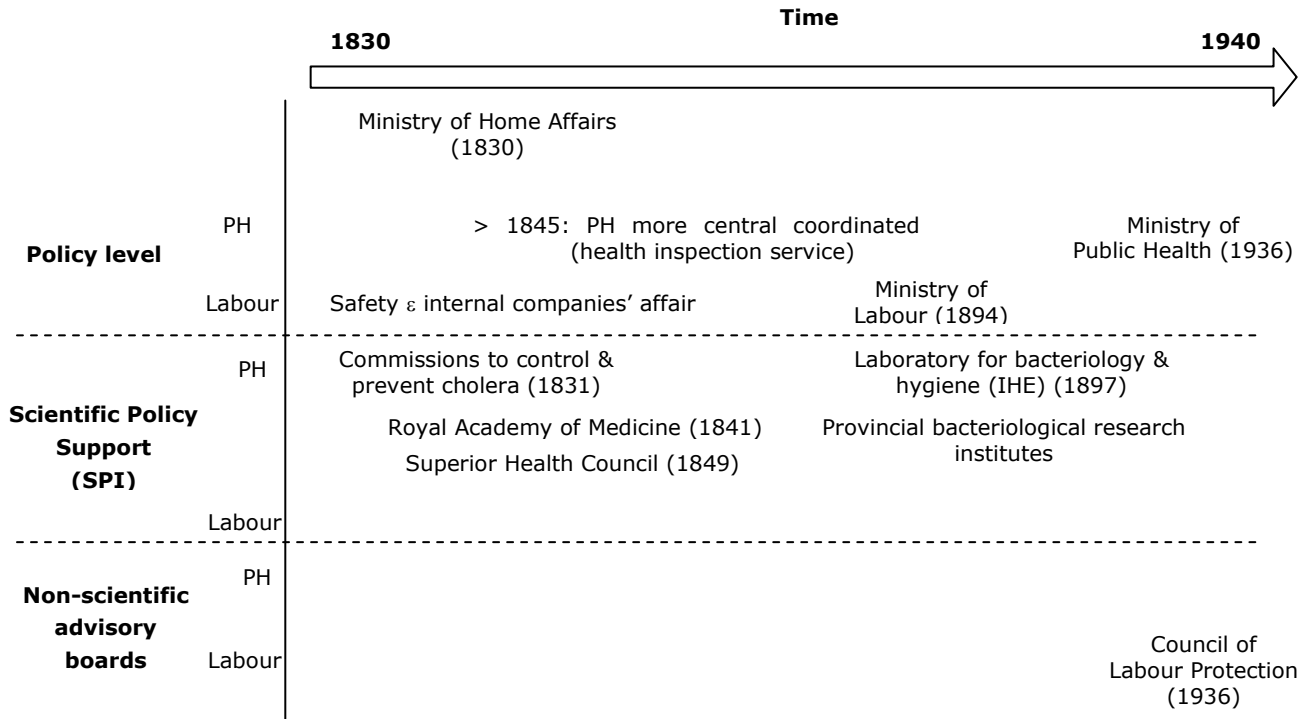


Figure 16: Actor map – Institutionalization of public health and industrial safety as separated policy arrangements.

- **Dissimilar Institutionalization Processes and Science-Policy Interaction Between Public Health and Industrial Safety**

The attention for industrial hygiene increased as a result of humanly disgraceful working and living conditions in the nineteenth century. Nevertheless, the institutionalization processes of both policy arrangements concerning environmental hygiene – public health, on the one hand, and industrial safety, on the other - were dissimilar in the first part of the twentieth century.

The public health arrangement was strongly science-based from the beginning. The early establishments of scientific advisory councils (e.g., HGR) and research institutions (e.g., PIH and Pasteur Institute) are an indication. As a consequence, the public health arrangement was originally characterized by an Expert-based Model (Hoppe, 2005). However, in the late nineteenth century, the desire for a more central-steering government became more obvious. Politics was given primacy by the establishment of a specific dedicated own Ministry of Public Health. As a consequence, public health authorities shifted from the provincial to the national governmental level. State-owned research institutions (e.g., IHE) were established in order to serve the public good, and experts and physicians were recruited as civil servants in national administration agencies.

The institutionalization process of occupational health and safety was initialized by a bottom-up approach by opposing societal forces, i.e., employers and employees, in order to accommodate their conflicts. The role of the state was limited to surveillance, monitoring, and the promulgation of science-based laws. Science was used by the government to legitimize its power and to act as a buffer between opposing concerns of employers and employees. The license-driven policy of the ARAB legislation, characterized by internal administrative procedures between government and license-holders, had more features of the Bureaucratic Model.

Last remark; the awareness for environmental hygiene increased during the nineteenth century, the resources for environmental hygiene, public health, and workers' protection were most of the time very limited until the twentieth century because of other priorities: the development of the Belgian State, the restoration after the Great Depression, the promotion of employment, and the rebuilding of the country after World Wars I and II.

- **Thinking About Science, Risks and Uncertainty: Towards a Post-Positivistic Epistemology and New Scientific Methods for Knowledge Production**

Scientific environmental health research in that time period was mostly driven by occupational physicians who focused on direct and biologically plausible toxic, infectious or allergenic mechanisms as a result of a highly exposure to one single pollutant in a local area. The assumption was made that all pollutants had a level which could be tolerated, also called the no-effect level or the threshold-hypothesis. New approaches, like epidemiology and toxicology, as well as new techniques (human biomonitoring) were developed to study the impact of (occupational) environmental pollutants on living organisms. It must be noted that the scientific research focused on the immediate health effects of pollutants. There seemed to be no realization that health effects could occur after a longer period of time (see also Harremoës et al., 2001). Scientific knowledge production was initially based on positivistic methodologies characterized by reductionism.

The philosophy changed after the atomic bombings at the end of World War II. Based on new and well-documented evidence, the International Commission for Radiation Protection (ICRP) had to recognize that the threshold-hypothesis, assuming that very small exposures were negligible, was not correct. A no threshold dose-effect relationship was introduced emphasizing that a human health risk exists at all dose levels. Also the idea that exposure to environmental pollutants can lead to long-term health effects increased. As a consequence, ICRP introduced the ALARA-principle in order to ensure that all exposures will be kept as low as reasonably achievable, social and economic factors included. The richness of epidemiological data related to the atomic bombings in Japan also laid the foundation for the development of the stochastic risk philosophy. Statistics were gradually used to deal with probabilistic uncertainty. As a consequence, the positivistic epistemology evolved into a post-positivistic approach. Although the epistemological shift in the radiation and nuclear field, it took some years to implement this knowledge on the "classic" environmental problems.

The modern environmental health epistemology was also influenced by the publication of "Silent Spring" in 1962. Carson's publication warned the society of the toxic effects of industrial chemicals on the environment and their impact on human health. Carson emphasized the multiple exposures to chemicals and their persistent and bio-accumulative characteristics which can cause delayed acute and chronic health effects. In other words, Carson laid the

foundation of a new paradigm shift in environmental health, which is described clearly in Chapter 6.

One last remark, in this time period, scientific uncertainty was a reason not to put an issue on the political agenda, rather to delay whatever policy measure until further scientific notice. This idea changes in the next period, as scientific uncertainty related to incidents causes new discourses (Chapter 6).

- **Dealing with Environmental Health Risks: Risk Management**

Initially, the environmental health discourse was limited to industrial hygiene and characterized by an anti-epidemic policy. After all, "Environmental pollution was considered as a necessary evil related to the increased economic developments. Only if there was a real danger for public health, the Belgian Government took measures without harming the economical goals" (Buyst, Lowyck, & Soete, 2011, my translation). From the public health point of view, priority was given to the installation of sanitation, on the one hand, and curative medicine (vaccination), on the other. In 1946, the focus changed towards a more general mental, physical and societal well-being in response to a new definition of health formulated by the WHO. Based on the Napoleon's Decree of 1810, the Ministry of Labour introduced a license-policy approach for the exploitation of unhealthy, unsafe, and nuisance industrial activities in order to protect the people living in the neighbourhood. As a consequence, the Ministry of Labour reduced environmental protection to an internal administrative procedure characterized by very detailed, technical laws.

5.2. The Institutionalization of 'Environment'

During the Nineteen Seventies, the amount of environmental legislation increased and the legislation gradually differentiated from the General Regulation of Labour Protection (ARAB), due to increased international public and political awareness and increased scientific knowledge. However, it must be noted that, in comparison with the neighbouring countries, the interest of the Belgian Government to develop an environmental policy increased rather slowly as a consequence of the different consecutive state reforms, which dominated the political agenda in the Nineteen Seventies and Eighties (Tieleman, Crabbé and Leroy, 2002). After the institutionalization of the Regions and Communities and their respective governmental structures, the environmental policy regained political attention. As a consequence of the federalization of the Belgian State, this section makes a distinction between

the period before (Section 5.2.1.) and after the constitutional reforms of the Belgian State in 1980 (Section 5.2.2.). Section 5.2.3. sums up the main lessons learned with reference to the dynamic emerging of the environmental health arrangement in Flanders/Belgium.

5.2.1. Before the Constitutional Reform of the Belgian State in 1980

This section reconstructs, analyses, and interprets the institutionalization process of the environment as a fragmented policy arrangement from the mid twentieth century until the constitutional reform of the Belgian State in Nineteen Eighty. The first part emphasizes the impact of the increased environmental concern in the Nineteen Seventies on the scope of scientific advisory boards and research institutions. The second part describes the scientific epistemology and methodology of that time period in order to investigate environmental pollution and its impact on human health. The third part deals with the differences between two policy arrangements which tried to gain environmental authorities: the public health policy arrangement and the industrial safety policy arrangement.

▪ Increased Societal and Political Awareness for the Environment

The post-World War II period was characterized by technological optimism, economical growth, and unprecedented prosperity, also called The Golden Fifties and Sixties. Simultaneously occurring, increased environmental pollution resulted in increased concern for the environment and the potential effects of pollution on human health. For instance, due to the industrialization and urbanization after World War II, the surface water was increasingly polluted in Belgium: "The quality of surface water of the rivers was almost comparable to an open sewer system during the summer" (Buyst, Lowyck, & Soete, 2011, my translation). This idea was confirmed by Kelchtermans (personal communication, February 19, 2010, my translation), "The unprecedented prosperity, economical and industrial growth of the Golden Sixties dominated the worldview of the youth of the day. We were shocked by the infinite misuse of nature." As a consequence, non governmental organizations focusing on nature preservation were established in the Nineteen Fifties (e.g., *Nationaal Verbond voor Natuurbescherming*).

Since 1970, the attention for nature preservation and the environment extended worldwide to an increased concern about the environment after some major disasters (for example the mercury poisoning in Minimata in 1951,

and the oil catastrophe of the Torrey Canyon in 1967 etc.). Also the students' and social revolutions in the 1960s in Europe and the consumers' union in the United States influenced this process (BBL, 2001). The report *The Limits to Growth* linked exponential growth, population growth, resource depletion, and energy consumption (Meadows et al., 1972). The main conclusion was that, if the growth trends in world population and industrialization continued unchanged, the model's limits to growth would be reached sometime within the next century. This publication was at the basis for the international discourse about sustainable development which took through in the late Nineteen Eighties. New specific environmental NGOs were founded in the early Nineteen Seventies, such as Greenpeace in the United States and the Federation for a Better Environment (*Bond Beter Leefmilieu*) in Belgium. In that time period, those NGOs' activities were characterized by activism and protest actions against nuclear tests, the import of seal pup skins, whalers at the international level, but also against very local policy initiatives like protests against highway constructions, local air and water pollution, etc. The increased environmental concern also influenced the establishment of green political parties. In Belgium, Agalev, the Flemish green political party, and Ecolo, the Walloon green political party, were established in 1979 and 1980, respectively. However, environmental health issues were mostly not explicit on their agenda.

At the same time, environmentalism gradually led to new political and administrative institutions at the international and Belgian level. For instance, at the international level, the *Declaration of the United Nations on Human Environment* set environmental preservation on the international political agenda (UN, 1972). A more detailed historical overview of the most important international developments is described in Chapter 4. In Belgium, the Ministry of Labour and the Ministry of Public Health tried to gain environmental authorities. Both ministries approached the environmental problem in a different way as a result of diverging perspectives about the environmental discourse. The Ministry of Labour increased the amount of environmental legislation within the ARAB regulation in order to protect employees and the people living in the neighbourhood taking into account a positivistic approach (see section 5.1.2.). The Ministry of Public Health promulgated laws on the control of air pollution (1964), the control and prevention of pesticides (1969), the protection of surface water (1971), and the prevention of noise annoyance (1973) in order to protect public health generally. These legislations were characterized by command and control environmental regulation. Citing Deketelaere (1998), "They established clear environmental norms which must be met (prohibitions and restrictions) and applied to everybody, the

government did not have to evaluate the individual circumstances of thousands of different cases, and the use of general norms limited administrative discretionary power and made it easier for companies to plan their own environmental policy.” Within the Ministry of Public Health, the environmental department was established in 1971, in order to coordinate and maintain these legislations. The different risk management approaches between both ministries are described in more detail in a further section ‘Environmental Risk Management: the Public Health Versus the Industrial Safety Approach’. In an attempt to ensure the coordination between the Ministry of Public Health and the Ministry of Labour, the Environmental Ministerial Committee (*Ministerieel Comité Leefmilieu*) was established in 1972.

- **Scientific Epistemology and Knowledge Development About the Environment**

Even before the increased environmental concerns, in Belgium, the Provincial Institute for Hygiene of Antwerp (PIH) raised the alarm in 1954 and applied itself to clinical and biological analysis in order to trace contamination of drinking-water and to analyse industrial waste water. The scope of PIH soon extended to air pollution, food quality, waste management, and noise nuisance (Claes et al., 1997). Also the Superior Health Council shifted the attention from food safety and the infrastructure of nursing homes to radiation, pesticides, noise pollution, etc. in 1963 (Bruyneel, 2009). Influenced by the international discourses about environmentalism, the scientific awareness increased and existing scientific institutions expanded their activities. For instance, the National Institute for Hygiene and Epidemiology (IHE) established a large-scale network to monitor the quality of air, surface and drinking water. As a result of the increased financial resources, the number of staff members of IHE increased fourfold during the Nineteen Seventies in order to deal with environmental issues (Thiers, 2004). Also, the Belgian Nuclear Research Centre (SCK-CEN) extended its activities to non-nuclear research by the Royal Decree of June 24, 1970. SCK-CEN had to use its infrastructure more intensively and wanted to make its experience available in the field of environmental technology, energy applications, information technology, etc. (Verwimp & Verledens, 2002). However, at the universities, scientists who were investigating environment related issues were very rare (De Wel, personal communication, 3 March 2010). Magnus (personal communication, March 25, 2010, my translation) illustrated the limited academic attention for environmental health issues by referring to an anecdote, “The Faculty of Medicine of the University of Leuven organized in 1974 a symposium about

another view on health care. A workshop about environment and health was not successful at all.” Moreover, the few environment-related research results did not enter the decision-making process fluently. For instance, according to Van Larebeke (personal communication, May 19, 2010) during the early Nineteen Seventies, scientific studies were published about the impact of mutagenic agents on genetic material, but their impact on decision making was limited.

In 1970, the KBC bank and insurance company (the then called *Kredietbank*) founded *Stichting Leefmilieu* (since 2002 called *Argus*) in order to emphasize its sense of societal responsibility. *Stichting Leefmilieu* was established to develop an objective, evidence-based and interdisciplinary approach of environmental problems by encouraging environmental sciences, publishing environmental studies and books, developing a documentation centre, organizing workshops, panel discussion, etc. (www.argusmilieu.be, May 23, 2011). At that time, *Stichting Leefmilieu* was the most important information source for environmental professionals in Flanders.

As already described in Chapter 4, since the Nineteen Sixties, risk assessment was commonly used as scientific methodology to investigate the impact of environmental pollution on human health in a comprehensive and objective manner (Bridges, 2003) and to set regulatory policies (Gochfeld & Goldstein, 1999). In that time period, risk assessment was primarily done based on, “descriptive toxicology comprised of dose and blood level measurements plotted against observed affects such as enzyme activities or organ function tests” (Schonwalder & Olden, 2003). Most research was done in one sharply defined aspect of an employee’s environment, i.e., the workplace, in order to gear evidence-based action (Eyles, 1997). As a consequence, occupational physicians still played an important role in early environmental health research mostly related to toxic chemicals like heavy metals (Loots, personal communication, July 9, 2008). Moreover, most research activities were incident-driven, in particular, limited to serious, single health effects in local areas as a result of acute exposure to an unusually high concentration level of a single pollutant (Eggermont, personal communication, June 25, 2008). The traditional way of investigating the relationships between the environment and health was driven by a (post)positivistic view of science whereas, “most problems can be understood by more precise measurements and those identified relationships which do not have plausibility with respect to the criteria of causal science are in some ways ‘irrational’ and therefore irrelevant” (Eyles, 1997). Through the years and especially driven by the atomic bombings in Japan (Section 5.1.3.), more attention has been given to statistically, quantitatively dealing with scientific uncertainty, as a result of an

increased awareness of the unavoidability of uncertainty. For instance in the Nineteen Eighties, according to Schonwalder and Olden (2003), “the difference between variability in biological experiments (a normal attribute which can be dealt with using statistical methods) and uncertainty (a lack of understanding) was realized.” In terms of today (see Section 2.1.1.), Van Asselt (2000) and Walker et al. (2003) make a difference between statistical uncertainty and ignorance. The then scientists also emphasized the need to improve the quantitative basis for low-dose extrapolation and requested the threshold hypothesis.

- **Environmental Risk Management: the Public Health Versus the Industrial Safety Approach**

In order to protect the employees and the people living in the neighbourhood of unsafe, unhealthy, or nuisance industries, the amount of environmental protection legislation integrated in the General Regulation of Labour Protection (ARAB) increased during the Nineteen Sixties and Seventies. However, according to De Wel (personal communication, March 3, 2010, my translation), this evolution was not a confirmation that environmental hygiene and environmental health were high priorities of the Ministry of Labour, “The civil service responsible for labour protection was just a small part of the Ministry of Labour. The main aim of the Ministry of Labour was the assurance of employment. As a consequence, it was not done to close a company that did not observe the regulations about industrial safety and nuisance.” As already described in Section 5.1.2., science was used by the government in order to legitimize its power and to act as a buffer between opposing concerns of employers and employees. In 1987, after a series of industrial accidents, the Belgian Government promulgated a law to manage risks of heavy accidents with certain industrial activities in response to the European Directive 82/501/EEC on the major-accident hazards of certain industrial activities, the so-called Seveso Directive, which was adopted in 1982.

In the meanwhile, inspired by the international and local discourses that environmental pollution could affect public health, the Ministry of Public Health allocated itself power over the environment, established the Environmental Department and promulgated environmental standards for specific environmental compartments (air pollution, pesticides, surface water and noise annoyance). After all, the public health advisory boards and state-owned research institutions already enlarged their scope to environmental research in the Nineteen Fifties and Nineteen Sixties. Although these laws were driven by health concerns, the environmental health discourse was less

transparent and mostly implicit (Hens, personal communication, June 13, 2008). Environmental health was only mentioned explicitly in ad hoc cases related to local crises. The latter is elucidated in more detail in Chapter 6.

The fragmentation of environmental authorities and the shared responsibility between the Ministry of Labour and the Ministry of Public Health required a strong cooperation and even coordination of these two policy areas. After all, coordination is more far-reaching and formal than cooperation and will lead to joint decisions and joint outcomes that may be quite different from their initial preferred outcomes (Meijers & Stead, 2004). However, in practice, the cooperation between those two ministries was a real struggle, "The civil servants of the Ministry of Labour considered the civil servants of the Ministry of Public Health as priors. After all, until then, the Ministry of Labour had the exclusive power to grant permission for exploitation. Since the Nineteen Seventies, the Ministry of Public Health imposed additional exploitation conditions" (De Wel, personal communication, March 3, 2010, my translation). Possible examples of inhibitors of coordination, confirmed by the interviewees, are the differences in disciplinary background of the civil servants (the lack of a common language, disparities in staff training, and differences in ideologies), differences in perceived threat and loss of authority, and differences in policy goals and priorities. After all, the Ministry of Labour was more interested in the creation and preservation of employment than in environmental protection or the protection of the neighbourhoods around dangerous industrial activities. Taken into account the origin of the industrial safety policy arrangement, this does not come as a surprise because the Ministry of Labour was most influenced by employers and employees' representatives. The Ministry of Public Health, on the other hand, focused more on the prevention of diseases and the protection of public health. As a consequence of the increased attention for the impact of the environment on public health, the Ministry of Public Health not only paid attention to curative medicine, but also started to focus on preventive health.

The Tessengerlo case, extensively analysed by Leroy (1983), provides a clear illustration of the diverging discourses and interests of both ministries. In Tessengerlo, the siting of a plant producing mercaptans (Phillips Petroleum) provoked a huge protest from citizens and environmental groups. The controversy on this anticipated production unit, however, had a wider background and scope: it revealed the long lasting bad environmental situation in the area, with heavy loads of emissions in SO₂, heavy metals, and a cocktail of pollutants originating from different plants. While the Environmental Department of the Ministry of Public Health advocated a strict sanitation and prevention programme for the area as a whole, the Ministry of

Labour explicitly opposed whatever measure that would go beyond the latter's plant-by-plant approach, based on the ARAB legislation, and advocated the employment interests solely. Nevertheless, the Tessenderlo case was innovative in another respect. As was already initiated in the Hoboken case, that preceded the Tessenderlo case a few years (Section 6.1.), the sanitation plan was designed by a steering group, in which representatives from different ministries, experts from universities and state research institutions, local authorities and even local and national environmental groups were invited. The establishment of such a workgroup could imply that the ARAB legislation at that time was not sufficient anymore to deal with this kind of complex environmental (health) problems. Chapter 6 illustrates how, throughout a series of environmental incidents and controversies, this multidisciplinary, multi-sector and multi-level approach gradually developed, spread, and institutionalized into a managerial pattern of environmental health risk management.

To conclude this section, Figure 17 presents a schematic overview of the impact of the environmental discourse on new legislation (rules of the game), and new actors within the Belgian science-policy arrangement in the Nineteen Seventies.

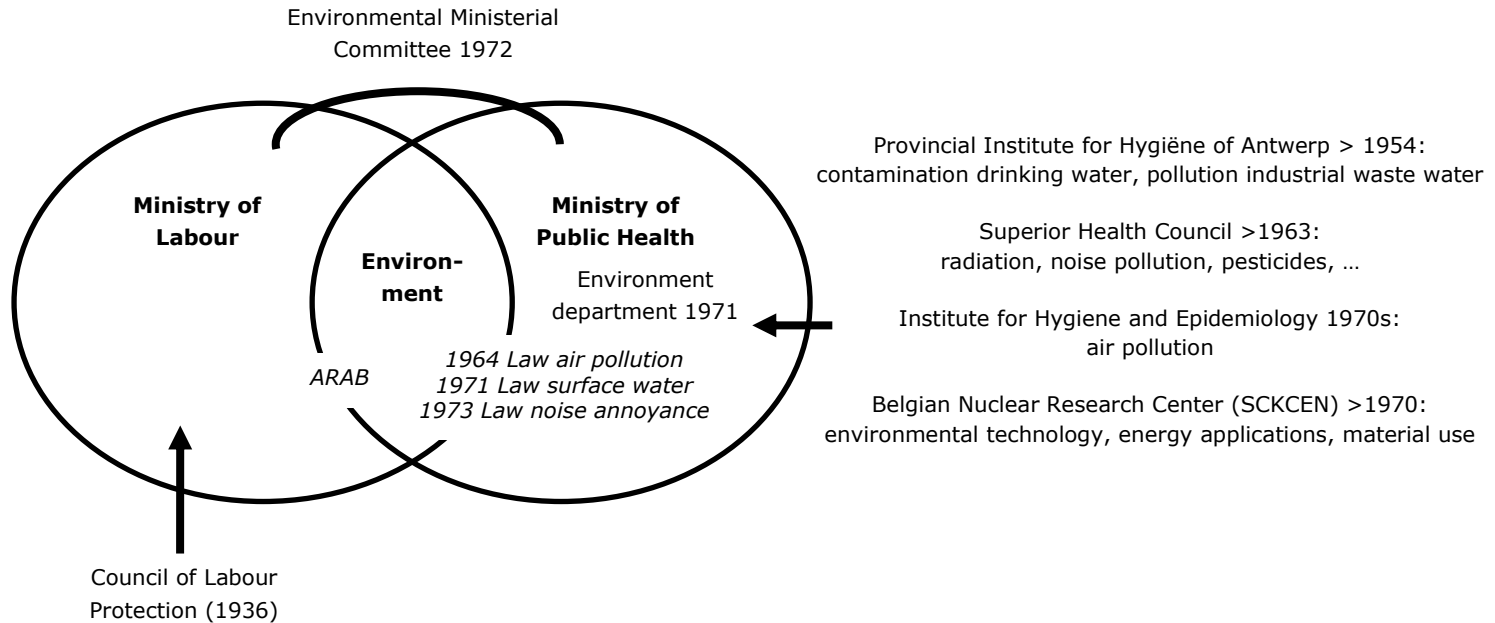


Figure 17: Schematic overview of the most important actors and legislation (cursive print) related to the environmental policy domain.

5.2.2. The Situation in Flanders after the Constitutional Reforms of the Belgian State (1980 – mid 1990s)

Within a relatively short period of time, Belgium transformed from a centrally ruled state into a full-fledged federal state, composed of Communities and Regions, which independently exercise their authority within their domains. Thence forth, the Flemish-, French- and German-speaking Communities are authorized with everything related to people, culture and language, such as education, preventive health care, culture, and welfare. The Regions (the Flemish Region, the Brussels Capital Region, and the Walloon Region) are responsible for matters related to territory, such as the environment, agriculture, employment, housing, regional and town planning, etc. The Federal State is authorized in the areas with respect to the common good of all Belgians: foreign affairs, national defence, justice, finance, social security, labour protection and the welfare of workers, and an important part of public health (i.e., drugs policy, health & disability insurance, funding of health care institutions, etc.). The Federal Government has also been authorized for a few environmental competencies that are regarded important to Belgium's international position: radiation, waste transport, and product standards.

Since the constitutional reforms during the Nineteen Seventies and Nineteen Eighties, the environmental field, the public health field, and the protection of labour field have developed into three separated policy domains, authorized to different governments. Labour protection has been authorized to the Federal State, whereas the authorities on environment and health issues have been left in the hands of the Regions and the Communities respectively. However, Flanders decided as early as 1980 to merge the Flemish Community with the Flemish Region. As a result, Flanders has one single parliament and one single government with competence over community-related and regional matters. Due to the constitutional reforms, not only the authorities have been reshuffled, also the knowledge and expertise of civil servants and researchers dealing with environment and health related issues have split up as well. More precisely, in the Nineteen Eighties, civil servants were dispersed and reorganized at the different governmental structures or they decided to leave in order to utilize their know-how in the private sector (Thiers, 2004; Thiers, personal communication, March 22, 2010). For instance, the personnel and financial resources of the National Institute for Hygiene and Epidemiology (IHE) substantially decreased in the Nineteen Eighties. The Dutch-speaking scientists of the environmental department of IHE were transferred to VITO and VMM in 1993 (Buyst et al., 2011). Another example is the split up of SCK-CEN by the Royal Decree of October 16, 1991 and the formation of VITO, the

Flemish Institute for Technological Research. VITO took over the non-nuclear activities of SCK-CEN in order to provide a better knowledge base from the 1990s onwards related to the environment, energy and (raw) materials (Verwimp et al., 2002).

With the institutional reforms, environment and health portfolios have been allocated to separate ministries in Flanders. Moreover, in the Nineteen Eighties, environmental policies and the preventive health field were no priorities for the Flemish Government which political agenda was dominated by the assurance of employment, the boost of the economy, and the institutionalization of the Flemish governmental departments and institutions. De Wel (personal communication, March 3, 2010, my translation) as well as Kelchtermans (personal communication, February 19, 2010, my translation) illustrated the triviality of both policy domains by referring to the same anecdote, "The ministers of the Flemish Government could choose their competencies in order of the hierarchy of the political parties. Environmental policy and public health were at the bottom of the list during the first Flemish Government conducted by Geens. To illustrate, the environmental policy was allocated to Lenssens, who was the last minister to choose authorities." According to De Wel (personal communication, March 3, 2010), Lenssens was not pleased with his new position, but nevertheless worked diligently toward the end of his first term, and succeeded in increasing environmental awareness in the society and adding environmental issues to the political agenda.

