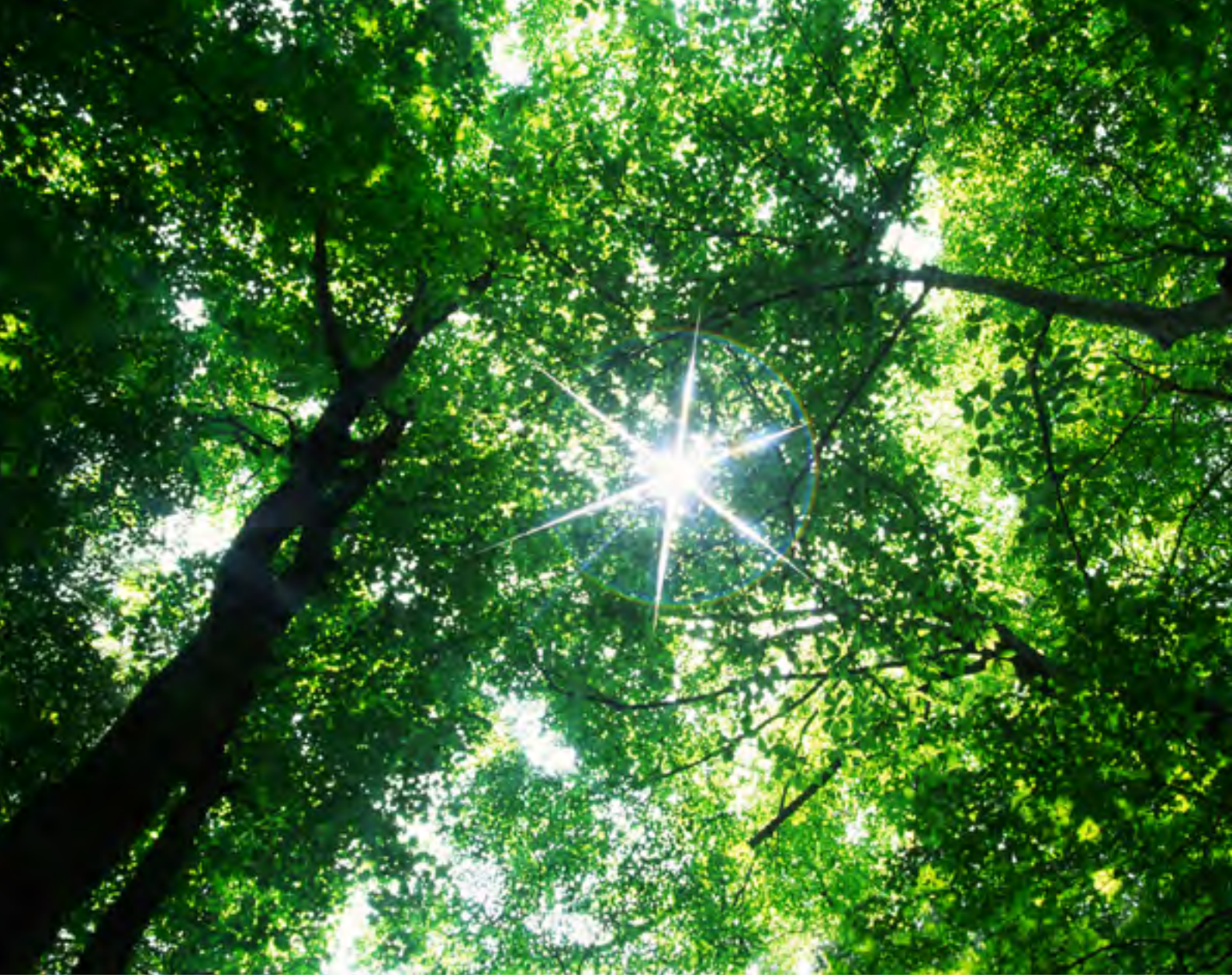

Report of the 2011 Belgian Bodiversity – Public Health Conference

Belgian Biodiversity Platform

Biodiversity.be

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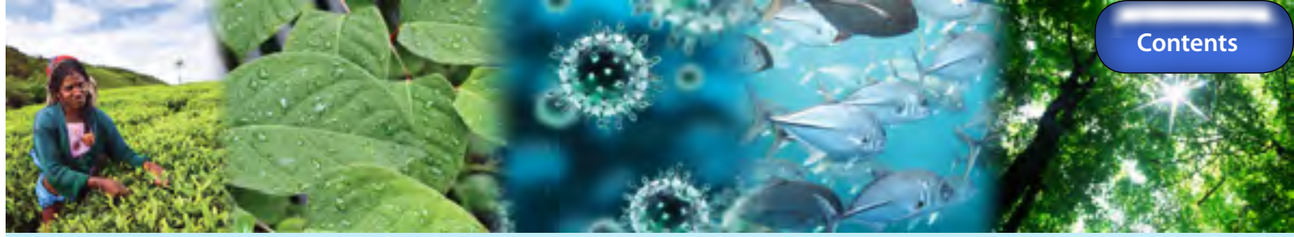
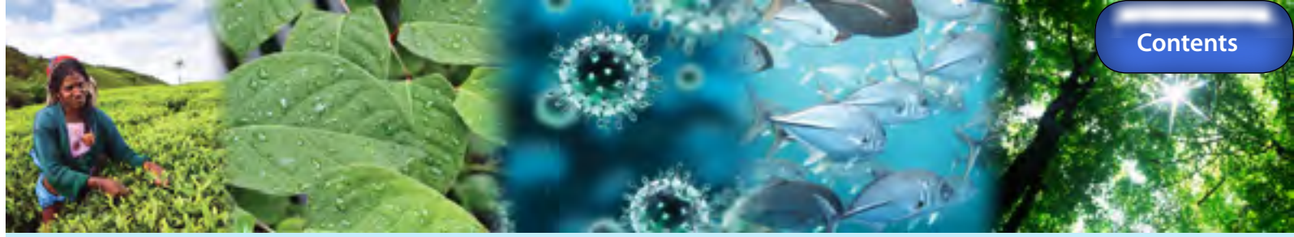


Contents

Report by Hans Keune, Guy Hendrickx, Marc Coosemans, Katrien Tersago, Veerle Versteirt, Etienne Thiry, Sophie Vanwambeke, Els Ducheyne, Marius Gilbert, Erik Mathijs, Ilse Simoens, Heidi Wittmer, Tom Bauler, Geert De Blust, Dimitri Brosens, Aaike De Wever, André heughebaert, Ann Van Herzele, Estelle Balian, Angelique Berhault, Francis Turkelboom, Melissa Ceuterick, Linda Meirsonne, Francoise Symoens, Aline Van der Werf



Introduction

Biodiversity and Public Health is an emerging field of interest in Belgium. In this context, the Belgian Biodiversity Platform organized the first Belgian Biodiversity and Public Health conference1[1] on November 30th 2011 in Brussels. The goals of the conference were to:

-Raise scientific and policy attention for the relation between Biodiversity and Public Health in Belgium
-Stimulate networking amongst experts and discuss how the knowledge base can be improved
-Contribute to building a Belgian Community of Practice regarding Biodiversity and Public Health

81 Belgian experts participated, among which:

-68% were scientists (universities and governmental scientific institutes; health, ecological and social science)
-16% represented policy interests (Federal, regions, provinces, cities; health, environmental, nature and land planning policy)
-Others: consultants (policy advice, eco-therapy, education), NGOs (nature protection, landscape development, ecological life and gardening, health insurance), media

This report contains an explanation of the relation between Biodiversity and Public Health and a presentation of the most important outcomes of the conference.

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Plenary session: introductory presentations by keynote speakers

1 http://www.biodiversity.be/health

According to McMichael (2009), "*Human population health should be the central criterion, and is the best long-term indicator, of how we are managing the natural environment*". The plea for human health as a sustainability indicator exemplifies the strategic importance of human health both in terms of ecosystem services and biodiversity conservation. The relationships between biodiversity and public health (see figure 1) are manifold (WHO 2006; Chivian and Bernstein 2008; Sala et al. 2009; European Commission 2011a; COHAB; Wittmer et al. 2012)[2].

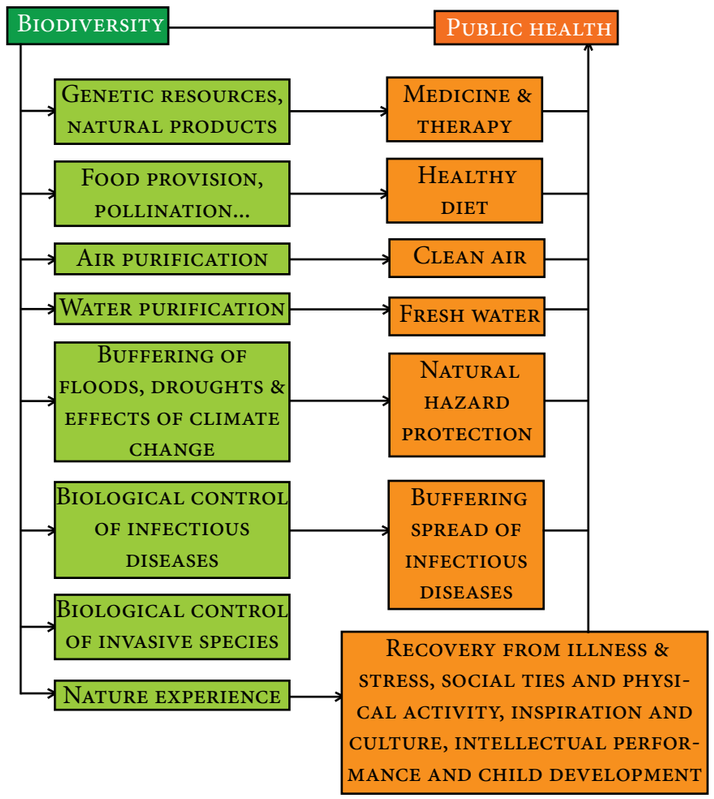
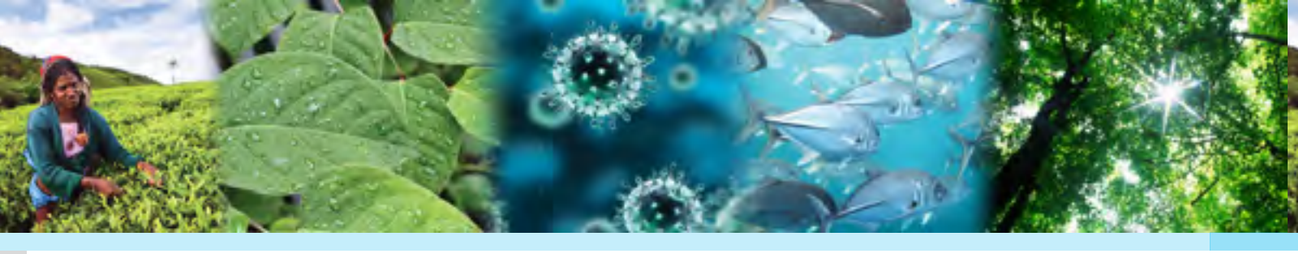


Figure 1

2 This text is based on the text Hans Keune and Pim Martens prepared earlier for inclusion in *"The Economics of Ecosystems and Biodiversity in Local and Regional Policy and Management"* (Wittmer et al. 2012; Berghöfer et al. 2012).

Diseases
The contribution of biodiversity to the control of the increasing threat of infectious diseases (e.g. malaria and Dengue fever in tropical regions, Leishmaniasis in tropical Americas, Europe and the Middle East, and Hantavirus, Lyme and other tick-borne diseases in North America and Europe) is of utmost interest in terms of public health and cost to society (WHO 2006; Chivian and Bernstein 2008; Molyneux et al. 2008; Thomas et al. 2009; Keesing et al. 2010). Infectious diseases are caused and spread by living organisms and as such exemplify biodiversity: diversity in pathogens and parasites (causing disease), hosts (organisms harbouring pathogens and parasites) and vectors (organisms carrying and transmitting the infection, e.g. malaria mosquitoes). On the other hand, a decline of biodiversity might lead to a faster rate of emergence and re-emergence of infectious diseases and may reduce the buffer function of biodiversity limiting the spread of infectious diseases amongst humans (Peixoto and Abramson 2006; Suzan et al. 2008; Pongsiri et al. 2009; Keesing et al. 2010). Finally recent studies show that declining biodiversity may be a contributing factor to the rapidly increasing prevalence of allergies and other chronic inflammatory diseases among urban populations worldwide (Hanski I. et al. 2012). Biodiversity thus can have an important contribution to both public health related ecosystem services and disservices.

Quality of food, air and water
Biodiversity is functional for safeguarding the quality of essential life support systems: food, air and water. The relation between biodiversity and food quality is reciprocal: healthy food depends on biodiversity, and biodiversity depends on how humans organize food production (Wilby A. et al. 2009). Biodiversity influences the quality of food especially by providing a variety of food sources, supporting a diverse diet which is essential for human health (Wilby A. et al. 2009; Hillel and Rosenzweig 2008). This diversity is under pressure by a decline of use and farming of traditional food plants, resulting in deficiencies of important nutrients in several regions. Genetic food diversity also functions as an insurance: when an important food source comes under pressure due to e.g. climate change or infections, food diversity may provide alternatives. The latter clearly is clearly not the case with mono-agriculture. Genetically diverse forms of agriculture furthermore show to be less vulnerable to diseases. Genetic diversity moreover functions as a biotechnological resource for e.g. crop improvement. Intensification of food production by use of e.g. pesticides both endangers biodiversity and human health. Still, worldwide population growth demands increased food productivity. To provide sufficient and healthy food in a sustainable manner will be a huge challenge. The role of and effects for biodiversity demand careful consideration. Specific aspects of biodiversity functional for food production are pollinator biodiversity and soil biodiversity (Hillel and Rosenzweig 2008). The role of pollinators for food production cannot be underestimated, and is very sensitive to biodiversity decline. Soil biodiversity is important e.g. for maintenance of soil fertility, water storage, carbon storage. Moreover is soil diversity important for air and water purification by means of pollutant degradation, which are also important human health related ecosystem functions (Melillo and Sala 2008).



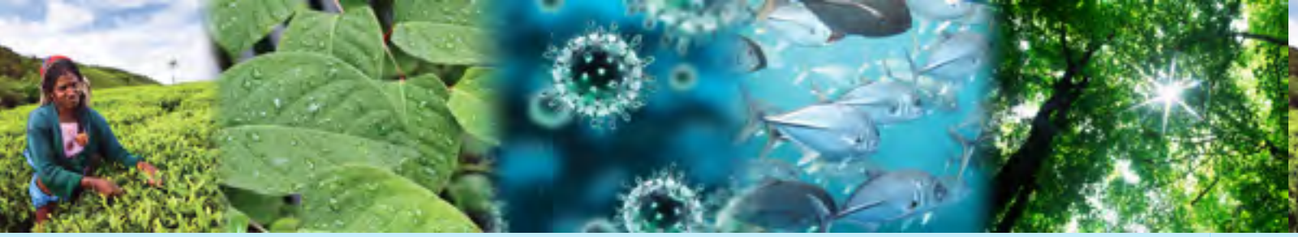
Medicine
Biodiversity is an important resource for medicine, both traditional and modern, both today and in the future (Newman et al. 2008; Chivian et al. 2008; Cox 2009; Chivian and Bernstein 2008d). A large part of chemically designed and produced medicines have natural origins and especially people in less developed areas heavily depend on medicines directly coming from nature (Newman et al. 2008; Cox 2009). Examples are quinine for malaria and pilocarpine for glaucoma. We have to realize that only a small proportion of species are analyzed for their medicinal potential. As species are lost at a very rapid rate, so is the potential for future medicine. The same unfortunately is true for traditional or indigenous knowledge regarding natural medicines. It is not only plants that potentially contribute to medicine; the potential contribution of animal species should not be underestimated (Chivian and Bernstein 2008d). A few examples: Osteoporosis prevention and treatment may benefit from further understanding of how denning bears do not seem to suffer from physical non activity over a longer period, that for other mammals (including humans) results in bone-loss. Cone snail peptides, used by the animals to defend themselves or paralyze their prey, can be very effective for chronic pain treatment amongst humans. Squalamine, found in sharks, is being investigated for its potential anti-tumour activity. The blood of horseshoe crabs is capable of killing bacteria; the study of the working of these antimicrobial peptides can be beneficial to designing more effective antibiotic therapies for humans.

Nature experience
The natural relation between biodiversity and human health perhaps best is brought to life in the biophilia hypothesis: the innate human tendency to affiliate with nature (Kellert 2009; Hartig et al. 2011; Melillo and Sala 2008; Nilsson et al. 2011). This contact with nature both has historical biological (genetically programmed) roots and present day beneficial health effects: studies show that living near nature enhances health, contact with nature is beneficial to recovery from illness or stress, it stimulates social ties and physical activity, nature elements are beneficial to productivity in working conditions, contact with nature stimulates intellectual performance and positively influences children's development (Kellert 2009). The complicatedness and sensitivity of the relation also is coined by the concept of biophobia (Ulrich 1993; Hartig et al. 2011): the relation is not necessarily (only) positive, neither historically nor in current perception and policies. Fear of dangers in nature (predators, snakes, poisonous plants) historically was functional for survival, alongside with positive cues such as potential food and water sources, shelter. Both illuminating human adaptive capabilities (Ulrich 1993). The relation also shows its dual face in the historical development of public health policies: especially in Western countries in the twentieth century the positive aspects of nature to human health have been mainly discarded. In cities the hygiene principle overshadowed the positive nature experience principle. The idea of coexistence of humans with nature being beneficial to human health slowly seems to be revitalized in current public health thinking. The special role of biodiversity in nature experience literally is both mysterious and complex: the quality of nature is of influence on the fruits of nature experience to human health (Kaplan and Kaplan 1989; Hartig et al. 2011).

Background
The natural relation between biodiversity and public health

Invasive species and diseases
Global travel, transport and trade have resulted in the introduction of new species to local ecosystems. Most introduced species do not cause problems in their new surroundings, but some of them become invasive and as such disruptive to ecosystems (Chivian and Bernstein 2008b). Invasive species may result in biodiversity decline and the success of an invasion may be the result of lack of biodiversity in the invaded habitat. The impact of invasive biological species on a diversity of the above mentioned human health related ecosystem services (and disservices) has become of increasing importance the past decades (Pysek 2011). Invasive species may introduce diseases to other habitats, often leading to dramatic emergence of infectious diseases (Thomas et al. 2009), and may cause injuries or allergies. They may accumulate toxins (e.g. heavy metals) which may end up in human food and may contaminate soil or water. And they may hamper nature experience e.g. by forming impenetrable stands or water coverage, or causing deterioration of environmental and aesthetic quality of ecosystems (Pysek 2011).

