Overview results of the inventory of scientific research needs and ideas Bodiversity – Public Health 2012

Biodiversity.be

Belgian Community of Practice Biodiversity - Public Health

CONTENTS

Report by: Hans Keune (Belgian Biodiversity Platform/INBO), Marius Gilbert (ULB), Lucette Flandroy, Sabine Wallens, Delphine Perremans, Maud Istasse, Frédéric Chemay (all Federal Public Service Health, Food Chain Safety and Environment), Jan Verboven, Hilde Heyrman (both Flemish Land Agency), Elke Van den Broeke (Flemish Government, Environment, Nature and Energy Department), Etienne Thiry, Ana Delagrandiere (both ULG), Pim Martens (ICIS; University of Maastricht), Alain Peeters (RHEA), Sophie Vanwambeke, Valerie Obsomer (both UCL), Veerle Versteirt, Wesley Tack (both Avia-GIS), Françoise Symoens (IPH), Anne-Mieke Vandamme, Liesbet Vranken, Erik Mathijs (all KU Leuven), Herwig Leirs, Katrien Tersago (both UA), Francis Turkelboom, Ann van Herzele, Ilse Simoens (all INBO).

January 2013

SYNTHESIS

CONTEXT

Our societies have gone through **three major epidemiological transitions:**

1st Epidemiological Transition

During what is called the first epidemiological transition, society moved toward sedentary agricultural societies, establishing larger groups in cities, which provided opportunities for pathogens such as malaria, smallpox, measles or tuberculosis to emerge and spread (Harper and Armelagos 2010).

2nd Epidemiological Transition

The second epidemiological transition started with the industrial revolution, when improved nutrition, and more effective public health measures resulted in a decline in child mortality. As populations aged, they began to experience a concomitant rise in chronic disease such as heart failure, cancer, and diabetes (Barrett et al. 1998).

3rd Epidemiological Transition

We are now experiencing the third epidemiological transition, which is characterized by the new emergence or re-emergence of pathogens, new types of exposure to environmental hazard, and changes in food regimes. These changes take place in a context of demographic transition, globalisation of travel, production and trade, as well as global changes in land use, biodiversity and climate. Today, the World Health Organization (WHO) estimates that one quarter of the global burden of disease in humans, disproportionately felt in the developing world, is due to environmental change (Prüss-Ustün and Corvalán 2007).

At the institutional level, the recognition that diseases and pathogens are part of integrated ecosystems has led to the emergence of the "One Health" concept, which aims to bridge the gap between practitioners and institutions dealing with human, livestock and wildlife diseases and their environment.

At the scientific level, whilst the association between biodiversity and stability of ecosystems is hardly disputed in ecology, the relationship between biodiversity, ecosystem services and public health has comparatively received fewer attention. We are only starting to quantify and understand the various mechanisms by which living organisms contribute to our health, directly (e.g. human microbiome) or indirectly (e.g. filtering of air). Future work aim to study new patterns (identify associations) and processes (gain understanding on the causal mechanisms) linking biodiversity and public health.

This inventory of research needs and ideas among the Belgian Community of Practice on Biodiversity - Public Health aims to get a clearer view on relevant research topics, the expertise in this emerging field, and the potential for collaboration. This overview aims to detect innovative ideas and potential clusters of research questions and research partners, to be synthesized for BELSPO and others relevant research funding institutions, to be taken into account when designing calls. The inventory round of scientific research needs and ideas regarding biodiversity – public health issues was organized in October – November 2012 and resulted in a wide range of policy needs and research ideas. This document is a synthesis of these results.

SYNTHESIS

POLICY NEEDS

From the Federal policy level, the Federal Public Service (FPS) Health, Food Chain Safety and Environment responded with several concrete research needs and five concrete research fiches (see appendix A). This exemplifies a clear and well articulated interest from the Federal policy side for research on the relation between biodiversity and public health.

From the regional policy side, several concrete research topics were submitted by the Flemish Government, Environment, Nature and Energy Department and the Flemish Land Agency, also indicating a clear need for biodiversity - public health related research.

The policy needs cover a wide range of topics and policy relevant issues. There is a general interest in integrated data assessment coupling ecological and public health developments, and a general interest in the relation between green space/nature – the living environment – public health.

Some research topics focus particularly on health risks, some on health benefits, some on both. More specific topical focuses are proposed on emerging diseases caused by exotic species and the biodiversity and public health linkages with food/diet diversity, medicine, cosmetics and thinning diets.

Regarding the relation between green space and public health, specific topics in need of research concern the distance between green space and resident's health benefits, the relation of different habitats/ecosystem services with cancer incidence, the mental and physical health benefits of contact with nature.

RESEARCH IDEAS

From the scientific community a wide range of scientific institutions responded to the call for research ideas, resulting in fifteen concrete research fiches (see appendix B) and some research topics.