Related to the policy content, Lenssens followed a segmented approach parallel to the different environmental compartments (soil, air, water, noise, etc.) and the environmental standards developed in the Nineteen Sixties and Seventies. This approach resulted in the development of environmental quality norms, "which are still of great importance in current environmental policy" (Tieleman et al., 2002). Risk assessment was commonly used to determine the environmental quality norms. In order to obtain the environmental standards, industrial activities were submitted to licenses in correspondence with the philosophy of the Napoleon's Decree (1810), distinguishing three classes of industrial activities. As a consequence, the legislation focused on industrial activities and clearly provable sources, but neglected scattered and mobile sources of environmental pollution such as agriculture and traffic (Leroy, 2011). The environmental priorities of the first Flemish Government were related to waste management and the protection of surface water (Loots, Van den Broek & Leroy, 2009). After all, in Flanders, the amount of waste increased, the capacity of waste treatment was too limited and the quality of the surface waters left much to be desired. Related to the

policy organization, Lenssens first assignment was to establish a Flemish environmental executive board, named *Administratie voor Ruimtelijke Ordening en Leefmilieu* (AROL), governmental institutions (e.g., OVAM and VWZ) and procedures in order to develop and implement a Flemish environmental policy. At first sight, it seems that all environmental competencies would be integrated into one governmental department. However, the competencies related to waste management and water quality (the first environmental priorities) were allocated to separate public institutions, OVAM (*Openbare Vlaamse Afvalstoffen Maatschappij*) and VWZ (*Vlaamse Waterzuiveringsmaatschappij*), respectively. As a result of the limited financial resources, the establishment of Flemish administrations was a difficult and slow process. Consequently, the first Flemish Ministers of Environment and Health were obliged to appeal to federal ministries. De Wel, civil servant of the first Flemish Environmental Ministry, declared the difficulty of this cooperation, "The Flemish Ministers needed to commission federal public servants who were not hierarchical dependent on each other. This led to difficult situations because the Flemish Minister of Public Health commissioned the federal civil servants to close a company for its dangerous and unhealthy activities, while the same federal civil servants were commissioned by the director of the federal Ministry of Labour to protect employment" (De Wel, personal communication, March 3, 2010, my translation). Civil servants at the federal level only gradually transferred to the regional levels, but the number of defected staff was not proportionate with the delegated authorities (Kelchtermans, 1990; De Wel, personal communication, March 3, 2010). Moreover, there was no scientific research institution on environment and/or health at the Flemish level yet. In order to scientifically support the Flemish environmental policy, policy-oriented environmental studies were financed related to air pollution, noise nuisance, or the determination of standards (De Wel, personal communication, March 3, 2010). Most studies were done by IHE, SCK-CEN, and VITO since 1991. After all, there was not much interest from the universities as only a few academics were dealing with environmental issues in the early Nineteen Eighties and they were more focusing on fundamental research.

A second boost to the environmental policy was given by Kelchtermans in 1989 in response to the increased recognition that the segmented, operational, ad hoc policy approach and the limited financial and governmental capacity were not sufficient to manage environmental problems (Loots, Van den Broek & Leroy, 2009). Moreover, the need for a strategic, long term, integrated process approach increased (Loots et al., 2009). Kelchtermans introduced the first Environment and Nature Policy Plan (Mina-plan) in 1990, in

order to integrate, and strive for coherence between, the different environmental compartments. In response to international discourses, sustainable development was introduced as the driving force for environmental policies and environmental problems were analysed on the basis of the DPSIR-model referring to "Driving forces", "Pressure", "State", "Impact", and "Response" (Tieleman et al., 2002). Kelchtermans reformed the Flemish environmental law in 1995, based on the advices of the Interuniversity Commission for the Reform of the Environmental Legislation in the Flemish Region, by developing a basic decree concerning general provisions relating to environmental policy and planning, called *DABM* or *Decreet Algemene Bepalingen Milieubeleid*. However, it must be noted that the new regulation was still based on the command and control approach establishing environmental quality norms for the protection of the environment. The main difference was that a distinction was made between basic environmental quality norms for the whole Flemish Region and specific environmental quality norms for areas which needed special protection, on the one hand, and between limit values and directional values, on the other (Deketelaere, 1998). However, Kelchtermans increasingly recognized the lack of technical and financial government in order to achieve the long-term strategic environmental policy goals and provided complementary environmental policy instruments next to the direct regulation (Deketelaere, 1998). As a consequence, Kelchtermans introduced environmental taxes, established the MINA-Fund, and privatized waste (water) treatment. For instance, the Flemish Government established levies on "the removal of waste (1986 and 1990), the pollution of surface waters (1990), the overproduction of manure (1991), the delivery of a permit for the intake of water (1990), the extraction of gravel (1993), and the import or export of waste (1994)" (Deketelaere, 1998). Those financial revenues were deposited in the MINA-Fund in order to finance and implement the Flemish waste and water policy. After all, the main environmental priorities at that time included: the installation of a sewage system and sewage treatment plants, and the separation and disposal of waste. However, Deketelaere (1998) emphasized that this kind of environmental levies are not sufficient to change the behaviour of polluters. The introduction of regulating environmental levies such as ecotax, fiscal advantages for environmentally friendly investments and subsidies were introduced to convince companies and individuals to invest in clean technology and products. At last, Kelchtermans transformed the Flemish Council for the Environment (Vlarale) into the Environment and Nature Council of Flanders (Mina-Raad).

Referring to Hens (personal communication, June 13, 2008, my translation), “the governmental approach to environmental policies evolved from a soft ministry characterized by starry-eyed idealists to a hard ministry driven by huge investments and infrastructure developments.” As a result, environmental policies became a more important and prior policy field in Flanders. To illustrate this, Kelchtermans referred to the same anecdote, “In the first Flemish Government conducted by Geens, environmental policy and public health were at the bottom of the list. Ten years later, environmental policy was at the top of the list. De Batselier, the second minister who could choose his competencies, preferred the environmental policy.” After all, in terms of financial resources, the budget for the Flemish environmental policy increased from 169 million euros in 1989 to 502 million euros in 1994, the second largest expenditure of the Flemish Budget (Buyst et al., 2011).

The air and water monitoring activities of the National Institute for Hygiene and Epidemiology (IHE) were transferred to the Flemish Environment Agency (VMM) in 1993. As a consequence, the VMM scientifically strengthened because it received a laboratory and a large-scale network to monitor the quality of air and surface water (Buyst et al., 2011). The VMM gained also the responsibility for the reporting on the state of the environment. Its first report *Milieu- en Natuurrapport Vlaanderen, Leren om te keren* (Verbruggen, 1994) can be considered as a way to give the environmental policy in Flanders a solid and scientific basis (Loots et al., 2009). MIRA integrates different environmental scientific expertise taking into account the DPSIR approach to systematically describe the current scientific state of affairs of causes and consequences. In 1994, the Flemish research programme TWOL (Environmental Scientific Research Programme) was initiated by the Flemish Ministry in order to have an own basis for financing policy oriented environmental research at the universities, environmental consulting companies and VITO.

Despite the international discourse on sustainable development (UN, 1972; 1992b), the European Environment and Health Process (WHO-Europe, 1989; 1994b; 1999; 2004a; 2010b), and the European Charter on Environment and Health (WHO-Europe, 1989), the link between the environment and health prevention was only implicitly acknowledged in the Flemish environmental policy (Denteneer, personal communication, March 2, 2010), unless as a result of specific cases or incidents (Dua, personal communication, February 11, 2010). Some examples are the lead incident in Hoboken in the Nineteen Seventies and the cadmium crisis in the Northern Kempen in the Nineteen Eighties, caused by the nonferrous industry (see also Chapter 6; Baeyens, personal communication, March 24, 2010). According to Kelchtermans and

Dua, the main plausible explanations were related to: 1) the other priorities of the Flemish environmental government (waste disposal, water treatment, environmental taxes, etc.); 2) the very strict demarcation of ministers' responsibilities; and 3) the influence of local politicians who tried to conceal this information for electioneering purposes or the protection of the local economy (Kelchtermans, personal communication, February 19, 2010; Dua, personal communication February 11, 2010). De Wel added that the differences in the disciplinary backgrounds and ideology of the civil servants of both the Ministry of Public Health and the Ministry of the Environment hampered the cooperation between both policy fields (De Wel, personal communication, March 3, 2010).

In contradiction with the implicit acknowledgement of health prevention in the Flemish environmental policy, the Flemish health policy already emphasized the importance of environment and health in the mid Nineteen Nineties (Demeester, 1995). However, as a result of understaffing, the tasks of the Flemish Health Inspection Service were limited to give advice about environmental licenses, to advise local authorities about unhealthy situations, to take preventive measures in order to protect the environmental quality, to support scientific studies about the soil contamination by heavy metals, and to develop an action plan for ozone depletion.

To conclude, Figure 18 presents a schematic overview of the relevant actors involved in the Flemish policy arrangements of the environment and public health from 1980 until the mid Nineteen Nineties.

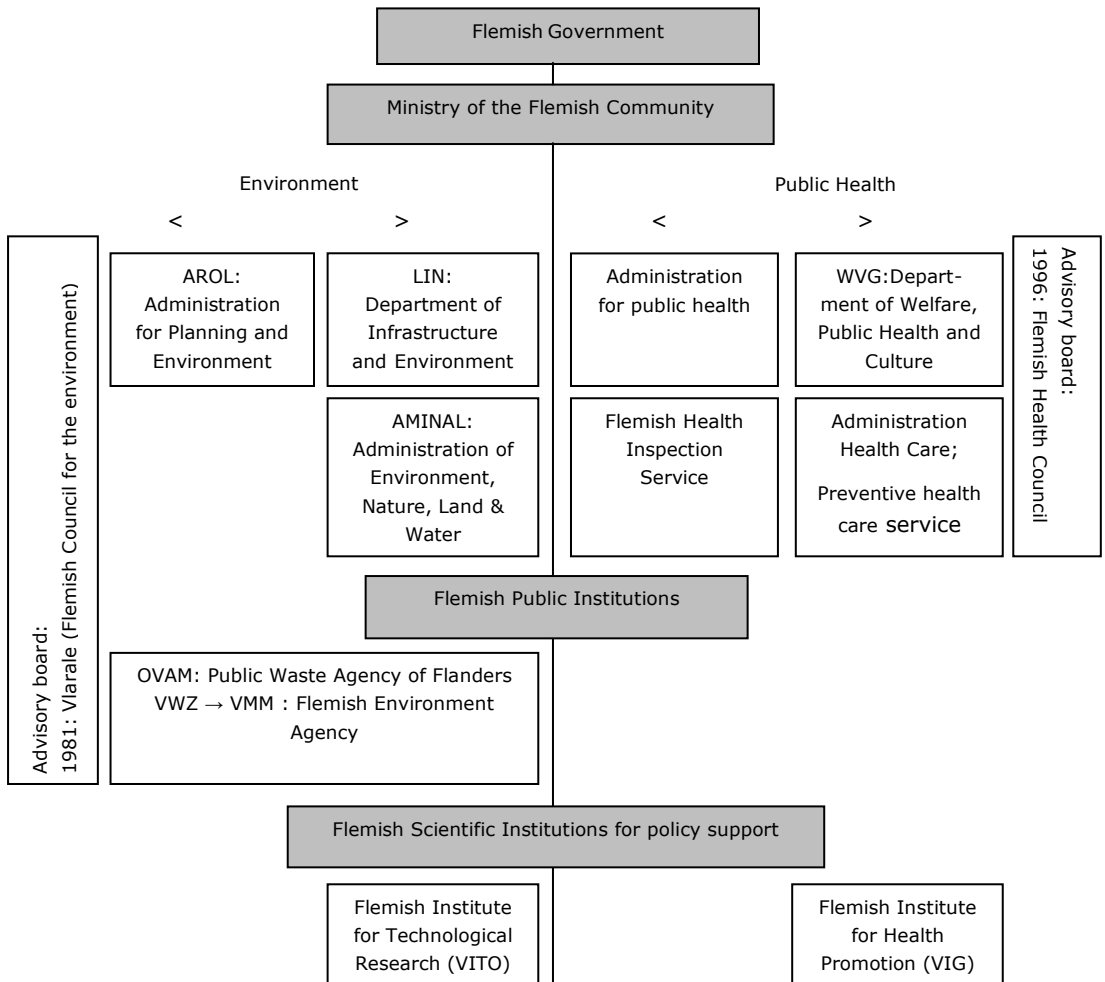


Figure 18: Actor map of the Flemish policy arrangements of the environment and public health from 1980 until the mid Nineties.

5.2.3. Lessons Learned

The next paragraphs sum up this period, taken into account all theories described in the literature review in Chapter 2.

- **The Institutionalization of the Flemish Environmental Policy: Managing Environmental Risks**

Initially, environmental problems were managed using a segmented approach and the development of environmental standards for each environmental compartment based on the traditional risk assessment methodology. As already described in Chapter 4, risk assessment was used in the Nineteen Eighties to estimate risks caused by environmental pollution to human health in order to make scientific information on probabilities useful to regulatory decision making. Through the years, the recognition increased that the segmented approach was insufficient to deal with environmental problems and that an integrated, strategic, long-term process approach was needed. In response to international discourses and developments, environmental policies and environmental problems were analysed on the basis of the DPSIR-model referring to "Driving forces", "Pressure", "State", "Impact", and "Response" (Tieleman et al., 2002).

Related to the policy organization, the Flemish Government had to develop its own institutions, advisory boards, legislation and financial resources in order to develop and implement a Flemish environmental policy after the constitutional reform in 1980. As a consequence, a Flemish environmental executive board was established as well as different public institutions (e.g. OVAM and VWZ). The environmental research activities were transferred from IHE and SCK-CEN to the Flemish Environment Agency (VMM) and the Flemish Institute for Technological Research (VITO). It was a lost opportunity to not establish one coordinated organization for environmental research. After all, to this day, the scientific expertise in environmental knowledge is very fragmented in Flanders (Buyst, Lowyck, & Soete, 2011). The strength of the *Flemish State of the Environment Report* (MIRA) is that it integrates different expertises in one report and website (Buyst, et al., 2011) in order to give the environmental policy in Flanders a solid basis (Loots et al., 2009). MIRA can be considered as a boundary tool between science and policy.

Financial resources were provided by introducing environmental taxes, establishing the MINA-Fund, and privatizing waste (water) treatment. These new initiatives were at the basis of a new type of interaction between state, society and economy, characterized by increased participation of relevant actors in the decision-making process (experts from the public institutions, Mina-Council, SERV, the environmental NGOs, etc.). The Flemish Government also invested in policy oriented environmental research by establishing VITO and financing a research programme for applied environmental studies.

The new discourses about policy content and policy organization resulted in a reform of the Flemish environmental law in 1995 and the development of a basic decree concerning general provisions relating to environmental policy and planning, called *DABM* or *Decreet Algemene Bepalingen Milieubeleid*. As such, new procedures and new environmental policy instruments were established.

In brief, in the Nineteen Eighties and Nineties, the Flemish environmental arrangement institutionalized. Changes in policy content and discourses (from a fragmented end-of-pipe towards an integrated, preventive, long-term approach) gradually evolved into new institutions (political structures, civil services, advisory boards, scientific institutions), rules of the game (legislation) and resources (MINA-fund, environmental taxes). However, it must be noted that in the early years of Flanders (1981-1985) priority was given to the creation of jobs and the increase in economic growth, "The investment climate is important for the future. Additional expenses, like the environmental tax, may not affect the competitiveness of the Flemish companies" (Beleidsnota DIRV-actie, 1984 in: Buyst, Lowyck, & Soete, 2011, my translation).

- **Environmental Health Discourse**

The impact of the international discourses and initiatives on the integration of environmental health policies was rather limited until the end of the Nineteen Nineties. The attention for environmental health issues was not explicitly mentioned in Flemish policy documents, unless related to specific, local problems. However, it must be noted that the segmented environmental quality standards were determined based on human health impact assessment. The main aim of the environmental policy, although only implicitly acknowledged, was to decrease the emission of environmental pollution in order to prevent negative human health effects. The incident-driven agenda setting of environment and health and the initially ad-hoc approach to manage them is clearly illustrated in Chapter 6.

- **Important Milestones in the Institutionalization Processes of Environmental Health**

The constitutional reform of the Belgian State was an opportunity to re-allocate environmental legislation from the ARAB-legislation and the Ministry of Labour and to develop a specific environmental policy arrangement at the Flemish governmental level. Allocating environment and health portfolios to separate ministries hampered the development of integrated policies in a

comprehensive and coordinated way. Another obstruction at that time was the fact that the health policy domain was slowly and gradually transferred to the regional communities, whereas the environmental policy field was much more quickly institutionalized into the regions. A third aspect that hindered the development of an integrated environmental health arrangement was the urgency of other environmental problems, like the capacity for waste sanitation and waste water treatment (Loots, Van den Broek & Leroy, 2009). The public health policy, on the other hand, was based on a more individualistic and curative approach despite the efforts of the World Health Organization to extend the definition of health to well-being. Fourth, as a consequence of the constitutional reform of the Belgian State, the Institute for Hygiene and Epidemiology lost its environmental health research activities, but there was not yet a scientific organization at the Flemish level to continue this field of study.

The Flemish environmental policy arrangement had most characteristics of the Bureaucratic Boundary Model of Hoppe until the mid Nineteen Nineties. Primacy was given to politics, while VITO was established as a policy-oriented Flemish research institution and the Mina-Council as an advisory board in order to support the decision-making process. The Flemish Government also launched the TWOL-programme in order to stimulate and finance environmental-oriented research at universities and private research organizations. Also the Flemish public health policy arrangement was characterized by the Bureaucracy Model, although the arrangement was only beginning to take shape in the second part of the Nineteen Nineties. The establishment of the Flemish Institute for Health Promotion and the Flemish Health Council provide evidence for this.

Chapter 6: Series of Environment and Health Incidents

This chapter provides an analysis of a series of environmental health related incidents in Flanders and their respective impacts on the environment and health field, both scientifically and politically. These incidents were mostly the long-term effects of the industrialization and urbanization period during the nineteenth and twentieth century and/or the industrialization of agriculture, stock breeding, and the food chain. According to the Risk Society Theory of Beck, a succession of environmental health related incidents can be regarded as a logic consequence of modernization.

It is out of scope to analyse all local incidents and events that occurred. This chapter contains a selection of four important cases, which laid the foundation for increased political and scientific concern, as well as the agenda-setting, for environmental health and the institutionalization of the Flemish environmental health policy arrangement. The cases are related to: 1) the metallurgic activities in Hoboken, 2) the cadmium crisis in the Northern Kempen, 3) the dioxin deposition by two waste incinerators in Wilrijk near Antwerp, shortly followed by the Belgian dioxin crisis in the food chain (4). Although the dioxin crisis was not restricted to Flanders and food safety was a federal authority, the crisis provided important new insights about the discourses, organization, and management of environmental health risks, which also influenced the processes of institutionalizing environmental health in Flanders.

The basic assumption is that politicians, scientists, and the population in general gradually shifted their discourses about (environmental health) risks and uncertainties (shifts in epistemology) during this period which gradually led to new scientific methodological challenges, on the one hand, and changes in the environmental health policy arrangement and the need to institutionalize this arrangement, on the other. Each case is analysed in order to determine how and to what extent each incident contributed to changes to the discursive, practical, and the institutional level. First, a summary of the historical review is described for each case. Second, a reflection is made in regards to the impact of the case on the institutionalization process towards an environmental health arrangement.

6.1. Lead Incident

6.1.1. A Historical Review

In 1887, a lead and de-silvering plant opened in Hoboken (Antwerp) to refine minerals and extract metals from waste. Since 1921, houses were built near the metallurgic plant in order to provide living facilities for the employees. It is possible that this was just done to limit opposition, since by 1920, labourers were already complaining about the unhealthy and unhygienic working conditions (Gijssels, 1979). The complaints of the neighbours in the mid Nineteen Sixties about the air and smell pollution and the large-scale destruction of honeybees could not force general public agitation and political attention. The limited reaction can be explained by the dependency of the population on employment and the priority the Ministry of Labour placed on employment instead of occupational health and safety. Besides, according to Gijssels (1979), victims were given underhanded compensation.

In the early Nineteen Seventies, the metallurgical industry was increasingly recognized as not only dangerous for human health as a result of occupational exposure, but also dangerous to the environment and the people living in the surrounding neighbourhood. In 1973, six cows and two horses belonging to a farmer near Hoboken died within a few days. Professor De Backere (Faculty of Veterinary Medicine, University of Ghent) attributed their death to the lead contamination of the nearby non-ferrous industry. His diagnosis was supported by a chemical analysis of the lead content in the deceased animals' organs and the hay feed, and an analysis of heavy metals in the soil (Léonard, Deknudt & Debackere, 1974). Nevertheless, referring to Debackere (De Standaard, April 20, 1973, my translation), these results did not confirm a negative impact on public health, "It is not easy to prove lead poisoning in humans. I can imagine that earlier defined vague complaints of people living in the neighbourhood can finally be allocated (...) The situation is precarious" (Merckx, 2008). By order of local authorities, a study was performed by the Provincial Institute for Hygiene (PIH) in May 1973 that confirmed the high concentration of heavy metals in soil, water, and grasses. PIH also confirmed the assumption that the metallurgical industry was responsible for the local pollution. As a consequence, PIH recommended to not cultivate vegetables in that area and to initiate a new research study in order to determine possible negative impacts on public health (PIH, 1973). In response to the recommendations of PIH, the Ministry of Public Health asked the mayor of Hoboken, "to advice the inhabitants discreetly against eating vegetables they have cultivated themselves" (Gijssels, 1979, my translation). As a result of

scientific uncertainty about the possible health effects, there was disagreement about which measures should be taken (Gijssels, 1979).

In 1974, pressured by local action committees (*Geneeskunde voor het Volk, Pluralistisch actiefrent tegen de Loodvergiftiging*), the attention in the media increased and a first small-scale biomonitoring survey was done with eleven-year-old children by the National Institute for Hygiene and Epidemiology (IHE). In the written reports of IHE to the local authorities, the seriousness of the research results was underestimated claiming that there was no reason to panic because the exposure levels were lower than the acceptable limits. However, based on the same data, Roels et al. (1976) concluded in an American scientific journal that 25 µg Pb/dl blood is the maximum biologically allowable concentration of lead in blood of school-age children and the average measured concentration of lead was higher (30.1 µg/dl) in two of the three schools in Hoboken (Table 14). Roels et al. also emphasized that children were a more vulnerable group than adults. As a consequence, the average exposure limits were questioned.

Table 14: Lead concentration in blood of school-age children (10-15 years old) near the lead smelter area in Hoboken compared to children in the rural area (Roels et al., 1976).

School	Number of Children	Average Lead Concentration in Blood (µg/dl)
Maalbootstraat en de Baron Sadoinestraat (Schools < 1 km of the lead smelter)	37	30,1 ± 0.94 (19.7 - 41.1)
Don Bosco (School located at 2.5 km of the lead smelter)	14	21,1 ± 0.90 (14.9 - 27.6)
Rural Area	92	9.4 ± 0.21 (4.7 to 15.6)

The local authority was duped and established a local working group in 1977 managed by Professor Clara (University of Antwerp) and consisted of medical experts (Prof. Eylenbosh, Prof. Deelstra, Prof. Masschelein, Dr. Merckx, Lic. Coeck). The working group reviewed and reanalysed the earlier published studies and concluded that, "The health conditions for children living close to the metallurgic industry were threatening (...) and a general exposure assessment is recommended" (Clara, 1977, cited in Merckx, 2008, my translation). IHE in cooperation with PIH were responsible for the general biomonitoring screening of the local population twice a year. In March 1978, the first research results became known and were much worse than expected

(Table 15). The average lead concentration in blood (34 µg Pb/dl blood) greatly exceeded the maximum biologically allowable concentration for school-age children (25 µg Pb/dl blood). Furthermore, the assumption was made that long-term lead exposure could cause negative cognitive effects, such as mental retardation.

Table 15: Lead concentration in blood, general biomonitoring screening of children in Hoboken in February 1978 (In: Gijssels, 1979).

School	% of children above 30 µg Pb/dl blood
Maalbootstraat (< 1km)	72%
Baron Sadoinestraat (< 1 km)	86%
Don Bosco (< 2.5 km)	8%

After the formal confirmation of the lead pollution in Hoboken and the revelation in the media, the Ministry of Public Health developed an action programme in 1978 in order to clean-up the contamination area (Keune et al., 2002; Royal Decree of July 1978). Previously proposed measures to create a buffer zone by finding a new accommodation for 3000 inhabitants did not succeed because of the opposition of the local working group (Gijssels, 1979). It is worth mentioning that the decontamination measures were discussed only between government and industry, without the interaction of other stakeholders (Keune et al., 2002). Nevertheless, according to Merckx (2008, my translation), "The symbiosis between scientists, such as Robert Clara and Willy Eylenbosch, and action groups resulted in drastic improvement measures that should be financed by industry and the government."

As part of the action programme of 1978, the PIH was responsible for biannual biomonitoring surveys of school-age children. In order to follow-up and discuss measures related to: 1) the decontamination of soil, 2) industrial measures to limit lead emissions, and 3) the sensitization of the inhabitants in order to prevent and diminish exposure to soil and particular matter, a ministerial working group was established composed of experts, representatives of the Ministry of Public Health, the Ministry of Labour, the Ministry of Agriculture, etc. (Leroy, personal communication, June 28, 2011). In later years, the ministerial working group merged with the local working group because both groups were dealing with the same issues and their membership partially overlapped (Vlaamse Raad, 1984).

To complete the lead case, the lead concentration in blood decreased gradually from an average of 40 µg/dl in 1978 to 24.3 µg/dl in 1984 (d'Aubioul, 2008). To date, new initiatives, action plans, and measures have been undertaken. It is out of scope of this research project to present an overview of all scientific surveys, political, and industrial actions that have been taken. Nevertheless, it is worth mentioning that a new *Action Plan Environment and Health for Moretusburg* (Hoboken) was established in 2003. The Action Plan was based on the results of an environment and health survey in Moretusburg done in 2001 by the Flemish Centre of Expertise on Environment and Health as a reaction to the increased commotion to a leaked feasible policy measure to pull down a part of the quarter. The renewed Action Plan had to overcome the difficulties of previous years by having: 1) a local focal point, 2) a better organizational structure to link environment with health and trace environmental health problems as soon as possible, and 3) actions to decontaminate the residential quarter Moretusburg. Since 2006, the average lead concentration of school-age children living in Moretusburg is below the recommended limiting value of 10 µg/dl prescribed by the American Centre for Disease Control and Prevention (d'Aubioul, 2008). In the *Brescia Declaration on Prevention of the Neurotoxicity of Metals* (2006) the limiting value was even set at 5 µg Pb/dl blood in order to reduce the incidence of subclinical neurotoxicity in children as well as the delayed consequences of developmental toxicity. The Declaration emphasizes that this value needs to be revised as new evidence accumulates regarding toxicity at still lower blood lead levels.

6.1.2. Lessons Learned and New Insights About Environmental Health Risks

This section analyses the challenges and needs in response to the experiences of the lead case in Hoboken. First, the changing discourses and thoughts on environmental health risks and uncertainties are summarized. How people living in the surrounding neighbourhood perceived the problem is also described. This reflects the epistemological shift during this period which gradually led to new scientific methodological challenges and changes in the environmental health policy arrangement.