Catastrophe control and climate change
Biodiversity and ecosystems can be functional in catastrophe control, e.g. in lowering the risk of floods (Melillo and Sala 2008) and droughts (Chivian and Bernstein 2008b) and as such decrease related public health risks. Climate change plays an important role here and does so also in relation to other of the above mentioned human health related ecosystem services (and disservices). Floods may result in water borne diseases and droughts result in malnutrition (Parmesan and Martens 2009). Climate change can have an effect on infectious diseases (Molyneux et al. 2008). E.g. due to climate warming in coastal ecosystems the spread of cholera can be enhanced. Moreover some vectors are sensitive to temperature: due to climate warming the spread of mosquitoes and their activity may be enhanced, and so may the spread of diseases like malaria. Extreme weather events such as heavy rainfall, flooding and droughts may both increase and decrease the activities of vectors. E.g. droughts may lead to the formation of small nutrient rich pools favourable to mosquitoes spreading the West Nile virus (Molyneux et al. 2008). According to Parmesan and Martens (2009), the tripartite relation climate change – biodiversity – human health due to complexity still is poorly understood. Existing studies illuminate the importance of monitoring and generation of further understanding.



Background
The natural relation between biodiversity and public health

Biodiversity and Public Health in Belgium
Research on the linkages between biodiversity and public health is an emerging issue that nevertheless has not yet received much concerted attention in Belgium. Considering that the issue attracts the interest of various scientific disciplines, including biodiversity, public health and social sciences, an interdisciplinary approach is called for. Promoting new linkages and collaboration amongst these disciplines, to propose appropriate new research ideas and topics is of priority interest. The expertise arising from such interdisciplinary research potentially has substantial added value for policy making. This will e.g. allow Belgium to live up to the Belgium Biodiversity Strategic aim of maximising the advantages for human health arising from biodiversity and expand the collaboration between the interested organisations/ public services[3]. Health is also one of the priority societal challenges identified in the European "Horizon 2020" strategy (European Commission 2011b) for research and innovation. To promote the integration of such expertise into relevant policy at different levels, moreover a transdisciplinary approach is called for to ascertain the involvement of relevant stakeholders from different sectors of society in the development of a research agenda and projects.

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Hans Keune, supervisor of the conference

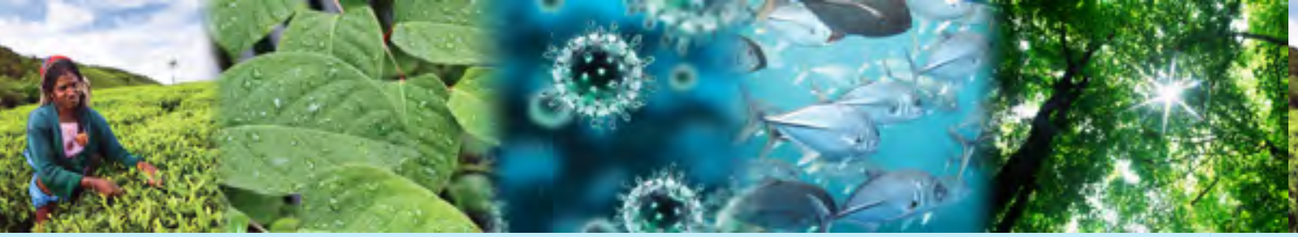
3 Belgium's National Biodiversity Strategy 2006-2016

Scientific Advisory Committee

In the organisation of the conference, the Belgian Biodiversity Platform was assisted by a Scientific Advisory Committee (SAC). This committee was composed of Belgian and international experts from both science and policy fields with an interest in Biodiversity and Public Health. The role of the members of the SAC was to advise on the best approaches that would ensure a successful meeting. The SAC was led by Hans Keune, Science Officer for the Belgian Biodiversity Platform.

Members of the SAC:

Bauler Tom - Institute for Environmental Management and Land-use Planning, Université libre de Bruxelles
Biot Pierre - Federal Public Service (FPS) Health, Food Chain Safety and Environment
Coosemans Marc - Institute of Tropical Medicine, University of Antwerp
Gilbert Marius - Biological control and Spatial Ecology Lab, Université libre de Bruxelles
Flandroy Lucette - Federal Public Service (FPS) Health, Food Chain Safety and Environment
Heyman Paul - Military hospital Belgium
Huyse Tine - Laboratory of Animal Diversity and Systematics, K.U.Leuven
Leirs Herwig - Department of Biology, University of Antwerp
Loots Ilse - Flemish Centre of expertise on Environment and Health, University of Antwerp
Mathijs Erik - Division of Agricultural and Food Economics, K.U.Leuven
Martens Pim - International Centre for Integrated assessment and Sustainable Development (ICIS), Maastricht University, The Netherlands
Navez Yseult - Federal Public Service (FPS) Health, Food Chain Safety and Environment
Nemery Ben - Flemish Centre of expertise on Environment and Health, Faculty of Medicine, K.U.Leuven
Peeters Alain - RHEA
Prieur-Richard Anne-Hélène, Diversitas
Symoens Françoise - Reference Centre in Medical Mycology, Scientific Institute of Public Health
Tack Wesley - Research Group Forest and water management, Faculty of Bioscience Engineering, Ghent University
Vander Aa Beatrijs - Research Institute for Nature and Forest (INBO)
Van Helden Jacques - Genome and Network Bioinformatics, Université libre de Bruxelles
Van Herzele Ann - Research Institute for Nature and Forest (INBO)
Van Ranst Marc - Faculty of Medicine, K.U.Leuven
Vanwambeke Sophie - Department of geography, Université catholique de Louvain
Verheeke Jan - Belgian Federal Council for Sustainable Development, Secretary of the Flemish Advisory Council for Environment, Nature and energy
Volckaert Filip - Laboratory of Animal Diversity and Systematics, K.U.Leuven
Wittmer Heidi – Helmholtz Centre for Environmental Research (UFZ), Germany



Full presentations of the keynote speakers, both the power points and video recordings can be found on the conference website. The following pages introduce the background of the keynote speakers and a brief introduction to their presentations.

Conor Kretsch

Conor Kretsch is executive director of Co-operation on Health and Biodiversity (COHAB)[4]. COHAB is a community of individuals and organisations working together to address the gaps in awareness, policy and action on the links between biodiversity and human health and well-being. The initiative supports efforts to enhance human security through the conservation and sustainable use of biodiversity and the goods and services it provides. COHAB provides a platform for dialogue, promoting understanding and experience sharing, and working to build partnerships across sectors and cultural divides.

In his presentation 'Reducing Risks - Linking Health and Biodiversity in Policy and Practice', Conor Kretsch first introduced the concepts of biodiversity and human health, the latter subdivided in a diversity of health aspects. He also highlighted the relations between biodiversity and human health and introduced several international initiatives, such as the Millennium Ecosystem Assessment, that assessed this important relation. Furthermore he sketched the policy challenges connected to these efforts, as well as the need of close collaboration between health and environmental/ecological experts.

Conor Kretsch

4 http://www.cohabnet.org

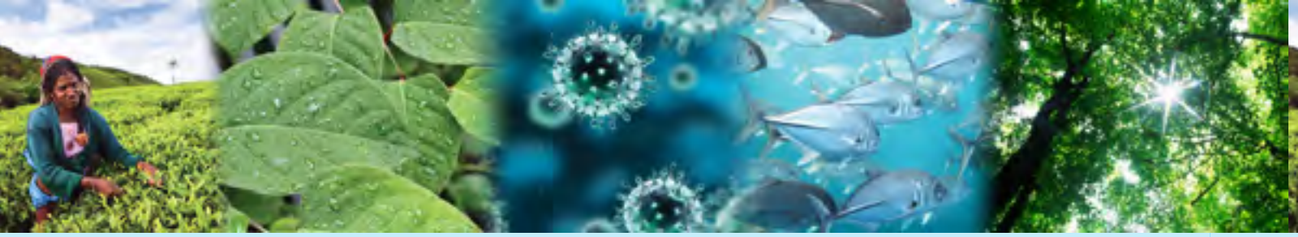
Keynote speakers

Terry Hartig

Terry Hartig is Professor of Environmental Psychology at the Institute for Housing and Urban Research and Department of Psychology of Uppsala University Sweden. The focus of his research is on daily places that most people care about: home, neighbourhood and natural settings such as forests. For instance, he has compared the emotional, cognitive and physiological changes measured in young adults who walked in either a Nature preserved area or urban settings after they faced a standard set of demands. With such studies, Terry Hartig tests current theories about how environments may promote or constrain restoration. In other field works, he contributed to theory development in different ways, situating brief restorative experiences in the on-going flow of activity over the days, weeks and years, and relating the use of natural environments for restoration to the performance of behaviour that in turn serves to protect the natural environment. The fundamental intent in all of these efforts is to inform environmental and policy measures that promote health.

In his presentation 'Linking Health with Nature Experience: Restoration and Other Pathways' Terry Hartig presented results of psychological research illustrating the importance of Nature experience for stress reduction and management of cognitive resources, how it stimulates social ties and physical activity, and how it supports development over the lifespan. He concluded with the intriguing dilemma that on the one hand restorative experiences in nature can help to support efforts to preserve biodiversity. But on the other hand, the desire for restoration in nature may also hinder efforts to preserve biodiversity.

Terry Hartig



Pim Martens

Pim Martens holds the chair 'Global Dynamics and Sustainable Development' at Maastricht (Netherlands) and Leuphana (Germany) University, and is a honorary professor at Stellenbosch University, South Africa. He is also Director of the International Centre for Integrated assessment and Sustainable development (ICIS) and the Academic Director of the Maastricht University Graduate School of Sustainability Science (MUST), Maastricht University. Prof. Martens is project-leader and principal investigator of several projects related to sustainable development and sustainability science, globalisation, environmental change and society. Pim Martens is editorial advisor of the International Journal Ecohealth, associate editor of Environmental Science and Policy, and member of several editorial boards.

In his presentation 'Biodiversity and Health - Friends or Foes?' Pim Martens presented many examples of the importance of the relation between biodiversity, sustainability and human health. He also highlighted the scientific challenges regarding these issues, the vast amount of scientific uncertainties and the gap between different paradigms of epidemiology: conventional epidemiology and eco-epidemiology.

Pim Martens

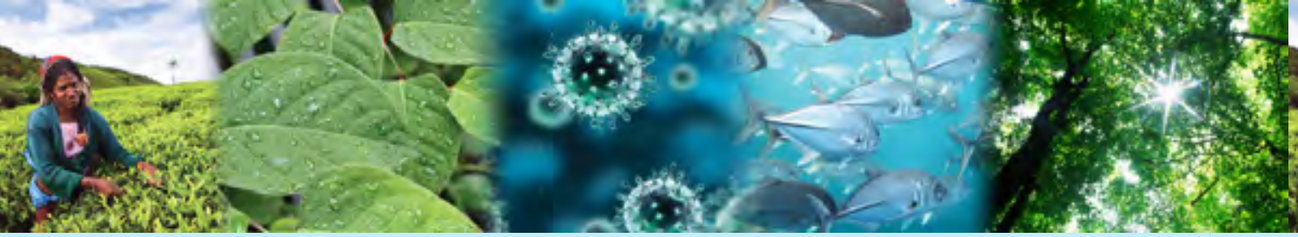
Keynote speakers

Marc Van Ranst

Marc Van Ranst is full professor at the Faculty of Medicine of KULeuven and head of the Department of Microbiology & Immunology of the KULeuven. Since May 2007, he has been appointed as Belgian Interministerial Commissioner for flu epidemics. He is also member of the Superior Health Council of Belgium.

In his presentation 'Zoonotic infections' Marc Van Ranst introduced the audience to the intriguing and dynamic world of zoonotic infections. This type of infections form the major part of pathogens that emerge in humans, which moreover is further enhanced by the way we organize our modern and globalized way of living. For example in the way we organize animal meat production, the intensity of global trade and global travel. He also presented other factors to be taken into account, such as climate change and ecological change. Furthermore he gave an overview of influenza epidemics, of which the Mexican flu is the most recent example causing international unrest. Finally he introduced developments of the hantavirus worldwide and presented results from research on the hantavirus in Belgium.

Marc Van Ranst



Workshops and panel discussions
The Scientific Advisory Committee selected five topical workshops. This selection was based on an assessment of the relevance to the conference aims and topical focus, and on the scientific quality of the workshop proposals. The selected workshops were set up by 'Workshop organisers', who were advised by the SAC on technical and scientific issues, and were asked to address issues specifically relevant to the Belgian perspective and policy relevance.

Workshop Vector-borne diseases, diversity and public health
Organizers: Guy Hendrickx (Avia-GIS), Marc Coosemans (ITM), Katrien Tersago (UA), Veerle Versteirt (IMT), Etienne Thiry (ULg)
In the infectious diseases workshop the focus was on vector-borne diseases, their diversity and their potential impact on public health. Recent results from a series of international research projects involving Belgian scientists were presented, highlighting different facets of the diversity of vector-borne diseases: the relationship between masting, rodent population dynamics and the incidence of hanta virus; mapping mosquito diversity in Belgium and The Netherlands; ongoing work on a novel 'One-Stop-Shop' system and service to assist with mapping and modelling vectors of disease; the risk of emergence of viral diseases driven by eco-climatic changes and socio-economical situations.

Workshop Spatial tools for studying environment and health
Organizers: Sophie Vanwambeke (UCL), Els Ducheyne (Avia-GIS), Marius Gilbert (Lubies, ULB)
The spatial tools workshop presented spatial approaches to investigate relationships between environment and health, that could be particularly useful for the understanding of vector-borne and zoonotic diseases. The presented case studies covered various disease transmission systems such as tick-borne diseases and culicoides-borne diseases. The case studies illustrated challenges encountered when using spatial methods, as well as the value and necessity to approach these questions in a multi-disciplinary framework.

Participants in the workshop *"Vector-borne diseases, diversity and public health"*

Workshop Biodiversity and food
Organizer: Erik Mathijs (K.U.Leuven)
The Biodiversity and food workshop focussed on the crucial role of biodiversity in the development of agriculture and food production. Wild species may still provide genes increasing crop or food quality. Moreover both malnutrition and over nutrition are related to a lack of diversity in food intake.

Workshop Nature experience and the Question of Health
Organizer: Ilse Simoens (INBO)
The automatisation, urbanisation and globalisation of our society strongly reduce nature related daily practices. This results in a society disconnected from the surrounding landscape and local food production. Nowadays, experience of nature has become an activity on its own, performed during our free time, based on individual choices and trends and with little relation to the landscape in which it takes place. Lots of studies of different disciplinary orientation show that our society suffers from an increasing number of burn-outs, depressions, identity crises, obesity, back problems and attention deficit hyperactivity disorder in children. The nature experience workshop focused on how the benefits of nature experience activities could help to decrease these problems.

Workshop Public health as an ecosystem service indicator
Organizers: Hans Keune (BBPF), Heidi Wittmer (UFZ), Tom Bauler (ULB)
According to McMichael (2009), *"Human population health should be the central criterion, and is the best long-term indicator, of how we are managing the natural environment"*. The plea for human health as a sustainability indicator exemplifies the strategic importance of human health both in terms of ecosystem services and biodiversity conservation: public health benefits from biodiversity, and in exemplifying these benefits, biodiversity conservation may be enhanced. The ecosystem services workshop addressed the question of how the relation between biodiversity and public health can be expressed in terms of ecosystem services: what are useful indicators of the value of biodiversity for public health and how is the value of biodiversity for public health best expressed in order to be taken into account in public debate and policy making?

Participants in the workshop *"Public health as an ecosystem service indicator"*

Before starting the discussions, participants in the workshop 'Vector-borne diseases, diversity and public health' listened to four presentations:

PRESENTATION 1: Puumala hantavirus epidemiology in Belgium: Impact of tree seed production and climate
By Katrien Tersago, Herwig Leirs, et al. (Evolutionary Ecology Group, University of Antwerp)

Katrien Tersago,
University of Antwerp

The bank vole (Myodes glareolus, Nl: Rosse woelmuis / Fr: Campagnol roussâtre) acts as a vector for the Hantavirus Puumala virus (PUUV). The number of new human infections is a function of the number of reservoir hosts, the virulence and longevity of the virus in the environment and the number of susceptible humans. Given the observation that the bank vole populations increase following years of higher resource availability (high tree seed production; mast years) and the coincidence of higher population densities with epidemic years, early warning systems could be based on models that predict the masting of oak and beech trees. The early warning model presented takes into account the occurrence of dry and warm summers (bud initiation in year-2) and the absence of late frost and little rain during pollination (flowering in spring year-1). The model has a high predictive power, but doesn't clearly explain the high infection rates in recent years and isn't optimized for taking into account spatial variation in masting. This could be related to availability of alternative food sources for the vector species. The presence of other rodent species (including Wood mice) could lead to a dilution effect as these species may compete for food resources but do not act as reservoir for the virus.
This research is clearly an important step towards an early warning system for Belgium. Scientific studies focusing on different pathways for infections could improve such early warning system. This study is a clear example where an early warning system may help policy makers. In addition, the workshop participants identified a clear need for collaboration between the different institutes working on Hantavirus.

PRESENTATION 2: Mapping mosquito diversity in Belgium and The Netherlands
By Veerle Versteirt (Institute of Tropical Medicine)

Veerle Versteirt,
Institute of Tropical Medicine

During the Modirisk project an extensive sampling campaign was set up to make an inventory of mosquito species in Belgium (900 random sites and risk areas) and The Netherlands (60 regular sampling sites). This allowed to detect exotic species which could act as potential disease vectors. Two Aedes species were detected in Belgium; A. japonicus, which is still stricted to imported tyre companies and A. koreicus, which appears to be tablished but not yet invasive. The detection of these potential vector species is relevant for policy-makers. There is a need for surveillance and rapid detection, for clear and uniform eradication protocol (who and what?) and for follow-up and continuation of this kind of studies. In addition, the vectorial capacity of these species is the most important question in this type of research.