Amongst the respondents both representatives of Federal, Walloon and Flemish research institutions. Amongst the respondents a wide range of expertise (spatial epidemiology of animal diseases, animal virology, agriculture and veterinary information and analysis, medical mycology, virus drug resistance, molecular epidemiology, virus evolution, population ecology and ecology of infectious diseases, medical geography, land science, agriculture, biodiversity, ecosystem approach, food quality, ecosystem services, consumption behaviour, decision support systems, economics, social and political sciences) representing a truly interdisciplinary research community.

The research ideas also cover a wide range of topics and research ideas. We distinguish topics focussing specifically either on health risks, health benefits or both.

Most research ideas are related to vector-borne diseases, e.g. focussing on patterns and mechanisms of emerging infectious diseases in domestic animals, surveillance and monitoring systems, mosquito abundance, characterisation of vector-borne diseases habitat typology, the relation with land use management, the virome (the viral population existing in a given organism, a given population or a given ecosystem, and the link with biodiversity and public health).

Several proposals draw attention to ecosystem health services, e.g. in relation to the contribution of diversity of habitats, landscape and species, urban greening and the demand for ecosystem services and biodiversity.

Two proposals focus on the relation with agriculture: the impact of agricultural practices in the development of resistance mechanisms to antimicrobial drugs in fungal human pathogens and Belgian social security costs and biodiversity loss in South America induced by soybean cropping.

On the uptake of scientific knowledge, one proposal focuses on health eco system services decision support for policy uptake, and on the role of environmental information in consumer uptake.
Finally one proposal asks for structural support for a Belgian Community of Practice Biodiversity – Public health by means of a cluster project.

COMPARISON POLICY NEEDS - RESEARCH IDEAS

When comparing demand (policy needs) and supply (scientific proposals) after a first inventory round, there are complementarities and gaps.

Some policy needs correspond with research ideas proposed by the scientific community, especially those focussing on integrated ecological and public health assessments and databases.

There is a clear fit between the policy need for more knowledge on the effects of green space on public health of residents living near those green spaces. Several other more specific policy needs are not yet covered in research proposals in this inventory: biodiversity and public health linkages with food/diet diversity, medicine, cosmetics and thinning diets and some specific issues regarding green space health effects, such as e.g. cancer incidence.

Some research proposals (in this inventory) so far lack clear articulation in policy needs, such as consumer behaviour studies, a community of practice cluster project and the development of practical policy relevant health valuation indicators for ecosystem services assessment and best practices to support decision making.

Noteworthy we mention here that after taking notice of the first results of the inventory, the FPS-policy representatives agreed to the relevance and importance also of the other research ideas they took notice of, even though initially they did not come up with these ideas themselves: a clear example of the benefits of close transdisciplinary collaboration between science and policy.

FIT FOR PURPOSE - BIODIVERSITY - PUBLIC HEALTH RESEARCH

Most proposed research needs and ideas focus specifically both on biodiversity and public health.

Most proposals moreover specifically focus on generation of new knowledge, which qualifies them as scientific challenges in need of science funding.

Some do this by generating completely new insights and data, some do this by building on and integrating existing data bases and knowledge in order to gain more integrated insights.

Some proposals moreover offer the potential of linking topics and experts focussed mainly on health risks with those focussed more on health benefits of biodiversity and nature.

Furthermore some proposals seek for producing new linkages between science and policy, both in transdisciplinary approaches, boundary concepts such as ecosystem services and best practices for policy uptake.

POTENTIAL WITHIN THE BELGIAN COMMUNITY OF PRACTICE ON BIODIVERSITY - PUBLIC HEALTH

The diversity of scientific disciplines, scientific institutes and policy institutions and the interest shown in many of the proposed research fiches, exemplifies an emerging community of expertise and practice with both the potential and the will for joining forces and building capacity.

This capacity is not only requested by the scientists and policy representatives taking part in this inventory, but also seems in need of further community building: the diversity of topics and approaches and simultaneously the many potential complementarities shows the mutual benefits of joint community and capacity building, of which this inventory is a good example.

Overview of concrete research needs & ideas

POLICY NEEDS

Respondents:
-Federal Public Service (FPS) Health, Food Chain Safety and Environment (group effort)
-Flemish Government, Environment, Nature and Energy Department
-Flemish Land Agency (group effort)

POLICY NEEDS: Fiches (abstracts; for full fiches, see appendix A)

1. Develop common and integrated databases on the results of studies on quantitative, qualitative and spatial evolution of plants, insects, microbes, vertebrates, and also of plants', animals' and human beings' health/illnesses, in particular facing the climate change, in different environments and agro-environments. This could be done at various spatial levels.

a. Inter- (incl social science) and transdisciplinary
b. Connecting existing knowledge and data generation
c. Connecting expertise & experts
d. New knowledge: integrated assessment
e. Clear link with biodiversity
f. Clear link with public health (both health risks and health benefits)
g. Capacity building
h. International (data) relevance