- **Changing (Epistemological) Discourses on Risks and Uncertainties**

The historical reconstruction of the problem of lead contamination in Hoboken demonstrates clearly that the impact of environmental pollution on human

health was initially unaddressed. There was only an assumption, and no scientific certainty, because a causal link was already demonstrated between the death of livestock and the lead contamination caused by the nearby non-ferrous industry. The situation in Hoboken was even more complex because of possible long-term health effects caused by the accumulation of lead and the negative well-being effects (e.g., mental retardation and cognitive effects) related to low-dose exposure. It must be noted that the attention focused solely on the problems related to the lead exposure, while the inhabitants were also exposed to dioxins and other carcinogenic metals (Onderzoek naar Factoren die Loodbloedgehalten van Kinderen in Moretusburg Beïnvloeden, 2002). A possible explanation is that, in that time period, scientific thinking was based on linearity and reductionism, while complexity was rather denied. Through the years, the complexity of the problem and the related scientific uncertainty has been increasingly recognized. As a consequence, the presumption of a unique epistemology, the Modern Model based on Positivism, was challenged.

A second discourse that broke through during the lead case was related to children. The assumption was made that children, especially school-age children, were more vulnerable. As a consequence, differentiation was needed in tolerable exposure levels and maximum biologically allowable concentration (MAC) in human bodies. In other words, scientists increasingly recognized that a norm, based on the average, would not protect all humans equally.

- **Risk Perception of the Lead Pollution by the People Living in the Neighbourhood**

Contrary to the ISVAG case (Section 6.3.), the reaction of the inhabitants of Moretusburg, a neighbourhood of Hoboken, was more moderate according to Vogels (personal communication, March 19, 2010). After all, the problem in Moretusburg was related to contaminated soils and the people living in the neighbourhood were concerned that the market value of their houses and properties would decrease. Moreover, many inhabitants were financially dependent on the non-ferrous industry. Those employees were also confronted with conflicting opinions. While *Dokters van het volk* (community doctors) and environmental activists were convinced of the public health impact caused by the non-ferrous industry, the industry countered that if there would be a danger to human health, the employees would be the first to have symptoms (Merckx, 2008). As a consequence, it was difficult to gain local support for action. To illustrate this, in July 1974, only a few dozens of people took part in a protest parade (Merckx, 2008).

- **The Impact of Changing Discourses on Scientific Knowledge Production**

In order to gain a profound insight into the lead problem in Hoboken, a local working group was established under the expert guidance of Professor Clara. The working group consisted of medical experts and physicians. The working group can be considered as a boundary organization to scientifically support local government and industry. It must be noted, however, that the scientific working group was only composed of medical experts. The need for interdisciplinary scientific working groups would increase during the ISVAG incident (Section 6.3.).

Regarding the fact that the Minister of Public Health tried to gain authority over the emerging environmental policy domain, the IHE and PIH (state-owned research institutions) were authorized to scientifically investigate if lead contamination negatively affects public health, especially in children. The integration of environmental research topics into public health research institutions resulted in a first integration of disciplines at the scientific level. IHE and PIH set up a small-scale, follow-up biomonitoring research of school-age children living in the neighbourhood of the non-ferrous industry. The lead concentration in blood was systematically measured across different generations of school-age children (and not in the sense that the same children were followed-up through the years). As such, biomonitoring was used in Belgium for the first time in a non-occupational setting.

- **Challenges and Needs to the Environmental Health Policy Arrangement**

First Steps towards Policy Coordination

The Ministry of Public Health tried to gain authority about the emerging environmental policy domain and, therefore, tried to monopolize the lead file. Similarly, the policy-supporting public health institutions had to extend their activities to include environmental pollution. However, due to the complexity of the problem, the establishment of an interdisciplinary ministerial working group was hard to avoid. After all, the lead case in Hoboken crossed the traditional ministerial boundaries and resulted in an increased need for an integrated policy approach including policy coordination. After all, policy coordination is necessary to avoid policy conflicts, by adjusting actions in order to create a greater coherence and to ensure consistency. The ministerial working group consisted of civil servants of the Ministry of Labour, the Ministry of Public Health, medical experts as well as engineers, and representatives of

the non-ferrous industry. Environmental action groups were not yet involved in the discussion determining an action programme and sanitation plan. According to De Wel (personal communication, March 3, 2010), the establishment of interdisciplinary working groups was revolutionary in a time period that was historically dominated by strict ministerial boundaries and authorities. Referring to Hoppe, the inter-ministerial working group can be considered as a boundary organization between science, policy, and society the latter being restricted at the time to business representatives. Note that the establishment of the ministerial working group contributed to ameliorate the coordination between the different governmental actors within only one governmental level; it was not yet the answer to ameliorate the interaction between different levels of government.

Science-Policy Interface Characterized by Advocacy

Referring to the boundary models of Hoppe (2005), the case of Hoboken had most characteristics of the Advocacy Model: each divergent political stance was looking for (scientific or industrial) experts who could legitimize their position, priorities and ambitions. Politicians willing to ensure employment, were looking for evidence to minimize the problem; politicians concerned about public health and the environment, were looking for the opposite evidence. Also, local action groups, environmental organizations, etc. were looking for scientific evidence to support their opinion.

Need for a Communication Strategy in the Case of Uncertainty

Confronted with scientific uncertainty, (local) politicians initially tried to minimize the environmental health problems in order to protect the economy. After the oil and economic crisis in 1973, the preservation of jobs was a priority for the Belgian Government. The communication strategy of the government was characterized more by tactfully trying to quiet down and keep the general population ignorant. In other words, scientific uncertainty was used as a reason not to take action. According to Thiers, "The Government of that day was not familiar with transparency and only communicated a half truth" (personal communication, March 22, 2010, my translation). This reaction from the authorities indicates that they were still inexperienced about communicating uncertain environmental health risks. However, there were no concrete actions taken on the short-term to ameliorate this communication aspect, as will be illustrated in the cadmium case (Section 6.2.).

6.2. Cadmium Incident

6.2.1. A Historical Review

The historical review of the cadmium case mainly focuses on the period between the early Nineteen Eighties (scientific concern) and the mid Nineteen Nineties (political action). The period since the mid-Nineteen Nineties until today is summarized more briefly. After all, the lessons learned from the dioxin crisis that occurred in the end of the Nineteen Nineties (Section 6.4.) have been influencing the general approach to environmental health problems.

In the mid-twentieth century, Belgium was one of the most important producers of cadmium and zinc in the world. After all, since the end of the nineteenth century, zinc smelters had been in operation in the Liège area and in the rural, northern part of the Kempen. These zinc smelters had been emitting cadmium, as a by-product, into the atmosphere since 1888 (Staessen et al., 1996). In the Nineteen Seventies, the cadmium emission decreased because zinc ovens used new technologies based on electrolytic refining. Some zinc smelters even ceased their activities. However, cadmium has an estimated elimination half-life of ten to thirty years and accumulates in the human body (Nawrot et al., 2008). As a consequence, both sites were - and still are - polluted by cadmium, mainly because of past emissions from those non-ferrous industries (Lauwerys et al., 1990).

In response to concerns from the local community and increased environmental awareness, three scientific studies were performed in the Liège area at the end of the Nineteen Seventies in order to assess whether or not the cadmium pollution in the environment led to an increased uptake of cadmium in the inhabitants and possibly to health effects. Until that time, only animal experiments were done to investigate the impact of cadmium on living organisms (Staessen, personal communication, May 11, 2010). Based on the results of the first study (Roels et al., 1981) which determined higher levels of cadmium in blood and urine in the Liège area in comparison with the control industrial area, a mortality study was performed. Lauwerys and De Wals (1981) observed a higher mortality rate for renal diseases in Liège compared to Charleroi or Belgium as a whole and emphasized the possible influence of environmental factors. A third study of autopsies (Lauwerys et al., 1984) concluded that there were higher accumulated cadmium levels in the renal cortex and liver of persons who had lived in the Liège area than in other areas in Belgium, notwithstanding differences in occupational exposure or smoking habits between the groups. Lauwerys et al. (1990) emphasized

that the results of these preliminary studies, i.e., environmental exposure to cadmium leads to a significant uptake of cadmium in human bodies which can cause renal health effects, must be interpreted cautiously, "These studies have been performed in the same area (Liège), and the influence of another unknown factor interfering with renal function remains a possibility."

As a consequence, the large-scale, cross-sectional epidemiological study *Cadmibel* was launched in the mid-Nineteen Eighties in order to further investigate if cadmium pollution in the environment causes health risks (Lauwerys et al., 1991). The *Cadmibel* Study was financially supported by several federal as well as regional ministries: the Ministry of Health and Social Affairs, the Ministry of the Flemish Community, the Ministry of the Brussels Region, the Belgian National Fund for Medical Research, and the International Lead and Zinc Research Organization (Lauwerys et al., 1990). The objectives were threefold: 1) to determine whether environmental exposure to cadmium leads to cadmium accumulation in the human body by measuring its level in urine and blood, 2) to establish whether this exposure induces renal dysfunction, changes in blood pressure, and the prevalence of cardiovascular diseases, and 3) to assess the critical internal dose level of cadmium for the general population (Buchet et al., 1990; Lauwerys et al., 1990; Lauwerys et al., 1991). The main conclusions of the *Cadmibel* Study were that environmental exposure to cadmium may induce renal tubular dysfunction; it could not be confirmed that increased cadmium exposure is related to blood pressure elevation and a higher prevalence of cardiovascular diseases (Lauwerys et al., 1991). According to Staessen, the impact of the results of the *Cadmibel* Study on the political agenda was limited (personal communication, May 11, 2010). Maybe, the most innovating aspects of the *Cadmibel* Study were scientific. Firstly, the researchers did a medical screening of the general population next to the earlier published studies based on animal experiments or occupational settings (Staessen, personal communication, May 11, 2010). Secondly, the exposure assessment was based on an individual approach using biological monitoring. Contrary to the lead survey in Hoboken, the cadmium biomonitoring survey was done on a larger scale. Biological monitoring has the advantage of reducing the uncertainty in the assessment of individual exposure to pollutants (Lauwerys et al., 1990). However, the authors emphasized, "The limited knowledge on the metabolic fate of environmental pollutants in the human body and their mechanisms of action restricts the applicability of such an approach." Nevertheless, the authors agreed that cooperation between different scientific disciplines - epidemiologists and biologists - is important to better assess the potential health impact of environmental pollutants (Lauwerys et al., 1990).

Although political action was not forthcoming, some progressive Flemish physicians established the Environment and Health Initiative (*Initiatiefgroep Leefmilieu en Gezondheid*) in 1989, following the earlier established Walloon International Society for Research on Civilization Diseases and the Environment (*Société Internationale de Recherché sur les Maladies de Civilisation et sur l' Environnement*), on the one hand, and as a reaction to the heavy metal pollution, on the other. After all, general practitioners felt the need for an expert committee (Magnus, personal communication, March 25, 2010). The naming of both organizations illustrates the discursive change from "disease of civilization" to "environment and health" in the end of the Nineteen Eighties. In 1991, the Initiative Group (*Initiatiefgroep*) was reformed into the Society for Research on Environment and Health (SREH). In the same time period, the Flemish Doctors for the Environment (*Vlaamse Artsen voor Milieu en Maatschappij - VLAMM*) were established at the request of the International Society of Doctors for the Environment. This organization must be considered more as an action group than as an expert panel.

In response to the recognition that exposure to cadmium can cause long-term human health effects, a follow-up research with the Cadmibel Study participants was undertaken by the PheeCad Study from 1991 until 1994. The main aim of this research was to investigate how exposure changes over time. Additional measurements were done related to bone metabolism and calcium homeostasis. The PheeCad Study was supported by the Research Foundation Flanders (*FWO*), the municipality of Hechtel-Eksel, and the International Lead Zinc Research Organization. The main finding, published by Staessen et al. (1999) in *The Lancet*, stated, "Even at a low degree of environmental exposure, cadmium may promote skeletal demineralization, which may lead to increased bone fragility (osteoporosis) and raised risk of fractures."

In response to these research results, Staessen wrote a letter to the local governments, appealing them to inform and educate their inhabitants to cope with this kind of environmental pollution. Staessen preferred the prevention and campaign strategy above cleaning up the area as, "the latter is very expensive and almost impracticable" (Forier, 1994, my translation). According to Staessen (personal communication, May 11, 2010, my translation), the local government reacted violently on the results of the PheeCad Study, "I was called by the local mayor. He complained that the land value would decrease as a result of the negative research results. He was so angry that he intimidated me by saying that my research would never be financially supported by any government." In a newspaper article, the same mayor reacted more moderately, "He hopes that the historical pollutant can be held

responsible for the effects of his pollution, and that the contaminated soil will be cleaned up immediately" ("Kempische bodem", 1994, my translation). A similar reaction was given by Jos Geudens (Administrator of Antwerp Province), "There is no reason to panic (...) the soil in the Kempen is naturally characterized by higher concentrations of arsenic, even without industrial soil pollution" ("Kempische bodem", 1994, my translation).

Nevertheless, Leona Detiège, the then Flemish Minister of Public Health, started to develop a brochure to inform and to sensitize the inhabitants of the contaminated area in 1994 (Belga, 1994). The brochure was developed by Staessen and colleagues and distributed in the Northern Kempen in the spring of 1995 (Thuwis, 1995). The Flemish Government advised inhabitants to reduce their environmental exposure to cadmium by using tap water instead of well water for drinking and cooking, by applying hand hygiene, and by not eating locally grown, leafy vegetables (Nawrot et al., 2008). Nevertheless, the Minister emphasized that there was no reason to panic because the health effects were still unclear and uncertain. Agalev, the Flemish Green Party, regretted that the Flemish Government was not convinced of the seriousness of the situation and pleaded that the region be cleaned up (Belga, 1994). The Flemish Minister of the Environment, De Batselier, promulgated a new Flemish Decree of Soil Remediation in February 1995.

Anticipating the clean-up operation of the polluted soil in the Northern Kempen, the Flemish Public Waste Agency (OVAM), in cooperation with the Flemish Health Inspection, the Province of Limburg, and Union Minière, started a new prevention campaign in the spring of 1999, after the successful campaign of 1995 (Hendrix & Reynders, 1999). The clean-up operation of the contaminated industrial sites (Hoboken, Olen, Balen, Lommel, Overpelt) and the nearest residential areas in the Northern Kempen started in 1997, took ten years, and cost 62 million Euros paid by Umicore (Union Minière) and the Flemish Government ("Sanering", 2006). In April 2004, the Flemish Government, Umicore, and the Flemish Waste Authority (OVAM) signed a new covenant in which Umicore agreed to spend a combined 77 million Euros on the remediation of the soil and groundwater in a larger radius around its plants over a period of 15 years.

To complete the cadmium case, in 2006, Nawrot and colleagues found an association between the risk of lung cancer and environmental exposure to cadmium, "Continuing or past pollution from non-ferrous smelters continues to present a serious health hazard, necessitating targeted, preventive measures." Two years later, Nawrot et al. (2008) determined a continuous hazard function between cadmium exposure and total, non-cardiovascular mortality without a

threshold level. The authors even emphasized that, “Even if zinc-cadmium smelters cease activity, historical environmental contamination remains a persistent source of exposure.”

The findings that cadmium exposure can cause lung cancer caused a major concern among the involved population and increased the social and political commotion. As a consequence, the Flemish Government published an Integrated Action Plan for Cadmium (42 actions and measures) in October 2006, in order to accelerate the remedial actions (Peeters, 2006a). The goal was fourfold: 1) to map population exposure to Cadmium, 2) to identify main sources of Cadmium exposure in population, 3) to tackle predominant sources to achieve lower exposure, and 4) to calm public concern. Under the authority of the Flemish Government, a new study was launched to determine the current exposure to heavy metals in Northern Kempen (Blootstellingsonderzoek Noorderkempen, 2008). In order to interpret these research results for political goals, the Flemish Government supported a participatory, follow-up study consisting of an expert consultation and workshops with local stakeholders. In order to follow-up the actions, a steering group was established consisting of local and regional civil servants, inhabitants, experts, and industry representatives (Aanpak Gezondheidsimpact Zware-matelen-erfenis Antwerpse en Limburgse Kempen, 2009).

6.2.2. Lessons Learned and New Insights about Environmental Health Risks

This section analyses the challenges and needs in response to the experiences of the cadmium case in Northern Kempen. First, the changing discourses and thoughts about environmental health risks and uncertainties are summarized. This reflects the epistemological shift during this period, which gradually led to new scientific methodological challenges and changes in the environmental health policy arrangement.

- **Changing (Epistemological) Discourses on Risks and Uncertainties**

The negative effect of industrial cadmium emission on human intake and human well-being was unknown and only assumed based on evidence in animal experiments. Furthermore, it was assumed that long-term cadmium exposure in low-dose concentrations could also cause health effects (e.g., osteoporosis). As a consequence, the discourse about environmental health shifted gradually from mortality and severe health effects caused by a short-

term, high-dose exposure to moderated health effects and the impact on well-being in response to a long-term, low-dose exposure.

The preliminary studies did not result in a scientifically certain conclusion. Unfamiliar with this situation, scientists were very cautious by communicating uncertainties, using words like "may" or "possible", for instance, "Long-term environmental exposure to cadmium may lead to hypertension" (Staessen et al., 1991) or "The influence of another unknown factor interfering with renal function remains a possibility" (Lauwerys et al., 1990).

- **The Impact of Changing Discourses on the Production of Scientific Knowledge**

The case of cadmium revealed important scientific developments and the need for large-scale biomonitoring surveys in order to investigate the real concentration of cadmium in human blood and urine. Contrary to the biomonitoring surveys of Hoboken, focusing on school-age children living nearby the lead smelter, the biomonitoring campaigns in Northern Kempen were more large scale, investigating the general population, in different areas that were environmentally (and not occupationally) exposed to cadmium. Moreover, the same people were followed over the years in order to investigate how exposure changes over time, and if cadmium exposure can affect human health in the long term. Statistical techniques and significance levels were used in order to scientifically deal with probabilities.

Additionally, the cadmium case made it clear that cooperation between different medical and environmental disciplines is needed to better assess the potential health impact of environmental pollutants. As a consequence, epidemiologists, toxicologists, and biologists were involved in different research projects.

- **Challenges and Needs to the Environmental Health Policy Arrangement**

At the political level, scientific uncertainty was used to delay the decision-making process and to disregard the problem in order to prevent panic. The Precautionary Principle, although recognized for the first time in the *World Charter for Nature* (UN, 1982), had not yet filtered through at the Flemish political arena. As a consequence, political actions were only taken in the mid-Nineteen Nineties, focusing on environmental hygiene. Until the mid-Nineteen Nineties, the Government did not consider a clean-up operation of the polluted soil and groundwater in Northern Kempen.

More Inter-Ministerial Cooperation Needed

Although the lead case in Hoboken made it clear that good cooperation between different ministerial departments is necessary to solve environmental health problems, I have not found any indication of concerted action in the cadmium case. A plausible explanation can be related to the constitutional reform. The lead incident mainly happened in the Nineteen Seventies, before the huge institutional reform of 1980, in contrast with the cadmium incident which occurred in the Nineteen Eighties. As a result of the constitutional reform of the Belgian State in 1980, the authority over environment and health issues has been left in the hands of the Regions and the Communities, respectively. However, the health policy domain transferred more slowly and gradually to the Communities, whereas the environmental policy field was quickly institutionalized into the Regions. Consequently, environmental policy and public health policy in the early Nineteen Eighties were not dealt with at the same governmental level nor evolved at comparable speed, which hampered coordination, cooperation, and integration. Secondly, as a consequence of the federalization, the Federal State lost its environment and health authorities and, at the same time, the knowledge and expertise of civil servants who had experience in dealing with environmental health issues. In addition, the institutionalization process of the Regions and Communities was not advanced enough to counterbalance this loss. Thirdly, Kelchtermans and Dua (personal communication, February 19, 2010; personal communication February 11, 2010) confirmed that there was a very strict demarcation of ministers' responsibilities during that time. Environmental policy and public health policy were considered as two separated policy fields. Moreover, the Minister of the Environment had other priorities (waste disposal, water treatment, environmental taxes, etc.).

Science-Policy Interface

The last lesson learned deals with the science-policy interaction. The anecdote about the reaction of the local mayor to the research results of Staessen is characteristic of the relationship between science and policy at the time. The local mayor was convinced of a strict demarcation between science and politics. Science has to create knowledge, but the decision-making process and transfer of information to the general public is up to the politicians. Referring to the boundary models of Hoppe (2005), this is a case of politicians who want to have primacy. Because the local mayor was more concerned about the local economy and the preservation of jobs, a discussion raised between scientists and politicians.

6.3. Dioxin Deposition of Two Waste Incinerators in Flanders

Since the Nineteen Seventies, more and more municipal waste was incinerated causing emissions, such as: CO, NO_x, dioxins, heavy metals, etc. However, during the early years of incineration, the air emissions were mostly not purified (Van Larebeke, 2000). Until the mid-Nineteen Nineties, the general public was less concerned about waste incinerators because, "they felt that the smokestack was high enough" (Kelchtermans, personal communication, February 19, 2010, my translation). According to Vogels (personal communication, March 19, 2010, my translation), the main difference between air pollution and soil contamination by heavy metals was that, "The ISVAG problem was related to air pollution and affected less personal property." As a consequence, it was easier to ignite a response from the inhabitants because there was less fear that the land value would decrease. Once the problem was recognized, and this was confirmed by all interviewees, the ISVAG-story played an important role in the institutionalization of environment and health as a policy arrangement. After all, the commotion in 1997 generated around the possibility that the high dioxin deposition of two municipal waste incinerators in residential areas was causing congenital abnormalities, created the opportunity to rethink current affairs concerning environmental health.

6.3.1. A Historical Review

Although the main protest action started in 1997, the first complaints from inhabitants living nearby the incinerator of Wilrijk (Antwerp) about smell and dust nuisances go back to the mid-Nineteen Eighties. In the early Nineteen Nineties, the complaints were more serious, linking different types of health problems (cancer and genetic anomalies) to waste incineration plants. Initially, those complaints were brushed aside by the local mayor, deferring to the lack of scientific certainty, "If there is dust at my desk, it does not mean that it will make me sick" (Keune & Craye, 2004, my translation). It is worth mentioning that the local authority of Antwerp was a main shareholder of the waste incinerator (Keune & Craye, 2004). However, as a result of the vicinity of two municipal waste incinerators, Wilrijk received the highest dioxin deposition in Flanders. Under societal pressure, the local government of Antwerp authorized the PIH to set-up a health survey in the residential area in 1995. The research team identified eight genetic anomalies, but was not able to conclude with certainty if these malformations were more likely a coincidence or could be attributed to the waste incinerations. The local

inhabitants, local physicians, local environmental action groups, and even scientists criticized the survey.

In the Neerlandquarter, a residential quarter located between two municipal waste incinerators (IHK and ISVAG), several children were born with congenital anomalies. Strengthened by the publication of Cremers et al. (1997), who reported ten cases of congenital malformations between 1988 and 1997, the inhabitants and local action groups linked these malformations to toxic emissions, particularly emissions of dioxins, caused by the incinerators. This conclusion was confirmed at a press release for a book written by Professor Hens (VUB) and Professor Schepens (UA). However, it must be noted that Neerlandquarter was heavily exposed to environmental pollution because the residential quarter was also surrounded by busy high ways, non-ferrous industry, and a crematory (Nouwen, et al. 2001). Nevertheless, the local inhabitants founded their reasoning on psycho-medical and social factors (the fear of the people), ethical considerations (principles of good government, good communication), and ecological principles (Lavrysen, s.d.). In the autumn of 1997, scientific experts revealed different opinions in the media. For instance, one professor explained that there was no scientific evidence about the relationship between the emission of dioxins by waste incinerations and the development of cancer, while another countered this finding, stating that there must be a causal relationship (Van Wiele & Vermeire, 1997). The inhabitants wanted a decisive answer and asked the Flemish and Federal Governments to take the dioxin problem to heart.

The then Flemish Minister of Public Health, Wivina Demeester, was very sensitive to the health concerns related to waste incinerators for personal/family reasons (Vogels, personal communication, March 19, 2010), but also because the incident was occurring in her electoral district (Dua, personal communication, February 11, 2010), and the fact that she was also authorized for the care of the disabled (Demeester, personal communication, February 18, 2010). Demeester participated in a local debate and decided to finance health research and to establish a local complaints' desk for environmental health problems. Demeester announced her wish in the Flemish Parliament to conclude a contract with VITO in order to permanently (and not on an ad hoc basis) study the impact of environmental pollution on public health (Vlaams Parlement, 1997). In the meanwhile, the Flemish Government financed two scientific public health studies in order to investigate the health effects in the Neerlandquarter and to determine whether there was a causal relationship between those health effects and dioxin pollution (Verschaeve & Schoeters, 1998; Aelvoet et al., 1998).

Kelchtermans, the then Flemish Minister of the Environment, only reacted a few weeks later after he was criticized in the Flemish Parliament about the regulatory emission limits and the do's and don'ts of closing municipal waste incinerators. In November 1997, in order to temper public concern, Kelchtermans temporarily closed down the incinerators which were exceeding the emission limit, taking into account the Precautionary Principle (two of them were IHK and ISVAG). The oldest incinerators (e.g., IHK) closed definitively in the long run, while the other incinerators, including ISVAG, restarted their activities, after some technical adaptations in order to respect the regulatory emission limits and after the unanimous permission of the Baeyens' Committee (Nouwen et al., 2001). The Baeyens' Committee (*Bijzondere Onderzoekscommissie Rookgassen en Verbranding*) consisting of engineers and medical experts, was established by Kelchtermans as an independent scientific advisory board in 1997, in order to evaluate the emissions of the municipal waste incinerators. Kelchtermans wanted to depoliticize the problem and to convince the general public that the decision-making process was science based and not (only) driven by the advice of the Flemish Environment Agency (VMM) or the Mina Council, which are financially supported by the Flemish Government and perceived by the general public as dependent and biased (Kelchtermans, personal communication, February 19, 2010; Daems, personal communication, May 6, 2010).

The advice of the Baeyens' Committee was expected in January 1998. However, according to some newspaper articles (Vermeire, 1998), the members of the committee had different opinions about whether to close or start up the ISVAG incinerator again. According to Hens, there was a huge difference of opinion between medical experts, who advocated additional public health studies, and technical experts (Vermeire, 1998). Kelchtermans agreed, in March 1998, to delay the start-up until there was scientific evidence about the concrete health effects related to the incinerator.

Verschaeve and Schoeters (1998) investigated genetic damage in chromosomes in certain types of blood cells, caused by exposure to genotoxins but the authors could not detect any difference in chromosomal aberrations between the exposed and the control group. According to Van Larebeke (2000), who reviewed the study, the statistical sensitivity was not able to detect effects at low intensity. Aelvoet and colleagues (1998) investigated children's health and determined an increased incidence of congenital malformations around the waste incinerators compared with Belgium as a whole, although the result was not statistically significant. The increase of allergies and use of medication was considered as significant. Van Larebeke (2000) expressed the need for further research studying individual exposure

and pre-symptomatic biological effects. The studies of Verschaeve et al. (1998) and Aelvoet et al. (1998) were questioned by other scientists and protest committees because of the many uncertainties (Schoeters, personal communication, March 4, 2008), the methodology used (Vlietinck, personal communication, March 12, 2010), and the way the results were communicated by VITO and the Flemish Government (Schoeters, personal communication, March 4, 2008). About the latter, VITO was reproached for suppressing information (Van Wiele, 1998), while VITO justified its communication strategy as a method to prevent commotion. Instead of objective, univocal, scientific advice, scientific controversy ensued (Keune & Craye, 2004).

Referring to the public health studies, the Baeyens' Committee concluded, "The dioxin emission standard of 0.1 ng TEQ/Nm³ (...) is perfectly acceptable and meets the legal emission limits and the objectives of the Precautionary Principle (...). The ISVAG incineration plant meets all emission standards from a technological and health point of view; and the impact of the residual emission of dioxin on the local residents will be so small as to be immeasurable or barely measurable, which means that the operation of the plant is acceptable from a technical, environmental and health point of view" (Lavrysen, s.d.). However, the Baeyens' Committee recommended a large-scale exposure survey to remove any remaining doubts. Nevertheless, Kelchtermans did not wait for scientific certainty and decided to restart ISVAG in January 1999, against the will of the action committees. As a consequence, some inhabitants went to the court to dispute the decision of the Minister.