Workshop: Vector-borne diseases, diversity and public health

PRESENTATION 3: Risk Of Emergence Of Viral Diseases Driven By Eco-Climatic Changes And Socio-Economical Situations – Results of the VIRORISK (Belspo SSD Spin-off) project
By Etienne Thiry (Université de Liège)

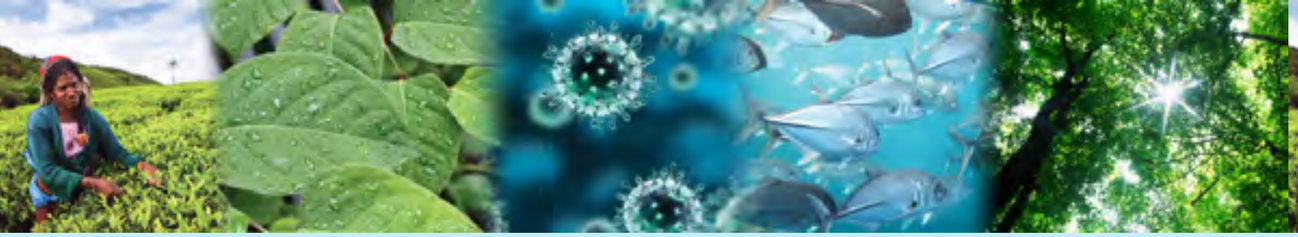
Etienne Thiry presented the case of bluetongue virus that made an outbreak in 2006 in ruminant populations. He drew a comparison with what would happen with a similar human infection and a similar type of vector (for Bluetongue the vectors are cucoides (Diptera: Ceratopogonidae). This bluetongue virus had not been known in Northern latitudes and the outbreak was a surprise, it is likely this situation could happen for human virus as well. The climatic conditions and their impact on bluetongue outbreak were not demonstrated in the introduction of the virus but their role was effective in the maintenance of the infection.
The eradication of the bluetongue epidemic was performed thanks to:
-vaccination
-natural immunisation
-natural decrease due to external conditions
In this epidemic, the importance of early detection is critical. There is currently not any early warning system in Belgium. The bluetongue outbreak was noticed and communicated through informal contacts.

Etienne Thiry, Université de Liège

PRESENTATION 4
VecMap - A One-Stop-Shop for Vector Mapping
By Guy Hendrickx (Avia-GIS)

VecMap is a product covering the whole process of vector mapping going from designing sampling strategies and obtaining relevant earth observation products to species and diversity modelling. Potential customers include academics, health professionals and commercial users. They can choose to use only selected functionalities (e.g. centralized database system) or opt for a full service package. As a use case, this tool was developed and extensively tested during the Modirisk project. The VecMap tool offers interesting possibilities for continued monitoring in a cost efficient way (it is possible to calculate the minimum requirements to maintain/update the database) and offers scientists a standardized tool enabling them to focus on data analysis.

Guy Hendrickx, Avia-GIS



Workshop: Vector-borne diseases, diversity and public health

Outcomes of the workshop on Vector-borne diseases, diversity and public health:

Research topics relevant for biodiversity:
-The distribution and abundance of reservoir and host species
-The influence of host diversity on disease transmission
-The diversity of pathogens and their geographical distribution patterns
-The biological relationship between all actors of disease lifecycles and how the diversity of resources (e.g. food) influences epidemiological cycles
-Which components can act as early warning indicators
-The vectorial capacity of disease vectors in their natural environment

The workshop stressed the need for more collaboration between Belgian research teams working on similar topics. The workshop also highlighted the need to collaborate between different policy sectors. For instance, since vector-borne diseases are very much affected by human induced landscape changes (e.g. creating new wetlands) it is essential that landscape management authorities exchange about this with public health agencies.

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Participants in the workshop *Vector-borne diseases, diversity and public health*

Disease Early Warning Systems:
-Look for pathogens
-Under detected diseases
-Diseases occurring in neighbouring regions: it would be useful to have a list of all zoonosis diseases present in neighbouring countries and establish their level of risk to prioritise the surveillance systems. Such prioritisation has been done at different levels in Europe, in several countries. Belgium could learn from these experiences.
-Diseases which may be introduced: e.g. bluetongue
-Syndrome surveillance should focus on symptom clusters or unexplained mortalities:
o Veterinary
o Public health
o Link both, taking into consideration simplification of the links between federal, regional and community institutions: a major challenge is to deal with a federal surveillance system and a regional legal framework for the notification of the infectious level.
-Epidemiologic intelligence: e.g. ECDC, FAO

Eradication of invasive species:
-As soon as species are detected and before the invasive stage
-The need for a simplified action plan.

Workshop: Spatial tools for studying environment and health

Before starting the discussions, participants in the workshop 'Spatial tools for studying environment and health' listened to three presentations:

PRESENTATION 1: "Intensification of poultry production and avian influenza: what are the spatial evidence linking biodiversity and disease emergence?"
By Marius Gilbert (Lubies, ULB)

Marius Gilbert, using the example of avian influenza and poultry farming, contrasted the diversity found among livestock and wildlife, two groups that are found in very different densities. He showed how the process of intensification of farming led to such contrast, and how overlap between the two populations was also an important element of the risk of disease. He indicated that biodiversity in livestock breeds was being sought now in an effort to limit disease risk. He highlighted factors operating at various scales (farm, landscape, etc.), and also the interaction between land uses/ land covers.

PRESENTATION 2: "Spatio-temporal modelling of an emerging disease: bluetongue"
By Els Ducheyne (Avia-GIS)

Els Ducheyne presented advanced modelling methods that have helped understand the spread of various bluetongue strains throughout Europe. The use of biomes to understand invasions was highlighted. The role of the models elaborated respectively for retrospective understanding and predictions was illustrated. Her presentation illustrated also the fact that health-related issues can become highly relevant literally overnight. The role of interfaces was also underlined.

PRESENTATION 3: "Spatial heterogeneity of disease risk: humans, vectors and the landscape"
By Sophie Vanwambeke (Georges Lemaître Centre for Earth & Climate Research, UCL)

Sophie Vanwambeke presented the general approach to investigate landscape and the risk of vector-borne disease in a spatially explicit context. This was illustrated by an empirical study of tick-borne encephalitis in Latvia highlighting the many facets of landscape (land cover, land use, land management) and a study of risk of dengue transmission using empirical data and a mechanistic approach.

Outcomes of the workshop on Spatial tools for studying environment and health:

Main issues relevant for Belgium:
Data issue: while a lot of data is collected and produced in Belgium, little is actually easily accessible, including for research purposes. This is also the case for health data. For spatially explicit research, a good level of resolution is required. Such detailed data is currently not available. Work is ongoing in that regard but further efforts are necessary.

There is a need for high resolution data freely accessible in non-crisis/peacetime situation:
• Geo-referenced health data is coarse-scale which limits the analyses of the disease systems
• Accessibility to detailed health data is required
• There are existing initiatives that should be further developed: e.g.: www.data.gov.be, that has started, though data sets are rather limited at the moment
• Data sharing becomes even more difficult when disease crises are ongoing - e.g. bovine TB UK, avian influenza
• Baseline biodiversity maps based on 'Biological Valuation map' in combination with species distribution maps are not available
• Need to integrate data from outside academic world such as www.waarnemingen.be

Scale issue of most problems pertaining to health and the environment:
• Scale issues often are problematic at a local scale (e.g. water pollution), while many influencing factors (e.g. policy decisions, source points, etc.) depend on a higher level of decision, such as the regional, national or international levels. And as far as Belgium is concerned, the competencies of each authority have to be taken into account (e.g.: environment is a regional competence while health partly is a federal competence).
• Different regions produce different maps in Belgium
• Issues must be integrated within EU context (problems do not 'stop' at the border)

Communication between scientists, stakeholders and decision-makers:
• A good communication between these actors is perceived as a challenge, but success stories of integration of various groups or of major translation efforts were mentioned in the discussion.
• The necessity to involve bureaucrats from local levels (as the main interlocutor to private managers, for example) was underlined.
• Current translations of science output by 'multiplicator' to politicians and general public:
-The Economics of Ecosystems and Biodiversity (TEEB)
-The Vlaams Instituut voor Zee (Flemish Marine Institute)
-Belgian NGOs acting as knowledge transfer on biodiversity: Natuurpunt, Natagora
-Flemish Forest Groups (they should include health impacts of forest management decisions)
-The Walloon observatory of forests health "Observatoire de la Santé
des Forêts" (the observatory should create working partnerships with private forest owners).

Workshop: Spatial tools for studying environment and health

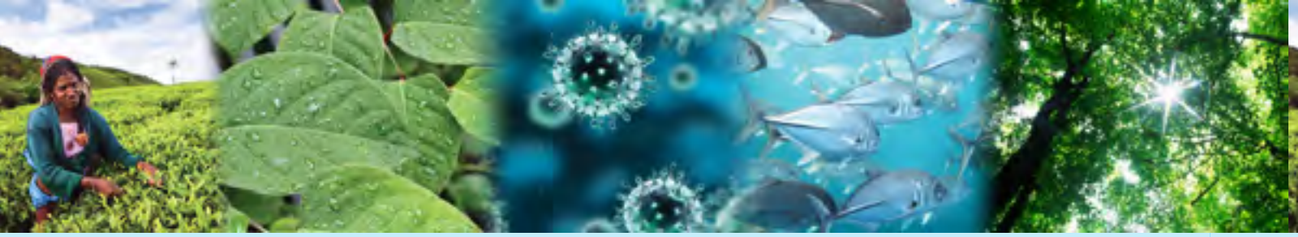
The nature of the link between biodiversity and health:
Belgian territory is intensively managed by authorities. Interfaces between ecosystems, and between humans, livestock, and wildlife are very important, including in spatial terms. It means that biodiversity levels are to a large extent "in our hands", but also that numerous confounding factors exist. However, biodiversity management or even more largely actions for the environment rarely examine consequences on health (whether they would be positive or negative).

Sophie Vanwambeke,
Georges Lemaître Centre for Earth & Climate Research, UCL

What is the relationship between biodiversity and health in Belgium?
• The ecosystem is moving towards a balance (nitrate, ammonia)the gradient between urban -> natural will give impact on direct and indirect health
• The interface between human/domestic animals and wildlife must be further investigated
• Switch towards corridor conservation
• Land management is very high in Belgium
• Switch towards corridor conservation
• Research is needed for relationship between climate neutral cities related to health
• Limited data

During the discussions, a theme that kept being mentioned was the necessity to pursue effort towards multidisciplinary work in the domain of biodiversity/ environment and health.

Participants in the workshop *Spatial tools for studying environment and health*



Before starting the discussions, participants in the workshop 'Biodiversity and Food' listened to three presentations:

PRESENTATION 1: Biodiversity, ethnobotany and new (fruit) crop development
Patrick Van Damme (UGent)

The presentation explained how we can learn more about food species and highlighted the role and importance of ethnobotany in doing so, with a special focus on tropical agriculture. Biodiversity is a direct source of food, medicine, basic need fulfilment, and also provides quite some other ecosystem services. In ethnobotany, there also is a focus on non-material benefits, which are linked to cultural values and aesthetics. These are of interest when we want to recover species for using them. The speed at which species are disappearing is much faster than before. Ethnobotanists are trying to keep abreast of still existing species but many of them were unknown to ethnobotanists even before they disappeared.

Ethnobotanists are mainly dealing with plants. An overview of food plants:
-270,000 higher plants (total: 1 to 2 million)
-7,000 ever used as a source of food somewhere
-only 20 major ones are for food
-only 3 -maize, wheat and rice- make up 60 % of our basic food/ energy
A reduction of the number of species we are using can be observerd. All systems are under pressure of replacing local landraces, higher yielding, exotic varieties, introduction of commercial varieties, including genetically modified organisms (GMOs) into traditional farming systems. 99% of soy is now GMOs. The main trend is towards more genetic and ecological uniformity, which increases the vulnerability of systems. Pressure comes from the food industry that demands for uniformity of production.

Ethnobotanists and new crop developers believe that the natural plants cover all basic energy and food needs. In their opinion, there is no need for GMOs. Ethnobotany can document plant use and characterise germplasm. Ethnobotany studies the relations between man and plants with an emphasis on plants used by people (through interviews, literature studies, etc.). In this respect the most interesting environments are traditional settings because people have developed coping strategies, we no longer have to cope with. People in traditional settings have to cope with sometimes extreme environments, in that way we can learn a lot about them. When we do ethnobotanical research we try to find those species with interest for domestication. The different steps are: inventorying – (botanical) description, determination and classification – domestication and new crop development for local, regional, and international markets.

Discussion:
What could be the relevance of ethnobotany for Belgium? In Belgium not much work has been done on this. Yet, Belgium is having an increased diversity of people, a reality that could be taken into account: e.g. through Diaspora, people bring in plants, from wherever they come.

Workshop Biodiversity and Food

PRESENTATION 2: Biodiversity and genetic diversity contribution to durability and quality in fruit production *By Wannes Keulemans (KULeuven)*

The presentation explained the importance of genetic diversity in fruit production, focusing on the case of the apple in Belgium. Agrobiodiversity is low in the agro ecosystem itself (but high compared to other crops). Increase of biodiversity as such is not evident, increase for specific aims (IPM) is more realistic, especially from an ecosystem services point of view. Genetic diversity is not the same as biodiversity! There is more genetic diversity available than used for modern cultivar breeding. Genetic resources from wild apples are underexploited. There is a high need for conservation because of loss of natural potential (e.g. disease resistance still present in wild apple, understand the difference in reaction between plants). An important research question is: how many genotypes do we need to conserve genetic diversity?

Wannes Keulemans, KULeuven

Some recommendations for policy makers:
-Reduce conservation for the sake of conservation (better knowledge is needed on why we conserve and the goal of it)
-Focus more on conservation of functional genetic diversity in crops (i.e. form, vitamin C content, firmness, size, taste, etc.) and their wild relatives
-Invest more in knowledge and applications of natural recourses (breeding)

Discussion:
Is there any kind of proof that eating different varieties of apples would be healthier than eating one specific type? We have so many different types of food that eating a Golden or a Cox will not make the difference. But, if consumers only had Goldens, and did not like Golden, they would not eat apples. This may have an effect on health as the apple, an healthy component, may drop out. People having a more 'biodiverse' diet, are healthier than the ones who mainly eat junk food. There is a necessity of showing that apples are an important component in a healthy diet.

Do orchards represent a good opportunity to combine biodiversity and food production? For instance, in relation to IPM (increase for specific aims) and also natural predators? This is complicated. It is sometimes good for the agricultural system, but we have to take in mind, that there is also a turnover effect to wild populations, that are not always positive. Especially in an intensive system, the application of the use of biodiversity is limited. It is much more pronounced in perennials, compared to wheat or maize for instance. It is recommendable to invest more in knowledge. In the past, research focused on pesticides and fertilizers. When will we do the same effort to invest in what is present in nature?

PRESENTATION 3: Biodiversity and Food: The transition towards a sustainable food system
By Erik Mathijs (KULeuven)

The presentation aimed to present the theme of biodiversity and food through a more global perspective of sustainable food production and to find out how the current food system could be transformed into a more sustainable system.

Eric Mathijs, KULeuven

What are the main challenges towards 2050?
-One billion people are hungry. Increase of world population with 30% living primarily in megacities in least developed countries
-Incomes will rise in developing countries, causing a diet shift towards more meat and vegetable oils; and towards a 'Western' diet including more sugar and salt
-The United Nations Food and Agriculture Organization (FAO) claims there will be a need for a rise in food production by 70%, despite an increase of population by 30%. However, whether we really have to increase food production by 70% or only by 30% makes a huge difference. There is too much emphasis
on the 'magical' 70%.
-Natural resources are becoming scarce (peak oil, peak fish, peak water, peak biodiversity, all reinforced by climate change).

How can we move towards a more sustainable food system? What changes would be possible?
1. Increase resource efficiency (increase productivity and input efficiency)
2. Recycle nutrients
3. Increase consumption efficiency. Reduce food waste: according to current estimates of FAO, 30% of the food that is used is being wasted or is lost… A change in diet composition towards health conditions (less meat, sugar, more vegetables and fruits) could also contribute to consumption efficiency
4. Accelerate demographic transition. Reducing population has the biggest effects
5. Reduce material consumption

One narrative about the food system clearly dominates: do more with less, efficiency, emphasizing productivity and aiming for a sustainable intensification. This narrative dominates another narrative: less is more, consume less, being demand and ecosystem driven. This dominance has great impact: "-regardless of its stated aims- a dominant narrative succeeds in the normative sense of gaining resources and power, while pre-empting alternative futures" (Levidow 2008). The question is: how can we combine both? Can both paradigms be reconciled? We need both.

Discussion:
We should not only feed people, but also improve their health. What did change in the last 50 years in Europe, in Belgium? We reduced the areal of permanent grassland and increase the areal of cereals and forage. And consumers started to eat more pig and poultry meat than red meat. Poultry is fed with grains, cereals and so on; while cattle, even dairy cows and beef cattle have increasingly been fed with cereals and maize. When grass is replaced by maize, one needs proteins. So we have to find protein somewhere else: in soybeans. So we have imported huge amounts with an exponential increase of animal feed since the 1960s, and as

Workshop Biodiversity and Food

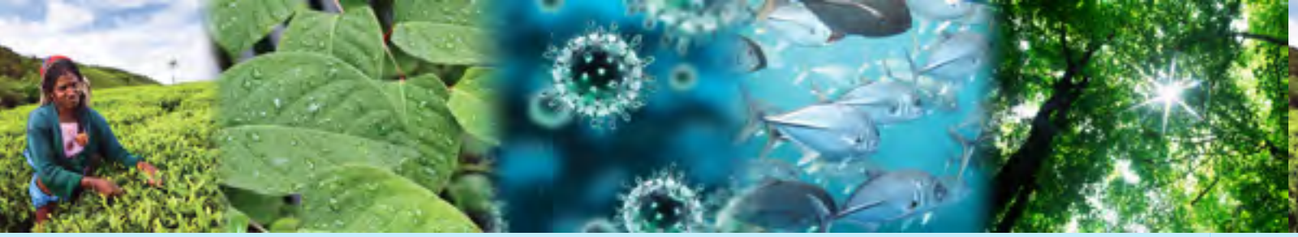
such, are destroying the campos in the south of Brazil, as well as the pampas. We are indirectly destroying the tropical rainforest in Brazil for feeding our pigs and poultry. Another issue is that feeding animals with grains instead of grass, results in having 3 times more of total fat in the food, 10 times more of Omega 6 than Omega 3 fatty acid, which induces obesity and allergies. Obesity in itself causes cancer and heart diseases. So we are destroying biodiversity in Europe because even intensive permanent grassland are better for biodiversity than arable land, and they are destroying species rich habitats in South America for producing soybeans. At the same time, all these are bad for our health. Here is a clear link between biodiversity and health. We should eat less pig and poultry meat, and we should feed our cattle with grass and not grains.