2. Studies illustrating links between food/diet biodiversity and public health.

a. Inter- (incl social science) and transdisciplinary
b. Connecting existing knowledge and data generation
c. Connecting expertise & experts
d. New knowledge: integrated assessment
e. Clear link with biodiversity
f. Clear link with public health (both health risks and health benefits)

3. The relation between biodiversity preservation and medicine: traditional medical systems, on the "industrialisation" of natural medicines, the importance of (non) voluntary ABS systems and the number and types of medical drugs originating from biodiversity in comparison to drugs from chemical or biotechnological origin.

a. Inter- (incl social science) and transdisciplinary
b. New knowledge, new data
c. Clear link with biodiversity
d. Clear link with public health (health benefits)

4. Study on the risk for Belgium and neighbouring countries of emerging diseases in human and animal health (domestic and wild fauna) caused by exotic animals playing as vectors or reservoirs, taking into account the impact of climate change, globalization and exotic animal trade. Current state of knowledge, investment and future requirements.

a. Interdisciplinary
b. New knowledge, new data
c. Clear link with biodiversity
d. Clear link with public health (health risks)

5. Studies illustrating links between (bio-)prospection for cosmetics ingredients, cosmetics production and use, biodiversity and public health, in particular the impacts and the dependencies on biodiversity and ecosystem services, including the new approach on access and benefit sharing concept ('ABS') and possible correlation with health.

a. Inter- (incl social science) and transdisciplinary
b. New knowledge, new data
c. Clear link with biodiversity
d. Clear link with public health (health, including mental, benefits)

POLICY NEEDS: Topics

1. Relation green space/nature – living environment – health.

a. Relation distance to green space – health
b. Relation different types of habitats/ecosystem services – cancer incidence
c. Relation green infrastructure/nature – mental health
d. Relation green infrastructure/nature – physical health
e. Relation specific nature elements – positive health effects
e-1. Indirectly: nature elements improving the quality of the living environment
e-2. Directly: recreation, relaxation, physical exercise
f. Relation species (indigenous , exotic) (e.g. moulds, grass) – respiratory allergies (e.g. asthma); both positive (e.g. air purification) and negative (causing allergies)

2. Should also be studied the impacts, on world agro-biodiversity and on public health, of specific thinning diets (most of them being "dissociated diets" promoting the consumption of limited groups of nutrients – mainly proteins or mainly fat but without sugars), in fashion in our societies next to diets leading to obesity and its illnesses correlations.

3. Support for earlier proposed topics.

a. We should recognise our (destructive) impact on remote continents' biodiversity, e.g. through the use of palm oil, meat consumption. Moreover, how beef is fed has also an impact on health. Regarding the destruction of the rainforest: it would be important to quantify the whole chain, and in the end evaluate what it costs to Belgian social security
b. Impact of agricultural practices such as use of pesticides in the development of resistance mechanisms in human pathogens

4. Same type of study as that establishing links between biodiversity/health/ABS for medicines and for cosmetics from natural origin could be done for biocides/pesticides from natural origin.

RESEARCH IDEAS

Respondents:
Etienne Thiry (ULG), Pim Martens (ICIS; University of Maastricht), Alain Peeters (RHEA), Sophie Vanwambeke (UCL) et al., Marius Gilbert (ULB) et al., Veerle Versteirt et al. (Avia-GIS), Anne-Mieke Vandamme (KU Leuven), Françoise Symoens (IPH), Liesbet Vranken (KU Leuven), Herwig Leirs & Katrien Tersago (UA), Francis Turkelboom et al. (INBO), Ann van Herzele et al. (INBO), Valerie Obsomer (UCL) et al.

RESEARCH IDEAS: Fiches (for full fiches, see appendix B)

(*Some original fiches are not distributed for copyright reasons but will confidentially be copied to BELSPO for inspiration)*

1. Emerging infectious diseases in domestic animals: testing the diversity/ stability hypothesis in the avian influenza epidemiological system *(Marius Gilbert (ULB) et al.)*

a. Interdisciplinary
b. New knowledge
c. Clear link with biodiversity
d. Direct link with public health (health risks)

2. Belgian social security costs and biodiversity loss in South America induced by soybean cropping: impact of Belgian soybean import on Belgian environment, biodiversity and human health and on biodiversity in originating countries *(Alain Peeters (RHEA))*

a. Inter- and transdisciplinary
b. Connecting existing knowledge and data generation
c. Connecting expertise & experts
d. New knowledge: integrated assessment
e. Capacity building and awareness raising
f. International (biodiversity) relevance
g. Clear link with biodiversity
h. Clear link with public health (health risks)

3. Impact of agricultural practices in the development of resistance mechanisms to antimicrobial drugs in fungal human pathogens *(Françoise Symoens (IPH))*

a. Interdisciplinary
b. New knowledge, new data
c. Link with biodiversity not fully clear
d. Clear link with public health (health risks)