Before implementing new institutional structures, Demeester obtained expert advice by the Flemish Health Council (VGR, 1998) and the personal advice of an expert committee consisting of Professor Vlietinck, Dr. Schoeters (VITO) and Dr. Vera Nelen (PIH) (Vlietinck, personal communication, March 12, 2010). In response to the scientific advice, one of the first actions of Demeester was the establishment of a complaints' office to deal with public health problems related to environmental pollution (Demeester, 1997). Demeester wanted to extend the number of complaints' desks by integrating them into local consultative structures for public health by the year of 1999. At the administrative level, Demeester split the Flemish Health Inspection Services into two sections: the Infectious Diseases Section and the Environmental Health Section. Demeester also recognized the need to finance (50 million BEF/year) long-term, policy-oriented environmental health research instead of short-term, ad hoc studies (Demeester, 1998). More precisely, Demeester ordered three scientific studies: 1) a pilot study on biomonitoring (Vlietinck et al., 2000), 2) a research project in social sciences about participation and communication (Craye et al., 2001), and 3) a

feasibility study about a medical environmental organizational structure in Flanders (Wildemeersch, personal communication, March 30, 2010; Jans & Van den Hazel, 1999).

The objective of the pilot study (Vlietinck et al., 2000) was to determine whether systematic biomonitoring surveying would be feasible and could be used complementary to traditional measure campaigns in soil, water, and air by the VMM and OVAM. After all, biomonitoring has the capacity to detect environmental pollutants in humans and pre-symptomatic markers of health effects and to compare differences in effects and exposure levels. As a result of the poor communication strategy in Wilrijk, Vlietinck emphasized the importance of integrating social scientists in the research team (Loots, personal communication, July 9, 2008). Vlietinck also wanted to involve health economists, but limited finances prevented this extension (Vlietinck, personal communication, March 12, 2010). The pilot Flemish Environment and Health Survey (FLEHS) showed that the situation in rural areas was not much better than the situation in industrial and urban regions (Baeyens, personal communication, March 24, 2010), indeed caused by different sources of pollutants. A large-scaled biomonitoring survey in the whole region of Flanders was suggested. According to Vlietinck (personal communication, March 12, 2010, my translation), the uncertainty discussion dominated the pilot study, "We had to agree about the accepted uncertainty limitations. Are there threshold values? How does the dose-response curve look like? How will we communicate uncertainties?"

As a result of the poor communication strategy in Wilrijk and the recognition that a better communication strategy could have prevented many ISVAG-related conflicts, Demeester also financed social scientific support in order to ameliorate the communication strategies between scientists, politicians, and the general public (Craye et al., 2001; Keune & Craye, 2004).

The third study investigated the feasibility of the implementation of a medical environmental organizational structure in Flanders. Two Dutch environmental health experts, Jans and Van den Hazel (1999), investigated if a health structure similar to the mold in the Netherlands, was feasible for Flanders. From a social science point of view, the establishment of a complaints' network was emphasized in order to ensure an evidence-based complaints' management; although the creation of many new institutions and organizations must be avoided in order to create synergy with the current organizations (Vlietinck et al., 2000).

When ISVAG restarted in October 1999, there was almost no commotion. Crabbé (2000) attributed this to the approach of the new Minister of the

Environment, Vera Dua of the Green Party. Dua preferred an approach based on dialogues and implemented several round-table conferences about the environmental health problems caused by waste incinerators.

6.3.2. Lessons Learned and New Insights about Environmental Health Risks

- **Changing (Epistemological) Discourses on Risks and Uncertainties**

Politicians, the general public, and action groups focused on science to determine whether there was a causal relationship between the incineration of municipal waste and congenital anomalies. However, science fell short of these expectations. Despite different scientific studies, there was no final proof that the incinerators damaged human health, "We cannot say with certainty there is a causal relationship" (Vlietinck, personal communication, March 12, 2010). Furthermore, the debate was characterized by scientific controversy. For instance, within the media, scientists not only revealed conflicting opinions, but also publicly contested each other about their statements, objectivity, and value-free judgments (Van Houtte, 1999).

The scientific studies, financed by the Flemish Government to prove the health impact caused by waste incineration, resulted in a set of warning signals that health could be threatened. According to Keune and Craye (2004), the scientific controversy hampered the political and social debate and the role of science as a judge in the decision-making process was not feasible anymore. As a consequence, the presumption of one unique epistemology – the Modern Model – came under review; science, as well as government, struggled about how to deal with these kinds of problems.

- **Risk Perception by Stakeholders**

Typical for the ISVAG case, was the plurality of stakeholders who all had their own vision and opinion about the health impact caused by waste incinerators. Crabbé (2000) already illustrated the role of the general public, the managers of the waste incinerator, scientists, politicians, and even the judiciary.

The people living in the neighbourhood of the waste incinerator claimed health damages caused by the incineration activities and required the closure of ISVAG. As such, the main contrast in concern of the general public between the lead case in Hoboken and the ISVAG case in Wilrijk was that the inhabitants of the Neerlandquarter (Wilrijk) claimed health damage caused by

the waste incineration activities, while the inhabitants of Moretusburg (Hoboken) denied possible health effects. Vogels (personal communication, March 19, 2010) attributes this difference in risk perception to the fact that the problem in Moretusburg was related to contaminated soils and the people living in the neighbourhoods were concerned that the value of their houses would decrease. Moreover, many inhabitants of Moretusburg were financially dependent on the non-ferrous industry. The managers of ISVAG, on the other hand, argued they did many technological efforts in order to comply with the emission standards. According to them, there was no problem.

As already mentioned in the previous section, there was also controversy between scientists. In the media, advocates and opponents were interviewed or cited. The media also reported on disagreement within the Baeyens' Committee, especially between the technical experts and the medical experts (Ceustermans, 1998; Belga, 1999).

At last, the debate about ISVAG was taken to court. The Court of First Instance concluded that ISVAG had to remain closed, based on the Precautionary Principle (Vandenberghe & Van Wiele, 1999).

▪ **New Needs for Scientific Knowledge Production**

Inspired by the increased recognition of complexity, the shortcomings of different ad hoc disciplinary studies were recognized. What was lacking was a complete, integrated risk analysis, in which different scientific disciplines should be involved. As a consequence, the then Flemish Minister of Public Health took the first steps to institutionalize long-term, policy-oriented, interdisciplinary environmental health research in Flanders (Demeester, 1998).

Biomonitoring was recognized by the scientific expert committee as an important complementary methodology to the traditional measure campaigns in soil, water, and air, in order to determine the concentration level of pollutants in human body (Vlietinck et al., 2000). The recognition of the complexity of environmental health problems expressed the need for an integrated assessment approach by a multidisciplinary team of experts (biologists, toxicologists, epidemiologists). Biomonitoring research on such a large scale and covering a high number of various pollutants was very innovative at that time. As a consequence, the research project was strongly driven by a discussion about uncertainty. Carefully dealing with, and communicating about, uncertainties and assumptions was recognized as important in order to regain the confidence of the general public (Craye et al., 2001; Keune & Craye, 2004).

The bad communication strategy used during the ISVAG case and the recognition that experts estimated the ISVAG risks different contrary to the general public (Keune & Craye, 2004), emphasized the importance of integrating social sciences and communication experts into the research team. Initially, Professor Vlietinck, the personal scientific advisor of Minister Demeester, also wanted to include economists in the research team. However, the limited financial resources hampered this extension (Vlietinck, personal communication, March 12, 2010).

To summarize, the case of dioxin pollution caused by two municipal waste incinerators revealed the need for a systematic, policy-oriented, integrated scientific approach within environmental health research, taking into account medical sciences, social sciences, technical sciences, etc. Scientific support by social scientists was necessary to ameliorate the communication strategy. Biomonitoring was proposed as a complementary research method in order to measure and interpret the concentration of pollutants in the human body.

- **Challenges and Needs of the Environmental Health Policy Arrangement**

The reaction of the two involved ministers on the ISVAG problem resulted in totally different approaches. Wivina Demeester, Flemish Public Health Minister from 1995 until 1999, was very sensitive to the local public concerns on this subject. Demeester's approach was very direct; she entered into a discussion with all stakeholders. Theo Kelchtermans, on the other hand, Flemish Minister of the Environment from 1995 until 1999, used a more technical approach. After all, his authority was to decide whether the waste incinerators had to be closed or not, based on objective facts and scientific evidence. Both ministers expressed the need for independent scientific support and established their own expert committees.

The establishment of expert committees can also be considered as a strategy to depoliticize the ISVAG problem. Vera Dua, Flemish Minister of the Environment in succession of Kelchtermans, used a totally different approach and emphasized the importance of intensive consultation of all stakeholders by organizing round-table conferences.

Although the ISVAG case was a problem that occurred at the border between the jurisdictions of public health and the environment, the cooperation between the Flemish Ministry of Health and the Flemish Ministry of the Environment was limited. Referring to Demeester, "The authorities for the environment and public health were completely separated. However, ISVAG

needed a coordinated approach, it was politically very difficult. Ministers are good colleagues, but at the same time also competitors. Each minister tried to oust the other one in an attempt to come into the public eye" (Demeester, personal communication, February 18, 2010, my translation). The ISVAG incident emphasized the need for a better coordination and even integration of both policy fields. This need is explicitly expressed in an integrated policy document on environment and health, which is described in Chapter 7.

According to Vogels (personal communication, March 19, 2010, my translation), Demeester laid the foundation for the institutionalization of the environmental health policy arrangement, "She sowed the seeds." The next Flemish Government, in which the Green Party participated, developed the initiatives into an institutional framework (Chapter 7). After all, Demeester emphasized the need to develop an organizational structure in order to detect environmental health problems as fast as possible and to manage them effectively. As already mentioned, Demeester established complaint desks which were incorporated into the Flemish Environmental Health Network, in later years (Chapter 7).

- **The Precautionary Principle as Political Response to Scientific Uncertainty**

In contrast with the lead and cadmium cases, the Precautionary Principle was invoked in the ISVAG case as a political strategy in response to scientific uncertainty (Antwerp Court of Appeal, October 11, 1999 In: Lavrysen, s.d.). The Baeyens' Committee and the Flemish Government gave shape to the Precautionary Principle by imposing on ISVAG the dioxin emission standard of 0.1ngTEQ/Nm³. This standard corresponded to the strictest standards that were imposed worldwide by way of precaution. Moreover, Kelchtermans already closed the waste incinerators in Flanders based on the Precautionary Principle anticipating the conclusions of the Baeyens' Committee.

- **Science-Policy Interface: From Advocacy to Mutual Learning**

The analysis of the newspapers during that period made it clear that all stakeholders were looking for scientific expertise that harnessed and legitimized their position. The debate between these stakeholders looked like an arena with advocates and opponents.

On the contrary, the Ministers of Public Health and the Environment emphasized the need for scientific consensus and financed environmental health research in order to make long-term studies possible and to gain

scientific certainty about the impact of environmental pollution on human health. The Flemish Government also recognized the importance of involving the general public, NGOs, and local action groups as soon as possible in the decision-making process. Complaint desks were established in order to trace local worries as soon as possible and to manage them efficiently. All those actions indicate the increased need to evolve towards a new kind of science-policy-society interface based on mutual learning and dialogue between scientists, politicians, and the other stakeholders involved.

6.4. Dioxin Crisis in the Food Chain: From Crisis to Scientific Knowledge and a New Policy

Shortly after the dioxin incident caused by two waste incinerators in Wilrijk, the dioxin affair struck Belgium during the spring of 1999. This dioxin crisis strongly influenced the elections of 1999 in a way that enabled the Green Parties (Agalev, Ecolo) to profit from public concern and ultimately join the newly formed Government from 1999 until 2004. Under the influence of the Green Parties, the new environmental health discourses were put on the political agenda. This gave the decisive impetus to establish the emergent environmental health risk governance arrangement (Chapter 7).

6.4.1. A Historical Review

The dioxin scare broke through in May 1999, when the contamination of animal feed by PCBs and dioxins was leaked to the media (Nemery et al., 2002). The mass media brought the dioxin contamination to the public's attention just a few weeks before the general elections of 1999 (Verbeke, 2001). However, the cause of the dioxin problem goes back to the end of January 1999, when a mixture of PCBs and dioxins was unintentionally mixed with recycled fats used for animal feeds in poultry, swine, and cattle farms in Belgium (Diricks, 2008; Covaci et al., 2008). The first symptoms were a drop in egg production, a reduction in egg hatchability, and an increased mortality of chicks (Bernard et al., 2002a). However, by February 1999, "No measures were taken beside the elimination of dead chickens" (Covaci et al., 2008). The scientific confirmation of the dioxin contamination was not forthcoming until the end of April, after a series of other hypotheses were tested and rejected (Bernard et al., 2002a). In response, the Belgian authorities tried to trace the food chain but that was very difficult due to various illegal practices and the

black market of animal feed trade (Covaci et al., 2008). The authorities were obliged to inform the European Commission on May 27, 1999.

The large latent period between the first signs of the problem and informing the public, triggered a major political and food crisis (Bernard & Fierens, 2002b). According to Lok and Powell (2000), the media coverage exploded, "Because the Government knew of the problem as early as February (...) [The media] accused the Government of serving the economic interests of farmers' unions and the meat industry, and of trying to protect themselves in preparation for the general elections on June 13, instead of protecting public health."

The general public reacted in a very emotional manner. According to Nemery et al. (2002), referring to Bennett and Calman (1999), the dioxin incident caused such a wide dioxin scare because of a combined number of factors that influenced risk perception greatly, "outrage (against the failing authorities and against modern food production practices), dread (even minimal amounts of chemicals may damage health), and lack of control (the hazardous agent cannot be perceived)."

The dioxin incident could also evolve into a dioxin crisis as a consequence of the scientific controversy about the possible health consequences of the incident and the uncertainty about the number of exposed individuals (Covaci et al., 2008). For instance, although most experts agreed that the Belgian dioxin/PCB incident was too limited in time and scale to affect public health (Bernard et al. 2002a/2002b), some scientists presented a more pessimistic view. Van Larebeke et al. (2001) estimated that the incident could cause between 40 and 8000 additional cases of cancer in Belgium. To summarize, the dioxin crisis was based on a lack of knowledge, scientific controversy, insufficient scientific support for the decision making process, and distrust in government (Diricks, 2008).

Driven by the general elections that would be held on June 13, 1999, the Federal Ministers of Health and Agriculture were forced to resign (Nemery et al., 2002), although the impact on public health was not proven. According to Lok and Powell (2000), "The ministers still felt they handled the situation properly but by resigning, they hoped to restore public calm and trust." The public health policy field and agriculture policy were temporarily allocated to the other federal ministers, who had to show their responsibility in order to reduce the damage to a minimum and to prevent an electoral defeat.

Influenced by: 1) the nearby elections, 2) the pressure of the European Commission on the Belgian Government to solve the crisis adequately (Covaci

et al., 2008), 3) the uncertainty about the real extent of the contamination, and 4) the difficulty of tracing the contaminated food that had been sold and people who consumed it (Bernard & Fierens, 2002b), drastic measures were taken. As a consequence, a massive international recall operation of eggs and chicken, followed by almost all meat products took place (Diricks, 2008); an embargo was placed on all Belgian food products of animal origin; and tons of eggs and meat products were destroyed (Lok and Powell, 2000). In Belgium, the slaughter and transport of poultry, cattle, and swine were prohibited (Covaci et al., 2008), and the Ministry of Public Health cautioned the general public against eating Belgian poultry and eggs (Lok et al., 2000). The economic damage was enormous; the Governmental cost was estimated around 437.5 million Euros, and the destruction of products cost an approximate additional 250 million Euros. The indirect costs for agriculture and industry should also be taken into account, although these are very difficult to estimate (Diricks, 2008).

Simultaneously occurring in June 1999, the Coca-Cola incident struck Belgium. An increased number of health complaints (discomfort, headache, nausea, malaise, respiratory problems, trembling, and dizziness) from children were associated with the consumption of Coca-Cola products. The new Minister of Public Health - as stated above, the previous minister was forced to resign after the outbreak of the dioxin crisis - wanted to show his responsibility during the peak of the election campaign and took drastic measures. As a consequence, the sale and consumption of Coca-Cola products was forbidden by the Belgian health authorities (Nemery et al., 2002) and the ad hoc scientific committee of the Superior Health Council was established under the authority of the Ministry of Public Health in order to investigate the Coca-Cola related complaints based on a toxicologist and psychological approach and to give instant advice (HGR, 1999). As a result of a lack of toxicological proof, geographical spread, the background of the dioxin crisis, and the scientific literature on mass psychogenic illness, the Superior Health Council concluded that the Belgian Coca-Cola crisis was essentially an instance of mass sociogenic illness (Nemery et al., 2002). According to Nemery et al. (2002), it was not surprising that Coca-Cola was targeted. After all, in the background of the dioxin crisis, the Belgian population was anxious about the quality of modern food, and Coca-Cola was seen as the symbol of modernity. This reasoning can be related to Beck's theses about the Risk Society. Food scandals can threaten health and the environment and will be experienced by people as a practical outcome of the risk society and modernization. The Coca-Cola incident seemingly appeared to bring Beck's theory into practice.

It is not surprising that the dioxin crisis, that struck Belgium in 1999, strongly influenced the elections of 1999. The governmental parties (the centre-left Christian-Democrat/Socialist coalition) had an electoral defeat, while the opposition parties (the Liberals and the Green Party) pulled votes. As a consequence, the quick succession of incidents enabled the Green Party to profit from public concern and to ultimately join the newly formed government from 1999 until 2004. After all, the Green Party was associated with food safety, healthy and biological food, etc.

Related to the dioxin crisis, the new Federal Government appointed a special commissioner, a crisis manager, to coordinate governmental action. A large monitoring programme for PCBs and dioxins was launched in June 1999 to detect contaminated products from suspected farms, although the programme rapidly extended to all farms over the country (Diricks, 2008; Bernard et al., 2002a). This programme evolved into a systematic and permanent national monitoring programme for food of animal origin (CONSUM system) in order to trace contaminated products and to restore the Belgian quality label (Covaci et al., 2008). The Ministry of Agriculture also commissioned an independent scientific study to compile all data available, to review the main sources of PCBs and dioxins, and to assess the effects of the contamination (Diricks, 2008). The conclusions of the scientific reports were used in the policy-making process, especially the message that food contamination is a very complex process which has to be managed through the whole food chain (Diricks, 2008). The Belgian inspection services were merged into one agency, The Federal Agency for the Safety of the Food Chain, responsible for the whole food chain, in order to detect possible food problems immediately, to manage them efficiently, and to avoid a public scare by communicating with the general public (Diricks, 2008). An independent scientific committee was founded to support the Agency.

In response to a series of European food scandals (BSE-crisis in UK, Belgian dioxin crisis, etc.) the European Food Safety Authority (EFSA) was established in January 2002, to strengthen the European collaboration on food safety and related scientific knowledge production which lead to decision making (Diricks, 2008). EFSA is responsible for independent scientific advice based on risk assessment and the communication about risks associated with the food chain. The European Union also introduced Maximum Residual Limits (MRL) for PCBs, dioxins, and other harmful substances in food.

6.4.2. Lessons Learned and New Insights about Environmental Health Risks

- **Changing Discourses on Risks and Uncertainties Stimulate Integrated Risk Assessment and Interdisciplinary Research**

Scientifically, the dioxin crisis illustrates the possibility that even minimal amounts of chemicals can seriously affect public health (Nemery et al., 2002). As a consequence, the threshold hypothesis has been questioned for the second time (see also Cadmium crisis, Section 6.2.).

Moreover, Bernard et al. (2002b) stress the complexity of the dioxin problem and the difficulty of tracing the origin of the food scandal. The several months needed to confirm the contamination with dioxins illustrates the complexity of the problem and the limited laboratory facilities. According to these authors, separated risk analyses could lead to contrasting conclusions, despite the use of the same database. As a consequence, the need for an integrated risk assessment has been emphasized, taking into account the entire food chain.

Moreover, the dioxin and Coca-Cola incidents demonstrate that risk perception by the general public is not only driven by scientific evidence, but is strongly influenced by the media, and psycho-sociological aspects. As a consequence, scientific support must be given by a multidisciplinary team of independent experts, in which psychologists and communication experts are also involved from the beginning. After all, the Coca-Cola incident illustrates that psycho-sociological factors must be considered in emergency situations (Nemery et al., 2002).

The scientific controversy, which dominated the dioxin crisis, resulted in a more intense research related to dioxins and PCBs. For instance, dioxins and PCBs have been integrated in the environment and health research financed by the Flemish Government since 2002 (Chapter 7).

- **Towards Efficient Crisis Management and Communication Strategies**

The dioxin incident demonstrated the poor crisis management and communication strategy of the Federal Government, which became the focus of intense public and media criticism (Covaci et al., 2008; Lok et al., 2000). The fact that the Belgian Government waited a month before informing the general public was not favourable for its credibility. The Belgian authorities claimed, "They did not want to alarm the public until they were sure dioxin had gotten into the human food supply" (Lok et al., 2000). As such, the

Precautionary Principle was not used by the Government, who hid behind scientific uncertainty. Public confidence in the government was damaged, “[the public was] accusing the government of protecting political and business industries more than public health” (Lok et al., 2000). As a consequence, social experts have been consulted in order to advise the Government about effective communication strategies and about new organizational structures in order to detect problems and/or concerns as early as possible and to develop a better system for effective surveillance of the whole food chain. After all, the Coca-Cola incident demonstrated that one major food crisis (the dioxin crisis) can lead to another.

The role of the media cannot be disputed in the dioxin and the Coca-Cola incidents. The manner in which the Coca-Cola incident was reported by the media definitely had an impact on the way the crisis escalated. According to Nemery et al. (2002), special attention should be given to the way findings and hypotheses are communicated to the media and the public, “A balance must be found between giving a credible reassurance, when this is needed and justified, and an honest admission of ignorance, when this is still the case.”

- **Towards Policy Integration**

The dioxin crisis could have been more severe since the ministries involved, and the coordination between those ministries, was limited. The need for more coordination between ministries, and their integration throughout the whole food chain became clear. The establishment of the Federal Agency for the Safety of the Food Chain illustrates that the food scandals in Belgium resulted in administrative organizations and the establishment of an integrated agency. In order to ensure policy integration about food safety, all related authorities have been authorized to the Federal Minister of Public Health.

- **Science-Policy Interface: Towards Mutual Learning**

The dioxin incident illustrates the need for a credible, independent structure capable of giving sound scientific advice about the measures that should be taken (or not) to reduce the risk/concern levels and to ensure a safe food chain (Diricks, 2008; Covaci et al., 2008). Moreover, in response to the scientific controversy, it is essential to define a more appropriate relationship between science and politics. Referring to the boundary models of Hoppe (2005), the Learning Model should be the most suitable. After all, the Learning Model is characterized by a dialogue between scientists and politicians in order to realize a process of mutual learning with the other stakeholders involved.

6.5. Conclusion

Although there were several opportunities to act (e.g., international and European environmental health discourses and initiatives or local environmental health incidents), the Belgian/Flemish Government and stakeholders of the Nineteen Eighties and Nineteen Nineties did not develop an integrated environmental health policy with a clear vision and well-defined targets. Until the end of the Nineteen Nineties, environmental health was characterized as an ad hoc policy field, where agenda setting was based on crises – also referred to as incident-driven – and not as the result of a structured, proactive, and forward-thinking approach. The scientific and political agenda setting of environmental health was mostly the outcome of an interaction between concerned inhabitants, local action groups, scientists, and environmental journalists who rallied around the problem.

The above case study analysis was done in order to investigate to what extent the four presented incidents (lead incident, cadmium incident, dioxin deposition by two waste incinerators, and dioxin food crisis) contributed to changes to the discursive, practical, and the institutional level. More precisely, each incident has contributed to the accumulation of initiatives, which has led to a clear problem definition (discourse) required to proceed with institutionalizing the environmental health arrangement. The gradual rethinking of the epistemological discourses about environmental health risks and uncertainties is described in Section 6.5.1. Based on Discursive Institutionalism, these new discourses are the driving force behind institutional preservation and change, and they cause new responsibilities, rules of the game, resources, and organizational structures. As a consequence, these four incidents have gradually challenged: 1) the scientific organization and methodologies for knowledge production (Section 6.5.2.); 2) the relationship between science, policy, and society (Section 6.5.3.); and 3) the risk communication and risk management strategies, including policy coordination between the environmental policy and health policy fields (Section 6.5.4.).

To summarize, the series of incidents created the opportunity to rethink and re-organize the current affairs concerning environmental health which will result into the institutionalization of a Flemish environmental health arrangement (Chapter 7).

6.5.1. Changing Epistemological Discourses on Environmental Health Risks and Uncertainties

Through the years, the quick succession of environmental health related incidents has demonstrated the lack of scientific knowledge and a controversy about the impact of environmental pollution on public health. Different contributors to lack of knowledge and controversy are identified: 1) the novelty of the field, 2) the complexity of environmental health problems, and 3) the interwoven character of environmental health problems in a larger context of economic, financial, and social values - resulting in a variety of divergent problem definitions and risk perception. As a consequence, the presumption of a unique epistemology - the modernist epistemology - has been challenged. Each of these issues is discussed in more detail in the following paragraphs.

The case study analysis of the series of environmental health related incidents demonstrates the novelty of environmental health research. Until the early Nineteen Seventies, knowledge development about the impact of environmental pollution on public health was mostly limited to well-defined, occupational environments, studying human health effects by employees exposed to high concentration levels of one single pollutant. As a consequence, there was a lack of knowledge about the impact of environmental health risks by people living in the neighbourhood. The lead case in Hoboken clearly illustrates that there was only an assumption and no scientific certainty about a causal link between public health effects and the lead contamination caused by the nearby non-ferrous industry.

Lack of knowledge and a scientific controversy is also a consequence of the complexity of environmental health problems. After all, the general public is exposed to different pollutants, emitted by several sources, which can affect human health and well-being in the short- and long-term. This complexity makes it difficult to determine whether there is a causal relationship between environmental exposure to pollutants and public health effects in a scientifically sound manner. Throughout the years, it has been increasingly recognized that even low-dose exposure to a cocktail of pollutants could damage human health and well-being (e.g., cognitive effects in the case of lead exposure, osteoporosis as a result of cadmium exposure, and congenital anomalies in children living around the waste incinerator). Because the most acute health effects caused by environmental pollutants were known and treated in the past, more chronic diseases and well-being effects have come surfaced. As a consequence, the threshold hypothesis has been questioned and the discourse about environmental health risks has gradually shifted from

mortality and severe health effects caused by a short-term, high-dose exposure to moderated health effects and negative effects on well-being in response to a long-term (low-dose) exposure. The complexity also takes shape in a new discourse emphasizing the need to differentiate various target groups. After all, during the lead case, the cadmium case, and the ISVAG case, children have been recognized as a more vulnerable group. In Hoboken, scientists focused on school-age children, while scientists in the ISVAG case even investigated the effect of environmental pollution on fetuses and breastfeed babies. This insight implies that environmental quality standards based on the average cannot protect all humans equally.

Moreover, the different cases illustrate that environmental health problems are embedded in a larger context of economic, financial, and social values resulting in a variety of divergent problem definitions and risk perception. As a consequence, the societal and political perception of environmental health risks can be completely dissimilar from the scientific risk assessment, on the one hand, and one stakeholder group can perceive similar environmental health problems differently in a dissimilar context, on the other. For instance, the people living in the neighbourhood of the non-ferrous industry in Hoboken almost denied health problems because they were afraid of losing their jobs and decreasing the value of their houses. The people living in the neighbourhood of the waste incinerators in Wilrijk, in contrast, claimed health damage caused by the incineration activities and required its closure. The managers of the waste incinerator tried to minimize the problem, arguing they did many technological efforts in order to comply with the emission standards. It is plausible that the sensitivity of the people living nearby ISVAG can be explained by the hope that the closure of ISVAG would increase the value of their properties, but no scientific study confirms this argumentation.