Outcomes of the workshop on Biodiversity and Food:
The participants of the workshop concluded on the following list of most urgent issues for Belgium:

Scientific relevance
-Need for studies on genetic diversity of food species and more studies on functional genetic diversity (e.g. traits such as firmness, colour, taste, size, etc.) in crops and wild relatives
-Need for studies on the level of diversification of diet for health and the relation between both (Is there a clear link between diversification of food intake and health? There is currently no consensus on optimal diet in the scientific community)
-Need for research on multifunctional agriculture, on 'gardinification' and alternative land-use changes in Flanders and the effect on biodiversity
-Need for studies on 'real' price of food (social-environmental-… costs) and how to incorporate these elements into policy instruments; research on new policy instruments including rewards (e.g. PES Evian)
-Need for studies on what resilience means for Belgium, including food consumption and health security
-Need for research on GMOs impacts on environment and health
-Need for more research on system analysis and studies on the interdependence of our global food system

Policy relevance
-Need for an increased consumer awareness on different effects of food consumption patterns on biodiversity (e.g. meat, production of waste, ecological footprint, etc.)
-Need for influencing catering chain for more environmental friendly behaviour
-Need for alternative proteins for livestock
-Need for change in awareness and consumer behaviour (e.g. other cattle breeds)
-Need for combined conservation measures and to focus on 'social diversity' and their use of biodiversity
-Need to focus on urban biodiversity (e.g. allotments, gardens)

Participants in the workshop *Biodiversity and Food*



Before starting the discussions, participants in the workshop 'Nature experience and the Question of Health' listened to three presentations:

PRESENTATION 1: Experiencing nature in or outside daily life: some reflections
By Ilse Simoens (INBO)

Ilse Simoens, INBO

This presentation was based on interviews with inhabitants of a specific area in Flanders on their perception of the landscapes, and based on a card game where the people were asked to rank the landscape services by importance. The results of the study showed that apart from clean water and clean air, people appreciate a lot of other services nature provide us with: e.g. the landscape experience. At the same time, the research results show that the intensity of daily contact with nature has been significantly reduced over the past 30 years.
Reasons why people are less in nature: industrialisation of the agriculture, regulations and privatisation of open space, children have less contacts with outside activities, household activities mostly take place inside nowadays, communication on the danger of nature and food consumption, exotic food and gardens. The nature-human relation shifted from a dependent to a non-committal contact so that spending time in nature becomes an activity in itself.

PRESENTATION 2: Green Care at the crossroads of agriculture, health care and social inclusion (case study: Flanders)
By Joost Dessein (ILVO)

Joost Dessein, ILVO

"Green care" or "Farming for care" in the UK and "Social farming" in Italy, are the same phenomenon: using farms to bring health care to people. The idea is that agricultural farms – animals, plants, gardens, the forest and the landscape – promote human mental and physical health, as well as quality of life, for a variety of client groups. Nature, work and the family are the three components that promote these benefits. In Flanders, there are around 500 farms. Simultaneously to this development is a growing pressure on agriculture from an environmental perspective. There is a lot of pressure from the policy makers to promote the concept of "Multifunctional Agriculture".

PRESENTATION 3: Ecotherapy 'Well-being in balance with nature'
By David Jelinek (Anima Mundi)

David Jelinek, Anima Mundi

David Jelinek explained what Ecopsychology is (a blend of fields: environmental philosophy, seperation theory, psychology, and ecology). At its core, ecopsychology suggests that there is a synergistic relation between planetary and personal well-being; and that the needs of the one are relevant to the other (inborn natural attraction to nature). Ecotherapy is based on his theory. By doing an exercise with the group, people could experience the way ecotherapy works.

Workshop Nature experience and the Question of Health

Outcomes of the workshop 'Nature experience and the Question and Health':

Three questions related to the presentations were discussed in breakout groups:
1. Do the benefits of experiencing nature interwoven in our daily life and connected to our daily activities differ from the benefits of outdoor recreation for human well-being? Is there a need to reintegrate nature experience in daily life practices and how would that be possible?
2. Nature, agriculture, well-being and health care merge together in the practice of 'care farming' or 'Green Care'. How can the diverse policy domains that are involved, support such an interdisciplinary practice? And should such practices merely be subsidised, or be handed over to the free market?
3. What are your personal experiences in life that had an effect on recognizing nature as a healing/ well-being source? (recollections, feelings, not evidence)

The discussions resulted in a table where the relation between nature experience and health were analysed on three levels: public health, health care delivery systems and individual (group) health:

	Public health	Health Care delivery systems	Individual/ group therapy
Where to insert	Transport Housing Work places Recreation Education	Hospital design Location at services	Interested communities
Temporal aspects	Every day	Program	Hybrid
Developmental issues	All ages	Different age groups different ability groups	Individuals concerned about earlier development and future personal development
Educational impact	Low-medium	Medium	High
Market involvement	Low	Medium	High

Depending on the level, participants of this workshop found differences that should be focused on in order to increase the benefits from nature experience.

Several other issues for further work on nature experience were highlighted:
-Involvement of different policy domains (agriculture, nature and health, education, spatial planning, mobility)
-Generic policy versus context specific developments
-Policy that supports small scale creative initiatives and that allows experiments and failure.

Before starting the discussions, the participants in the workshop 'Public health as an ecosystem service indicator' listened to two presentations:

PRESENTATION 1: What is biodiversity?
By Anne Franklin (RBINS)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Anne Franklin, RBINS

Anne Franklin presented some slides introducing biodiversity: an insect, soil and plants, a river, a woman bearing sisal on her head. The participants were asked to characterize these images by some words that first came to their minds. These words were quite different for each participant. For example, in the case of the river picture, different words were mentioned: the water cycle, the fauna (fish, birds), the flora, but also all the aspects linked to human well-being (swimming, relaxing, hiking, fishing). Perceptions moreover can be influenced by many factors, e.g. weather conditions.

The definition of biodiversity of the Convention on Biological Diversity (article 2) was introduced: *"Biological diversity means the variability among living organisms from all sources including interalia terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes biodiversity within species and of ecosystems"*. In the common definition of biodiversity, the ecological complex is generally forgotten; this means that biodiversity is more than the organisms; the systemic and dynamic aspects are very important.

Then, the Ecosystems Goods and Services definition was presented: *"Ecosystem goods and services can be defined as the contributions that ecosystems make to human well-being and arise from the interaction of biotic and abiotic processes"* together with their classification (CICES = Common International Classification of Ecosystem Goods and Services) according to theme (provisioning, regulating and maintenance, culture), classes and categories. The example of agave sisalina (sisal) was developed; this plant being important from an economic point of view (fabrication of carpets, baskets, ropes), but can also be an invasive plant.

PRESENTATION 2: The unclear relationship between Health-wellbeing and biodiversity
By Tom Bauler (ULB)

Tom Bauler touched upon the impact of biodiversity on ecosystems services, which is in some cases health related, health being an important constituent of well-being. In fact, the final indicator of well- being could be public health. As such, the definition of well-being is not only important but also fundamentally problematic. The cascade diagram of Haines-Young (Figure 2) makes a distinction between ecological structures and processes created or generated by living organisms and the benefits that people may derive from them.

Workshop Public health as an ecosystem service indicator

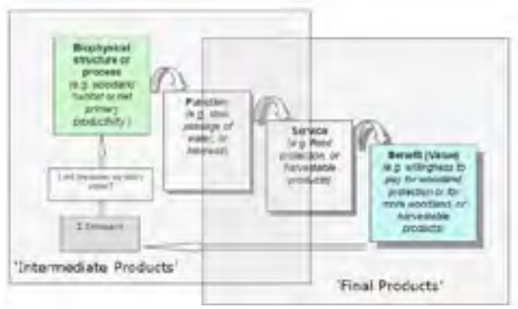
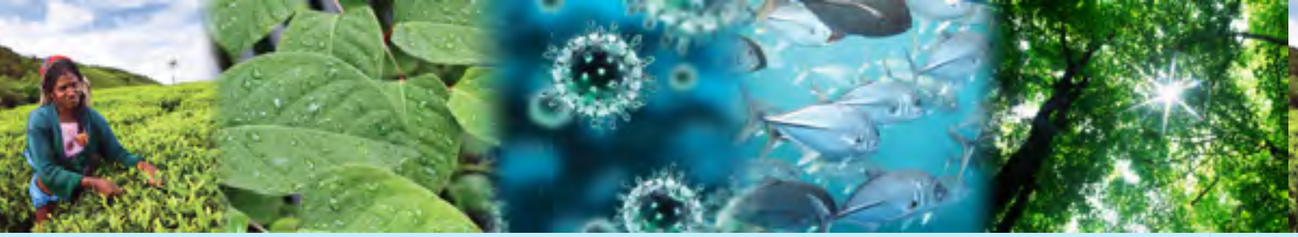


Figure 2: The relationship between biodiversity, ecosystem function and human well being. (Haines-Young and Potschin, 2010)

The Millenium Ecosystem Assessment diagram (Figure 3) representing the links and the intensity of the links between ecosystem services (supporting, provisioning, regulating, cultural) and constituent of human well-being (security, basic material for good life, health and social relations) present another way of framing the relation between biodiversity and public health.

Figure 3: The Links between Ecosystem Services and Human Well-being (after Millennium Ecosystem Assessment, 2005)

The relation between biodiversity and public health is complicated as the constituent complexes of elements (biodiversity, public health and well-being) may have contradictory relationships. The directions of the relations are not always clear and quantification is difficult. For example, more biodiversity may have a positive effect on health e.g. through nature experience, but nature conservation may need restricting access to experiencing nature, thus limiting the positive effects of biodiversity for human health.



Workshop Public health as an ecosystem service indicator

Outcomes of the workshop on 'Public health as an ecosystem service indicator':

The ecosystem services indicator workshop was generally considered to touch upon a relevant generic issue from the perspective of all other biodiversity and public health related topics. This is exemplified in the broad interest conference participants showed for this workshop. Participants were given the option to choose a first and a second choice workshop to attend. Whereas most participants chose a topical workshop close to their field of interest/expertise, many selected the ecosystem services workshop as a second choice. During the workshop this generic significance was underlined, but also seen as a challenge that probably was a bridge to far considering the current state of development in the broader domain of biodiversity and public health. As such preliminary steps were suggested.

Public health related ecosystem services considered relevant for Belgium:
-Food: urban agriculture versus wild nature
-Air: fine particles (traffic, house warming)
-Water: storm water management
-Infectious disease: Lyme, hantavirus, exotic mosquitoes
-Nature experience: urban green spaces, mental health, youth conflicts
-The bees population as an indicator for pollination and biodiversity

Issues considered relevant both for science and policy:
-Catalogue of linkages between biodiversity and public health
-Trying to connect what is already available: data, indicators, etc.

Issues specifically considered relevant from a scientific perspective:
-Better communication of the issues by experts to policy makers
-Health science should open up to environmental/biodiversity issues
-To what extent can health be included in cost benefit analysis and related ethical and scientific issues?

Issues specifically considered relevant from a policy perspective:
-Better evidence based and/or precautionary dialogue between policy makers, scientists and the public at large
-Linkage to (other) policy priorities, e.g. climate change
-Development of new indicators
-Cost benefit analysis of potential policy measures

Panel discussion and closure of the conference

Panel discussion and closure of the conference

A common denominator of all workshop discussion outcomes as presented in the final panel discussion was the need to build bridges and join forces, both amongst different fields of expertise, different policy domains and societal sectors.
In the conference closure statement of Jurgen Tack (Member of the Board of Directors of the Belgian Biodiversity Platform and Director of INBO), this was once again underlined.
He expressed his interest in next steps to be taken for building on the good experience of the conference as to make the best of establishing a Community of Practice for the important relation between biodiversity and public health in Belgium.

Etienne Thiry and Marc Van Ranst

Samia Hammadi

Jurgen Tack

Tine Huyse, Veerle Versteirt and Etienne Thiry

Ann Van Herzele and Heidi Wittmer

Filip Volckaert and Wannes Keulemans

Posters

Posters presented during the conference:

"The use of medicinal plants among Andean migrants in London (UK): Urban ethnobotany, reslilience and coping strategies"
By M. Ceuterick

"Pathogen infectivity and virulence in freshwater zooplankton modified upon cyanobacterial algal exposure"
By M. Coopman, E. Decaestecker and K. Muylaert

"Evidence for recent expanded distribution of arbovirus and Malaria vectors in Belgium caused by man-made breeding sites"
By W. Dekoninck, F. Hendrickx, W. Van Bortel, V. Versteirt, M. Coosemans, D. Damiens, T. Hance, E.M. De Clercq, G. Hendrickx, F. Schaffner and P. Grootaert

"The natural relation between biodiversity and public health: an ecosystem services perspective"
By H. Keune, P. Martens, H. Wittmer and J. Förster

"Modelling the spatial dynamics of pathogen transmission in tick-borne disease system"
By S. Li and S. O. Vanwambeke

"Impacts of the volcanic plumes in North Kivu (D.R. Congo) - Preliminary results"
By C. Michellier, B. Smets, M. Dramaix-Wilmet, J-B. Kahindo, F. Kervyn

"The effects of a changing N:P stoichiometric ration on Daphnia*-parasite interactions"*
By L. Reyserhove, K. Muylaert, E. Decaestecker

"Converting pine plantations to mixed species forests: Implications for Ixodes ricinus ticks and public health"
By W. Tack, M. Madder and K. Verheyen

"Landscape and vector-borne diseases: a complex interaction illustrated with mosquito- and tick-borne diseases"
By S. O. Vanwambeke

The use of medicinal plants among Andean migrants in London (UK): Urban ethnobotany, resilience and coping strategies

Melissa Ceuterick (current affiliation: Research Institute for Nature and Forest, Brussels) melissa.ceuterick@inbo.be

BACKGROUND

Analysing why and how ethnobotanical traditions 'survive' is important for a better understanding of migrants' health care behaviour (Pieroni & Puri 2010; Ceuterick et al. 2011). This study investigates the use of traditional medicinal plants among first generation migrants from Bolivia and Peru in London (UK), in relation to practices among a peer group in their home countries. By comparing data on active plant uses and their applications, overlap and differences between health care practices before and after migration can be outlined.

MAIN QUESTION

How does the use of home-remedies among two Andean communities in the UK change and subsist in the light of migration?

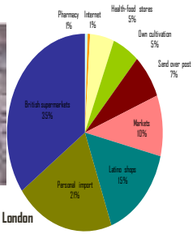
Comparison of most salient species before and after migration

Ten most salient species Lima	Ten most salient remedies Peruvians London:
1. Matricaria recutita L. (Asteraceae) Manzanilla 2. Citrus spp. (C. aurantifolia, C. limon) (Rutaceae) Limón 3. Eucalyptus globulus Labill (Myrtaceae) Eucalipto (*) 4. Solanum tuberosum L. (Solanaceae) Papa 5. Plantago major L. (Plantaginaceae) Llantén (*) 6. Pimpinella anisum L. (Apiaceae) Anís 7. Erythroxylum sp. (Erythroxylaceae) Coca 8. Chenopodium ambrosioides L. (Chenopodiaceae) Paico (*) 9. Petroselinum crispum (Mill.) Nyman ex A. W. Hill. (Apiaceae) Perejil (*) 10. Mentha sp.(Lamiaceae) Hierba buena	1. Matricaria recutita L. (Asteraceae) Manzanilla 2. Citrus spp (C. aurantifolia, C. limon) (Rutaceae) Limón 3. Aloe vera L. (Liliaceae) Sábila 4. Uncaria tomentosa (Willd.ex Roem.et Schult.) DC (Rubiaceae) Uña de gato 5. Allium sativum L. (Liliaceae) Ajo 6. Erythroxylum coca Lam. (Erythroxylaceae) Coca 7. Origanum vulgare L. (Lamiaceae) Orégano 8. Lepidium meyenii Walp. (Brassicaceae) Maca 9. Chenopodium quinoa Willd. (Chenopodiaceae) Quinua 10. Pimpinella anisum L. (Apiaceae) Anís
Ten most salient species Cochabamba	**Ten most salient remedies Bolivians London**
1. Matricaria recutita L. (Asteraceae) Manzanilla 2. Eucalyptus globulus Labill (Myrtaceae) Eucalipto 3. Erythroxylum coca Lam. (Erythroxylaceae) Coca 4. Malva parviflora L. (Malvaceae) Malva 5. Citrus spp. (C. aurantifolia, C. limon) (Rutaceae) Limón 6. Carica papaya L. (Caricaceae) Papaya (*) 7. Aloe vera L. (Liliaceae) Sábila 8. Citrus sinensis Pers. (Rutaceae) Naranja, flor de azar 9. Gnaphalium versatile Rusby (Asteraceae) Wira wira (*) 10. Camellia sinensis (L.) Kuntze (Theaceae) Té	1. Erythroxylum coca Lam. (Erythroxylaceae) Coca 2. Matricaria recutita L. (Asteraceae) Manzanilla 3. Citrus spp. (C. aurantifolia, C. limon) (Rutaceae) Limón 4. Cinnamomum verum Presl. (Lauraceae) Canela 5. Mentisan® Mentholated ointment 6. Allium sativum L. (Liliaceae) Ajo 7. Pimpinella anisum L. (Apiaceae) Anís 8. Coffea sp. (Rubiaceae) Café 9. Mentha piperita L. (Lamiaceae) Menta (MC48) 10. Eucalyptus globulus Labill (Myrtaceae) Eucalipto
(*) not reported among other national peer group; hence 'disappeared' after migration	

Herbal market 'La Parada', Lima;

Latin herbal shop London

'The average medicine cabinet': Cochabamba vs. London



Provenance of herbs in London

METHODS

Data on plant uses in London were collected during 20 months of fieldwork in 2005–2007, covering: 98 semi-structured interviews (on their use and perception of traditional medicine) in London (UK), Cochabamba (Bolivia) and Lima (Peru) (conducted in Spanish) + voucher specimens of all reported species were collected and identified (n=149)

RESULTS

- Peruvians and Bolivians in London continued to use traditional medicine for common, self-limiting ailments that were also widespread in their countries of origin, e.g. gastro-intestinal complaints, common cold (shift from more severe ailments such as hypertension, diabetes)
- Reasons for using herbal medicine: practical, health concerns, cultural and/or economic. Cultural motives became more important after migration.
- Less species (between 25-42% of home-countries) were used for fewer health conditions due to availability of more biomedical alternatives and diminished access to traditional herbal remedies
- The same widely used (either readily available cosmopolitan or culturally relevant) plant species appeared in the post-migration group (e.g. coca, chamomile, lemon, eucalyptus…)
- Less freshly available medicinal species were used in London and more edible, primary food species were consumed for medicinal purposes after migration, teabags were more popular after migration

MAIN CONCLUSIONS

Bolivian and Peruvian migrants in London prove to be resilient in their use of home-remedies when faced with the changes that come with migration. The observed ethnobotanical coping strategies are characterised by: 1) the **preservation of culturally salient species** (cultural key stone species); 2) a **positive influence** of the presence of **cultural diversity** (cultural edge effect); 3) a creative blending of different kinds of knowledge and resources, noticeable in an **increased use of dried, processed alternatives and food species**; 4) a **reliance on social networks** for the exchange of plant material.