4. Exploration of the virome, i.e. the entire viral population existing in a given organism, a given population or a given ecosystem, and the link with biodiversity and public health *(Etienne Thiry (ULG))*

a. Interdisciplinary
b. New knowledge, new data
c. Link with biodiversity
d. Clear link with public health (both health risks and health benefits)

5. Setting up surveillance systems of emerging and re-emerging infectious diseases: global warming will change local ecosystems, new diseases or disease only known from warmer climates will now also spread in our area *(Anne-Mieke Vandamme (KU Leuven))*

a. Interdisciplinary character not clear
b. International collaboration
c. New knowledge, new data
d. Link with biodiversity not fully clear
e. Clear link with public health (health risks)

6. The relationship between vector-borne & zoonotic diseases and land use & management: creative use of innovative methods of representing land use and land management in ways that can be included in quantitative models addressing the risk of disease *(Sophie Vanwambeke (UCL) et al.)*

a. Interdisciplinary (including social sciences)
b. International collaboration
c. New knowledge, new data
d. Link with biodiversity not fully clear
e. Clear link with public health (both health risks and health benefits)

7. Develop a general model to predict mosquito abundance over several years and to identify the main determinants of mosquito population dynamics in wetland areas *(Veerle Versteirt et al. (Avia-GIS))*

a. Interdisciplinary especially linkages with social science
b. New knowledge, new data
c. Link with biodiversity
d. Clear link with public health (health risks)

8. Mapping the demand for ecosystem services and biodiversity taking into account public, ecological and health preferences for nature development and conservation, as a basis for decision making *(Liesbet Vranken (KU Leuven))*

a. Inter- (incl social science) and transdisciplinary
b. New knowledge, new data
c. Clear link with biodiversity
d. Clear link with public health (both health risks and health benefits)

9. Analyse how environmental information provision (standards, labelling, educational campaigns, etc..) can alter consumer behaviour in order to maintain biodiversity and produce sufficient food for the world population to live a long and healthy life. *(Liesbet Vranken (KU Leuven))*

a. Inter- (incl social science) and transdisciplinary
b. New knowledge, new data
c. Capacity building and awareness raising
d. Clear link with biodiversity
e. Link with public health not fully clear

10. Joining of existing geolocated datasets of detailed local species richness and species distribution homogeneity in Belgium and epidemiological infection patterns in humans, pets or cattle. Based on this spatial maps: monitoring plan for local pathogen richness related to local reservoir host and non-host species richness. Also focused experimental studies of dilution mechanisms for (vector-carried or directly transmitted) rodent-borne infections and pathogen co-infection patterns. *(Herwig Leirs & Katrien Tersago (UA))*

a. Inter- and transdisciplinary
b. Connecting existing knowledge and data generation
c. Connecting expertise & experts
d. New knowledge: integrated assessment
e. Clear link with biodiversity
f. Clear link with public health (health risks)

11. The contribution of diversity of habitats, landscape and species for nature experience to physical, mental and social health. *(Francis Turkelboom et al. (INBO))*

a. Inter- (incl social science) and transdisciplinary
b. New knowledge, new data
c. Clear link with biodiversity
d. Clear link with public health (both health risks and health benefits)

12. Designing integrated decision support methods for policy uptake of scientific knowledge on health related ecosystem services *(Ann van Herzele et al. (INBO))*

a. Inter- (incl social science) and transdisciplinary
b. Connecting existing knowledge
c. Connecting expertise & experts
d. New knowledge, new data
e. Clear link with biodiversity
f. Clear link with public health (both health risks and health benefits)

13. Disaggregate spatially species interactions for characterisation of vector-borne diseases habitat typology and better targeting areas at risk though land use management control and prevention *(Valerie Obsomer (UCL) et al.)*

a. Transdisciplinary
b. Connecting existing knowledge
c. Connecting expertise & experts
d. New knowledge, new data
e. Clear link with biodiversity
f. Clear link with public health (both health risks and health benefits)

14. Community of Practice Biodiversity – Public health cluster project *(Hans Keune et al.)*

a. Transdisciplinary
b. Connecting existing knowledge
c. Connecting expertise & experts
d. Capacity building
e. Clear link with biodiversity
f. Clear link with public health (both health risks and health benefits)

15. Studies are needed for quantifying and valuing the whole chain from species-rich ecosystem destruction in developing countries or in oceans, by unsustainable agricultural systems, to the feeding of livestock and the quality of food in general in Belgium, to the impact on public health and possibly to the costs for the Belgian social security and the State budget *(Alain Peeters (RHEA))*

a. Inter- and transdisciplinary
b. Connecting existing knowledge and data generation
c. Connecting expertise & experts
d. New knowledge: integrated assessment
e. Capacity building and awareness raising
f. International (biodiversity) relevance
g. Clear link with biodiversity
h. Clear link with public health (health risks)

RESEARCH NEEDS: Topics

1. Urban greening, biodiversity and human well-being (research on the influence of green urbanization as such and on human well being)
2. Ecosystem health services: a global GIS analysis (global analysis of potential effects).