As a consequence of the increased recognition of the scientific uncertainty and controversy about environmental health problems, the presumption of a unique epistemology was challenged. Until the Nineteen Seventies, the modernist approach was the most dominant epistemology. This Modern Model is characterized by a reductionist, technocratic, and positivistic vision and assumes to be based on objective, valid, and reliable scientific knowledge and controlled uncertainties. In response to the increased awareness of the shortcomings of science to deliver certain answers, the case study analysis gradually illustrates the need for careful management of uncertainty. It must be noted, though, that scientists originally were not familiar with this shift in epistemology. For instance, the cadmium case demonstrates that scientists were very cautious about communicating uncertainties, in contrast, the pilot study in response to the ISVAG incident was dominated by uncertainty

discussions (see also the section on communication below). The series of environmental health incidents also illustrates the scientific controversy about most environmental health problems. During the ISVAG incident, scientists not only revealed conflicting opinions, but also publicly contested each others' statements, assumptions, and values. As a consequence, the results of the case study analysis emphasize the need to integrate all relevant knowledge (see Section 6.5.2.) and to transparently communicate about the assumptions made and the values taken into account. To summarize, the epistemology in the case of environmental health problems has more characteristics of the later introduced Post-Normal Science epistemology, in which the quality of the knowledge production is as much important as the knowledge outcome itself.

6.5.2. Scientific Organization and New Methods for Knowledge Production

The epistemological shift in response to scientific uncertainty and controversy has influenced the organizational context of the knowledge production and the introduction of new scientific methodologies. Moreover, the scope of environmental health research has extended from one pollutant to many pollutants, from the exposure to one pollutant to cocktail exposure, and from the focus on one part of the chain to the whole chain of causes and effects. As a consequence, the knowledge-production process requires a more integrated approach at the organizational (interdisciplinary research teams) as well as methodological (integrated risk assessment) level. For instance, the dioxin crisis pointed out the need for an integrated risk assessment taking into account all aspects of the entire food chain and different types of (scientific) knowledge. The increased challenges for interdisciplinary research teams and integrated risk assessment methods are described more comprehensively in the sections below.

The series of incidents gradually illustrates the need for continuously broadening the number of scientific disciplines which should be included in interdisciplinary research teams, in order to deal efficiently with environmental health problems. Whereas scientific input in the lead case was dominated by medical experts solely, the cadmium case study already illustrated the need to cooperate between different medical and environmental scientific disciplines (epidemiologists, toxicologists, engineers and biologists). The poor communication strategy of the scientific community and government during the ISVAG incident emphasized the importance of integrating social sciences and communication experts into the research team. The dioxin and Coca-Cola incidents made it clear that psycho-sociological factors must be considered in

emergency situations, and psychologists must be included in the expert group. Also the integration of professionals from other disciplines, such as economists and lawyers, could strengthen the research team. It must be noted that the discussion is limited to the integration of a variety of scientific disciplines. The need to include other types of expertise within the knowledge-production process such as lay-knowledge and industrial knowledge has been explicitly recognized in later years, as analysed in Chapter 7. Few indications towards this direction are the invitation to general practitioners, industrial representatives and non-governmental organizations to participate in the debate (see section 6.5.3. about the science-policy-society interface).

At the methodological level, the analysis of the case studies demonstrate the increased recognition for integrated risk assessment methods, taking into account the entire cause-effect chain of environmental health problems. As a consequence, biomonitoring has been introduced as a complementary research method - next to epidemiology, toxicology, and the measurement of pollutants in the environment - in order to measure and interpret the concentration of pollutants in the human body, caused by environmental pollution. Throughout the four cases, biomonitoring was used for an increasing number of pollutants, following-up the same people across different time periods (systematic) and a wider geographical research area. The biomonitoring survey in Hoboken was very site specific, while the cadmium study was done on a larger scale; the dioxin incident made it clear that it is worth knowing and setting a benchmark in Flanders. Biomonitoring research on such a large scale and related to the high number of pollutants was very innovative at that time.

As a self-evident part of the novel methodological developments, research projects have been strongly driven by discussions about uncertainty. As such, the debate about uncertainties has evolved from an epistemological aspect, to a methodological question about how to scientifically deal with uncertainties, and finally into a communication aspect. Communication in the case of uncertainties is described in more detail in Section 6.5.4.

As a final remark, the series of incidents emphasized the need to institutionalize long-term, policy-oriented environmental health research in order to measure and interpret the concentration of pollutants in human body and to deal with scientific uncertainty. This aspect is elaborated on in Chapter 7, establishing a Flemish Centre of Expertise on Environment and Health.

6.5.3. Science-Policy-Society Interface

The poor scientific evidence and scientific controversy have influenced the science-policy interface and emphasized the need to invite different stakeholders to join the decision-making process in order to increase both its quality and legitimacy.

Initially, the science-policy interface had most characteristics of the Modern Model, which was still the most dominated model in that time period. The Belgian and Flemish Governments established expert committees (e.g., the local medical expert group in Hoboken, the Baeyens' Committee at ISVAG) to legitimize political decisions. The establishment of experts' committees can also be considered as a strategy to depoliticize the problems. However, the complexity of the environmental health risks challenged the presumptions of the Modern Model because scientists were not able to produce univocal conclusions in the short term. As a consequence, the Belgian and Flemish Governments had to develop new strategies to deal with scientific uncertainty and to legitimize the political decisions.

During the lead and cadmium crisis, the Belgian Government (mis)used scientific uncertainty to delay the decision-making process and pass over the problem in order to prevent panic. Nevertheless, the Hoboken and Tessenderlo cases (see Section 5.2.1.) already initiated working groups, in which representatives from different ministries, experts from universities and state research institutions, local authorities, professionals (general practitioners and industrial experts), and even local and national environmental groups were invited to participate. The establishments of these working groups could imply that it was not sufficient anymore to only involve politicians and scientists to deal with this kind of complex problems. Characteristic of both cases is that all actors were looking for scientific or industrial experts who could legitimize their position, priorities, and ambitions. However, the reaction of the local authorities during the cadmium incident illustrated that, referring to the boundary models of Hoppe (2005), the shift from the Modern Model towards the Advocacy Model was no sinecure. After all, the local mayor was still convinced of a strict demarcation between science and politics, and the decision making had to be authorized to politics. The ISVAG case illustrated that politicians were triggered to apply the Precautionary Principle in response to the challenges of scientific uncertainty. The dioxin crisis, at last, indicated that the application of the Precautionary Principle in the case of complex problems was insufficient. Referring to the boundary models of Hoppe (2005), first indications towards a Model of Mutual Learning are identified. A broader interpretation of stakeholder participation

has been emphasized to legitimize the knowledge-production as well as the decision-making processes. Science has been considered to be one actor engaging in the social learning process together with other stakeholders.

To summarize, the traditional science-policy interface, based on the Modern Model, failed. Throughout the cases, the science policy arrangement has evolved from the Enlightenment Model towards the Advocacy Model and the Mutual Learning Model in which all stakeholders are involved.

6.5.4. Risk Communication and Risk Management in the Case of Uncertainty

The above case study analyses finally demonstrate how the debate about uncertainty has evolved from an epistemological aspect, to a methodological question about how to scientifically deal with uncertainty, and finally to a challenge for government about how to manage uncertain environmental health risks and how to communicate about them.

Related to risk communication, all incidents were characterized by a lack of transparency by the governmental authorities. Although the importance of communication was already emphasized during the lead case in the Nineteen Seventies, no concrete actions were taken on the short-term to ameliorate the communication. After all, until then, the public authorities were unfamiliar with scientific uncertainty and ignorant about communication strategies in the case of uncertain environmental health risks. As a consequence, the authorities tried to discreetly quiet the public's concern and kept the general population uninformed. This strategy corresponds to the first developmental stage defined by Fischhoff (1995), in which technical experts believe they are the best qualified to assess risks, and risk communication with an ignorant public is considered unnecessary. Through the years, the analysis of incidents made it clear that scientists and politicians became more aware of the importance to organize local information meetings in order to present scientific information to the general public, explain them the significance and meaning of the information, and listen to the concerns of the stakeholders. This corresponds to the development stages two through six of Fischhoff (1995). However, the lack of transparency and debate cost the authorities dearly during the dioxin crisis. The mass media, non-governmental organizations and the general public accused them of serving the economic interests of farmers' unions and the meat industry and of trying to protect themselves in preparation for the general elections, instead of protecting public health. In response to the poor communication strategy in all four cases, the importance

of consulting social experts has been emphasized, in order to advise the public authorities on effective communication strategies in the case of uncertain and complex environmental health risks. As described clearly in Chapter 7, the novel risk communication strategy has more characteristics of the seventh developmental stage of Fischhoff (1995), "All we have to do is make them partners," trying to organize stakeholders' participation at a high level and to give them an active and constructive role in the knowledge-development and decision-making processes.

In order to effectively manage environmental health problems, the quick succession of incidents illustrates an increased need for: 1) the establishment of an organizational structure in order to detect environmental health problems as fast as possible and 2) policy coordination and integration between the environmental policy and health policy fields. Related to the early detection of concerns about public health problems, possibly related to environmental pollutants, complaint desks were established after the ISVAG incident. As described in Chapter 7, those complaint offices are, in later years, integrated as the first organizational sub-network within the Flemish Environmental Health Network, bridging the gap between the general public, the general practitioners, and the Flemish authorities. In order to manage environmental health problems effectively and efficiently, the results of the case study analysis emphasize the need to better coordinate and integrate the efforts done by the Ministry of Public Health and the Ministry of the Environment, which were historically developed as strictly separated institutions. The first step to avoid policy conflicts was the establishment of ministerial working groups. The food scandal also resulted in organizational reformations at the Federal Government and the foundation of an integrated agency, responsible for the whole food chain.

6.5.5. General Conclusion

In the previous chapter, the institutionalization and differentiation of industrial safety, public health, and in later years, the environment as fragmented policy arrangements were analysed (Chapter 5). Although there were several opportunities to act (e.g., international and European environmental health discourses and initiatives, constitutional reforms of the Belgian State, etc.), the Belgian/Flemish Government and stakeholders of the day did not develop an integrated environmental health policy with a clear vision and well-defined targets. In other words, environmental health did not get off the ground, in the political nor the scientific agenda. Based on the results of the case study analysis, it is entirely clear that until the end of the Nineteen Nineties,

environmental health was characterized as an ad hoc policy field. The political and scientific agenda setting was based on crises – also referred to as incident-driven - and not as the result of a well-thought, proactive, and forward-thinking approach. Notwithstanding, each case has gradually resulted in an increased need for:

- 1) the institutionalization of long-term, policy-oriented, interdisciplinary environmental health research using different scientific methods in an integrated risk assessment, in order to shed some light on the scientific uncertainty and controversy surrounding complex environmental health problems;
- 2) new forms of interactions between science, politics and society, tending towards the Mutual Learning Model in which all relevant stakeholders are involved, in order to increase the legitimacy of the knowledge-development and decision-making processes;
- 3) the development of an effective communication strategy in interaction with social experts and the establishment of an organizational structure in order to detect environmental health problems as fast as possible and to react immediately, in order to prevent the evolvement of environmental health incidents into crisis; and
- 4) policy coordination and integration between the environmental policy and health policy fields in order to manage environmental health problems effectively and efficiently.

Using the words of Vogels (personal communication, March 19, 2010, my translation), the quick succession of incidents, “sowed the seeds” for the institutionalization of a Flemish environmental health policy arrangement. Chapter 7 analyses how the numerous initiatives, taken during the several environmental health incidents, have evolved into a systematic and structured approach used to detect, manage, and communicate effectively about complex environmental health risks. After all, the Green Party, which was able to profit from the dioxin crisis in order to participate in the next Flemish Government, succeeded in translating the new discourses and needs into an organizational environmental health network, new resources, legislation, etc.

Chapter 7: Institutionalization of the Flemish Environmental Health Arrangement

The series of environmental health related incidents, analysed in Chapter 6, resulted in the de-legitimization of the traditional discourses and approaches. The new notions about environmental health have emphasized an increased need for the institutionalization of a Flemish environmental health arrangement characterized by new scientific and political structures, legislation, resources, rules of the game, and new forms of interactions between science, politics and society. First, this chapter analyses how the numerous ad hoc initiatives taken during the several environmental health incidents have evolved into a well-thought and structured approach in Flanders (Section 7.1.). The identified decisive moments are: 1) the establishment of a Parliamentary Ad Hoc Committee on Environment and Health resulting in the White Paper on Environment and Health, 2) the launch of the Policy Research Centre Programme which was an opportunity to establish the Flemish Centre of Expertise on Environment and Health, and 3) the establishment of the Flemish Environmental Health Network in which the Centre of Expertise participates. This network is established in order to detect, manage and communicate effectively about complex environmental health risks. This organizational structure is described in more detail in Section 7.2.

A main objective of the establishment of the Flemish Environmental Health Network is to ameliorate the science-policy interaction. The Phased Action Plan, as described in Section 7.3., is developed in order to translate scientific data on environment and health into concrete policy measures. In the last section (Section 7.4.) a reflection is made as to what extent the Flemish Environmental Health Network comes up to the expectations to deal effectively and efficiently with complex environmental health risks, taking into account the challenges analysed in Chapter 6.

Last remark, the scope of this chapter is limited to the analysis of the institutionalization process of the Flemish environmental health arrangement. In the same period, from 1999 onwards, the Federal Government, in cooperation with all authorities of the Regions and Communities in Belgium, has developed a National Action Plan on Health and the Environment (NEHAP) in response to the European Commitment in 1994 at the Second Ministerial Environment and Health Conference. The development process of the Belgian NEHAP, its strengths and weaknesses, are already described in Section 4.1.2.

7.1. Towards an Integrated Environmental Health Policy Field

The Green Party (Agalev) could profit from the increased public concern after the dioxin crisis to participate in the next Flemish Government from 1999 until 2004. The Flemish Minister of Health (Vogels) and the Minister of the Environment (Dua) were both members of the Green Party. Together, they elaborated the earlier discourses, lessons learned, and initiatives on environment and health from the series of environmental health incidents, as described in Chapter 6. More precisely, the Five-Year Policy Letters 1999-2004 of the Flemish Ministers for the Environment and Health presented the actual changes in policy discourses and priorities (Vogels, 1999; Dua, 1999). The Flemish Minister of the Environment (Dua, 1999) emphasized the direct impact of environmental pollution on nature and human health. As a consequence, the Minister's priority was to adapt the environmental quality standards to the most vulnerable groups and ecosystems. As such, the Minister tried to put the discourse of vulnerable groups into practice. The Flemish Minister of Public Health (Vogels, 1999) explicitly emphasized the importance of risk communication to the general public, the need to increase preventive health measures to limit the negative effects of environmental exposure to public health, and the establishment of a new organizational structure, the Flemish Environmental Health Network, in order to deal efficiently with environment and health problems. Supported by the Parliamentary Ad Hoc Committee on Environment and Health (Vlaams Parlement, 2001), the Ministers tried to translate the new discourses into institutional changes - new actors (Section 7.1.1. and Section 7.2.), financial resources for research (Section 7.1.2.), legislation and policy documents (Section 7.1.3.), and new decision-frameworks (Section 7.1.4.) - in order to create a sustaining environmental health policy arrangement.

7.1.1. The Flemish Authority Adopts the Environmental Health Discourse

The new Flemish Minister of Public Health (Vogels) published a Green Paper on Environment and Health in April 2000 in order to convince the Flemish Government to rethink the current affairs about environmental health (Vogels, personal communication, March 19, 2010). The content of the Green Paper was based on the results of the pilot study on biomonitoring, the social science research on risk communication and the feasibility study on an environmental health organizational structure in Flanders; three studies initiated by the

previous Flemish Minister of Public Health (Demeester) after the ISVAG incident (Chapter 6). In the same time period, the Flemish Health Council (VGR) and the Flemish Council for the Environment and Nature (Mina-Council) published their advice to reduce scientific knowledge gaps on environment and health (VGR, 2000; Mina-Raad, 2001). Both councils emphasized the need to establish a knowledge and information centre and to use human biomonitoring complementary to environmental monitoring and epidemiology in knowledge development.

Influenced by the Green Paper on Environment and Health and the advices of the Flemish Health Council and the Flemish Council for the Environment and Nature, the Flemish Parliament decided, on December 21, 2000, to establish a Parliamentary Ad Hoc Committee for 2001. Gathered from the principle that only two Ad Hoc Committees are established each year, can be concluded that the Flemish political authority collectively recognized the importance to discuss the management of environmental health problems in Flanders. To develop solid advice, all relevant stakeholders' groups, advisory boards, and scientists were asked for input. The Parliamentary Ad Hoc Committee on Environment and Health, managed by Johan Malcorps (Green Party), resulted in the publication of a White Paper on Environment and Health (*Maatschappelijke Beleidsnota Milieu en Gezondheid*; Vlaams Parlement, 2001), recommending: 1) to pay more attention to vulnerable groups; 2) to invest in permanent biomonitoring surveys and to increase financial resources for research in general in order to realize evidence-based decision making; 3) to apply the Precautionary Principle and to stimulate environmental hygiene in order to prevent, or at least decrease, the public health impact of environmental pollution; 4) to better integrate the environmental and public health policy and to intensify the cooperation between the public health and environmental governmental departments; 5) and to establish an environmental health network in order to ameliorate the communication and knowledge/information transfer between the general public, the policymakers, and the experts. Although the resolutions of an ad hoc committee are not enforceable, the advice is usually adhered to the Flemish Government (Vogels, personal communication, March 19, 2010). As such, the recommendations were copied in its entirety in the Integrated Policy Letter Environment and Health (Vlaams Parlement, 2001) as the main principles and priorities of the newly emerging environmental health policy field.

7.1.2. Resources for Environmental Health Research

Independent from the evolutions in the environmental health policy field, the Flemish Government reformed policy-oriented research in 2000. After all, it was increasingly recognized that the financial resources for research were too divided, mostly focusing on short-term, operational projects (Vogels, personal communication, March 19, 2010), while there was a need for more in-depth, multidisciplinary, and long-term scientific support (Daems, personal communication, May 6, 2010). As a consequence, the Policy Research Centre Programme (*Steunpunten Beleidsrelevant onderzoek*) was launched in 2001 to provide structural funding for policy-oriented research, in order to quickly anticipate social challenges or priority policy themes and to take proactive measures (Policy Research Centres, s.d.). Related to the emerging environmental health policy field, the establishment of Policy Research Centres was a great opportunity to develop and finance a critical mass of multidisciplinary knowledge about the impact of environmental pollution on human health and to transfer that knowledge to the Flemish Government. The reformation of policy-oriented research occurred at the optimal moment to continue the pilot study on environment and health (Baeyens, personal communication, March 24, 2010; Vogels, personal communication, March 19, 2010). Environmental health was accepted as one of the 12 research centres of the first generation (2002-2006), as well as one of the 14 expertise groups in the second (2007-2011) and third generation of research centres (2012-2016). More details about the actors involved in the Flemish Centre of Expertise on Environment and Health, the dominated discourses within the Flemish environmental health research policy centre, and its financial resources are described in Section 7.2.3.

7.1.3. The Operational Embeddedness of Environmental Health Discourse Survives Different Legislatures

The efforts of the Integrated Policy Letter on Environment and Health (Vlaams Parlement, 2001) were beginning to pay off within a few years. From 1999 onwards, the environmental health discourse has been gradually embedded in policy documents, legislation, and the Flanders Environment Report, regardless of the government coalition in power. In other words, the environmental health discourse has become structured and formalized.

Since 2001, the annual policy letters of the Flemish Ministers of the Environment and Health, in which they justify their policy for the upcoming year, have given explicit attention to environmental health issues (Vogels,

2001/2002; Byttebier, 2003; Vervotte, 2005/2006; Vanackere, 2007/2008; Vandeurzen, 2010; Dua, 2001/2002; Sannen, 2003; Peeters, 2005/2006b; Crevits, 2007/2008; Schauvliege, 2010). Also, in the Flemish Environmental Policy Plan 2003-2007, the increased attention for environment and health was obvious, focusing on human biomonitoring, dealing with uncertain risks, vulnerable groups, policy integration, environment and health communication, etc. At the start of the next Flemish Government (2004-2009), in which the Green Party was not involved, the Minister of the Environment was very ambitious in regards to environment and health: "Towards 2010, the Flanders region must be comparable to the other economic top regions in Europe concerning environment and health" (Peeters, 2004, my translation). This strategic ambition was translated into four operational objectives: 1) Flanders must do pioneering work in environmental health research; 2) vertical and horizontal integration of environmental health policy; 3) systematic application of scientific evidence in decision-making processes; and 4) sufficient participation of all stakeholders. Also, the next Flemish Minister of Public Health integrated environment and health in her Annual Policy Letters, focusing on biomonitoring, efficient risk management and communication, the prevention of health effects related to noise exposure, exposure to radiation and cadmium, and indoor air quality (Vervotte, 2005/2006). The current Flemish Minister of the Environment is also convinced of the necessity of environmental health and the ambition to prevent human health damage taking into account the most vulnerable groups (Schauvliege, 2010). Concretely, the Flemish Minister of the Environment identified three priorities in her Five-Year Policy Letter 2009-2014: 1) transport-related environmental pollution and health impacts, 2) dealing with uncertain risks, and 3) gearing environmental measurements towards each other (Schauvliege, 2009). The current Flemish Minister of Public Health emphasized the intention to react fast and accurately to environmental problems negatively affecting human health by developing action plans, implementing efficient prevention measures, and using a participatory approach (Vandeurzen, 2009).

In 2003, a new Flemish Decree on Preventive Health Policy was promulgated (BS, 2004b). This Decree enabled the Flemish health authorities to take initiatives to prevent environmentally-related illnesses caused by both indoor and outdoor sources involving physical, chemical, and biological factors. The Decree's major principles are: informing the public, taking measures to reduce emissions based on the Precautionary Principle, and responding to complaints about pollution in buildings and in the atmosphere. As a consequence, the Decree mandates the Flemish Government to take measures to develop and perform a human biomonitoring programme. As a consequence, the use of

biomonitoring is laid down by law. Following the Prevention Decree, the Flemish Government promulgated the Indoor Decree on June 11, 2004, in which the Precautionary Principle should be applied when human health risks are uncertain (Vlaamse Regering, 2004a). In the case of uncertainty, the measures should be weighed against the probabilities and seriousness of the supposed health effects, the number of exposed people, and the supposed societal impact of the measures.

From 2003 onwards, the Flanders Environment Report (MIRA), in which the actual environmental state is described, analysed, and assessed, includes a chapter that is devoted specifically to the health impact of environmental pollution. The indicators used to evaluate the effects of environmental pollutants on public health are Disability Adjusted Life Years (DALYs), the concentration of polluting substances in humans measured by human biomonitoring, and the number of certain diseases and cancers which are strongly related to the environment. Van Steertegem (personal communication, March 18, 2010, my translation) is sceptical about the current environmental health indicators, "It is very difficult to gather policy-relevant information from human biomonitoring results (...) DALYs are characterized by huge uncertainty ranges and almost no significant differences, which make it difficult to use this indicator to compare different scenarios in time."

7.1.4. Towards a Policy Framework for Uncertain Risks

One of the goals of the Five-Year Policy Letter 2009-2014 of the Flemish Minister of the Environment (Schauvliege, 2009), as well as one of the intentions of the Environmental Policy Plans 3 and 4, is related to the development of a risk management policy to deal with uncertain environmental health risks. Taking into account the best practices in the Netherlands, Germany, and the United Kingdom, the Environment, Nature, and Energy (LNE) department of the Flemish Government developed a first draft procedure of a transparent and balanced decision framework for uncertain risks (Reynders, 2010). Uncertain risks are defined as risks which are characterized by large uncertainties, ambiguity, and complexity that hamper decision making (e.g., non-ionized radiation, nanotechnology and GMOs). The procedure describes a theoretical framework which has to be put into practice for each risk individually. The procedure consists of four phases: 1) problem framing; 2) risk assessment taking into account scientific, social, political, and economical aspects; 3) risk evaluation; and 4) risk management and policy evaluation. These phases are similar to the Risk Governance Framework of Renn (2005), as described in Chapter 4. Risk communication

and stakeholders' participation are considered as important issues within the whole process, but these issues are limitedly elaborated upon (SERV, 2011). In the year 2011, the procedure is applied to the case of non-ionized electromagnetic fields. Using a learning by doing approach, the procedure will be optimized in the near future.

To conclude, new actors (Ministers of the Green Party, the Parliamentary Ad Hoc Committee on Environment and Health) elaborated the new environmental health discourses and succeeded to institutionalize them into new legislations, policy documents, and resources. Not only the political environmental health discourse was able to get through to the authorities, also the new epistemological and methodological developments in response to complex risks were formalized into policy documents.

7.2. The Establishment of an Organizational Structure: the Flemish Environmental Health Network

The institutionalization of the Flemish environmental health arrangement does not only take shape in the formalization of new discourses in policy documents, resources and legislation. The organizational structure of the environmental health policy domain was also reconsidered in order to ensure that the main principles of the Flemish environmental health policy field (Section 7.1.1.) could be made operational. In response to the advice of the Parliamentary Ad Hoc Committee on Environment and Health, the Flemish Government launched the Flemish Environmental Health Network in 2001 in order to prevent public health problems due to environmental pollution and to trace potential threats as expediently as possible. Instead of developing a new and insulated environmental health organizational structure, the philosophy is to emphasize the integration of environmental considerations within public health policy, and vice versa, based on committed cooperation and coordination between these policy fields. The network also aims at the actual participation of diverse stakeholders at different policy levels to improve the cooperation and communication between science, politics, and society.

The Flemish Environmental Health Network consists of three sub-networks: 1) the local environmental health officers (Section 7.2.1.), 2) the Flemish Health Ministry and the Flemish Environment Ministry (Section 7.2.2.), and 3) the Flemish Centre of Expertise on Environment and Health (Section 7.2.3.). It is

obvious that the political power is authorized to the Minister of Public Health and the Minister of the Environment who has to give account to the Flemish Parliament. The most important advisory bodies of the Flemish Government related to environmental health topics are the Flemish Health Council (VGR) and the Environment and Nature Council Flanders (Mina-Council). A schematic overview of the key actors within the Flemish environmental health policy arrangement is presented in Figure 19. As clearly illustrated in this figure, the boundaries of the three sub-networks of the Flemish Environmental Health Network overlap. After all, the detailed descriptions of each sub-network in the next sections demonstrate that each sub-network fill a combination of functions (knowledge development, policy making, communication). This is also the reason why I opted for the term 'sub-network' instead of 'levels', although the latter is used in official publications by the members of the Flemish Environmental Health Network.

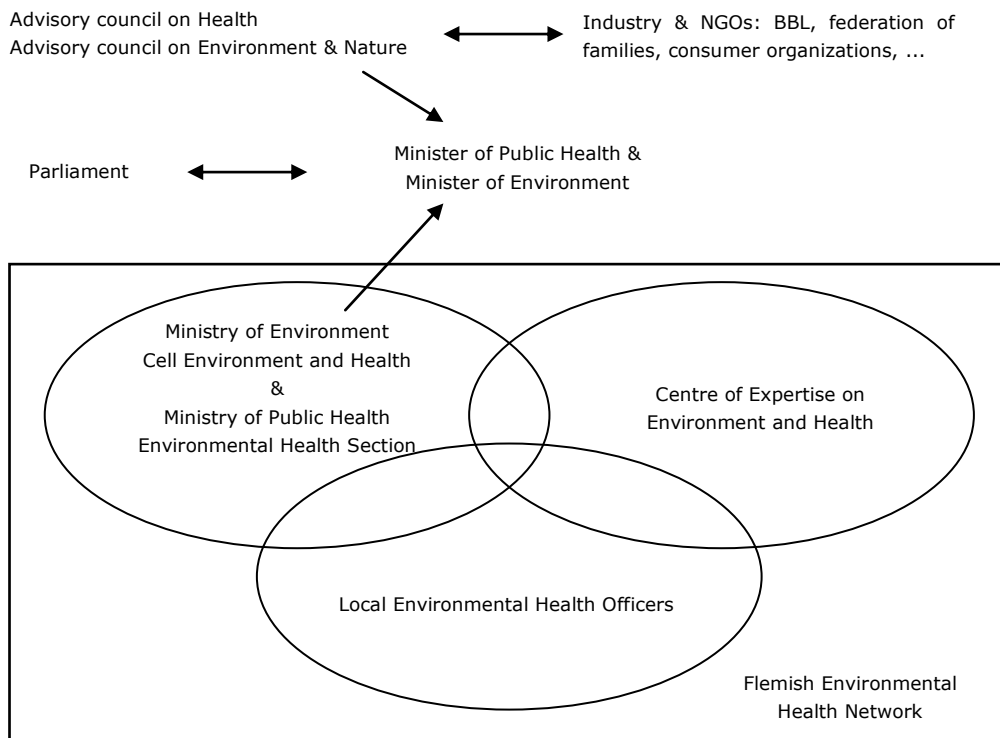


Figure 19: Key actors within the Flemish environmental health policy arrangement (Stassen, Gislason & Leroy, 2010).