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Pieroni, A. and Puri, R. (Eds.) 2010. Ethnobotany of Europe. Berghahn, Oxford, UK: 112–146.

ACKNOWLEDGEMENTS: The presented results form part of a larger study on the use and perception of traditional medicine among Latin-American migrants in the UK (Leverhulme Research Project Grant F/00 235/D). Special thanks go out to all participants in this study.

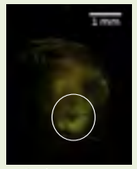
Pathogen infectivity and virulence in freshwater zooplankton modified upon cyanobacterial algal exposure

Coopman M., Decaestecker E. and Muylaert K.

Introduction

The water flea *Daphnia magna* is a small crustacean with a very important role in lakes. It is a primary grazer of phytoplankton in lakes, by such controlling phytoplakton blooms and bringing freshwater systems in a stable clear water state (Scheffer, 1999). But due to severe eutrophication, cyanobacteria blooms have become a worldwide problem in freshwater ecosystems (Codd et al., 2005). Cyanobacteria blooms are harmful for fish, other aquatic communities and humans by the production of neurotoxins, heptotoxins (f.e. microcystins), cytotoxines and endotoxins. For this reason different lakes in Belgium were banned of recreation during 2010 due to a cyanobacterial blooms: Schulensmeer (Lommel), Donkvijvers (Oudenaarde), Paalse Plas (Beringen)… (VMM, 2010) Also *Daphnia* is sensitive to the toxins of cyanobacteria and declines strongly when cyanobacteria blooms occur (Ghadouani et al., 2003; Hansson et al., 2007), all the more in favour of the blooms.


Uninfected *Daphnia magna*


Daphnia magna infected with *White Bacterial Disease*

Investigations mostly focus on *Daphnia*-cyanobacteria-interactions, but in this research also a *Daphnia* parasite (*White Bacterial Disease*) is taken into account, by such achieving a more realistic effect of *Microcystis* on *Daphnia*.


On September 3th 2010 total recreation was banned out the "Donkvijvers" in Oudenaarde (Belgium) due to a cyanobacteria bloom (including *Microcystis*).


Colony of *Microcystis aeruginosa*


Cells of *Microcystis aeruginosa*

Results

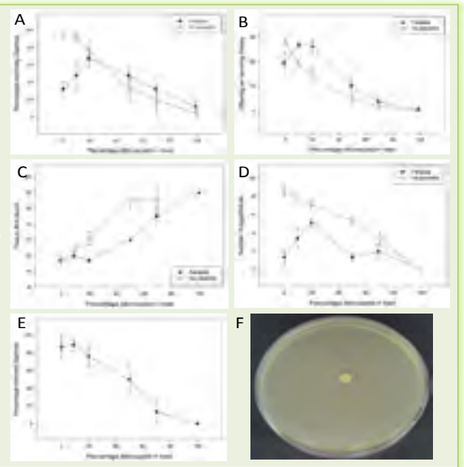
In this study, *Daphnia magna* was simultaneoulsy exposed to different concentrations of a non-microcystin producing cyanobacterium *Microcystis aeruginosa* and his parasite *White Bacterial Disease*. Infected hosts can easily be distiguished by their bright white adipose tissue with a slight greenish shine in reflected light.

Results show:
• A significant negative effect of *Microcystis aeruginosa* on *Daphnia magna* individuals. *Daphnia* survival (A), total offspring per surviving female (B) and clutch size (D) decreases, and time to first clutch (C) increases with increasing *Microcystis* concentrations.
• The parasite *White Bacterial Disease* had a significant negative effect on *Daphnia* by decreasing survival (A) and clutch size (D).

When *Daphnia* individuals were simultaneous exposed to *Microcystis* and *White Bacterial Disease*, interactions were most obviously seen between 0% and 20% *Microcystis*, thereby weakening unilateral effects of the parasite or the cyanobacterium concentration.
• The parasite effect is weakened by *Microcystis* in case of survival (A) and clutch size (D).
• The cyanobacteria effect is weakend by *White Bacterial Disease* in case of time to first clutch (C).

Moreover *Daphnia* individuals produce more individuals when exposed to both parasite and *Microcystis* (B). This rise can be due to an earlier first brood, but not to clutch size.

The positive effect of *Microcystis* on the parasite effect, can be explained by a reduction of the parasite *White Bacterial Disease* by *Microcystis* (E). A paper disc diffusion confirmed the antibacterial activity of the *Microcystis* lysate on *Escherichia coli* (F).



Conclusion

Low concentrations of a non-microcystin producing *Microcystis aeruginosa* protect *Daphnia* exposed to parasites from dying. Moreover these *Daphnia* have a higher fitness by a better survival and a higher production of offspring. So low concentrations of non-microcystin producing *Microcystis* are no harm and can even boost natural *Daphnia* populations thereby stimulating the decrease of phytoplankton and promoting the aquatic communities and the biodiversity of the lake.

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Evidence for recent expanded distribution of arbovirus and Malaria vectors in Belgium caused by man-made breeding sites

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RBINS COLLECTIONS

Ancient mosquito records from the period 1900-1960 were retrieved from a revision of the **Belgian Culicidae collection** at Royal Belgian Institute of Natural Sciences

Historic observed mosquito diversity
=Estimate of Historic diversity/distribution

MOSQUITO DIVERSITY
Per UTM 10x10km grid cell

MODIRISK

Standardised Collecting Technique
A recent inventory of native and invading mosquito species in Belgium; a dataset with records of a recent mosquito mapping

Mosquito Magnet Liberty Plus

1000 visited sites during 2007-2008

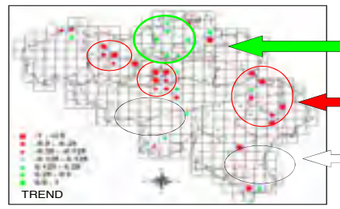
Recently observed mosquito diversity
=Estimate of Present diversity
Present distribution

1) Recent Belgian situation

Analyses with well surveyed grid cells in both periods

To correct for difference in sampling intensity and methods during both inventory systems we calculated a correction factor COR
=(ΣPresDiv)/(ΣFormDiv) = + 1.215.

For each of the well surveyed grid cells a trend criterion was calculated
TREND= [PresDiv – (ForDiv * COR)] / [(ForDiv * COR) + PresDiv]
With TREND value between
-1 (all diversity lost) and +1 (all diversity new)



INCREASE in mosquito diversity
Trend +0,25 <x>+1

DECLINE in mosquito diversity
Trend -0,25 <x> -1

No information on changes in mosquito diversity

Health Risk Assessment / Vector communities
RECENT CHANGES in MOSQUITO DIVERSITY in BELGIUM

+

CHANGING VECTOR COMMUNITY, vectors, =species from man-made breeding sites

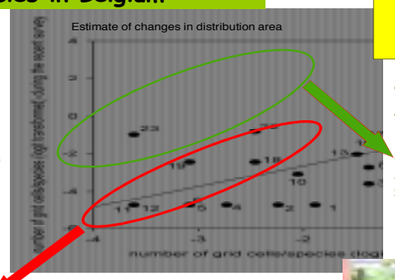
2) Estimate the relative changes in distribution area for each mosquito species in Belgium

Proportions in both surveys were calculated as P=(x+1)/(n+1) where x is the number of recorded grid cells for a given species and n is the total number of grid cells surveyed.

The logit-transformed proportions were calculated as logit(P)=ln[P/(1-P)]

The index of relative change in distribution area for each species was calculated by its standardized residual from the fitted regression line of logit (P) recent inventory versus logit (P) collections

(i) only grid cells that were well surveyed in both periods
(ii) species that were recorded in these grid cells.
56 grid cells and 23 species fulfilled these restrictions.



Culiseta morsitans
Aedes sticticus
Aedes annulipes

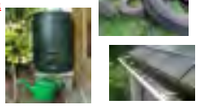
Species below the regression line decreased their relative distribution area

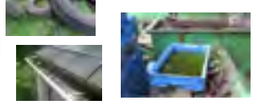
Species from forest and natural sites

Culex pipiens *Anopheles claviger*
Aedes vexans *Anopheles plumbeus*
Culex torrentium

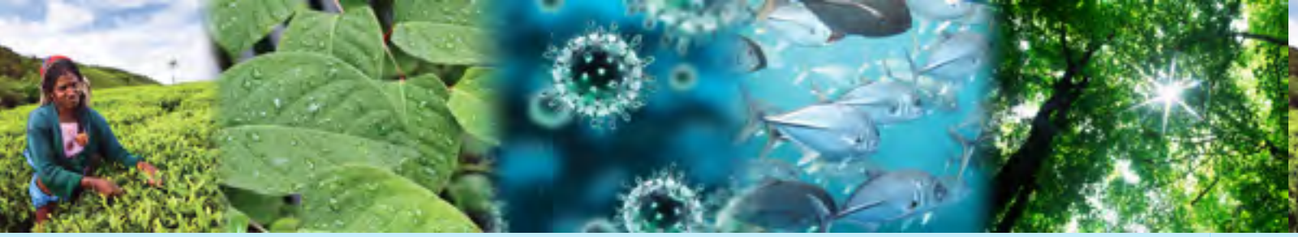
Species above the regression line increased their relative distribution area.

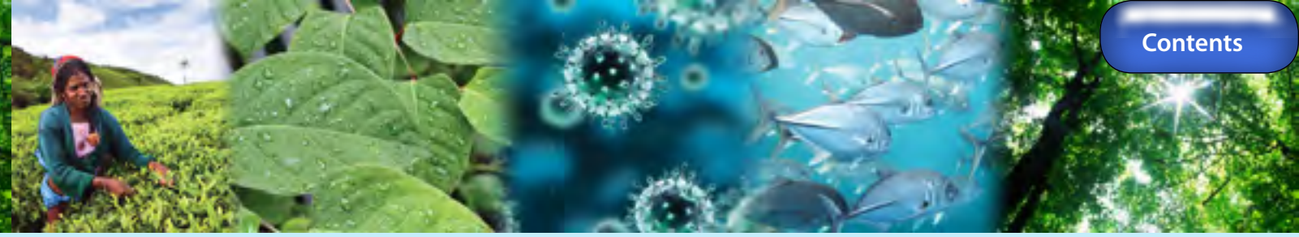
The majority of these species are vector for *Plasmodium* sp. and arboviruses;
+ species that breed in man-made sites





Acknowledgements: pictures by: J. Constant, F. Schaffner, data collected during MODIRISK project, INBO and RBINS-projects, thanks also to the RBINS Entomology collection team. References: Dekoninck W, De Keyser R, Hendrickx F, Kerkhof S, Van Bortel W, Versteirt V & Grootaert P. 2011. Mosquito (Culicidae) voucher specimens in the RBINS collection: remnants of a past glory or hidden treasure? *European Mosquito Bulletin*, 29: 13-21; **Dekoninck W**, Hendrickx F, Van Bortel W, Versteirt V, Coosemans M, Damiens D, Hance T, De Clercq EM, Hendrickx G, Schaffner F & Grootaert P. 2011. Expanded distribution associated with the use of man-made larval habitats of the day active mosquito *Anopheles plumbeus*, experimental vector of West Nile virus and a potential vector of human malaria in Belgium. *Journal of Medical Entomology*, 48(4): 924-928





Contents

The natural relation between biodiversity and public health: an ecosystem services perspective

Hans Keune*, Pim Martens, Heidi Wittmer*** & Johannes Förster*****

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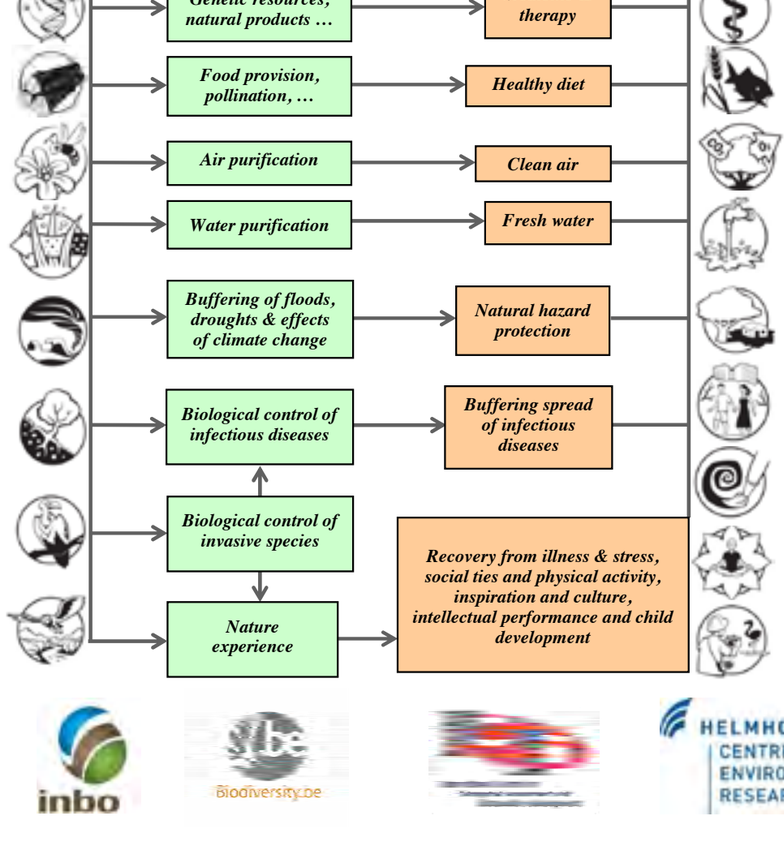
*** International Centre for Integrated Assessment and Sustainable Development (ICIS), The Netherlands*
**** Helmholtz Centre for Environmental Research – UFZ, Germany &TEEB scientific coordination*

2011 Belgian Biodiversity – Public Health Conference, Brussels, November 30

Biodiversity at all levels directly and indirectly influences human health.

'Sacred Cows and Sympathetic Squirrels' (Dobson et al. 2006) beautifully illustrates this natural relation. The cows, sacred in India for religious reasons, also serve as a buffer against the spread of malaria: they are bitten by mosquitoes that would otherwise bite humans. The squirrels are known for a similar buffer effect as they help prevent the spread of Lyme disease amongst humans. Control of infectious diseases is an important human-health related ecosystem service.

The relationships between biodiversity and public health are manifold :



Examples from TEEB cases
(available at www.teebweb.org)

Water tank rehabilitation benefits rural development, Sri Lanka: Intact water tanks provide multiple benefits for livelihoods including cultivation of rice, vegetables, fruits, lotus flowers and roots, water for domestic use and livestock.

Compensation scheme for upstream farmers in municipal protected area, Peru: Water users in the city of Moyobamba agree to pay an additional charge on their water bill for financing upstream watershed protection which secures water quality and quantity.

River restoration to avoid flood damage, USA: Restoring the natural ecosystems of the river banks of the Napa River prevents floods and related damages and creates new space for outdoor recreation, increasing the quality of life for residents.

Biodiversity decline can increase the spread of infectious diseases: The loss of diversity in small rodent species increases the risk for the transmission of diseases like the hantavirus. Practices and policies that maintain or enhance natural biodiversity can help to reduce the spread of diseases.

Natural Spaces and Health: Mapping Accessible Natural Greenspace in Wales, UK: Public green spaces enhance both mental and physical health. Local authorities in Wales promote health by increasing and making natural spaces accessible.

(c) Icons by Jan Sasse for TEEB

inbo · Biodiversity.be · HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH - UFZ

Modelling the spatial dynamics of pathogen transmission in tick-borne disease system

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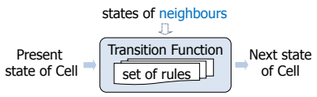
OBJECTIVE

To develop a **spatially-explicit** model, based on cellular automata (CA), to represent **spatial heterogeneity** and simulate **spatial dynamics** of a tick-borne pathogen in **non-static populations** of ticks, reservoir reproduction hosts.

BACKGROUND

Typical epidemic models are non spatial and assume an even spatial pattern for ticks, hosts and pathogen. These assumptions are rarely valid for tick-borne diseases. A CA model can simulate disease dynamics in a spatially explicit context.



A CA is a collection of **cells** on a grid of specified shape that evolves through a number of **discrete time** steps according to a set of **transition rules** based on the **states** of neighbouring cells.

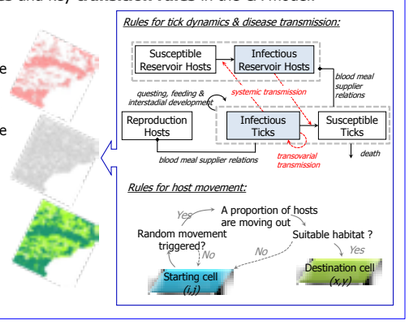
THEORY OF THE PROPOSED MODEL

Three layers of cell **states** and key **transition rules** in the CA model:

Tick population layer
- all post-egg life stages
- infectious vs. susceptible

Host population layer
- infectious vs. susceptible reservoir host
- reproduction host
- random movement

Landscape layer:
- static
- woodland vs. grassland vs. non-vegetation



RUNNING THE MODEL: CONSEQUENCES OF LANDSCAPE FRAGMENTATION

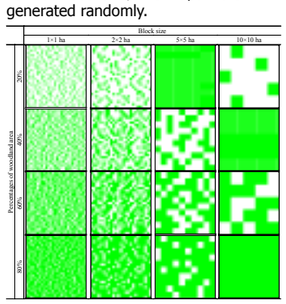
Scenarios

32 scenarios based on:

(i) two elements of **woodland (green area) fragmentation**:
- percentage of woodland
- size of block

(ii) two situations of **adjacent land cover (white area) types**:
- grassland (situation I)
- non-vegetation area (situation II)

For each scenario, five maps were generated randomly.

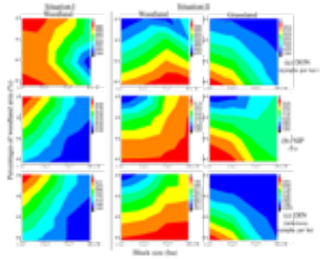


Model outputs

Indices of Lyme disease risks:

- **DON** (density of nypmhs)
- **NIP** (nymphal infection prevalence)
- **DIN** (density of infectious nymphs)

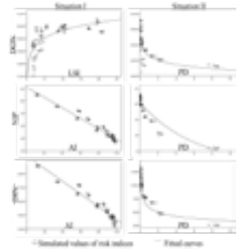
For each scenario, we averaged values of indices over the five maps.