COMPARISON POLICY NEEDS – RESEARCH IDEAS

POLICY NEED	RESEARCH IDEA
POLICY FICHE 1 Integrated database ecosystem – public health/ tools for integrated monitoring system, land planning, risk management	**Research fiche 1:** Emerging infectious diseases in domestic animals: testing the diversity / stability hypothesis in the avian influenza epidemiological system
	Research fiche 4: Exploration of the virome, i.e. the entire viral population existing in a given organism, a given population or a given ecosystem, and the link with biodiversity and public health
	Research fiche 5: Setting up surveillance systems of emerging and re-emerging infectious diseases: global warming will change local ecosystems, new diseases or disease only known from warmer climates will now also spread in our area
	Research fiche 6: The relationship between vector-borne & zoonotic diseases and land use & management: creative use of innovative methods of representing land use and land management in ways that can be included in quantitative models addressing the risk of disease
	Research fiche 7: Develop a general model to predict mosquito abundance over several years and to identify the main determinants of mosquito population dynamics in wetland areas
	Research fiche 8: Mapping the demand for ecosystem services and biodiversity taking into account public, ecological and health preferences for nature development and conservation, as a basis for decision making
	Research fiche 10: Joining of existing geolocated datasets of detailed local species richness and species distribution homogeneity in Belgium and epidemiological infection patterns in humans, pets or cattle. Based on this spatial maps: monitoring plan for local pathogen richness related to local reservoir host and non-host species richness. Also focused experimental studies of dilution mechanisms for (vector-carried or directly transmitted) rodent-borne infections and pathogen co-infection patterns.
	Research fiche 13: Disaggregate spatially species interactions for characterisation of vector-borne diseases habitat typology and better targeting areas at risk though land use management control and prevention
	Research idea 2: Ecosystem health services: a global GIS analysis (global analysis of potential effects)
	Research topic 12: Designing integrated decision support methods for policy uptake of scientific knowledge on health related ecosystem services

COMPARISON POLICY NEEDS – RESEARCH IDEAS

POLICY NEED	RESEARCH IDEA
POLICY FICHE 2 links between food/diet biodiversity and public health. Evolution with globalisation and related changes in agriculture and food practices; related socio-economic impacts of these evolutions, linked to impacts on biodiversity and leading potentially to health impacts	**Research fiche 2 (partly):** Belgian social security costs and biodiversity loss in South America induced by soybean cropping: impact of Belgian soybean import on Belgian environment, biodiversity and human health and on biodiversity in originating countries

POLICY NEED	RESEARCH IDEA
POLICY FICHE 3 Relation between biodiversity preservation and medicine	~ **Research fiche 9**, if ~ adapted to medicines

POLICY NEED	RESEARCH IDEA
POLICY FICHE 4 Emerging diseases in human and animal health (domestic and wild fauna) caused by exotic animals (and also globalization, climate change and land use change)	**Research fiche 1:** Emerging infectious diseases in domestic animals: testing the diversity/ stability hypothesis in the avian influenza epidemiological system
	Research fiche 4: Exploration of the virome, i.e. the entire viral population existing in a given organism, a given population or a given ecosystem, and the link with biodiversity and public health
	Research fiche 5: Setting up surveillance systems of emerging and re-emerging infectious diseases: global warming will change local ecosystems, new diseases or disease only known from warmer climates will now also spread in our area

POLICY NEED	RESEARCH IDEA
POLICY FICHE 5 Studies illustrating links between (bio-) prospection for cosmetics ingredients, cosmetics production and use, biodiversity and public health, in particular the impacts and the dependencies on biodiversity and ecosystem services, including the new approach on access and benefit sharing concept ('ABS') and possible correlation with health.	~ **Research fiche 9**, if ~ adapted to cosmetics

POLICY NEED	RESEARCH IDEA
POLICY IDEA 1A Relation distance to green space	**Research fiche 11:** The contribution of diversity of habitats, landscape and species for nature experience to physical, mental and social health if ~ adapted to medicines

POLICY NEED	RESEARCH IDEA
POLICY IDEA 1B Relation different types of habitats/ ecosystem services – cancer incidence	~ **Research fiches 1 and 11:** (these fiches are not specifically focused on cancer incidence; but cancer is one important example of physical disease, and ~ known to be promoted by mental not well being)

POLICY NEED	RESEARCH IDEA
POLICY IDEA 1C Relation green infrastructure/ nature – mental health	**Research fiche 6:** The relationship between vector-borne & zoonotic diseases and land use & management: linking the risk of vector-borne & zoonotic diseases with social scientific research on appreciation of recreation in nature
	Research fiche 11: The contribution of diversity of habitats, landscape and species for nature experience to physical, mental and social health
	Research idea 1: Urban greening, biodiversity and human well-being (research on the influence of green urbanization as such and on human well being)