7.2.1. First Sub-Network: Local Environmental Health Officers

The root of the appointment of local environmental health officers was the establishment of a complaint desk by a previous Flemish Minister of Public Health, Demeester, after the ISVAG incident (Chapter 6). Demeester wanted to establish an organizational structure to detect public health concerns related to environmental pollution as soon as possible. The intention was to extend the number of complaint desks by integrating them into local consultative structures for public health by the year of 1999 (Demeester, 1998).

In April 2004, after a theoretical education and practical training at the Flemish Health Inspection Services, 13 local environmental health officers were appointed. Nowadays, there are 15 officers. Together, they make the first sub-network of the Flemish Environmental Health Network (Houben & Van Peer, 2004). These local officers are the primary contact persons for questions and complaints about environment and health by the general public. They also assist the Flemish Government and the Flemish Centre of Expertise on Environment and Health in risk communication (Houben, 2004).

The assignment of the local environmental health officers is threefold (Houben, 2004). First, local environmental health officers must detect and intercept possible environmental health problems in the beginning. As such, they are the primary contact persons for the general public and the primary health care giver for environment and health related questions or concerns. The local officers have to register and analyse the problems and try to find a solution, consulting the Flemish Health Inspection Service, the local governments, or other knowledge centres. Second, local environmental health officers are at the interface between science and the society. By order of the general public or primary health care workers, they have to assist in interpreting scientific results. Turning it round, local environmental health officers can help scientists determining whether there is a local, social support for a human biomonitoring survey in the region (Keune, personal communication, March 5, 2010; Verlaek, personal communication, February 15, 2010; Nelen, personal communication, April 13, 2010), and they also play an important role in the facilitation and optimization of risk communication and environmental health education (Loots, personal communication, July 9, 2008; Wynants & Verlaek, 2004). Third, local environmental health officers are at the interface of politics and society. They observe environmental health problems and notify the authorized governments. The description of the tasks of the local environmental health officers are specified by the implementing order of the Flemish Government related to the Local-Regional Health Consultation and

Organizations (LOGOs), May 29, 2009. To conclude, the local environmental health officers facilitate: 1) policy integration by bridging the environment and public health domain; 2) multi-level governance between the local authority level and the Flemish authority level; and 3) boundary work between science and society, on the one hand, and between politics and society, on the other.

Organizationally, the local environmental health officers were initially employed at an independent, non-profit organization - *OCL vzw* - in order to ensure their impartiality when dealing with complaints or giving advice. Nevertheless, *OCL vzw* was recognized, subsidized, and instructed by the Flemish Government. In practice, the local environmental health officers were integrated in the LOGOs in Flanders. These local health organizations were established by the Flemish Community in 1997, in order to decentralize the implementation of promoting health and preventive health care policies (Corens, 2007) aiming to protect and preserve the population's health and to reach the health targets set by the Flemish Government (www.zorg-en-gezondheid.be, September 13, 2011). Since 2004, environment and health has been added as a seventh health target by the Flemish Government, next to the targets related to suicide prevention, breast cancer screening, (ab)use of tobacco, alcohol and drugs, nutrition, fall prevention, and vaccination. LOGOs are intended to lead health promotion work at the district level, covering a territory between 250,000 and 300,000 inhabitants. As such, the establishment of the LOGOs reflects the idea that the World Health Organization emphasized as, "think globally, act locally" (Wildemeersch, personal communication, March 30, 2010). In order to reach its goals, all local health care givers (general practitioners, pharmacists, dieticians, medical school management, health centres, etc.) participate in the LOGOs and each LOGO is supported and coordinated by a multidisciplinary central team.

Since 2010, the local environmental health officers are employed by the LOGOs, resulting in the ability to operate locally (Verlaek, personal communication, February 15, 2010). Contrary, some respondents questioned the employment of the local environmental health officers in the LOGOs. For instance, Wildemeersch (personal communication, March 30, 2010) considered a possible bottleneck referring to the fact there is no unity of management anymore. Each local environmental health officer has their own employer. Vogels is concerned about overworking these local officers by charging them with the other health targets of the LOGOs (personal communication, March 19, 2010). However, Wildemeersch countered this by stating that the financial support of LOGOs is dependent of their realized targets, in which environmental health is part of (personal communication, March 30, 2010). Whether these concerns are fair, time will tell.

7.2.2. Second Sub-Network: the Flemish Governmental Authority

As already described in Section 7.2.1., the local environmental health officers are responsible for the initial response to questions and concerns of the population and the primary health care givers. This first sub-network serves as a buffer for the second sub-network, the Flemish governmental authority, who is responsible for the preparation, execution, and evaluation of the Flemish policies.

The establishment of the second sub-network of the Flemish Environmental Health Network occurred simultaneously with the creation of a new reform project of the Flemish Government entitled the Better Administrative Policy (*Beter Bestuurlijk Beleid*). This project aimed at a reorganization of the Flemish Government (the Ministry of the Flemish Community, the agencies, Flemish Public Institutions, and the advisory boards) taking into account three fundamental principles: simplicity, coherence, and effectiveness (www2.vlaanderen.be, September 14, 2011).

As a consequence of this coincide, there was an opportunity to think about an integrated environment and health administrative service. However, according to Daems and Aerts (personal communication, May 6, 2010 and May 28, 2010), the development of such an integrated service was unmentionable for the general directors of AMINAL (LNE) and TOVO, the Flemish Administrations for the Environment and Public Health respectively. Referring to Daems (personal communication, May 6, 2010), "Both administrations were afraid to lose power, human, and financial resources." Moreover, the institutional framework was not adapted to an integrated service that bridges different administrations and departments, because governmental budgets and civil servants were allocated to one specific department (Aerts, personal communication, May 28, 2010). As a result, two administrative services on Environment and Health were established, one within the Flemish Health Administration (TOVO) and the other within the Flemish Environmental Administration (AMINAL/LNE).

The Flemish Health Inspection Services was already divided by 1996 into two sections: the Infectious Diseases Section and the Environmental Health Section (Demeester, 1995). Each section of the Flemish Health Inspection Services consists of a centralized coordination team and a field organization, for each of the Flemish provinces. The Environmental Health Section is multidisciplinary, composed of biologists, general practitioners, biomedical scientists, nurses, a pharmacist, and a laboratory assistant. Based on his

experience in the ISVAG incident, Wildemeersch explicitly expressed the desire to also include psychologists and chemists in the environmental health service (personal communication, March 30, 2010).

In 2002, the Environment and Health Service was established within the Flemish Environment Administration (AMINAL/LNE). Its main aims are: 1) to limit the negative effects of environmental disturbances on human health, 2) to foster the development of knowledge about environment and health in Flanders, and 3) to propose measures on the basis of the results of the human biomonitoring programme (LNE, s.d.). Originally, the Environment and Health Service was staffed with three policy advisors and one administrative staff member (Vlaamse Regering, 2004b). Over 2011, there are six employees.

The division of tasks between both environmental health services is rather ascribed in an informal way, taking into account the institutional context of both services (Aerts, personal communication, May 28, 2010). The Environment and Health Service of the Flemish Environment Administration focuses more on the preparation of environmental health policy and supports policy-oriented, environmental health research. Policy execution is more ascribed to the Environmental Health Section of the Flemish Health Administration. After all, the Environmental Health Section can make an appeal to its field organizations and to the local environmental health officers (Van Campenhout, personal communication, March 29, 2010; Wildemeersch, personal communication, March 30, 2010). In order to ensure the complementary cooperation and to determine a joint position towards both ministers, there is bimonthly consultation between the two environmental health services. Within all these efforts, the lack of managerial unity is still considered as a disadvantage (Wildemeersch, personal communication, March 30, 2010). However, Chovanova (personal communication, March 30, 2010) counters, believing that the current institutional circumstances have the advantage of having easier access to the other services of the environment or health administration which come under the same policy department and the same minister.

In the case of exceeding the traditional policy boundaries, like environment and health, the allocation of personnel and financial resources is a difficult process. After all, different ministers and general directors need to collaborate. Moreover, all ministers want to communicate about their successful results, but in case of policy exceeding authorities, successful actions cannot be accredited to just one person (Aerts and Biot, personal communication, May 28, 2010). Although the general directors could not get along, the cooperation in the field between the environment and health civil

servants went well (Baeyens, personal communication, March 24, 2010; Daems, personal communication, May 6, 2010). Nevertheless, friction cannot be excluded, given that these two environmental health services have their own perspective on environmental health problems, their own institutional dynamics, and their own agendas (Keune, personal communication, March 5, 2010).

7.2.3. Third Sub-Network: the Flemish Centre of Expertise on Environment and Health

The reformation of the policy-oriented research towards the Policy Research Centre Programme in 2000, as described in Section 7.1.2., was a great opportunity to establish the third sub-network of expertise in the Flemish Environmental Health Network. This Centre of Expertise on Environment and Health was ordered to scientifically pinpoint the Flemish environmental health policy (Wildemeersch, personal communication, March 30, 2010). The call of the Flemish Government in 2001 reflected the new discourses and lessons learned during the series of environment and health incidents (Chapter 6). As a consequence, the specifications focused on the development of environmental health indicators, the establishment of a general biomonitoring survey across Flanders in order to detect the impact of environmental influences on human health for different age groups in different regions, innovative toxicological and epidemiological research, as well as social science research related to risk perception and risk communication (Lastenboek Milieu & Gezondheid, 2001). It is out of scope to discuss the research results of the large-scale human biomonitoring survey or the procedure for stakeholder deliberation in detail. The description of the Flemish Centre of Expertise on Environment and Health is limited to its institutional developments taking into account the actors involved in the multidisciplinary research team, the research contents of the Flemish environmental health research programmes, the discourses that dominate the discussions within the Centre of Expertise, and its financial resources. The last section describes the evaluation of the Flemish Centre of Expertise by the interviewees and its future directions.

- **From Multi- to Inter- and Trans-Disciplinary Research Teams**

Based on scientific, policy-relevant, and management-oriented criteria, the first contract for the establishment of a Flemish Centre of Expertise on Environment and Health (2001-2006) was assigned to the consortium conducted by professor Baeyens (VUB). In this consortium, environmental health experts from all Flemish universities and two research institutions (VITO

and PIH), with a different disciplinary background, jointly investigated the complex relationship between the environment and health (www.milieu-en-gezondheid.be, September 14, 2011). The scientific disciplines involved in the first Flemish Centre of Expertise on Environment and Health were statisticians, chemists, political and social scientists, (bio-)medical experts, and toxicologists. The constitution of the second generation of the Flemish Centre of Expertise on Environment and Health was slightly different than the initial constitution mostly due to other personal/scientific interests, change of job, retirement, falling short of expectations during the first research centre programme, or the need of new experts due to a shift in focus in the second programme (Baeyens, personal communication, March 24, 2010).

Initially, the research team worked together based on a more multidisciplinary approach. Each researcher studied one or more aspects of the environmental health problem without crossing the boundaries of his/her disciplinary field. In later years, the research team evolved into an interdisciplinary team, jointly investigating environmental health problems, using knowledge and concepts from different disciplines and integrating them into a synthesized, coordinated, and coherent result. More recently, stakeholders are involved in different stages of the knowledge-development process. For instance, different stakeholders were involved in the selection of hot spots which will be studied, taking into account different knowledge bases and not mere experts (Keune, Morrens, Croes, et al., 2010). As a consequence, the research team has evolved from a more multidisciplinary to a more trans-disciplinary team, taking into account different types of knowledge.

Although professor Baeyens can be considered as an outsider - almost all the other partners were already involved in the pilot study - Baeyens has coordinated the Flemish Centre of Expertise on Environment and Health. After all, "After eight years of work at a Federal Government Cabinet, he has most expertise related to the science-policy interface" (Baeyens, personal communication, March 24, 2010, my translation). Vlietinck and Van Larebeke has been appointed as official spokesmen because communication about the environmental health research results has been considered as an important aspect after the bad experiences during the series of environmental health related incidents (Chapter 6). The spokesmen are the interface between the Flemish Centre of Expertise on Environment and Health, the Flemish Government and its administrations, the public, and other stakeholders.

▪ **Contents of the Environmental Health Research Programme**

A general biomonitoring survey, using biomarkers of exposure and effect, is developed in order to measure and evaluate human exposure to environmental pollution. After all, the results of the pilot Flemish Environment and Health Survey (FLEHS) stimulated the establishment of a large-scale biomonitoring programme on infants, adolescents, and the elderly in different regions (industrialized, rural, urbanized, near waste incinerators, and near fruit orchards) in order to compare the internal dose of pollutants (Schoeters, personal communication, March 4, 2008; Keune et al., 2007). As such, human biomonitoring has been the preferred scientific methodology when conducting environmental health risk assessments (Baeyens, personal communication, March 24, 2010).

The main conclusion of the first human biomonitoring programme (2001-2006) was that, "Even in a region as densely populated and polluted as Flanders, living in different areas has a measurable impact on the internal exposure levels of different pollutants. One striking result is that the values of some pollutants (PCBs, dioxins, HCB, and DDE) in the three age groups were consistently higher in the rural area of Flanders, where there is less 'pressure' of habitation, industry and traffic." (Keune, Morrens, Springael, et al., 2009).

The programme 2007-2011 is a continuation of the first programme. The human biomonitoring survey is still the core research activity of the Flemish Centre of Expertise on Environment and Health. One of the new research goals is to obtain reference values for the Flemish population obtained in a representative population sample for a broad series of pollutants, not only for the traditional pollutants, but also for newer emerging chemicals (for instance Bisphenol A, Brominated flame retardants, and Phthalates) (www.milieu-en-gezondheid.be, September 16, 2011). These reference values would be useful when comparing the general Flemish data with international studies, or the results from high risk populations living in hot spots (strong polluting point sources) or characterized as vulnerable groups. A transparent and deliberative procedure is developed for the identification of hot spots, taking into account different stakeholders and knowledge bases and not merely experts (for more details, see Keune, Morrens, Croes, et al., 2010). The regions of Genk-South and Menen were selected for a detailed biomonitoring survey in the second programme. Also the Phased Action Plan is further developed in order to elaborate the results of the first biomonitoring survey into concrete policy measures and to make the results useful for preventive policy with regard to environmental health care. The philosophy of the Phased Action Plan, developed to increase the collaboration between policymakers and scientists,

is described in more detail in section 7.3. During the second programme, an action plan was developed for asthma and another for chlorinated hydrocarbons (PCBs, dioxins, DDE). New topics integrated into the environmental health research programme are: fine dust, nanoparticles, social inequality, and the inclusion of new chemicals in the biomonitoring survey. Other topics such as food contamination and genotoxicology discontinued (Baeyens, personal communication, March 24, 2010; Aanvraag tot erkenning en betoelaging als steunpunt voor beleidsrelevant onderzoek voor het thema Milieu & Gezondheid, 2007).

In regards to biomonitoring, Flanders is pioneering the assessment of the general population's exposure to chemicals found in the environment. At international forums, Flanders advocates this methodology. To illustrate, under influence of the Flemish experience, the Belgian Federal Public Service on Health, Food Chain Safety and Environment coordinates the European project DEMOCOPHES in order to test the feasibility of a coherent approach to human biomonitoring in Europe. Belgium also participates in the European project COPHES, a scientific consortium that elaborates the necessary methodologies, a functional framework and policy recommendations (www.eu-hbm.info/democophes, November 16, 2011).

▪ **Dominant Discourses about Environmental Health**

Three topics generally dominate the discussions between the scientists of the consortium and the steering group: 1) the balance between policy oriented and fundamental research, 2) the right of the general public to have access to research results, and 3) the interpretation and communication of uncertainties.

In regards to the search for a good balance between policy-oriented research and fundamental studies, professor Baeyens, coordinator of the Flemish Centre of Expertise on Environment and Health, more or less obliges the partners of the consortium to respond to policy questions, irrespective of its limited academic value. After all, through his political experience at the Federal Government Cabinet in the early Nineteen Nineties, he has been aware of the needs of politicians and civil servants (Baeyens, personal communication, March 24, 2010).

Concerning the right to information, the partners of the consortium have been aware of the importance of transparently communicating their research results and giving the participants the results of their blood and urine tests and the opportunity to discuss their individual results with medical experts (Van Larebeke, personal communication, May 19, 2010). The general results are all

available at the website of the Flemish Centre of Expertise on Environment and Health and announced by a digital news letter, while specific documentation is drawn up for general practitioners and local environmental health officers (Nelen, personal communication, April 13, 2010).

The third debate concerns the question: Could one communicate about the concentration of pollutants in human fluid, even though the research team does not agree on the scientific meaning of this phenomenon? (Vlietinck, personal communication, March 12, 2010). After all, for some measured pollutants, the dose-response relationships are still less or unknown. As a consequence, a different communication strategy is developed for the scientifically known and the unknown pollutants, in the sense of whether or not it is possible to scientifically interpret the results. In the case of less known pollutants, participants can retrieve their personal results with the statement that it is currently not possible to interpret the results. In the case of known pollutants, the results are supported with an interpretation, as well as possible causes of an increased level, and measures to reduce the future concentration of the pollutant in human body (Nelen, personal communication, April 13, 2010; Vlietinck, personal communication March 12, 2010). The communication strategy also emphasizes the difference between the results at the individual and collective level (Van Larebeke, personal communication, May 19, 2010). The communication strategy is put into practice by a guideline about the rules of the game by external risk communication (Goorden et al., 2002; Keune, Morrens & Loots, 2008; Keune, Loots and Morrens, 2009). The most important principles of the *Rules of Risk Communication* are:

- all forms of knowledge are relevant and should be taken seriously,
- two-way communication with, and participation of, all relevant stakeholders and mutual understanding is necessary,
- controversies and differences of risk perception are standard in the case of complex environment and health issues and should be respected,
- controversies and uncertainties are inevitable and should be communicated transparently, and
- all stakeholders have the right to receive all information.

▪ **Financial Resources**

The Flemish Centre of Expertise on Environment and Health is financed by the Flemish Department of Science (\pm 867,630 Euros/year) and co-financed by the Flemish Minister of Environment and the Flemish Minister of Public Health.

During the first period, only the Public Health Department co-financed the Flemish Centre of Expertise on Environment and Health (\pm 371,840 Euros/year) (Lastenboek Steunpunt Milieu & Gezondheid, 2001). However, Wildemeersch (personal communication, March 30, 2010) nuanced this finding because the environmental administration financed additional environmental health research through addenda (759,750 Euros for 5 years). Plausible explanations, given by the interviewees, for the originally less co-financing of the environmental administration are, "as a result of historical developments, the Environmental Department (AMINAL/LNE) was less dealing with environmental health issues, but in the early years of 2000 they were working to make up lost ground" (Daems, personal communication, May 6, 2010, my translation), and "the Ministry of the Environment had already an other policy research centre to finance, while the Ministry of Public Health was only involved into one policy research centre" (Vogels, personal communication, March 19, 2010, my translation).

In the second period of the Flemish Centre of Expertise on Environment and Health (2007-2011), the opposite occurred. The total budget of 925,000 Euros was divided between the Flemish Department of Science (625,000 Euros/year), the Flemish Environmental Administration (200,000 Euros/year), and the Public Health Department (100,000 Euros/year) (*Beheersovereenkomst Steunpunt Milieu & Gezondheid 2007-2011*). Plausible explanations, given by the interviewees, for the less co-financing by the Public Health Department are: "the fact that environmental health is just one very small aspect within public health and more resources should be spend to curative medicine because of a societal desirability" (Wildemeersch, personal communication, March 30, 2010, my translation), and "the Public Health Department had also an other policy research centre to finance concerning welfare, public health, and family, which was considered as covering the entire policy domain in a more comprehensive manner, while the Environmental Department was only involved into the Flemish Centre of Expertise on Environment and Health" (Baeyens, personal communication, March 24, 2010, my translation).

- **Evaluation of the Flemish Centre of Expertise on Environment and Health by the Interviewees and its Future Directions**

Most interviewees affirm the added value of the Flemish Centre of Expertise on Environment and Health. The Centre of Expertise is commended because of its interdisciplinary approach taking into account various complementary experts who fecundate each other; and the combination of fundamental,

policy-relevant and applied policy preparatory research (Baeyens, personal communication, March 24, 2010; Daems, personal communication, May 6, 2010; Vlaamse Regering, 2011). As a result, the Flemish Centre of Expertise on Environment and Health has evolved into one of the most important research groups worldwide on environment and health (Van Larebeke, personal communication, May 19, 2010). The few comments to the work of the Flemish Centre of Expertise on Environment and Health are related to its limited value for the policy-making process (Verheeke, personal communication, May 28, 2010). For instance, Van Steertegem emphasizes the difficulty to gather policy relevant information from the results of human biomonitoring surveys (personal communication, March 18, 2010). Although, the phased action plan (see Section 7.3.) tries to meet these objections.

The second programme of the Flemish Centre of Expertise on Environment and Health ended in December 2011. In July 2011, the Flemish Government launched a third call for the development of policy research centres during the period 2012-2016, among which the Flemish Centre of Expertise on Environment and Health was included (Vlaamse Regering, 2011). It must be noted that the call might have been written for the current consortium, given that some research activities should be continued. The content of the call also illustrates the future direction of environment and health research in Flanders. The Flemish human biomonitoring programme should be continued. The risk communication approach and the methodology (Phased Action Plan) developed to translate biomonitoring research data into policy measures (see Section 7.3.) are praised worldwide and should also be continued and optimized. The call emphasizes the need to increase research efforts to integrate the results of human biomonitoring surveys in cost-benefit analyses, to link the results of human biomonitoring surveys with the measurement or modelling of environmental quality, to extend existing surveillance systems with health effects caused by environmental pollution, and to organize a debate with the general public about the acceptability of carcinogenic risks caused by environmental pollution. At last, the call sums up some new scientific developments, such as the health impact of industrialized nano-materials. The new five-year programme on Environment and Health is ratified by the Flemish Government and will run from 2012 until 2017. The new programme builds further on the strengths and knowledge gained during the previous ten years.

7.3. From Science to Policy: Towards a Trans-Disciplinary Phased Action Plan

The human biomonitoring surveys of the Flemish Centre of Expertise on Environment and Health have generated a large amount of data on the complex issues regarding environmental health (Keune, Koppen & Van Campenhout, 2007). However, all these data cannot be directly translated into policy measures and decision making because there is a long process of interpretation that must be done in advance (Van Campenhout, personal communication, March 29, 2010). As a result, the authorized ministers can be discredited when they are confronted with negative human biomonitoring results and are not able to formulate fast and effective policy actions (Aerts and Biot, personal communication, May 28, 2010). In order to determine political priorities with regard to preventive environmental health care, the experts of the Flemish Centre of Expertise on Environment and Health, in cooperation with policy representatives, have developed a framework. (Keune et al., 2007; Wildemeersch, personal communication, March 30, 2010). The so-called Phased Action Plan for policy interpretation of human biomonitoring data can be considered as a tool to bridge science and policy and is described in more detail in the sections below.

The aim of the Action Plan is threefold. The Action Plan has: 1) to assess how significant the data are in regards to health, 2) to determine the origin and pathways of the pollutants from the environment into the body, and 3) to develop policy measures (Keune, Koppen, Morrens et al., 2010; Aanvraag tot erkenning en betoelaging als steunpunt voor beleidsrelevant onderzoek voor het thema Milieu & Gezondheid, 2007). The framework is characterized by extended stakeholders' participation in order to increase the quality and legitimacy of the decision-making process, ensuring more robust and well-informed decision making, knowledge broadening including scientific as well as societal considerations, and an increased public support for policy measures (Keune, Morrens, Springael et al., 2009; Keune, Koppen, Morrens et al., 2010; Van Campenhout, personal communication, March 29, 2010).

In order to define its expectations, the Action Plan contains a pre-phase and three successive phases (Keune, Morrens, Springael et al., 2009; Aanvraag tot erkenning en betoelaging als steunpunt voor beleidsrelevant onderzoek voor het thema Milieu & Gezondheid, 2007). In the pre-phase, the biomonitoring results are compared to existing (international) data and guidelines. It must be noted that for many pollutants there are no reference values or guidelines yet (Loots, personal communication, July 9, 2008). Moreover, even if

reference values exceed the guidelines, it does not automatically imply serious health concerns or immediate action. After all, the internal doses can be caused by a variety of causes: environmental pollution, life style factors, individual characteristics, etc. If the scientific experts of the Flemish Centre of Expertise on Environment and Health assess the results as "serious to public health", then the results proceed to the first phase of the Action Plan (Keune, Koppen, Morrens et al., 2010). The first phase focuses on the seriousness of the specific results in regards to public health risks, taking into account environmental, medical, social, and political criteria (Keune, Morrens, Springael et al., 2009). These criteria are determined by a multi-disciplinary expert consultation. The assessment of the criteria has to be done by desk research and expert consultation. A stakeholder jury must judge all relevant data and knowledge, in order to prioritize the different environmental health risks. However, the ultimate decision about the priorities for policymaking is allocated to the authorities. The highest priority problems continue to the second phase (Keune, Koppen, Morrens et al., 2010). In this phase, the causes of the elevated internal biomarker concentrations are studied in more detail (Van Campenhout, personal communication, March 29, 2010). If environmental factors are acknowledged as a determinant, the local sources of environmental pollution should be identified. As a result, policy options can be defined and prioritized, complementary to the current affairs, in close collaboration between scientists, policy representatives, experts, and stakeholders. The final phase refers to policy decisions, the determination of feasible policy measures that can reduce or even prevent the environmental health problem in the near future. It is up to the authorities to implement, or not, the proposed policy actions and to evaluate them.

The Flemish Phased Action Plan, although still being developed, is presented at the European level as an innovative and good practice to identify gaps in environmental health knowledge development and decision making (Keune, Koppen, Morrens et al., 2010). The boundary work between different scientific disciplines and between scientists, policymakers, and stakeholders is considered to be fruitful. A good composition of teams, characterized by trust and respect in the expertise and experiences of the other, is mentioned as a determining factor for successful participation (Keune, personal communication, March 5, 2010). The framework is also considered as complex. After all, the Phased Action Plan is not a "ready for use" recipe, although the past experiences can be useful in a new context in the sense of learning by doing (Keune, personal communication, March 5, 2010; Teughels, Van Campenhout and Chovanova, 2008). The complexity of the Phased Action Plan makes it difficult to convince politicians, the media, and the general public

of its added value (Wildemeersch, personal communication, March 30, 2010). It is out of scope to evaluate the Phased Action Plan in full detail. After all, the Flemish Centre of Expertise on Environment and Health has already evaluated the procedure of the Phased Action Plan and formulated concrete recommendations to ameliorate the Phased Action Plan in the future (Keune, Koppen, Morrens et al., 2010). The recommendations are related to the inclusion of risk perception research, methodological issues, the composition of the list of assessment criteria, measures to increase experts' and stakeholders' participation.