Further analysis

Three landscape level metrics were obtained for woodland: **PD** (patch density), **LSI** (landscape shape index) and **AI** (aggregation Index)

Indices of woodland were regressed against metrics using linear, power and exponential regressions.



Findings

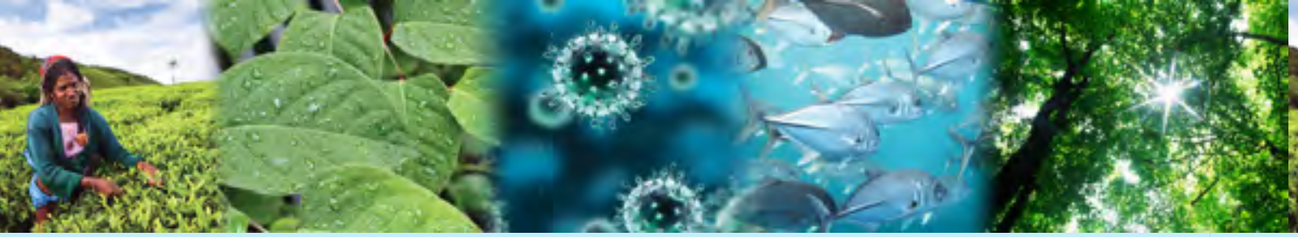
(i) Land cover adjacent to woodland had a major impact
(ii) Lyme disease risks in woodland and grassland responded differently to the variations of woodland coverage and block size
(iii) Sellected landscape metrics were all significant predictors to Lyme disease risks

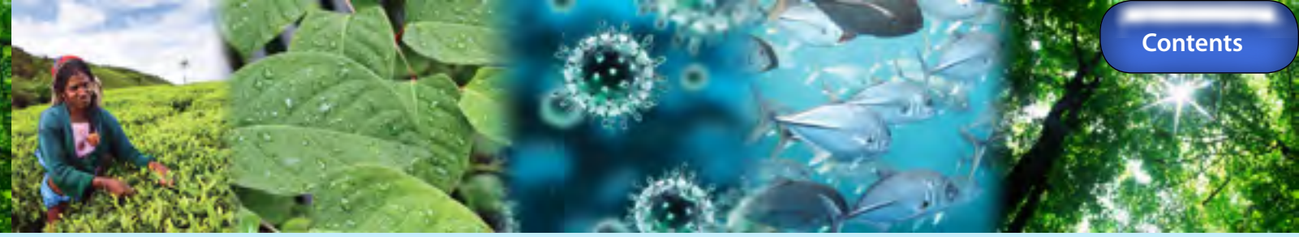
FUTURE DEVELOPMENT & APPLICATIONS

The proposed model can be:

- further developed to include **climatic influences** on tick biology (e.g. survival, questing activity, interstadial development, *etc.*)
- integrated with agent-based models to assess **human exposure** to tick-borne diseases;
- applied to specific real world cases (e.g. Lyme borreliosis in Belgium) to simulate the role of **landscape heterogeneity, climate changes** and **host composition & dynamics** on pathogen transmission.

Funded by:
FNRS





Contents

2011 Belgian Biodiversity & Public Health Conference - 30th November, 2011

Impacts of the volcanic plumes in North Kivu (D.R. Congo) Preliminary results

Caroline Michellier[1], Benoît Smets[1], Michèle Dramaix-Wilmet[2], Jean-Bosco Kahindo[3], François Kervyn[1]

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General Context

Our study aims at assessing the risk on population health and vegetation resulting from the volcanic plumes emitted by Nyiragongo and Nyamulagira, two of the most active volcanoes in Africa, located in the East Democratic Republic of Congo (DRC). Here are presented the studied region and the preliminary results.

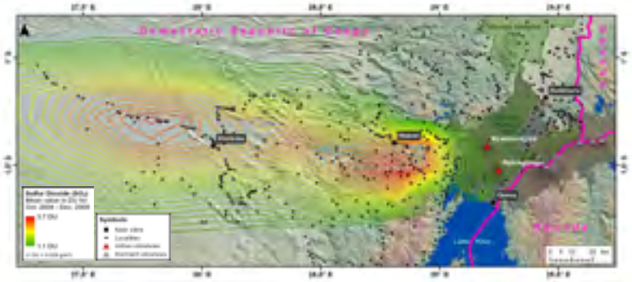

Figure 1 - Map of the studied area. Nyiragongo and Nyamulagira volcano are located in the Virunga, a volcanic chain of the East African Rift.

Nyiragongo (3470 m a.s.l.)
- Semi-permanent SO_2-rich gas plume
- Last eruption: 17th Jan. 2002 (0.093 Mt SO_2)
- SO_2 emissions = 2 to 50 kt per day (Carn, 2003; GORISK, 2010)

Nyamulagira (3058 m a.s.l.)
- Eruption every 2-4 years with huge release of SO_2.
- Currently in eruption.
- SO_2 emissions = 0.31 to 4.2 Mt per eruption (Bluth & Carn, 2008).

Virunga National Park (790 000 ha; 680 m to 5109 m a.s.l.)
- Endangered UNESCO World Heritage (illegal woodcuts, poach, etc.)
- One of the African national parks with the highest biodiversity, especially in terms of vegetation (equatorial forest, swamps, steppes, savannahs).
- Vegetation affected by volcanic activity.

The studied region
- Densely populated
- Very low standard of living.
- Goma region (>700 000 inhabitants) directly threatened by Nyiragongo lava flows (2002 eruption = ~150 victims, ~10% of the city destructed).
- Sparse appropriate medical infrastructure to face effects of the extended volcanic plumes.

Impacts of the volcanic plume on vegetation biodiversity

Direct impact
The response of vegetation to high atmospheric dose of volcanic SO_2 sustained exposure results in a strong reduction in the number of plant communities (Delmelle et al, 2002).

Indirect impact
Rainwater + acidic gases = acidic rainfall and mist
Consequences: foliar injuries for a large number of plants, which participate to deforestation (WHO Air Quality Guideline, 2005)

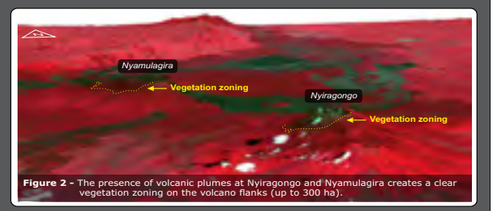

Figure 2 - The presence of volcanic plumes at Nyiragongo and Nyamulagira creates a clear vegetation zoning on the volcano flanks (up to 300 ha).

Impact of the volcanic plume on public health: preliminary results

Sulfur dioxide from eruptions and degassing events are commonly associated with acute respiratory infections (ARI) as well as eye and skin irritations (e.g. Hansell & Oppenheimer, 2004), but the risk has not yet been assessed in the Nyiragongo-Nyamulagira region. CEMUBAC (ULB's NGO; RMCA's partner in the GORISK project) is supporting the health information system in the DRC (15-year data collection). After data selection (80 health centres under the average SO_2 plume; 4 studied pathologies, ARI kept), data cleaning (double data checking) and statistical imputation (data gap removal)), and based on the hypothesis that the ARI risk decreases accordingly to the increasing distance to volcano, ARI data were plotted (Figures 3 to 7).

ARI Relative Risk (RR) decreases with distance (Poisson regression): with reference health centres (RR = 1) located >102 km from the volcano, RR = 2.61 [1.57; 4.35] for health centres ≤26 km; RR = 2.63 [1.61; 4.30] for those >26 to ≤48 km; RR = 1.93 [0.99; 3.75] for those >48 to ≤102 km.

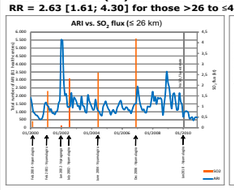

Figure 3 - The ARI cases number is relatively stable. A huge peak following the Nyiragongo 2002 eruption is observed, despite low SO_2 discharges. It could be due to both gas bursts and emanations around lava flows as well as ash falls.

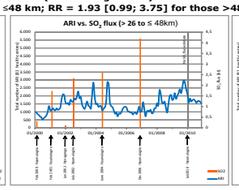

Figure 4 - Data correspond to the highest region (1500 to 2500 m). The high altitude could explain part of the respiratory morbidity. Seasonal effect should be statistically study (time series analysis).

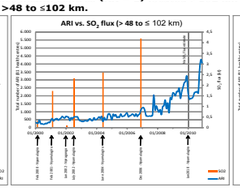

Figure 5 - No apparent relationship is observed >49 km from the volcanoes. The ARI cases number increasing registered from 2006 is mainly due to data collection extended to additional health centres in this area.

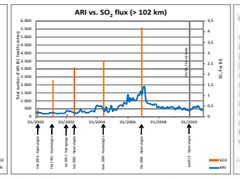

Figure 6 - The trend is stable, apart from the 2005-2007 period. Although the paroxysm in ARI cases number is recorded just after the 2006 Nyamulagira eruption, it requires more statistical researches.

Figure 7 - 2002: the high RR is a possible consequence of the Nyiragongo eruption. 2008-2010: High RRs could be due to the massive presence of refugees around Goma, fleeing conflict situation.

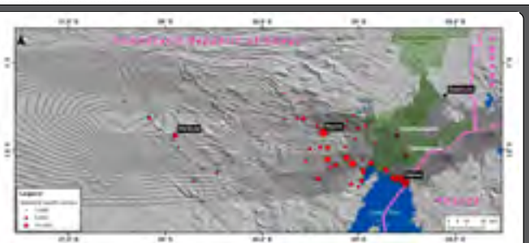

Figure 8 - Map of the studied area with total number of ARI cases, from 2000 to 2010.

Concluding remarks

- Not possible to conclude at any relationship between ARI and SO_2 concentrations, despite study results from other volcanic areas (e.g. Hansell & Oppenheimer, 2004).
- The ARI cases number 2002 peak contrasts with low SO_2 discharges linked to the Nyiragongo 2002 eruption.
- The preliminary results require statistical approach as *times-series* analysis to reduce the seasonal data effect.
- New spatial and statistical approaches can be developed: e.g. using population age groups, origin of the population (close to the health center or further), etc.

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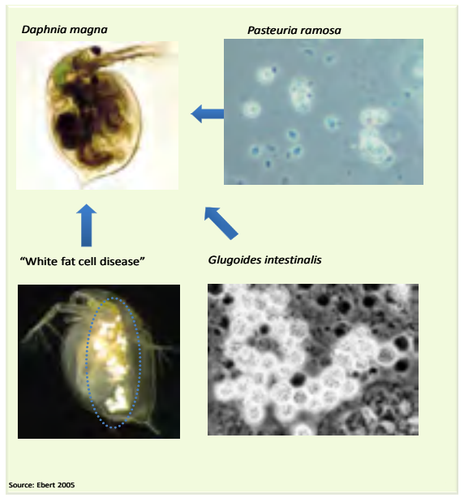
The effect of a changing N:P stoichiometric ratio on *Daphnia*-parasite interactions

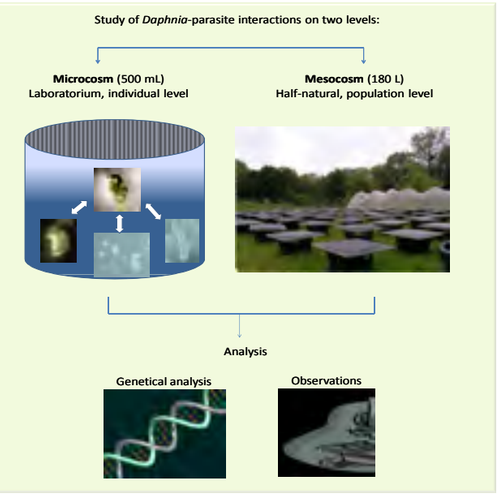
Lien Reyserhove, Koenraad Muylaert, Ellen Decaestecker

Scientific aim

Environmental fluctuations are often excluded from host-parasite coevolutionary studies. The proposed research project aims at obtaining insight into the influence of changes in ecosystem quality, focusing on a changing N:P ratio and the effect on eco-evo dynamics in *Daphnia* with respect to parasitism. We will focus on multiple parasite species, differing in growth rate and competitive ability, two aspects assumed to be affected by P-limitation ('growth rate hypothesis'). We will first evaluate the short-term effects of elemental constraints on *Daphnia* parasitism, focusing on within-host parasite competition. Then, we will test the effect of a changing N:P stoichiometry on (i) population level, (ii) *Daphnia* microevolutionary changes and (iii) the top-down control of phytoplankton by *Daphnia*. P-limitation could lead to a reduced 'top-down control' of the phytoplankton, which in turn could reduce the efficiency of the current efforts to reduce P-emissions in natural ecosystems; an effect that we hypothesize to be affected in a parasitized ecosystem.

Methodology





Expected results

We expect that the effect of a changing N:P stoichiometrical ratio will depend on the presence of parasites. We suggest that a changing N:P stoichiometric ratio will result in a higher virulence and a lower infectivity and infection-intensity of the parasites

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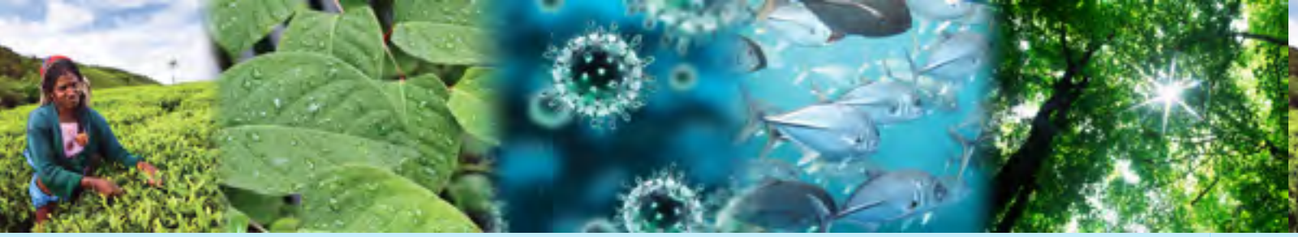

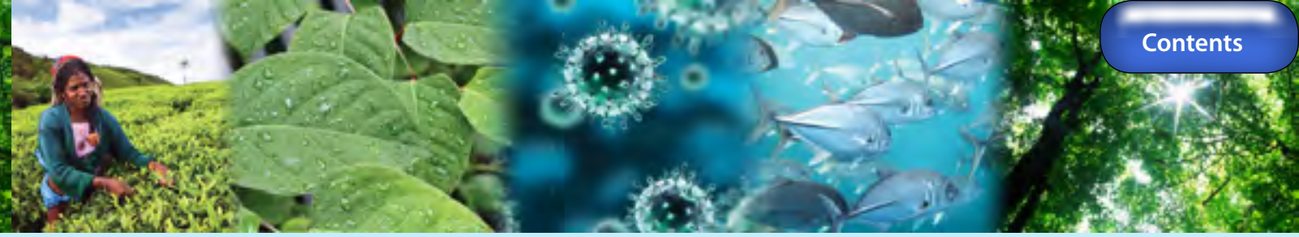

Contents

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Converting pine plantations to mixed species forests:
Implications for *Ixodes ricinus* ticks and public health

Introduction

At present, large areas of northern Belgium are dominated by homogeneous pine plantations on nutrient-poor and acid sandy soils. However, in common with many other parts of Europe, the current forest management aims at increasing the share of deciduous and mixed forests, which might create more favourable habitats for the sheep tick (*Ixodes ricinus*). This tick species is Europe's main vector of Lyme disease, now the most prevalent vector-borne disease reported in the northern hemisphere.

Considering the threat to human health, it is important to know which factors regulate tick abundance. Adequate vegetation cover, providing protection against adverse environmental conditions, and access to host animals for feeding and reproduction are essential for the survival and development of *I. ricinus* ticks. We selected forest stands varying in dominant tree species (pine or oak), shrub cover and herb layer abundance to determine the importance of those factors and to evaluate the impact of forest conversion on tick abundance.

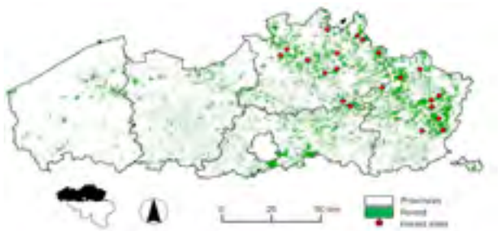

Fig 1. Map of northern Belgium showing the location of the 21 forest sites sampled.

Material & Methods

Study site and experimental design. Fieldwork was carried out at 21 forest sites in northern Belgium (Fig. 1). At each forest site, 5–15 forest stands were selected for tick sampling. A total of 176 forest stands were sampled, 109 of which were pine stands (*Pinus* spp.) and 67 were oak stands (*Quercus* spp.). Of the selected forest stands, 37% had less than 10% shrub cover, 30% had a shrub cover of 10–50%, and 33% had more than 50% shrub cover. The following local habitat measurements were used for the analysis: main tree species (pine or oak), shrub cover and herb cover.

Tick sampling. Questing ticks were sampled from the vegetation by drag sampling, using a white flannel blanket (1 m × 1 m) attached to a wooden dowel (Fig. 2). Each forest stand was visited once between July and September 2009. Four 1-min blanket drags, each of them covering 25 m of distance, were established at random in each stand. After each drag, ticks were removed from the blanket using forceps and stored in 70% ethanol for later identification and counting in the laboratory.

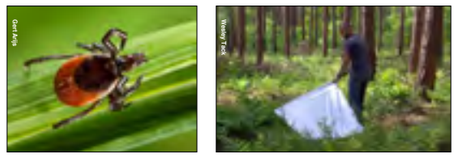

Fig 2. Left: a female *Ixodes ricinus* tick. Right: collecting ticks by drag sampling.

Results

A total of 25,204 *Ixodes ricinus* ticks were collected: 21,502 larvae, 3,456 nymphs and 246 adults. All life stages were found at each of the 21 forest sites sampled. The results indicated a significant effect of tree species and shrub cover for all three life stages ($P < 0.001$). The herb layer cover and the interaction terms were not related to tick abundance. The abundance of larvae, nymphs and adults was significantly higher in oak stands compared to pine stands, and a significant positive effect of shrub cover was found for all three life stages (Fig. 3). Oak stands with high shrub cover yielded 6–7 times more ticks than pine stands with low shrub cover.