POLICY NEED	RESEARCH IDEA
POLICY IDEA 1D Relation green infrastructure/ nature – physical health	**Research fiche 6:** The relationship between vector-borne & zoonotic diseases and land use & management: linking the risk of vector-borne & zoonotic diseases with social scientific research on appreciation of recreation in nature
	Research fiche 11: The contribution of diversity of habitats, landscape and species for nature experience to physical, mental and social health
	Research idea 1: Urban greening, biodiversity and human well-being (research on the influence of green urbanization as such and on human well being)

POLICY NEED	RESEARCH IDEA
POLICY IDEA 1E Relation specific nature elements – positive health effects. Indirectly: nature element improving the quality of the living environment Directly: recreation, relaxation, physical exercise	**Research fiche 1:** The contribution of diversity of habitats, landscape and species for nature experience to physical, mental and social health

POLICY NEED	RESEARCH IDEA
POLICY IDEA 1F Relation species (indigenous , exotic) (e.g. moulds, grass) – respiratory allergies (e.g. asthma); both positive (e.g. air purification) and negative (causing allergies)	

POLICY NEED	RESEARCH IDEA
POLICY IDEA 2 The impacts, on world agro-biodiversity and on public health, of specific thinning diets	

POLICY NEED	RESEARCH IDEA
POLICY IDEA 3A Belgian social security costs and biodiversity loss in South America induced by soybean cropping: impact of Belgian soybean import on Belgian environment, biodiversity and human health and on biodiversity in originating countries	**Research fiche 2:** Belgian social security costs and biodiversity loss in South America induced by soybean cropping: impact of Belgian soybean import on Belgian environment, biodiversity and human health and on biodiversity in originating countries

POLICY NEED	RESEARCH IDEA
POLICY IDEA 3B Impact of agricultural practices in the development of resistance mechanisms to antimicrobial drugs in fungal human pathogens	**Research fiche 3:** Impact of agricultural practices in the development of resistance mechanisms to antimicrobial drugs in fungal human pathogens

POLICY NEED	RESEARCH IDEA
POLICY IDEA 4 Same type of study as that establishing links between biodiversity/ health/ ABS for medicines and for cosmetics from natural origin could be done for biocides/pesticides from natural origin. ~ Policy Fiche 2: Links between food/diet biodiversity and public health. Evolution with globalisation and related changes in agriculture and food practices; related socio-economic impacts of these evolutions, linked to impacts on biodiversity and leading potentially to health impacts	**Research fiche 9:** Analyse how environmental information provision (standards, labelling, educational campaigns, etc..) can alter consumer behaviour in order to maintain biodiversity and produce sufficient food for the world population to live a long and healthy life

POLICY FICHE 1 Integrated database ecosystem – public health/tools for integrated monitoring system, land planning, risk management	**Research fiche 12:** Designing integrated decision support methods for policy uptake of scientific knowledge on health related ecosystem services
	Research fiche 14: Community of Practice Biodiversity – Public health cluster project

APPENDIX A: FICHES (FEDERAL) POLICY NEEDS

Fiche 1	
Name	Lucette Flandroy
Organisation	Federal public Service Health, Food Chain Safety and Environment
Expertise	Biodiversity/ Biosafety
Biodiversity – Public Health interest	Long-dated personal interest, and through my background (molecular biology + environmental sciences + tropical medical biology), for the various now recognized links between biodiversity and health. In the context of my present professional position, interest for preservation of biodiversity services and for avoiding negative impacts due to biodiversity and ecosystems' functioning deterioration.
Research need or idea	Develop common and integrated data bases on the results of studies on quantitative, qualitative and spatial evolution of plants, insects, microbes, vertebrates, and also of plants', animals' and human beings' health/illnesses, in particular facing the climate change, in different environments and agro-environments. This could be done at various spatial levels.
Argumentation	This could help to establish eventual correlations between these various evolutions
Scientific relevance	This could help and implicate scientific community networking and help to discover still unsuspected ecological and epidemiological links between various elements of the ecosystem. Possibility to collaborate with the GEOSS (Global Earth Observation System of Systems) international programme on this issue.
Policy relevance	This should help and lead to integrate monitoring systems for agricultural, animal and human health. It could help to improve land use planning and management, in particular with a view to avoid any kind of epidemics and to improve the general health of the ecosystem, the agro-ecosystem, including human beings. This would need capacity-building.
Societal relevance	Reduction in illnesses in the human, domestic animal or agricultural environment, and adaptation as well as possible to the climate change, would obviously bring societal benefits.
Potential for collaboration	Collaboration between biologists, microbiologists, environmentalists, agronomists, human epidemiologists, veterinarians, etc. Collaboration between Environment, Health, Agriculture ministerial departments and monitoring networks.
Other remarks?	The integration of these monitoring systems and consequences in knowledge improvement and application also would bring financial benefits (reduction in costs by integration of different systems of monitoring; reduction in public health and agricultural costs by reduction in epidemics)