7.4. Reflection

The series of environmental health incidents, analysed in Chapter 6, created the opportunity to rethink and re-organize the current affairs concerning environmental health in Flanders. More precisely, each incident resulted gradually in: 1) changing epistemological discourses about (environmental health) risks and uncertainties, 2) an accumulated organization of scientific knowledge and expertise and new methodologies for knowledge production, 3) new relationships between science, policy, and society, and 4) challenges for risk communication and risk management, including policy coordination and integration between the environmental policy and health policy fields. In this chapter, the institutionalization process of the Flemish environmental health arrangement is analysed, studying the organizational developments related to knowledge creation and decision making (e.g., the Flemish Environmental Health Network), tools and methods to ameliorate the science-policy interface (e.g., Phased Action Plan), the resources available, new legislation, policy documents, etc. In this section, a reflection is made as to what extent the Flemish Environmental Health Network comes up to the expectations to deal effectively and efficiently with complex environmental health risks, taking into account the challenges analysed in Chapter 6? More precisely, the following topics are reflected upon:

- the impact of the changing epistemological discourses about complex environmental health risks on the knowledge development process;
- the impact of complex environmental health risks on risk management;
- the Flemish Centre of Expertise on Environment and Health and the Flemish environmental health administrative services as boundary organizations between science and policy;

- the Local Environmental Health Officers as boundary people between science, politics, and society.
- Human biomonitoring and environmental health indicators as boundary objects between science and policy; and
- the Phased Action Plan as a trans-disciplinary assessment framework and boundary tool to bridge science, policy and society.

7.4.1. Impact of Epistemological Discourses about Environmental Health Risks on Flemish Knowledge Production

The complexity and scientific uncertainty of environmental health problems has been increasingly recognized during the series of environmental health incidents, as analysed in Chapter 6. The reasons behind its complexity are the non-linear causal relationships between environmental pollutants and human health effects, the exposure to a mixture of different pollutants caused by several sources, the individual variability, the long delay periods and the degree to which environmental health problems are interwoven with economic, financial, and social values. Moreover, biomonitoring research on such a large scale and related to the high number of pollutants was innovative one decade ago. As a consequence, there has not always been certainty about methodological choices or the interpretation of results.

In order to deal with this complexity and scientific uncertainty, two evolutions can be distinguished. First, the knowledge development process has evolved from a multi- to an inter- and even trans-disciplinary approach, taking into account a plurality of perspectives. Second, more importance has been given to the quality of the research process of the Flemish Centre of Expertise on Environment and Health, open communication, and dialogue about the research process and its results, as well as the management of uncertainties.

Related to the first issue, the series of environmental health incidents already illustrated the need for interdisciplinary research teams, taking into account environmental experts (engineers, biologists) and medical scientists (toxicologists, epidemiologists, etc.). After the poor communication strategy during the ISVAG incident, the social experts have been included to focus on "risk communication, risk perception, and on process aspects of knowledge production, interpretation, deliberation and cooperation between different scientific disciplines and other social actors" (Keune, Morrens, Croes et al., 2010). Experts from other disciplines like economics, psychologists, and jurists could also strengthen the research team, but have not been included

because of limited financial resources. Initially, the research team worked together based on a more multidisciplinary approach, more or less separately studying one or more aspects of the environmental health problem without crossing the boundaries of the scientific disciplines. In later years, the research team has evolved into an interdisciplinary team, jointly investigating environmental health problems, using knowledge and concepts from different disciplines and integrating them into a synthesized, coordinated, and coherent result. Influenced by social sciences, the experts of the Flemish Centre of Expertise on Environment and Health and the policy representatives have been convinced of the added value to integrate all types of knowledge (lay-knowledge, industrial knowledge, and scientific knowledge) to enrich the scientific assessment with other than technical, medical, and environmental criteria and to deal efficiently with environmental health problems. This trans-disciplinary knowledge production takes shape in the Phased Action Plan and the Guidelines on Risk Communication. For instance, the Guideline on Risk Communication states, "All forms of knowledge are relevant and should be taken seriously" (Goorden et al., 2002; Keune, Loots and Morrens, 2009).

Uncertainty management is needed to legitimize the scientific knowledge for the decision-making process. As such, the research team has developed a strategy to deal with uncertainties, based on uncertainty communication. However, it must be noted that the experts themselves have a good comprehension of what they understand about uncertainty management, but there has no concrete methodology developed, yet. In contrast with the National Institute for Public Health and the Environment (RIVM) and the Environmental Assessment Agency (MNP) in the Netherlands (Van der Sluijs, Risbey, Klopogge, et al., 2003), in Flanders, no official procedure has been developed to assess and to communicate uncertainties with the general public.

To conclude, all characteristics summed up in this section remind one of the Post-Normal Science epistemology of Funtowicz and Ravetz (1990), as described in Section 2.1.1.

7.4.2. Flemish Risk Management in Response to Complex Environmental Health Risks

In order to effectively and efficiently manage complex environmental health risks and to prevent health problems due to environmental pollution in the near future, two types of actions have been taken. First, the Flemish Environmental Health Network is established as an organizational response to the increased need to institutionalize the environmental health arrangement in

Flanders. Complementary, concrete methodological tools are developed like the Phased Action Plan and the decision framework for uncertain risks.

The Flemish Environmental Health Network is established in response to the organizational needs expressed by the series of environmental health incidents in order to manage environmental health problems effectively. After all, the sub-network approach consisting of the Flemish Centre of Expertise on Environment and Health, the Administrative Services on Environment and Health, and the Local Environmental Health Officers comes up to the expectations: 1) to institutionalize policy-oriented environmental health research; 2) to coordinate or even integrate environmental health efforts by the Ministry of Public Health, on the one hand, and the Ministry of the Environment, on the other; and 3) to develop an organizational structure in order to detect environmental health problems as fast as possible, to manage them effectively, and to communicate transparently.

Related to the second requirement, instead of developing a joint new environmental health policy field, the philosophy is to emphasize the integration of environmental considerations within public health policy, and vice versa, based on committed cooperation and coordination between these policy fields. The development of an integrated environment and health administrative service was hampered by the institutional organization of the Flemish Government (path dependencies), the institutional difficulty to allocate governmental budgets and civil servants to an integrated administrative service, and the resistance of some personalities in managerial positions. As a result, two administrative services on environment and health have been established within the existing governance structures: the Flemish Health Administration (TOVO) and the Flemish Environmental Administration (AMINAL/LNE). Both administrative services have to cooperate and coordinate with each for their activities. Referring to the different conceptualizations of policy integration of Bauer and Rametsteiner (2007), as described in Section 2.2.2., the environment and health policy can be considered as the result of the process and output of policy coordination between those two policy fields. The lack of integrated policy letters on environment and health illustrates that 'real' policy integration has been a too far-reaching goal. In order to avoid policy conflicts and to create a greater coherence between the environment and health policies, tasks have been clearly allocated and there is a bimonthly consultation between both environmental health services. Nevertheless, friction cannot be excluded given that these two environmental health services have their own perspective on environmental health problems, their own institutional dynamics, and their own agendas (Keune, personal communication, March 5, 2010).

Since the establishment of the Flemish Environmental Health network, no environmental health disaster has occurred. However, it is difficult to determine whether this is just a coincidence or a result of a good working network. Nevertheless, the network succeeds in increasing the exchange of information between the local and the Flemish level, between scientists and policymakers, between environmental civil servants and public health civil servants, between the general people and the experts or policymakers (Verlaek, personal communication, February 15, 2010). According to Wildemeersch (personal communication, March 30, 2010), the network organization also succeeds in detecting and managing concerns and problems quickly, which prevents concerns or problems evolving into crises. In Section 7.4.3., the boundary function between science and policy of the Flemish Centre of Expertise on Environment and Health is discussed in more detail.

Complementary to the organizational developments, methodological tools have been developed to facilitate the decision-making process on complex environmental health risks: the Phased Action Plan and the decision framework for dealing with uncertain environmental health risks. Both methodological tools are still in a preliminary phase and are no ready-for-use recipes. They offer a framework which should be adapted to new contexts or environmental health risks. The Phased Action Plan is a tool to assess the significance of environmental health data, to determine the origin and pathways of pollutants from the environment into the body, and to develop policy measures (Keune, Koppen, Morrens, et al., 2010). In Section 7.4.6., the Phased Action Plan as a trans-disciplinary assessment framework and boundary tool to bridge science, policy, and society is discussed. The decision framework describes the procedure to facilitate a transparent and balanced decision-making process in case of uncertain environmental health risks, based on the conceptual ideas of Renn (2005). The main added value of both tools is that they take into account a plurality of stakeholders' perspectives and emphasize the need of a qualitative process. As such, the tools try to put into practice the Post-Normal science epistemology. Based on the learning by doing strategy, both tools will be optimized in the near future.

7.4.3. Flemish Centre of Expertise and Administrative Services on Environment and Health: Boundary Organizations Between Science and Policy?

The Flemish Centre of Expertise on Environment and Health, as well as the Administrative Services on Environment and Health within TOVO and LNE can be considered as boundary organizations, bridging the different social

communities of science and politics. Both organizations try to bring people on either side of the boundary together to increase mutual understanding and to create mutually boundary objects in order to “facilitate evidence-based and socially beneficial policies and programmes” (Drimie and Quinlan, 2011).

The Flemish Centre of Expertise on Environment and Health fills the knowledge gaps and supports policy-oriented research, while dealing with complex and uncertain environmental health problems. The Centre has a clear dual accountability to science and policy communities, which is defined by Cutts et al. (2001) as one of the features of a boundary organization. The accountability to science is ensured by the publications of research articles in international, peer-reviewed journals. The accountability to politics, on the other hand, is ensured by the basis principle of the Policy Research Centres Programme, i.e., that the programme not only has the intention to finance research, but the government, as the client, also expects clear, usable results. The social scientists of the Flemish Centre of Expertise on Environment and Health try to resolve the discrepancy in issue framing between scientists and policymakers and play an important role to make scientific results comprehensible to politics and society and to ameliorate risk communication. The only characteristic of a boundary organization that can be discussed in case of the Flemish Centre of Expertise on Environment and Health is its stable, durable, and persistent nature (Franks, 2010). After all, once every five years the themes of the Policy Research Centres Programme are discussed and new candidacies can be submitted by the research institutions.

The two administrative services on Environment and Health, established within the Flemish Administrations for Health (TOVO) and the Environment (AMINAL/LNE) are responsible for the preparation, execution, and evaluation of the Flemish environmental health policy. To put evidence-based policy-making into practice, the administration services are occupied by civil servants with a scientific education, on the one hand, and they are charged with the finance and the steering of policy-relevant research, on the other.

The scientists of the Flemish Centre of Expertise on Environment and Health and the civil servants of the environmental health administrative services meet each other at the steering group of the Flemish Centre of Expertise. The interaction, discussions, and the exchange of information between the scientists and policy representatives (civil servants) have resulted in the creation of the Phased Action Plan in order to translate the results of human biomonitoring surveys into concrete policy actions, and environmental health indicators to evaluate the Flemish policy. As discussed in Section 7.4.5 and Section 7.4.6., respectively, environmental health indicators and the Phased

Action Plan can be considered as boundary objects. The agreement about boundary objects is considered as one of the characteristics of the work of boundary organizations (Franks, 2010; Cutts et al., 2011).

To conclude, the boundary work at the science-policy interface by the Flemish Centre of Expertise on Environment and Health and the Administrative Services on Environment and health have most characteristics of the Learning Model (Hoppe, 2005), dominated by debate, convergence, mutual understanding, consensus and trust.

7.4.4. Local Environmental Health Officers: Boundary People Between Society and Science/Politics

The structure of Local Environmental Health Officers can be considered as a boundary organization while the local officers themselves can be considered as boundary people between science and society, on the one hand, and between the society and politics, on the other. Related to the science-society interface, the local environmental health officers have to detect early warning signals and concerns from the society and transfer this information to the Flemish Centre of Expertise on Environment and Health. The local officers also have to facilitate human biomonitoring surveys in the sense of informing the general public about the importance of environmental health research and to stimulate them to participate in the survey. At the policy-society interface, the appointment of local environmental health officers can be considered as an answer to the communication problem, next to the involvement of social scientists in the Flemish Centre of Expertise on Environment and Health. After all, the series of environment- and health-related incidents revealed the lack of transparency and communication strategies by the Flemish Government (Chapter 6). The local environmental health officers are the primary contact persons for questions and complaints about environment and health by the general public, and they assist the Flemish Government in risk communication.

To conclude, the Local Environmental Health Officers facilitate the flow of information between the society and the other two communities of science and politics, which all have their own specific norms, knowledge, discourses, practices, priorities, etc. In other words, they bridge the gap between these different perspectives in order to find common ground and to co-produce knowledge. As such, in general, the local environmental health officers play an important role in guaranteeing the legitimacy of the environmental health policy arrangement.

7.4.5. Human Biomonitoring and Environmental Health Indicators: Boundary Objects Between Science and Policy

Human biomonitoring surveys and environmental health indicators can be considered as boundary objects in the sense that they meet scientific as well as political criteria, they are scientifically valid and policy relevant at the same time.

The establishment of a global human biomonitoring survey in Flanders is considered as a policy instrument to early detect public health effects caused by environmental pollution in the first call for Policy Research Centres (Lastenboek Milieu en Gezondheid, 2001). Most policymakers as well as scientists have faith in this methodology. However, not all individuals are convinced of its added value for the policy-making process. The difficulty to gather policy relevant information from the results of human biomonitoring surveys and the priority given to more concrete measures to abide the public health standards taking into account the socio-economic context are the most common counter-arguments (Verheeke, personal communication, May 28, 2010; Van Steertegem, personal communication, March 18, 2010). Although, the Phased Action Plan tries to meet these objections. Thanks to the many, individual as well as collective, communicative efforts of Professor Loots, Professor Van Larebeke, and doctor Vera Nelen, human biomonitoring is not only favoured by the scientific and political community, also the civil society inspired confidence in human biomonitoring.

Environmental health indicators can be defined as boundary objects in the Flemish environment and health arrangement. After all, their selection is the result of boundary work between the scientific and the political community, they facilitate cooperation between those communities, and they can be used by both communities for specific purposes without losing their own identify (Guston, 2001). Scientific input is necessary to understand the underlying system and processes that indicators reflect. Political contribution is needed to integrate normative, ethical, political, and social issues in the debate (Turnhout et al., 2007). The indicators used in the Flanders Environment Report (MIRA) to evaluate the effects of environmental pollutants on public health are Disability Adjusted Life Years (DALYs), the concentration of polluting substances in humans measured by human biomonitoring, and the number of certain diseases and cancers which are strongly related to the environment. The multitude of environmental health indicators reflects the complexity of environment and health problems and the difficulty of selecting just one indicator in the case of complexity and uncertainty. In spite of the funding of

different research projects to define effective environmental health indicators, there is less progress in this field. The development of an effective environmental health indicator would force a breakthrough in the future (Eggermont, personal communication, June 25, 2008).

7.4.6. Phased Action Plan: Trans-disciplinary Assessment at the Science, Policy, and Society Interface

In this section two issues related to the Phased Action Plan are discussed: the Phased Action Plan as a form of trans-disciplinary assessment tool and the Phased Action Plan as boundary object at the science, policy, society interface.

The Phased Action Plan can be considered as a trans-disciplinary assessment tool, because it tries to structure (summarize, organize, interpret, evaluate, integrate, and present) all relevant knowledge, considerations, and experiences simultaneously with the intention to support decision making by selecting adequate policy measures in a trans-disciplinary way. Convinced by the idea that knowledge also exists and is produced in societal fields other than science; scientists, policymakers, as well as societal interest groups (organized by stakeholder juries) are involved in order to legitimize the assessment process and to permit the government to make well-informed decisions.

The Phased Action Plan can also be defined as a boundary object, referring to tools and methods which are developed and used at the interface between different communities, in our case science, politics, and society. Moreover, the Phased Action Plan can be considered as a boundary object because it meets the criteria of science, policy, and society in the sense that the Phased Action Plan is scientifically valid, policy relevant, and socially accepted at the same time. Referring to Turnhout (2009), the Phased Action Plan can even be considered as an effective boundary object because it is, "able to connect the science and policy, flexible enough to have meaning in both social worlds, and stable enough to travel back and forth between them." After all, the Phased Action Plan is a result of cross-boundary cooperation (Keune, Morris, Spingael et al., 2009) based on dialogical interaction between experts, policy representatives, and stakeholders. The social scientists are helpful in bridging the gap between these communities by emphasizing their commonalities (Keune, Koppen & Van Campenhout, 2007). The Phased Action Plan succeeds in its intention, making it possible to utilize the results of human biomonitoring surveys for preventive policy by defining priorities and concrete policy measures.

Chapter 8: Conclusions and Discussion

8.1. Introduction

The main objective of this thesis is to reconstruct and analyse the dynamic emergence and the institutionalization of the Flemish environmental health arrangement. More precisely, the impact of new thoughts and discourses regarding complexity on the institutionalization process is investigated.

Complexity reveals itself at two levels. Complexity at the level of variables refers to its multi-dimensional character (physical, social, economic, political), multi-causality, non-linear behaviours, long delay periods between cause and effect, cross-bordering time and scale, and the unclear sense of all consequences and/or the cumulative impact of collective action (Briggs, 2008). As a consequence, complex problems are intrinsically clouded with partly irreducible uncertainties and imperfect knowledge (Van der Sluijs, 2007). Second, environmental health problems are complex at the societal level. After all, these problems are interwoven with moral, financial, economic, environmental, socio-cultural, and socio-political norms and values, resulting in a plurality of legitimate – often conflicting and controversial – perspectives. These two key features of complexity – radical uncertainty and a plurality of legitimate perspectives (Funtowicz et al., 1999) – induce challenges for science, politics, and most notably, the science-policy interface. As such, complexity goes parallel with three related shifts: 1) beyond the modern positivistic epistemology, characterized by rationality, full knowability and disciplinary reductionism towards Post-Normal Science and co-production of knowledge; 2) from traditional, sectoral policy arrangements and policy levels within government to governance; and 3) a shift towards new arrangements in the science-policy interface, reconsidering the role of knowledge, as science is no longer the unquestioned source of legitimacy for policy arguments.

From a discursive institutional perspective, the assumption is that new and changing discourses are the driving forces behind institutional dynamics, challenging the development of novel organizational facilities and methodological tools, within the (scientific) knowledge-production as well as the (political) decision-making processes. In order to study the impact of the newly emerging discourses about environmental health and complexity on the institutionalization process of the Flemish environmental health arrangement, a historical analysis is performed, covering a period of forty years, from the Nineteen Seventies until the first decade of the twenty-first century. The developments within the Flemish environmental health arrangement are

studied against the background of the international and European context in order to determine the strongest triggers and drivers for institutional change and continuity. Data are gathered, analysed, and interpreted according to a qualitative approach, and using a triangulation of methods (document analysis and in-depth interviews), to get a detailed and balanced picture of this institutionalization process.

In Section 8.2., conclusions are drawn regarding the institutional dynamics (or the lack thereof) of the Flemish environmental health arrangement. First, the drivers and triggers for the institutionalization of a Flemish environmental health arrangement are discussed (Section 8.2.1.). A distinction is made between the internal (local problems, incidents, and crises) and the external (international and European developments) drivers. Second, a reflection is made regarding the extent to which the institutional changes and continuities respond to the novel discourses towards risk governance when dealing with complexity, taking into account: 1) the changing epistemological discourses related to uncertainty and risks, 2) the governmental shift from government to governance, and 3) the shift in the science-policy interface from the linear Modern Model to co-production of knowledge and extended participation frameworks (Section 8.2.2.). Section 8.2.3. includes a discussion of the effectiveness of the Flemish environmental health arrangement, using a broad set of indicators. The section ends with some recommendations for future directions of the Flemish environmental health arrangement (Section 8.2.4.). Section 8.3. presents a reflection on the theoretical, analytical, and methodological limitations of the study and discusses recommendations for future research in this field.

8.2. Conclusion

8.2.1. Drivers to Institutionalize a Flemish Environmental Health Arrangement

The historical analysis made it clear that the international and European discourses, and the initiatives for environmental health policy and planning which followed such discourses, were not the primary drivers that triggered the development of a Flemish environmental health arrangement (Chapter 4). The discursive shifts caused by a series of environmental health related incidents that occurred between the Nineteen Seventies and the Nineteen Nineties in Flanders (Chapter 6) are identified to have been the dominant triggers for change. These incidents can be considered as shocking events

that were able to cause a re-thinking of the traditional discourses which, in turn, were then able to break through a stalled process. Conclusions regarding the drivers which caused the institutional changes in the Flemish environmental health arrangement are presented in the sections below. More precisely, the impact of the top-down approach, characterized by a more systematic, proactive, forward-thinking, and realistic policy approach, enforced by the European governmental level, is discussed against the bottom-up approach, characterized by an incident-driven and highly improvised approach.

▪ **Discourses Gradually Developed in Response to a Series of Environmental Health Related Incidents in Flanders**

The incidents related to the metallurgic activities in Hoboken, the cadmium pollution in the Northern Kempen, the dioxin deposition by two waste incinerators in Wilrijk near Antwerp, shortly followed by the Belgian dioxin crisis in the food chain, gradually shifted the discourses of politicians, scientists, and the population in general regarding environmental health risks and uncertainties. This epistemological shift, in turn, led to new scientific organizational and methodological challenges, on the one hand, and changing discourses about the environmental health policy arrangement and the science-policy-society interface, on the other. This section is restricted to the gradual rethought of discourses through this series of environmental health related incidents in Flanders, which induced an epistemological and organizational renewal. The impact of these discourses on the Flemish institutionalization process is described in more detail in Section 8.2.2.

Observed key discursive changes reflect:

- 1) The increased recognition of the uncertainty of knowledge and the existence of scientific controversy (e.g., during the dioxin incident caused by municipal waste incinerators when dealing with public health problems caused by cocktail-exposure to environmental pollutants, emitted by several sources), including the need to be transparent about the underlying assumptions and uncertainties;
- 2) The need to widen the knowledge-production process, taking into account several scientific disciplines such as medicine, environmental sciences, social and political sciences, communication experts, etc., on the one hand, and other (non-scientific) forms of knowledge, on the other;

- 3) The questioning of the threshold hypothesis since the series of incidents gradually made it clear that even long-term exposure to low-dose pollutants can affect public health. As a result, the environmental health discourse shifted from mortality and severe health effects to moderated health effects and negative effects on well-being (e.g., cognitive effects in the case of lead exposure, osteoporosis as a result of cadmium exposure, and congenital anomalies by children living around the waste incinerator);
- 4) The need to differentiate various target groups when establishing environmental quality standards, as one realized that some societal groups like unborn fetuses, young children, and the elderly are more vulnerable (e.g., Hoboken);
- 5) The increased recognition that different stakeholders can have a completely dissimilar perception of an environmental health risk, and even one stakeholder group can perceive similar problems differently in a dissimilar context (see for instance the case of Hoboken versus the case of ISVAG);
- 6) The need to better coordinate the environmental and public health policy and to take into account all kinds of knowledge from all stakeholders in the decision-making process.

To conclude, these discourses altogether require a more integrated approach of the knowledge-production process, at the organizational (interdisciplinary research teams) as well as methodological (integrated risk assessment) level. Related to the science-policy-society interface, these discourses emphasize the need to invite different stakeholders to join the knowledge-development (trans-disciplinarity) as well as decision-making (multi-actor governance) processes in order to increase both their quality and legitimacy. The analysis of the series of environmental health incidents finally demonstrates how the debate about uncertainty has evolved from an epistemological aspect into a governmental challenge. The latter was expressed in the increased needs to develop efficient and effective communication strategies, on the one hand, and to realize multi-sector governance – also referred to as policy integration – on the other.

- **Multi-Level Governance: Impact of International, European, and Federal Discourses on the Flemish Environmental Health Arrangement and Vice Versa**

The impact of the recently emerged international, particularly European, discourses and agreements for better policy planning on environmental health (e.g., National Environmental Health Action Plans) on the domestic environmental health arrangement in Flanders is rather limited (Stassen et al., 2010).

At the EU-level, in itself clearly contextualized by the renewal of environmental health discourses at the global level, three major discourses have emerged: 1) integration of the policy fields concerned; 2) stakeholder involvement in both policy formation and implementation; and 3) children as a specifically vulnerable category, and therefore, as a prioritized target group. In addition, European policy documents highlight complexity and evidence-based decision making as important issues, reflecting the trend that over time the complexity of environmental health issues has been appreciated.

Before beginning to review its impact on Flanders, it is clear from the analysis in Chapter 4 that these novel discourses have greatly affected the European environmental health policy arrangement. New organizations have been established (e.g., European Centre for Environment and Health), representatives of the civil society are increasingly participating in official advisory boards and committees (e.g., youth participation in the European Environment and Health Committee), new agreements, charters and legislation have been established, which led to the development of the Environmental Health Action Plan for Europe (EHAPE) and the Children's Environment and Health Action Plan for Europe (CEHAPE).

The implementation of international discourses and agreements to develop systematic policy making on environmental health has unfolded rather slowly at the level of the Belgian Government, partly due to the internal complexity of the Belgian State's Government. The development of the Belgian NEHAP is a good example of such a stalled process. Although the Belgian Government already committed itself to develop a Belgian Environmental Health Action Plan (NEHAP) in 1994, the first Belgian NEHAP was just launched in 2003. As a result of the constitutional reforms in the Nineteen Seventies and Nineteen Eighties, the Belgian State evolved into a federal country in which the Regions and Communities were authorized for almost all environmental and preventive health policies, respectively. Consequently, there was hardly any competence at the federal level about environment and health issues in the early Nineteen Nineties. Moreover, there was no formal organizational structure yet for the

environmental health debate between the different governmental levels in Belgium. The moment the several governmental authorities in Belgium started the debate to develop a NEHAP, Flanders already had a well-developed environmental health decision-making and knowledge-development process, driven by a series of environmental health related incidents, while the other Regions in Belgium fell behind. As a consequence, the Flemish authorities dominated the discussions and adopted their experiences and lessons learned into the Belgian NEHAP. The NEHAP case illustrates that the developments at the federal level could profit from the Flemish efforts that have been taken in response to local crises. On the contrary, the institutionalization of the Flemish environmental health arrangement could hardly profit from the international and European developments requesting for more systematic policy making because the limited annual financial and personnel resources allocated to the Belgian NEHAP inhibited the ability to make positive changes in environmental health policy.

The Flemish efforts to communicate about the results of biomonitoring surveys and the development of the Phased Action Plan, translating scientific data on environment and health into concrete policy measures, are considered to be good practices at the international, European, and federal level. Flanders is a frontrunner in assessing and managing the environmental health implications of events (e.g., the chemical exposure of the population in general and of specific target groups within it). In other fields, for instance the development of a policy framework for dealing and managing uncertain risks, Flanders can learn from good practices in other countries (e.g., the Netherlands, Germany, and the United Kingdom), and the Risk Governance Framework developed by Renn in cooperation with the International Risk Governance Council (IRGC).

8.2.2. Institutionalization of the Flemish Environmental Health Arrangement

The discursive shifts related to complexity and environmental health, combined with the participation of the Green Party in the Flemish Government from 1999 until 2004, created a window of opportunity to rethink the current situation of environmental health and to take further initiatives to establish a well thought out and structured approach for preventing environmental health incidents in the future. Supported by the Parliamentary Ad Hoc Committee on Environment and Health in 2001, the ministers of the Green Party, who had authority over the environment and public health, elaborated the new environmental health discourses, caused by the series of incidents. Each discourse has transformed - to a greater or lesser extent - the Flemish

environmental health arrangement, by giving opportunities to new agencies and organizational structures to enter the arena, establishing new rules, inducing altered power relations, and developing tools and methods to ameliorate the science-policy interface. This section reflects on the impact of the changing epistemological and governmental discourses as well as new thoughts about boundary work at the science-policy interface on the institutionalization of the Flemish environmental health arrangement.

- **Dealing with Complexity and Uncertainty within Flemish Knowledge Production**

Most knowledge production on environment and health issues in Flanders occurs within the Flemish Centre of Expertise on Environment and Health. However, it must be noted that this Centre of Expertise does not operate within a vacuum. First, the research partners within the consortium are also participating in international and European projects. For instance, the Unit Environment and Health of VITO participated in several European projects such as INTARESE and HEIMSTA in order to develop and apply integrated approaches for environmental health risk assessment, and still participates in DEMOCOPHES in order to test the feasibility of a coherent approach to human biomonitoring in Europe. Second, (Flemish) scientists not involved in the Centre of Expertise produce useful knowledge on environmental health, mostly characterized by a more fundamental and less policy-oriented approach. However, through scientific conferences and scientific journal articles, this knowledge will trickle to researchers of the Flemish Centre of Expertise on Environment and Health. As such, the partners can profit from international, European, and Belgian knowledge building through their network. This section further focuses on the organizational and methodological changes in the Flemish knowledge-production process that occurs within the Flemish Centre of Expertise on Environment and Health.