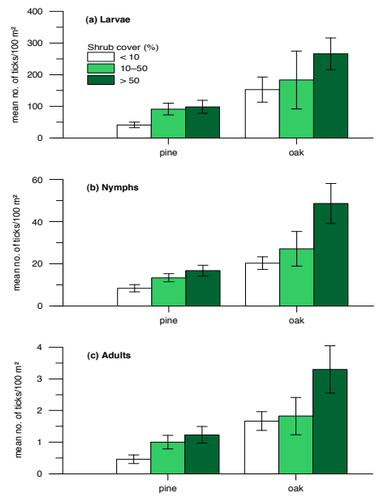

Fig 3. The effect of shrub cover on the abundance of *Ixodes ricinus* ticks in pine and oak stands. The shrub cover estimates were grouped into three classes: low (< 10%), intermediate (10–50%), and high shrub cover (> 50%). Bars represent the mean (± SE) number of ticks per forest stand. Note the difference in values on the y-axis.

Conclusions

Ixodes ricinus ticks occurred throughout the study area, which means the entire region represents an area of risk for contracting tick-borne diseases such as Lyme borreliosis. At the forest stand level, the main tree species and the shrub cover significantly affected the abundance of all life stages of *I. ricinus*. The abundance was higher in oak stands compared to pine stands and increased with increasing shrub cover. These patterns may be explained by the habitat preference of the tick's main hosts, such as roe deer (*Capreolus capreolus*). Our results suggest that forest conversion might create more suitable habitats for ticks. As forest-based tourism and recreation are likely to increase in the future, there is a growing demand for efficient and effective tick control. The results obtained in this study supports the use of vegetation management as a tool to control ticks.

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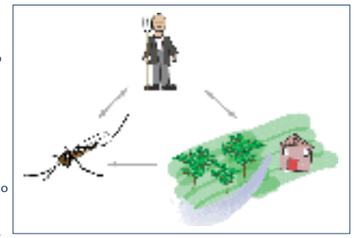
Landscape and vector-borne diseases : a complex interaction illustrated with mosquito- and tick-borne diseases

Sophie O Vanwambeke *sophie.vanwambeke@uclouvain.be*

INTRODUCTION



Vector-borne and zoonotic diseases have strong ties with the environment in relation to vectors, hosts and pathogen development.
A number of these environmental influences can be identified at the landscape level. Such factors, however, do not simply describe suitable habitats for vectors and hosts. Indeed, landscapes result from the combination of several elements potentially influencing the distribution of vector-borne and zoonotic diseases, especially if the degree of human exposure is considered. Indeed, landscapes result from physical factors as well as from the activities of human yesterday and today. Several major characteristics of landscapes can be considered: whether their environment is suitable for vector and host populations (depending on land cover); whether the local human population is likely to enter the vector or host habitats on a regular base (depending on land use); and whether the spatial distributions of these two aspects are likely to intersect, through access rules (as a function of land ownership). We illustrate the richness of the landscape concept for the study of vector-borne diseases based on mosquito-borne diseases and tick-borne diseases.

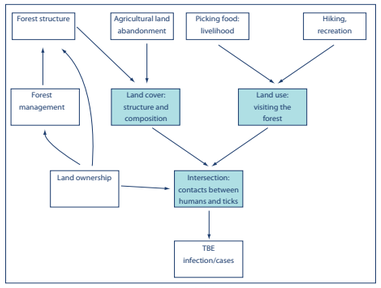
LAND COVER INFLUENCES THE DISTRIBUTION OF INFECTIOUS VECTORS

Mosquito larvae were trapped in Thailand and the value of land cover variables extracted from remotely sensed data with the help of a GIS were tested. Land cover variables were as efficient at predicting the presence of larvae than larval-habitat level variables. For example, the presence of *Anopheles minimus* larvae, an important malaria vector, was associated with the importance of forest around the larval habitat, but also of villages (where streams where *An. minimus* breeds are also found).

LAND USE INFLUENCES THE DISTRIBUTION OF SUSCEPTIBLE HUMANS

Humans use land for various purposes and visit parts of the landscape for various activities, and different times of the day or year. In Hawaii, the distribution of human populations corresponding to various activities (i.e. uses of the land) were mapped, and overlaid with *Aedes albopictus* distribution. The resulting maps effectively represent the vector-to-host ratio used in epidemiological models. They indicate that various land uses (here residential and recreational) correspond to various levels of risk. Recreational activities all take place in places with high mosquito density.

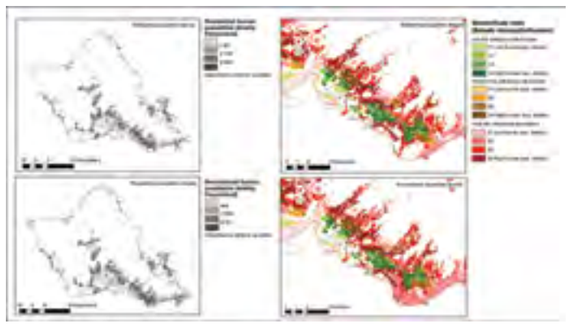
LAND OWNERSHIP REGULATES THE OVERLAP BETWEEN INFECTIOUS VECTORS AND SUSCEPTIBLE HUMANS



In a study of the spatial distribution of tick-borne encephalitis (TBE) in Latvia, the role of forest ownership was investigated using census data as well as customised land cover maps. It was found to be a significant variable for explaining the spatial distribution of TBE. Public forests are indeed accessible to anyone wishing to visit a forest (for hiking or forest produce collection) whereas access to private forests can be restricted. However, different ownership correspond to different management practices
(e.g. intensity of clearcutting, plantation or natural regrowth) that may influence the attractivity of these forests to humans and the habitat suitability of ticks and their hosts

LANDSCAPE ATTRACTIVITY INCREASES VISITS TO HIGH-RISK AREAS

In this study, we investigated the environmental risk factors around settlements where TBE infections have been recorded, using standard land cover and GIS data. Apart from land-cover, the provider of suitable habitat for the tick-vector and its hosts, we investigated the effect of variables related to land-use, and more specifically, we investigated the factors describing the attractivity of the landscape for human risk activities, such as leisure outdoor pursuits. This includes factors such as the accessibility, the availability of infrastructures for visitors (such as holiday houses), and the landscape features attractive to holiday goers, such as lakeshores. Preliminary results indicate that the probability of TBE presence is higher is place attractive to people, through road accessibility, the proximity of seashores and large settlements, the availability of infrastructure. Effects of the land cover structure (on ticks and their hosts, and on attractivity, need to be clarified.



CONCLUSION

The concept of landscape as defined by geographers, that is, as being shaped by physical as well as cultural, economic and other human factors, is extremely useful for understanding the distribution of vector-borne diseases. The studies presented above indicate that there are many "layers" in the landscape concept that are relevant to disease transmission, giving insight into the ecology of the transmission cycle but also into human exposure. Tools for documenting are varied and range from detailed field survey, through classical census data, to standard or customised land cover maps. This data can then be overlaid and processed in a GIS before being analysed using either empirical statistical models or process-based models. There is much promise in the developments of spatially-explicit models of disease transmission that elaborate on the landscape principle.

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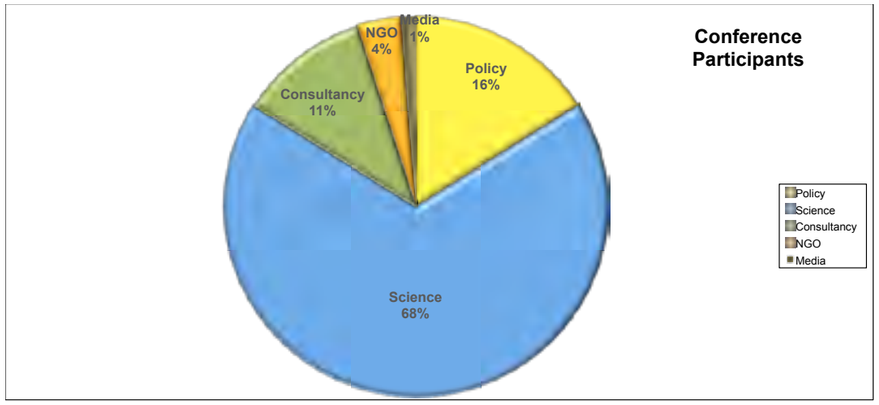
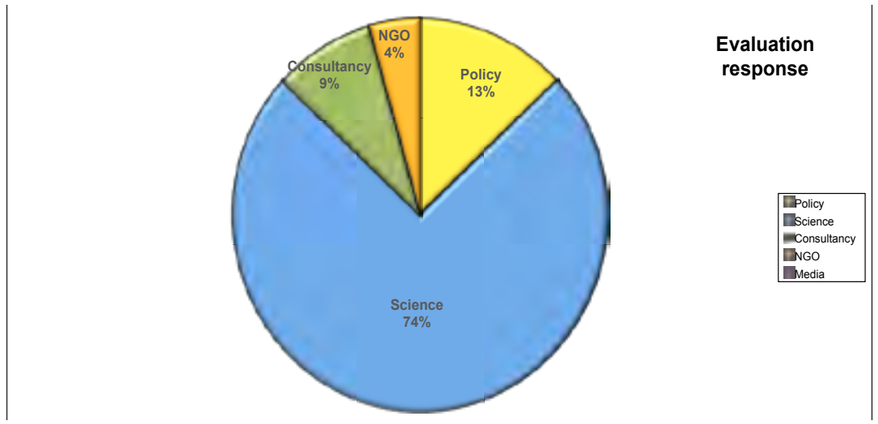
The organisers of the conference asked participants to give their feedback on the conference in a short questionnaire. Almost 30% of the participants responded:

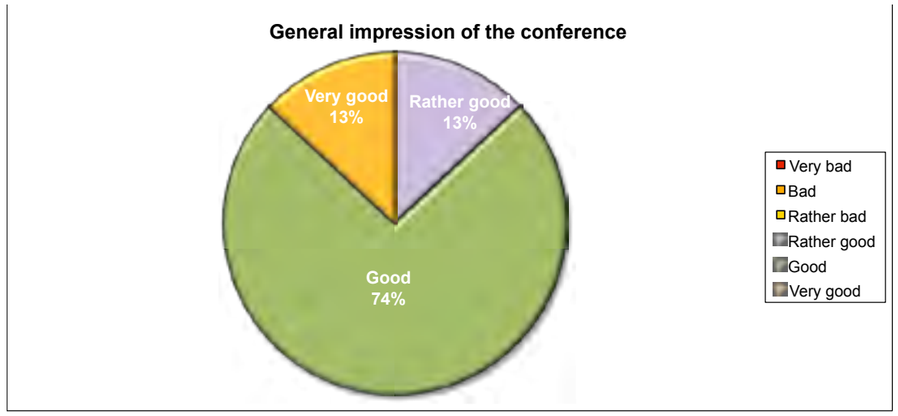
Response rate						
	Policy	Science	Consultancy	NGO	Media	Total
Participants	13	55	9	3	1	81
Response	3	17	2	1	0	23
Response rate	23,10%	31%	22,22%	33,33%	0%	28,40%





1. What is your general impression of the conference?

The general impression of the conference was positive:



Some comments:

"Very interesting, but a lot of (too many ?) different aspects in a short time, thus also few time for networking for people who did not already know each other."

"The overall intention was excellent, and I was happy to see that the organizers succeeded in bringing policy makers together with researchers. Everything worked quite well, though I would have preferred a deeper room to a wider room. I especially appreciated the inclusion of workshops in the program, allowing for substantial exchange among participants."

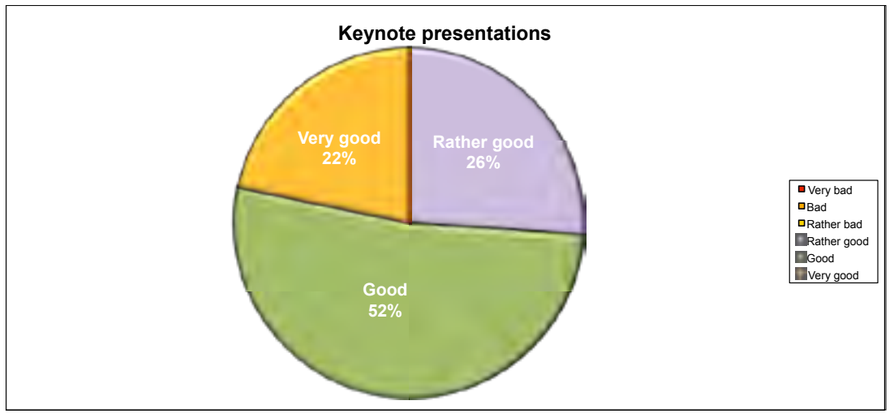
"This obviously was a first attempt at bringing together science and policy making. Much more efforts will be needed to achieve long term results. At this stage focus should be on getting scientists to agree on the link between biodiversity and public health. This was still very unclear at this stage, and it may have confused decision makers."

"I liked the initial goals of the conference, but it seems as though the approach to each these goals was not focused enough. A focused approach would be to simply categorize all possible views on this topic and next to identify priorities in each category. This is what the conference tried to do, but the final step of gathering all ideas seemed a bit too difficult. Maybe the different views on public health differed too much to be able to come to a joint conclusion?"

"Good initiative, but too academic, reality is broader."
"Next time we need more medical/public health people!"
"Great mix of people. Challenging to organize but I would say, a success."

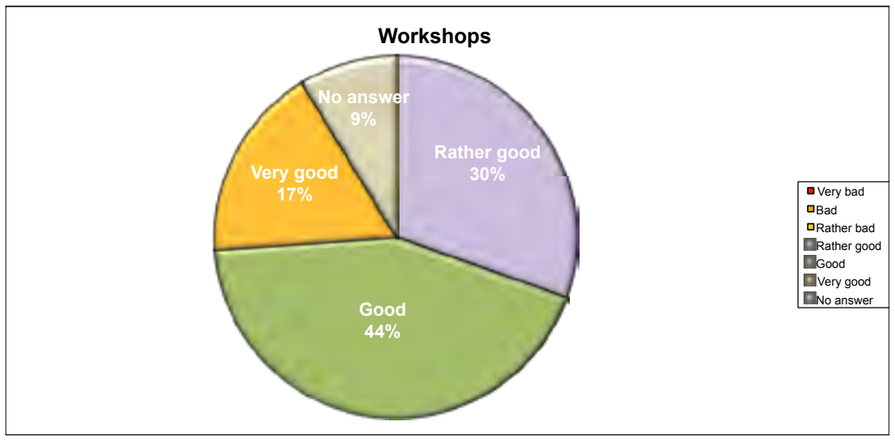
2. What is your impression of the keynote presentations?

The keynote presentations were positively evaluated:$



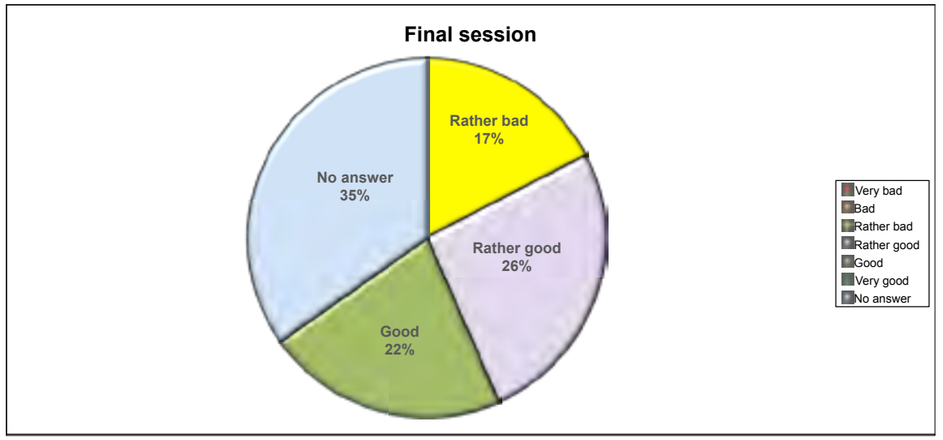
3. What is your impression of the workshop you attended?

Most participants appreciated the workshop they attended:



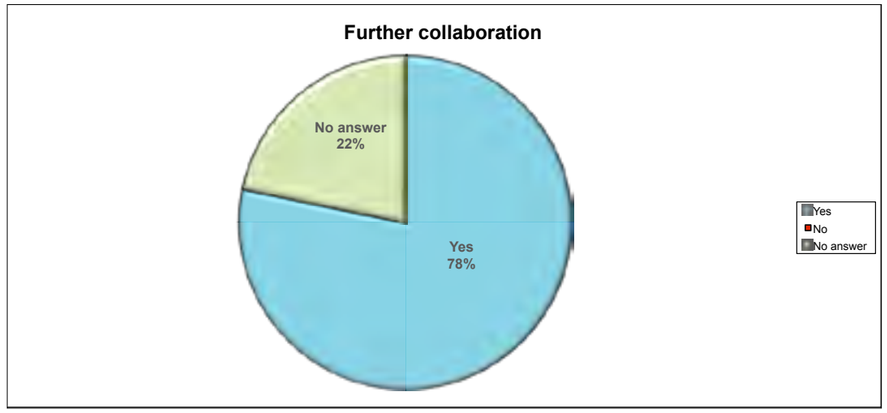
4. What is your impression of the final panel discussion?

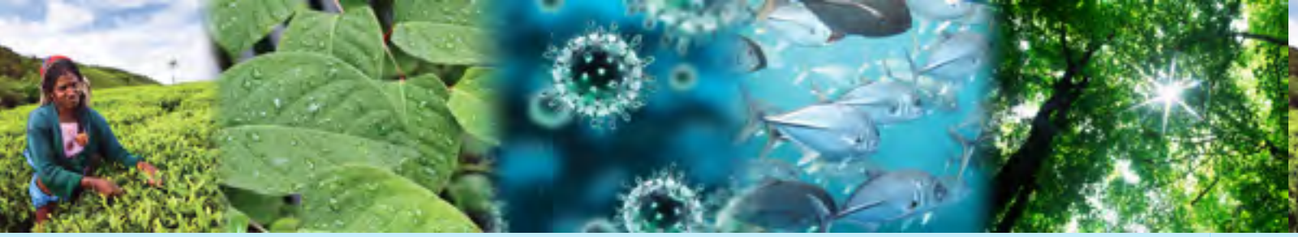
Mixed feelings are observed on the final panel discussion:



5. Are you interested in further collaboration on Biodiversity - Public Health?

Almost 80% of the respondents indicated they would be interested in further collaboration on Biodiversity - Public Health:





Some ideas that were suggested by participants:

"Prepare a short position statement note suitable to communicate with relevant expert organisations and institutions. Prepare a discussion note on next steps regarding organization of the network. Prepare a short note on a limited number (3?) of emerging research questions."

"Monitoring biodiversity in rural and suburban areas."

"A concrete proposal would be to integrate the lessons learned from the conference into a statement for publication in a relevant journal."