Fiches (federal) policy needs

Fiche 2	
Name	Lucette Flandroy + Sabine Wallens + Delphine Perremans
Organisation	Federal public Service Health, Food Chain Safety and Environment
Expertise	Biodiversity/ Biosafety
Biodiversity – Public Health interest	Long-dated personal interest, and through my (LF) back-ground, for the various now recognized links between biodiversity and health. In the context of our professional position, it is important, in order to be able to influence more heavily some political decisions, to make the link between impacts that world food production and trade may have at the same time on biodiversity, ecosystems, and on public health, on threats to biodiversity and threats to food security and to local and indigenous populations that preserve biodiversity .
Research need or idea	Studies illustrating links between diet biodiversity and public health. - In particular, studies illustrating locally different traditional food systems, that take benefit of the local biodiversity and ecosystem to elaborate diets equilibrated in all necessary nutrients and micro-nutrients. Illustrate if and how changes in world agricultural and food practices have changed these traditional systems, how is the biodiversity of diets modified and disrupted by these changes, and what are eventual correlations with local health/ illness parameters and possible correlation between biodiversity and 'healthy food' and health parameters. - In particular, studies on eventual correlations between newly largely cultivated and marketed strains of staple foods (cereals, ….), eventually GM, and evolution/ raise of allergies and/or other immune system perturbations in the population. - In particular, studies illustrating precise changes in local and global wild and cultivated biodiversity and of the agro-ecosystem and in local diets composition brought by the introduction of GMOs on the world market (including eventual changes in the micro-nutrients content of locally cultivated food plants) and possible impacts on local public health parameters. These studies should involve the precise analysis (if not precise genomic analysis, then precise statistical analysis of the consequences on genetic diversity) of the voluntary crossings of specific GM events (developed in laboratories) with local strains of the same food plants and the consequent effects on the intra-specific genetic diversity (local and global) of the concerned plants. Also, the socio-economic impacts, potentially resulting in health impacts, of the eventual patenting of these crossings, and of any and all effects (direct and indirect) generated by GMOs import or cultivation on the local wild biodiversity and genetic agro-biodiversity, including the local changes in the agro-ecosystem and their eventual impacts on local ecosystem services, should be studied (cf. Art. 26 of the Cartagena Protocol).

Research need or idea	Besides, the impacts (direct and/or indirect) on local and global agro-biodiversity and the socio-economic, including health, local and global impacts of the industrial selection of performing genes from local traditional agricultural varieties and of their transfer in patented varieties (with or without ABS system – see § below) should also be studied in this context. Such studies could be partially based on real cases, but also be partially prospective, based on modelling and analogies with similar situations. Attention should be given to distinguish the impacts of concerned specific GMOs from impacts of the general current world agro-food-industry system; anyway, the links with and impacts of these GMOs cultivation on the world agro-food system should be taken into account. Along these studies, specific cases should be tackled but generalizations could also be drawn when possible and appropriate. Moreover, all these studies should take into consideration the general framework of any binding or non-binding ABS instruments (specifically the Nagoya Protocol and the International Treaty on Plant Genetic Resources for Food and Agriculture but also any voluntary ABS guidelines) in order to assess the impact of such instruments on biodiversity (are the benefits generated from the use of genetic resources for food and agriculture allocated to the conservation of biodiversity? What is the impact on biodiversity?) and public health (does the access and benefit sharing regime put in place under those instruments provide a favourable framework for using GR (genetic resources) for food and agriculture, therefore contributing to global food security? What about the access and benefit sharing to GR for GMO and the link between GMO and public health?). Beside epidemiological studies suggested here-above to take place in the monitoring phase of GMOs placed on the market, long term effects on health of GMOs should be studied in the risk assessment phase taking place before placing on the market, with adequate experimental protocols. Belgium should also collaborate with the new GRACE project launched by the Commission for this purpose. Concerning all the studies proposed to be realized in this frame, the development of adequate methodologies allowing to realize these studies the most properly and scientifically-sound possible is worth wile in itself if these methods are missing.
Argumentation	Some of these kind of studies already exist (at least for the 1st § of studies proposed here-above), relatively to the existence and importance of traditional local "agro-food ecosystems", but should, I think, still be illustrated by more examples, compilations, correlations, as well in order to be generally convincing as for the importance of their local reality and for the models that can constitute these local realities. Concerning potential GM food impacts on health, few if any epidemiological studies have been done. The same is true for long-term health impacts of GMOs feeding laboratory studies, and for the real long-term impacts of GMOs placing on the market on local and global agro-biodiversity (and the potential consequent socio-economic and health impacts).