In order to systematically deal with complexity and uncertainty during the knowledge-production process, the Flemish Centre of Expertise on Environment and Health has evolved from a multi- into an inter- and even trans-disciplinary research team, using integrated risk assessment tools and emphasizing the importance of appropriate uncertainty management and communication about uncertain risks.

Related to the organizational aspect, the Flemish Centre of Expertise on Environment and Health is composed of environmental experts (engineers, biologists, chemists, etc.), medical scientists (toxicologists, epidemiologists, etc.), and social experts (sociologists, communication experts, etc.). Initially,

the research team worked together based on a more interdisciplinary approach, jointly investigating environmental health problems, using knowledge and concepts from different disciplines and integrating them into a synthesized, coordinated, and coherent result. Influenced by the social sciences, the experts of the Flemish Centre of Expertise on Environment and Health and the policy representatives have been gradually convinced of the added value of a trans-disciplinary team, integrating all types of knowledge (lay knowledge, industrial knowledge, and scientific knowledge) in order to enrich the scientific assessment with criteria other than technical, medical, and environmental. Although non-scientists are not explicitly involved in the research team, stakeholders are involved in different stages of the knowledge-production process. For instance, different stakeholders participate in the selection process of hot spot areas taking into account a plurality of perspectives within the assessment process. As a consequence, integrated assessment tools are used to balance different qualitative and quantitative criteria and perspectives.

With regard to the monitoring of the quality of the research process, the Flemish Centre of Expertise on Environment and Health attaches great importance to appropriate uncertainty management and transparent communication about the research process and its results. Although the experts themselves have a good comprehension of what they understand about uncertainty management, there has no concrete methodology or procedure developed, yet. In addition, guidelines on risk communication have been developed to establish the rules of the game by external risk communication. This strategy makes a difference between the scientifically known and unknown pollutants, and between the results at the individual and the group level.

To conclude, all conceptual characteristics summed up in this section remind one of the Post-Normal Science epistemology of Funtowicz and Ravetz (1990), as described in Section 2.1.1. At a more operational level, the importance is given to: 1) stakeholder participation during the problem-framing process in order to select research areas for human biomonitoring surveys; 2) societal risk assessment (risk perception research) next to environmental health risk assessment; and 3) appropriate uncertainty management and transparent risk communication, sharing common characteristics with the American and European integrated environmental health risk assessment frameworks (Section 4.2.1.). After all, both frameworks emphasize the importance of problem formulation and scoping, on the one hand, and stakeholder involvement, on the other.

- **Multi-Sector Governance and Policy Integration: Progress Made but Still Far to Go**

The strategy to realize policy integration on environment and health has evolved from a more top-down to a bottom-up approach (European Environmental Agency, 2005a). Environmental health policy integration was initiated by a clearly top-down approach. Referring to the *Green and White Paper on Environment and Health*, the Flemish Government committed itself to increase its efforts on environment and health, established administrative services on environmental health, financed policy-oriented environmental health research, etc. Over the years, however, complementary to the top-down approach, a bottom-up strategy has developed in which the civil servants of the environmental health administration services influence higher hierarchical levels. As confirmed by the European Environmental Agency (2005a), such a complementary approach is necessary to ensure a gradual process of change towards policy integration.

Instead of developing a joint new environmental health policy field, the philosophy is to emphasize the integration of environmental considerations within public health policy, and vice versa, based on committed cooperation and coordination between these policy fields. Referring to the different conceptualizations of policy integration of Bauer and Rametsteiner (2007), as described in Section 2.2.2., the Flemish environment and health policy has been the result of the process and output of policy coordination between the environment and public health policy field. As a consequence, environmental health objectives are set with close cooperation between the environment and public health policy fields.

In order to coordinate and even integrate environmental health efforts by the Ministry of Public Health, on the one hand, and the Ministry of the Environment, on the other, both ministries have established an administrative service on environment and health. The development of a single integrated administrative service was hampered by the institutional organization of the Flemish Government, the institutional difficulty to allocate governmental budgets and civil servants to an integrated administrative service, and the resistance of some personalities in managerial positions.

In order to prevent conflicts and to create greater coherence between the environment and health policies, tasks have been clearly allocated and there is a bimonthly consultation between both environmental health services. As a result, the Environment and Health Service of the Flemish Environment Administration focuses more on the preparation of environmental health policy and supports policy-oriented, environmental health research. Policy execution

is more ascribed to the Environmental Health Section of the Flemish Health Administration, which can make an appeal to its field organizations and to the local environmental health officers. This clear demarcation of tasks and the frequent consultations support mutual understanding and improve the relations between these two environmental health services who have their own institutional background. Moreover, both environmental health services can be considered as the driving spirit behind the Flemish environmental health network. After all, each one advises its authorized minister's personal staff. Taking into account these advices, the latter decides on whether or not making financial resources available to continue the research activities of the Flemish Centre of Expertise on Environment and Health and to integrate local environmental health officers in the Local-Regional Health Consultation and Organizations (LOGOs). An evaluation of the effectiveness of policy integration at the Flemish governmental level is elaborated in Section 8.2.3.

Although the Flemish Government has done many efforts to increase policy integration on environment and health issues, the scholarly literature (Section 2.2.2.) suggests integrating environmental health objectives in non-environmental and non-public health policy domains such as energy, transportation, agriculture, and the economy, in order to realize them efficiently and effectively. The latter is not yet the case in Flanders, in the sense that environmental health objectives are not structurally and explicitly integrated in other policy domains, not to mention that environmental health objectives might outweigh sectoral policy objectives. This issue is further elaborated in Section 8.2.4., dealing with the recommendations for future directions of the Flemish environmental health arrangement.

- **Science-Policy-Society Interface: Towards Boundary Work Characterized by Mutual Learning**

The series of environmental health related incidents challenged the science-policy interface. During the Nineteen Eighties and early Nineteen Nineties, the Flemish public health and environmental policy arrangements had most characteristics of the Bureaucratic Model typified by a central-steering government and state-owned research institutions (e.g., VITO). Throughout the consecutive incidents, additional expert committees were established (e.g., the local medical expert group in Hoboken, the Baeyens' Committee at ISVAG) to legitimize political decisions and even to depoliticize the problems. However, due to the complexity of the problems causing the incidents, scientists could not come up with a universal truth, and therefore scientific controversy dominated the knowledge-production process. The establishment

of a working group in the Hoboken case, in which different stakeholders' representatives were invited to participate, can be considered as a first indication that it was not sufficient anymore to only involve politicians and scientists to deal with this kind of complex problems. Nevertheless, all actors were looking for (scientific or industrial) experts who could legitimize their position, priorities, and ambitions. As such, the science-policy interface evolved towards the Advocacy Model. During the ISVAG incident and dioxin crisis in the food chain, a broader interpretation of stakeholder participation has been emphasized to legitimize the knowledge-production as well as the decision-making processes. Science is considered to be one actor engaging in the social learning process together with other stakeholders who also add valuable knowledge, experience, and information into the process. Referring to the boundary models of Hoppe, one can observe characteristics of the Model of Mutual Learning.

Summarizing, throughout the cases, the science-policy arrangement has evolved from the Enlightenment and Bureaucratic Model, characterized by a strict demarcation between science and politics, towards the Advocacy Model and the Mutual Learning Model in which all stakeholders are involved. As a consequence, new (boundary) organizations and platforms (e.g., Local Environmental Health Officers, the Administrative Services on Environment and Health, and the Flemish Centre of Expertise on Environment and Health), on the one hand, and new (boundary) tools and methodologies (e.g., Flemish programme on human biomonitoring, environmental health indicators, Phased Action Plan), on the other, have been developed to optimize the interaction between science, politics, and society when dealing with complex environmental health risks in Flanders.

8.2.3. The Performance of the Flemish Environmental Health Arrangement

As a result of the historical reconstruction and analysis of the Flemish environmental health arrangement, information has been gathered which is useful when examining the effectiveness or performance of the arrangement. Based on Runhaar et al. (2009; 2010), an effective environmental health arrangement ensures that the region or country progresses in meeting its environmental health objectives and succeeds in reducing environmental health risks to levels that are acceptable to decisionmakers, the public, scientists, and other stakeholders. The evaluation framework presented in Table 10, Section 2.4., is used to assess the performance of the Flemish environmental health arrangement.

- **Political Commitment, Vision and Leadership**

The first initiative to develop an overarching environmental health strategy dates back to 2000, when a Green Paper on Environment and Health, supported by the Parliamentary Ad Hoc Committee on Environment and Health, evolved into an Integrated Policy Letter describing the main principles and priorities of the environmental health policy field. From 2001 onwards, the five-year and annual policy letters of the Flemish Ministers of the Environment and Public Health as well as the Flemish Environmental Policy Plan have given explicit attention to environmental health issues. Although the political commitment for environmental health has survived different legislatures, concrete long and medium-term environmental health objectives are lacking. Moreover, an overarching environmental health strategy that is structurally and explicitly integrated in all policy fields (e.g., energy, transportation, agriculture, and the economy) is absolutely out of the question, not to mention that environmental health objectives might outweigh sectoral policy objectives.

- **Policy Integration at the Governmental Level: Administrative Culture and Practices**

In order to be qualified as integrated, the policy must be comprehensive, aggregated, and consistent (Meijers and Stead, 2004; Persson, 2004). Comprehensiveness refers to the broader scope of the input stage, and aggregation means that policy measures should be evaluated from different perspectives. The decision framework for uncertain risks, developed by the Flemish Environmental Agency, emphasizes the importance of balanced problem framing and policy evaluation, taking into account different knowledge, perspectives, and values. It must be noted that this approach is still in development, as the procedure will be optimized in the near future based on learning-by-doing.

Consistency implies that all components of the policy are in agreement across different policy levels and all government agencies at a certain level. As already stated in the earlier sections, the Flemish environmental health policy is made from close cooperation between the Ministry of the Environment and the Ministry of Public Health. In both ministries, an administrative service on environment and health was established to plan, implement, and evaluate environmental health policy.

Both administrative services have succeeded to elaborate the new environmental health discourses and translate them into new legislation, policy

documents, decision frameworks, and financial resources. For instance, a new Flemish Decree on Preventive Health Policy was promulgated in 2003, emphasizing the Precautionary Principle, public participation, and biomonitoring as the major principles. The Flemish Environmental Administration (LNE) developed a first draft of a transparent and balanced decision framework when dealing with uncertain risks, inspired by good practices in the neighboring countries and the Risk Governance Framework of IRGC. Both services have also succeeded in convincing their ministers to permanently invest in environment and health research - the duration of the Centre of Expertise on Environment and Health has been extended twice - and the number of local environmental health officers has increased over the years.

Related to the vertical integration, the Flemish civil servants of the administrative services on environment and health intensively participate in European governmental platforms and networks (e.g., the inter-ministerial conferences on environment and health organized by WHO-Europe and the Consultative Forum on Environment and Health set up by the European Commission meeting once or twice a year). Moreover, the Flemish Government takes a leading role in the environmental health discussion at the European level. For instance, during the Belgian Presidency of the Council of the European Union (July 1, 2010 – December 31, 2010), the Flemish Minister responsible for the environmental policy domain selected environment and health as one of the priorities. As a result, several workshops, conferences, and meetings on environment and health were organized and a roadmap was laid out to create a second European Environment and Health Action Plan. The vertical integration between the Flemish governmental level and the local and provincial levels is less explicit. Nevertheless, the local environmental health officers of the Flemish Network on Environment and Health can be considered as the bridging function between these governmental levels.

To conclude, the Flemish environmental health policy meets the requirements for policy integration rather well. One exception, real policy integration, i.e., the integration of environmental health objectives in non-environmental and non-public health policy domains, is still a long way to go (Section 8.2.4.).

- **Knowledge Development for Decision Making**

Most policy-oriented knowledge development on environment and health issues occurs within the Flemish Centre of Expertise on Environment and Health. The Flemish Ministry of the Environment also has the Flemish research programme TWOL (Environmental Scientific Research Programme) at its

disposal for the financial support of additional research projects. Given that the content of both research funds are defined by the Flemish Government, and the Flemish Government participates in the steering group of the Flemish Centre of Expertise, this research is anticipated to be policy relevant. In order to ensure that (these and other) environmental health results are really used to determine concrete policy actions, the Phased Action Plan has been developed. The Phased Action Plan can be considered as a trans-disciplinary assessment tool, structuring all relevant knowledge, considerations and experiences simultaneously with the intention to support decision making. The fact that the duration of the Centre of Expertise on Environment and Health has been extended twice, also confirms that the scientific research of the Flemish Centre of Expertise on Environment and Health is appreciated by the Flemish Government.

The scientific work of the Flemish Centre of Expertise is also valued by the international scientific world. The invitation of researchers of the Flemish Centre of Expertise at international conferences as key-note speaker and the publication list, composed of national and international peer-reviewed journal articles, that is available at their website (<http://www.milieu-en-gezondheid.be/English/publications.html>) attest to this.

As already elucidated in Section 8.2.2., the Flemish Centre of Expertise has evolved to an interdisciplinary research team. Moreover, non-scientific stakeholders are participating in some parts of the research (e.g., the selection of hot spot areas) in order to take into account the plurality of perspectives, experiences, values, etc. The Centre also attaches great importance to appropriate uncertainty management and risk communication. According to the scholarly literature (Chapter 2), these characteristics are necessary to deal more effectively with complex environmental health risks.

- **Science-Policy Interaction**

The Flemish Centre of Expertise on Environment and Health, as well as the Administrative Services on Environment and Health within TOVO and LNE, can be considered as boundary organizations, bridging the different social communities of science and politics. After all, both organizations try to bring people on either side of the boundary together to increase mutual understanding and to create mutually boundary objects in order to facilitate the knowledge-development and decision-making processes. The accountability to science is ensured by the publications of research articles in international, peer-reviewed journals. The accountability to politics, on the other hand, is ensured by the basis principle of the Policy Research Centres

programme to finance policy-relevant research. The only characteristic of a boundary organization that can be discussed in case of the Flemish Centre of Expertise on Environment and Health is its stable, durable, and persistent nature, being flexible and adaptive in the same time. This issue is further elaborated in Section 8.2.4.

The Local Environmental Health Officers can also be considered as boundary workers as they bridge the gap between the society, on the one hand, and science and politics, on the other, in order to find common ground, to co-produce knowledge, and to guarantee the legitimacy of the environmental health policy arrangement.

With regard to boundary tools and objects, the establishment of the Flemish biomonitoring programme, the selection and use of environmental health indicators and the development of the Phased Action Plan are worthy of mention. Human biomonitoring surveys and environmental health indicators can be considered as boundary objects in the sense that they meet scientific as well as political criteria, they are scientifically valid and policy relevant at the same time. However, it must be noted that not all respondents are convinced of their boundary character; some question the added value of human biomonitoring research for the policy-making process and emphasize the difficulty in selecting one or even a few indicators in the case of complex environmental health risks. The Phased Action Plan, a trans-disciplinary assessment tool to define policy priorities and measures based on the results of human biomonitoring survey - even goes a step further: it facilitates the interaction and cooperation between experts, policy representatives, and stakeholders.

▪ **Participation of Stakeholders**

The reason to involve stakeholders in the knowledge-production and decision-making processes is threefold. First, from a normative point of view, participation facilitates democratic and emancipatory values. Second, the instrumental perspective emphasizes that participation will increase legitimacy and public support. Third, participation increases the quality of the decision-making process, and enriches the knowledge that will be taken into account.

Today, stakeholders are indirectly involved in the decision-making process through the traditional, formal advisory boards that are allowed to express their opinion in order to map out diversity as input for the decision making. As a consequence, although environmental health problems can be very site-specific, local actors are often excluded. These local people are often directly

involved in different stages of the knowledge production and the human biomonitoring surveys, although the establishment of a real trans-disciplinary research team is a too far-reaching goal at this moment. Through their involvement in the knowledge-production process, local actors increase their knowledge about the problem and it is quite conceivable that they want to be involved in the output phase of the decision-making process, reaching consensus on the best policy actions. It is recommended to delineate a political project defining policy measures in cooperation with the local people in the near future in order to increase stakeholders' participation in the decision-making process (Section 8.2.4.).

▪ **Outcome of the Arrangement and its Monitoring**

The analysis has made it clear that the network succeeds in increasing the exchange of information between the local and the Flemish level of government, between scientists and policymakers, between environmental civil servants and public health civil servants, between the general people and the experts or policymakers. Moreover, the human biomonitoring surveys, in combination with the work of the local environmental health officers, succeed in detecting potential environmental health problems quickly, thus preventing concerns or problems from evolving into crises. Since the establishment of the Flemish environmental health network, no environmental health disaster has occurred. However, it is difficult to determine whether this is just a coincidence, or a result of a good working network.

The monitoring of environmental health indicators and the comparison of their outcome with clearly defined environmental health targets or objects can also be helpful to evaluate the effectiveness of the Flemish environmental health arrangement. However, at the Flemish level, concrete policy objectives on environment and health are lacking and there is still no agreement on well-defined, effective environmental health indicators. The indicators used to evaluate the effects of environmental pollutants on public health, yearly published by the Flanders Environment Report, are Disability Adjusted Life Years (DALYs), the concentration of polluting substances in humans, and the number of certain diseases and cancers which are strongly related to the environment. The development of an effective environmental health indicator would force a breakthrough in the future.

To conclude, taking into account the evaluation of the several criteria that are listed above, the Flemish environmental health arrangement is considered to be effective. Nevertheless, the analysis has also provided insights into some

shortcomings and recommendations to ameliorate the arrangement in the future. These recommendations are elucidated in Section 8.2.4.

8.2.4. Recommendations for Future Directions of the Flemish Environmental Health Arrangement

Before turning to the recommendations, it is noted that the Flemish environmental health arrangement is still in the making and has not yet achieved its endpoint. The institutionalization process will be influenced by new discourses and experiences and will be continuously changing. The likelihood that what has constructed over the last four decades will be deconstructed (also called de-institutionalization) in the near future is rather low in my opinion. After all, the Flemish environmental health network has already survived different legislatures with politically divergent coalitions. Nevertheless, it is important that the institutional arrangement allows renewal and change because environmental health is a fast developing field.

The recommendations to optimize the Flemish environmental health arrangement regard its content as well as its organizational structures.

The content recommendations relates to:

- 1) The development of a formalized procedure, which is available for all stakeholders, to ensure appropriate uncertainty management. Although it is noted that no standard rules can be given for dealing with uncertainties, a global framework can be useful. An example of a good practice is the guidance in assessing and communication uncertainties developed by the Netherlands Environmental Assessment Agency (RIVM/MNP/PBL);
- 2) The increase of the efforts to integrate environmental health objectives structurally and explicitly in all relevant policy domains (and not only in the environment and public health domain) such as energy, transport, agriculture and economy; and to ensure that all knowledge about environment and health affects sectoral policies such as particulate matter, indoor air quality, telecommunication, product standards, urban development, etc.;
- 3) The strengthening of the Phased Action Plan as a boundary object and its optimization in order to ensure that the results of environmental health research are supportive for the decision-making process;
- 4) The optimization of the Flemish decision framework for uncertain risks and making the framework operational in practice;

- 5) The re-start of research and the socio-political debate about 'good' environmental health indicators. After all, in spite of the funding of different research projects to define effective environmental health indicators, there is less progress in this field and no consensus yet. The development of an effective environmental health indicator would force a breakthrough in the future that would cause an evaluation and optimization of the environmental health policy in Flanders.

At the organizational level, the main question is how co-production of knowledge and multi-actor governance can be facilitated. After all, the analysis makes it clear that most actors are convinced of the added value of participation, but there are some obstructions to put it into practice when dealing with urgent issues because participation is often considered as a time-consuming and labor-intensive process which tends to delay decision making. Moreover, the participation of stakeholders (e.g., local citizens, local action groups, etc.) in the knowledge-production and decision-making processes may be hampered by different levels of knowledge and power as well as social, cultural, and institutional affiliations. However, the intention of this thesis does not allow me to give a scientific underpinning to the optimization of the participation process. Possible strategies to transform the consortium of the Flemish Centre of Expertise into a real trans-disciplinary research team, its strengths and pitfalls, as well as the possibilities to increase multi-actor governance in the Flemish environmental health arrangement can be a point of interest in future research.

Another organizational aspect relates to the procedure and the content of the Flemish Centre of Expertise on Environment and Health. The latter is established within the Policy Research Centre Programme, which was launched in 2000 in order to provide a more structural scientific support for policy. However, the structural character of the Centres of Expertise is relative, since the themes of the Policy Research Centre Programme are discussed every five years, hampering its stable, durable, and persistent nature. Durable, long-term research activities should add value in terms of setting up longitudinal surveys and building research capacity. Advocates use the argument of being competitive, result-oriented, and innovative. Related to the Flemish Centre of Expertise on Environment and Health, the latter is not really the case, as the analysis makes it clear that the second and third call were written for the current consortium, given that some research activities should be continued in order to gain insight into long-term exposure to environmental pollutants and the long-term impact of policy-measures. As a consequence, competition of other consortia is nearly impossible and the current research team holds the monopoly, so to speak. To date, built in mechanisms to ensure innovation are

limited to the review of the research proposals by an international team of experts, leaving a great deal of the responsibility to be kept on ongoing innovation with the researchers involved in the Centre of Expertise. It is interesting to further study the innovative capacity of the Flemish Centre of Expertise on Environment and Health in order to identify and implement additional mechanisms that should further and assure innovation as a permanent part of the long term scientific knowledge production.

8.3. Theoretical and Methodological Discussion

Section 8.3. presents a discussion of the theoretical perspectives and the analytical and methodological approaches that were used in this study and adds recommendations for future research.

8.3.1. Reflection on Concepts and Theories

The combination of a Discursive Institutionalism stance and a historical analysis based upon the Policy Arrangement Approach enabled the study of the gradual, but eventually far-reaching, institutionalization process of the Flemish environmental health arrangement. This study identified the epistemological and governmental discursive shifts as well as new insights into the science-policy interface as the primary triggers for institutional dynamics. The impact of the top-down approach, initiated at the European level was limited.

By studying the institutional impact of each incident (discourses, rules of the games, resources, actors), insight is gained as to whether and to what extent actors have learned, experienced, etc. Each analysed incident shows evidence of some sort of learning and knowledge development because it opens the eyes and minds, while the accumulation of incidents within a short time period, shortly followed by elections, was necessary to achieve institutional change. As such, the series of environmental health incidents in Flanders can be considered as a wake-up call, window of opportunity or shocking event. The fact that these incidents occurred within a short time period is of crucial importance, as the attention of the general public, media and policymakers is likely to be quite short-lived.

Through the years, the Flemish environmental health arrangement has been able to institutionalize into a rather stable arrangement, and it has been able to perform successfully. The institutionalization has occurred across the boundaries of science and policy, and the increased interaction between

science, policy, and society is also considered as one of its strengths. In the scholarly literature, different groups of authors have been rethinking the science-policy interface when dealing with complex problems, each from a different perspective or conviction. However, all theoretical points of view have a reflexive, participative approach in common. As the concept of complexity is strongly related to epistemology, the Post-Normal Science concept of Funtowicz and Ravetz (1993) was an important topic in this research. Given that the ideas behind Mode 2 Science and trans-disciplinary knowledge production are quite similar with Post-Normal Science, the conclusions of the research would not vary that much when another perspective would have been applied.

The theory on Boundary Work is interesting as it gives a more operational perspective – in contrast with the earlier mentioned theoretical approaches – on the novelties of the science-policy interface, characterized by mutual knowledge exchange and co-production of new expertise. The idea that science and politics increasingly interact in the case of complexity stimulates mutual learning and results in new discourses which in turn can cause institutional dynamics. As such, the theory on Boundary Work can be easily linked to Discursive Institutionalism, which was the analytical perspective of this thesis. By focusing on boundary discourses or texts, boundary organizations, boundary people, and boundary tools – also called the TOP-approach – the concept of boundary work accurately pictures what is occurring in the interaction between science and policy. Moreover, this TOP-approach fits well in the Policy Arrangement Approach, which was used as the analytical framework in this thesis. The typology of boundary arrangements was useful to characterize shifts in science-policy models of interaction.

For this type of research, studying institutional developments, the Policy Arrangement Approach turned out as a very helpful analytical framework. First, the Policy Arrangement Approach allows the study, the understanding and explanation of the development, change and continuity of a policy arrangement, in this case, for environment and health. Second, the approach provides insight into how a new arrangement relates to the pre-existing institutional context, in this case public health, labor protection and the environmental policy field. Third, the PAA examines the content as well as the organizational structure of a policy arrangement. Both aspects are determined to be influencing institutional stability or change, mostly in the sense that they are working complementary towards the same result, and they strengthen each other; discursive renewal has institutional effects and vice versa. For instance, the discursive shifts related to complexity and environmental health combined with the participation of the Green Party in the Flemish Government

from 1999-2004 and the establishment of the Parliamentary Ad Hoc Committee on Environment and Health, created a window of opportunity to rethink the current affairs about environmental health.

The final reflection on the analytical framework relates to the question: if an alternative analytical framework (e.g., the framework for characterizing, explaining, and evaluating environmental health risk governance regimes of Runhaar et al., 2010) was used, would the results be comparable? First, in my opinion, the visual presentation of the framework is too complex to be helpful. Second, the framework emphasizes the judicial approach, primarily focusing on the rules of the game and on procedures. As such, the impact of discourses is given too little attention, while changing discourses play a pivotal role in explaining institutional dynamics. The latter was already elucidated in scholarly literature (e.g., Hajer, 1993; 1995; 2000; Scott, 2001; Padt, 2007) and confirmed by the empirical analysis of this doctoral thesis.

8.3.2. Reflection on Methodology

The combination of content analysis of (policy) documents and in-depth interviews with the main stakeholders over the last forty years resulted in a detailed and balanced understanding of the institutional changes and the mechanisms behind them related to the Flemish environmental health policy and knowledge arrangement. The strength of this data and methods triangulation approach is its internal validity. After all, the in-depth interviews were used to verify conclusions from the document analysis and to gather information that goes behind the written document, as such, discussions and discourses lagged behind the formal agreement which was written down. On the other hand, document analysis was used to double-check the answers of respondents and to have the impressions or expressions gathered from the interviews clarified.

Contrary to its internal validity, the external validity of the results is rather limited. The results of the historical analysis of Flanders can not be generalized to other regions and countries, on the one hand, and other policy sectors, on the other. Since the intention of this study is not to be generalized, its limited external validity poses no particular problem. Having said that, comparative approaches of risk governance arrangements would be interesting for further research. After all, a longitudinal, either cross-sector, or cross-regional/cross-national comparison of risk governance arrangements would allow: 1) to identify good practices, which could be exchanged cross sectors or territories, and 2) to build a typology of risk governance

arrangements, taking into account differences in terms of discourses and the type of risk, relations between agencies, available resources, and rules of the game. This, in turn, could lead to draw lessons for contemporary and future risk governance arrangements. More precisely, a cross-sector comparative analysis allows studying differences and similarities between different types of (complex) risks. A cross-regional/national analysis has the advantage to provide a more detail, multi-level governance - the extent to which emerging international discourses leads to changes in domestic institutional arrangements, and vice versa - and to study different approaches to governance in order to increase mutual learning.

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Curriculum Vitae

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2. Academic output

IT (Articles in internationally reviewed journals)

Buekers, J., Stassen, K., Int Panis, L., Hendrickx, K. & Torfs, R. (2011). Ten years of research and policy on particulate matter air pollution in hot spot Flanders. *Environmental Science & Policy*, 14(3), 347-355.

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Stassen, K., & Leroy, P. (2010). An epistemological shift towards complexity: challenges for the Flemish Environmental Health Policy Arrangement. *HENVINET Final Conference Approaching Complexities in Environment and Health*; Brussels; April 14-15, 2010.

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