"1. Not too much emphasize on reports but focus on real exchange between people and disciplines. 2. Experience focused approach, by creating a mixture between the mental level and the experience level, which would not be harmful for scientists, on the contrary.
3. Involve more people from a diversity of contexts to give presentations, not only scientists. Otherwise you risk inward looking in academic circles, when the outside world (reality) is not always in accordance with scientific findings. The bio-divers system of humans and nature is more than the sum of the parts, but instead is an interactive interplay of many actors, not only scientific research. My main message is: invite more people from many contexts who are dedicated to biodiversity, it is only then you can reach an integrated full picture. A challenging opportunity."

"Yes, It's important to organize such meetings at the Belgian level. Also interesting for the communication between scientists and policy makers."

"Catalogue of health – biodiversity link. Cost benefit study."

"Direct concrete ideas are situated within the field of evaluating and the impact of biodiversity on rodent borne zoonotic disease transmission. I liked the idea about conflicting interest between species conservation through restoration of specific habitats and its impact on species invasion and introduction or re-emergence of zoonotic pathogens. Biodiversity from the conservation point of view is extremely important and should remain first priority. Nevertheless it is interesting to consider possible secondary effects of certain changes in land use, but also land disturbance, habitat quality, … on zoonotic disease risk."

"Yes, indeed, to consider the biodiversity of prokaryotes and viruses, I'm concerned by the virodiversity that is not really considered by the biodiversity (of course, I understand that the society does not perceive biodiversity in that way)"

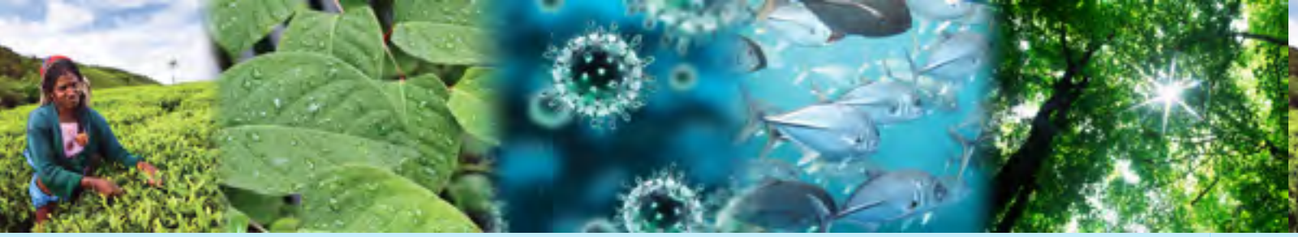
"Yes. Networking on concrete, and societal relevant topics."

Participants evaluation

"Yes. Continuity would be great. A COHAB course sounded nice (and potentially an idea to remove further disciplinary divides (as was still reflected by most workshops)."

"I would definitely suggest to continue working on the issue at the Belgian level. There is much research needed at the interface health-biodiversity-ecosystem services, as well as awareness raising in the scientific, policy-maker and educational communities of both biodiversity and health stakeholders. Regarding the timing, I would probably suggest holding several small-size, and more focused workshops throughout the two years to come. This will help gather the scientific community around a common interest, would generate the much needed case studies at Belgian level and would start a dynamic that can lead to policy changes. For example, these workshops could take a similar form as those under the BEES project."

"The "e-forums" of the Belgian Biodiversity Platform have been used on several instances to exchange ideas and information, at the time when it was needed to gather momentum for scientific suggestions for policy changes (cf. the forest forum and the alien species forum). An 'e-forum' on health and biodiversity could be created, pending there is one or a few moderators ready to maintain the discussions going. It does not need to have a permanent life-span, but at least could be used for a limited period of time."



The need for a Belgian Community of Practice on Biodiversity and Public Health

A broadly supported generic outcome of the conference was a need for further capacity and network building. Therefore in February 2012, a policy brief was issued (Bauler et al. 2012) in which a variety of experts (science, policy, society) call for the support for the establishment of a Belgian Community of Practice on Biodiversity and Public Health. A Community of Practice (CoP) is a network made up of individuals and organisations that share an interest and practice, who come together to address a specific challenge, and further each others' goals and objectives in a specific topic area (Wenger and Snyder 2000; Meessen et al. 2011). An interesting international example is the Canadian Community of Practice in Ecosystem Approaches to Health (COPEH).

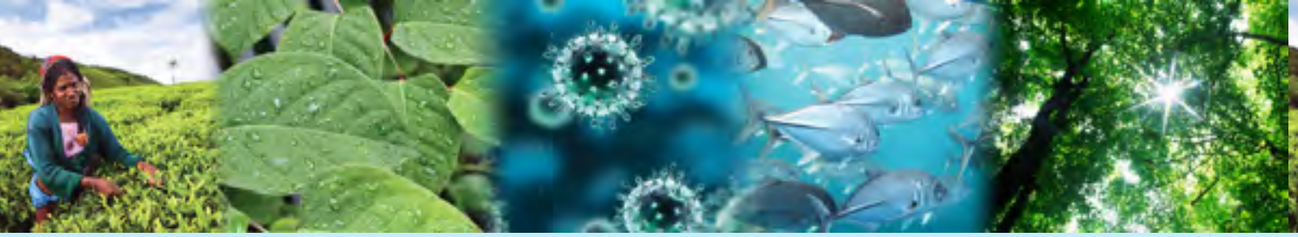
A Belgian Community of Practice on Biodiversity and Public Health would aim to build a strong network, stimulate capacity building and to produce an overview of the current state of Belgian knowledge capacity regarding Biodiversity and Public Health. Furthermore it would have the ambition to facilitate response to the demands of policymakers and stakeholders regarding Biodiversity and Public Health expertise at the Belgian level as well as at the international level in the context of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[5].

Copies of the policy brief in different languages can be found on the following pages and on the Belgian Biodiversity and Public Health website[6]. Currently the conference organisers are working on a scientific publication reporting on the conference outcomes and the need for the establishment of a Belgian Community of Practice on Biodiversity and Public Health, that hopefully will gain support as a funded cluster project.

5 http://www.ipbes.net
6 http://www.biodiversity.be/health

Policy Brief

The need for a Belgian Community of Practice on Biodiversity and Public Health



Biodiversity and Public Health are closely related

Biodiversity impacts Public Health in various ways [1-7]. First of all, biodiversity is safeguarding the quality of food, air, water, and providing resources for medicine (traditional or modern) as well as aiding stress reduction and management of cognitive resources, stimulating social ties and physical activity, and supporting development over the lifespan for those experiencing nature. Moreover the contribution of biodiversity to disaster mitigation (e.g. flooding or drought) and the control of the increasing threat of infectious diseases (in Belgium e.g. Hantavirus, Lyme and other tick-borne diseases; in Europe e.g. West Nile virus, Chikungunya, Leishmaniasis) is of utmost interest in terms of public health and cost to society. The large media coverage of a breakthrough in linking micro-organism diversity and human health[8, 9], involving Belgian researchers, illustrates the societal relevance and interest in the topic. In addition, according to McMichael[10], *"Human population health should be the centra criterion, and is the best long-term indicator, of how we are managing the natural environment."* The 2001 - 2005 Millennium Ecosystem Assessment in collaboration with the World Health Organization, dedicated a full report[6] to the relation between ecosystems/biodiversity and human health. Public Health is also one of the priority societal challenges identified in the European "Horizon 2020" strategy[11] for research and innovation.

Biodiversity and Public Health in Belgium: an emerging field of interest

Research on the linkages between biodiversity and public health is an emerging issue that nevertheless has not received much concerted attention in Belgium to date. Considering that the issue attracts the interest of various scientific disciplines, including biodiversity, public health and social sciences, an interdisciplinary approach is called for. Promoting new linkages and collaboration amongst these disciplines, to propose appropriate new research ideas and topics is of priority interest. The expertise arising from such interdisciplinary research potentially has substantial added value for policy making. This will e.g. allow Belgium to live up to the Belgium Biodiversity Strategic[12] aim of maximising the advantages for human health arising from biodiversity and expand the collaboration between the interested organisations / public services. To promote the integration of such expertise into relevant policy at different levels, a transdisciplinary approach is called for to ascertain the involvement of relevant stakeholders from different sectors of society in the development of a research agenda and projects.

On November 30th 2011, the Belgian Biodiversity Platform organized the first Belgian Biodiversity and Public Health[13] conference. The meeting attracted 81 Belgian experts, 68% of whom were scientists (universities and governmental scientific institutes; health-, ecological- and social science), 16% represented policy interests (Federal, regions, provinces, cities; health-, environmental-, nature- and land planning policy), and the remainder comprised of consultants (policy advice, eco-therapy, education) and persons involved in NGOs (nature protection, landscape development, ecological life and gardening), or from media.

Discussions during the conference focused on priority scientific and policy challenges and resulted in the identification of several topical issues of priority interest. A general need for further capacity and network building was highlighted. This will require structural follow up of activities for science to adequately address societal challenges related to the Biodiversity and Public Health domain.

** A Community of Practice (CoP) is a network made up of individuals and organizations that share an interest and practice, who come together to address a specific challenge, and further each others' goals and objectives in a specific topic area[14, 15, 16]. An interesting international example is the* Canadian Community of Practice in Ecosystem Approaches to Health (COPEH)[14]. *This CoP has vast experience in establishing collaborative relationships and capacity building.*

A Belgian Community of Practice on Biodiversity and Public Health

Conference participatns call for **the establishment of a Community of Practice* on Biodiversity and Public Health in Belgium** which will:

-Build a strong network and stimulate capacity building
-Produce an overview of the current state of Belgian knowledge capacity regarding Biodiversity and Public Health
-Respond to the demands of policymakers and stakeholders regarding Biodiversity and Public Health expertise at the level of Belgium as well as at the international level in the context of the establishment of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)

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13. 2011 Belgian Biodiversity - Public Health Conference, http://www.biodiversity.be/health
14. Canadian Community of Practice in Ecosystem Approaches to Health (COPEH), http://www.copeh-canada.org/index_en.php
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16. Wenger E. and Snyder W. M. (2000), *Communities of Practice: The Organizational Frontier,* In: Harvard Business Review, January-February 2000, pg 139 – 145.

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Wesley Tack and Christel Cochez

Lucette Flandroy


Catherine Linard and Sen Li


Francis Turkelboom

Alain Peters and Anne Franklin


Heidi Wittmer


Ilse Simoens and Geert de Blust

Aiko Gryspeirt

Appendix 1: Programme of the conference

MORNING (8.30 - 13.00)
9.00 - 11.15 Plenary session

Introduction by Hans Keune (Belgian Biodiversity Platorm)

Conor Kretch: "Reducing Risks: Linking Biodiversity and Human Health in Policy and Practice"

Terry Hartig: "Linking Health with Nature Experience: Restoration and Other Pathways" (9.45

Pim Martens: "Biodiversity and health: friends or foes?" (10.15 - 10.45)
Marc van Ranst: "Zoonotic infections: a changing landscape in Belgium" (10.45 - 11.15)

11.30 - 13.00 First (parallel) workshop sessions

Presentations of discussion papers/ statements

Group discussion: main research challenges

13.00 - 14.00 Poster session

AFTERNOON (14.00 - 17.30)
14.00 - 15.30 Second (parallel) workshop sessions

Group discussion: main research recommendations

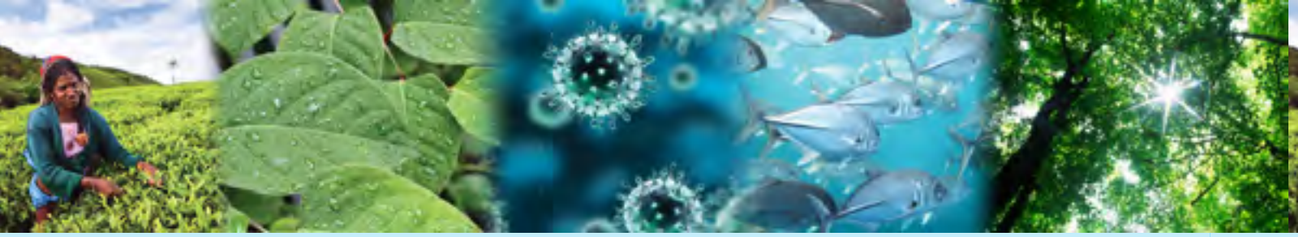
15.45 - 17.15 Plenary session

Reporting from the workshop discussions by workshop representatives

Interactive panel discussion: reflecting on the outcomes and on the way forward for this starting community of expertise
Panel members: Workshops representatives
Moderator: Geert De Blust (INBO)

17.15 - 17.30 Closure of the conference

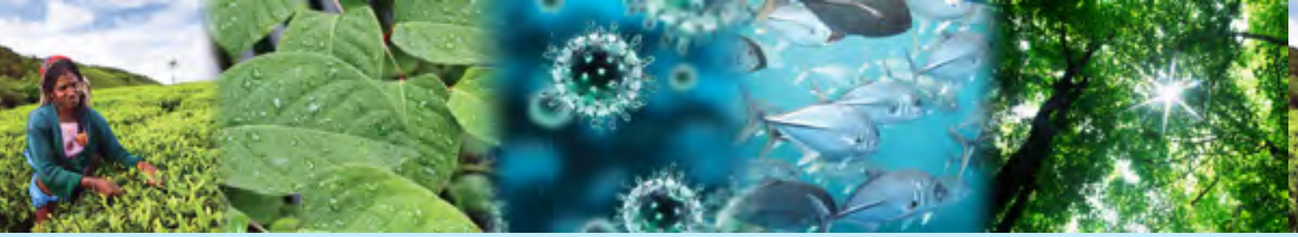
By Jurgen Tack (Director of INBO and member of the Board of Directors of the Belgian Biodiversity Platform)



Participants 2011 Belgian Biodiversity – Public Health Conference		
Name	***Institution***	***Workshop***
Registered for a specific workshop		
Guy Hendrickx	Avia-GIS	*Vector-borne diseases, diversity and public health*
Katrien Tersago	UA	
Veerle Versteirt	ITM	
Etienne Thiry	ULG	
Caroline Zeimes	UCL	
Charles Denonne	FPS Health, Food Chain Safety and Environment	
Darren Drewry	Max Planck Institute	
Paul Heyman	Military Hospital	
Christel Cochez	Military Hospital	
Wouter Dekoninck	RBINS	
Thibaud Rigot	ULB	
Tine Huyse	KUL	
Aiko Gryspeirt	ULB	
Dieter Decleene	EOS-magazine	
Kristof Baert	INBO	
Sen Li	UCL	
Samia Hammadi	WIV/ISP	
Valerie Obsomer	UCL	
Ana de la Grandière	ULG	
Estelle Balian	Belgian Biodiversity Platform	
Aaike De Wever	Belgian Biodiversity Platform	
Sophie Vanwambeke	UCL	*Spatial tools for studying environment and health*
Els Ducheyne	Avia-GIS	
Marius Gilbert	ULB	
Caroline Michellier	Africa museum	
Denis Etiendem Ndeloh	VUB	
Gilda-Georgiana Serea	ULB	
Wesley Tack	UGent	
Yseult Navez	FPS Health, Food Chain Safety and Environment	
Filip Volckaert	KUL	
Catherine Linard	ULB	
Steven Verdrengh	Natuurpunt	
Sanne Helsen	UAstudent	
Ann Van Herzele	INBO	
André Heughebaert	Belgian Biodiversity Platform	
Erik Mathijs	KUL	*Biodiversity and food*
Patrick Van Damme	UGent	
Wannes Keulemans	KUL	
Alain Peeters	RHEA	
Marlies Coopman	KUL	
Martijn Callens	KUL	
Lien Reyershove	KUL	
Lucette Flandroy	FPS Health, Food Chain Safety and Environment	
Jurgen Tack	INBO	
Greet Tijskens	VELT	
Francis Turkelboom	INBO	
Melissa Ceuterick	INBO	

Appendix 2: Participants list

Ilse Simoens	INBO	*Experiencing Nature and the question of health*
Terry Hartig	University of Uppsale	
David Jelinek	Anima Mundi	
Joost Dessein	ILVO	
Eric Lambin	UCL	
Grete De Maeyer	Provincie Vlaams Brabant	
Herlinde Smet	Stad Antwerpen	
Marie-Celine Godin	Brussels Environment	
Johan Royeaerd	Advieswerk Infinite	
Joris Aertsens	VITO	
Christophe Van Thuyne	Anima Mundi	
Gloria Jimenez-Tobon	ULB	
Sara Simon	ICASO	
Angélique Berhault	Belgian Biodiversity Platform	
Hans Keune	Belgian Biodiversity Platform	*Public health as an ecosystem service indicator*
Heidi Wittmer	UFZ	
Tom Bauler	ULB	
Conor Kretsch	COHAB	
Elke Van den Broeke	LNE	
Kristin Bluekens	TRITEL	
Francoise Symoens	WIV-ISP	
Anne Franklin	RBINS	
Ingrid Beuls	Provincie Vlaams Brabant	
Nathalie Pipart	ULB	
Martin De Pelsmaeker	VLM	
Tanya Cerulus	LNE	
Lara Steenwegen	Socialistische Mutualiteiten	
Machteld Gryseels	Brussels Environment	
Tanya Moens	Vlaams Agentschap Zorg en gezondheid	
Linda Meiresonne	INBO	
Not attending a specific workshop		
Marc Van Ranst	KUL	*Key note speaker*
Pim Martens	ICIS	
Jamila Buziarsist	WIV-ISP	
Jan Caudron	Photgrapher	
Dimitri Brosens	Belgian Biodiversity Platform	*Organisation (Belgian Biodiversity Platform) members not taking part in a specific workshop*
Nicolas Noé	Belgian Biodiversity Platform	
Julien Cigar	Belgian Biodiversity Platform	
Geert De Blust	INBO	



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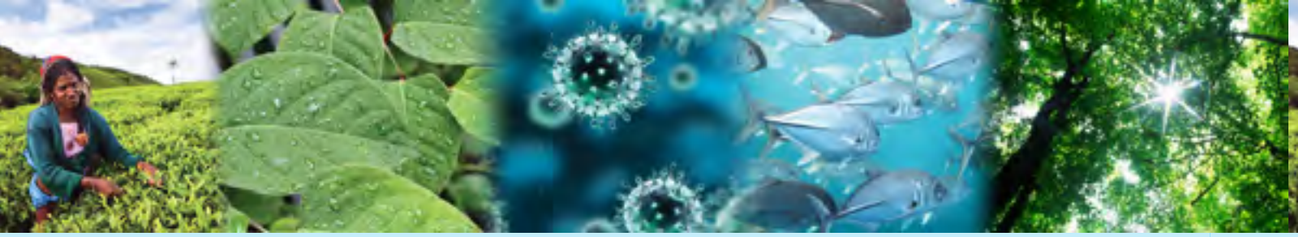

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