Fiches (federal) policy needs

Scientific relevance	There are still gaps of knowledge in this field. These studies can implicate scientific networking in the scientific community. Correlations between biodiversity, various diets and health/illness of populations established by this way could still help to discover unknown links between nutritional elements and health. Concerning various impacts of GMOs on biodiversity and health, the type of studies suggested here are still missing, as mentioned in the preceding frame, while GMOs are placed on the world market since about 20 years. Adequate methods are even still to be developed and approved for some of these kinds of studies.
Policy relevance	Facing the rapid alterations brought in the world food systems by global market changes, it is important for political deciders to avoid or place brakes to changes that can affect almost irreversibly the populations health as well as the agricultural biodiversity (known to be important to mitigate environmental changes and insure long term food security), and to give them relevant scientific arguments allowing them to promote food providing situations that favour public health, including food security. Concerning the types of impacts of GMOs on biodiversity and ecosystems and health proposed to be studied, data are still missing while legislations oblige to assess them. Concerning socio-economic related impacts, EU legislations and the Cartagena Protocol allow to take them into account, and the debate on this issue is raising at the EU as well as the international level.
Societal relevance	See frame above. In addition, food biodiversity is often linked to cultural habits, that can bring themselves social coherence and health.
Potential for collaboration	Collaboration between nutritionists, medical doctors, agronomists, biologists, anthropologists, sociologists, etc. Collaboration between Agricultural, Biodiversity, Food and Consumers protection, Health, etc. ministerial departments can be necessary and fruitful for the convergence of world biodiversity and health and food security preservation.
Other remarks?	See frame Societal relevance. In addition, health promoting situations bring financial benefits for the public health sector.

Fiche 3	
Name	Sabine Wallens + Lucette Flandroy + Delphine Perremans
Organisation	Federal public Service Health, Food Chain Safety and Environment
Expertise	Biodiversity/ Business and biodiversity/ Ecosystem services
Biodiversity – Public Health interest	Professional interest in relation with the integration of biodiversity (more axed on the sustainable use of) and ecosystem services concerns by market actors (including business sector, companies, consumers, trade unions, NGO's).
Research need or idea	Studies illustrating links between medicine-drug prospection, production and use, biodiversity and public health, in particular the impacts and the dependencies on biodiversity and ecosystem services, including the new approach on access and benefit sharing concept ('ABS') and possible correlation with health. In particular, studies synthetizing: - the positive and negative impacts and/ or dependencies of traditional medical systems on biodiversity preservation (including ecosystem services). - the positive and negative (real and foreseeable) impacts and/or dependencies on biodiversity preservation (including ecosystem services) of the "industrialisation" of natural medicines (i.e. of the interest of the business sector for traditionally known natural drugs, for new natural drugs prospection, research and development, leading eventually to extraction, modification and patenting of the most active compounds) - the positive and negative (real and foreseeable) impacts and/ or dependencies on biodiversity preservation (including ecosystem services) of (non) voluntary ABS systems put in place and operationalized before the adoption of the Nagoya Protocol on Access and Benefit Sharing (case studies on various relevant countries and/or legal entities taking into account the potential connections with the new EU draft regulation on this topic). - the impacts and/or dependencies on local biodiversity and ecosystem services, and on the local and indigenous communities health that use that biodiversity, of the development of new drugs originating from traditional local natural medicines, in absence of ABS systems. - the number and types of medical drugs originating from biodiversity (explaining the various biodiversity phyla involved and clarifying if biodiversity is coming from ex situ or in situ conditions) in comparison to drugs from chemical or biotechnological origin; this through various periods, covering on the one hand periods before the developments of modern biotechnology applications (thus, ~ before 1970) and on the other hand after this "revolution" (for this last period, also consider drugs in R & D); at the same time, compare the development and production costs (and development time-consuming), the financial volumes of the marketed products and the importance for public health of the respective drugs, and identify the general future trends.

Argumentation	This kind of studies may already partially exist but probably not including the ABS aspects. Moreover, in order to stop the biodiversity degradation and loss, it is particularly important to determine the impacts and dependencies on biodiversity and ecosystem services of such activities as medicine/drugs. Traditional medicine continues to play an essential role in health care, especially in primary health care. Traditional medicines are estimated to be used by 60% of the world's population and in some countries are extensively incorporated into the public health system. Medicinal plant use is the most common medication tool in traditional medicine and complementary medicine worldwide. Medicinal plants are supplied through collection from wild populations and cultivation. Many communities rely on natural products collected from ecosystems for medicinal and cultural purposes, in addition to food.
Scientific relevance	There are probably lacks and gaps of knowledge in this field. These studies can implicate scientific networking in the scientific community. Correlations between biodiversity, various medicine-drugs prospection, production and use and health could be useful and relevant for the sectorial integration of biodiversity. Although synthetic medicines are available for many purposes, the global need and demand for natural products persists for use as medicinal products and biomedical research that relies on plants, animals and microbes to understand human physiology and to understand and treat human diseases. In addition, many synthetic or semi-synthetic medicines have their origin in natural products.
Policy relevance	With the economic crisis, it is of particular importance to find synergies between different topics and could lead to mainstream biodiversity in several sectors. The possible correlation between medicine-drugs, biodiversity and health is a good example. To integrate biodiversity in the particular medicine-drugs sector, it could be useful to have a solid scientific basis on the link between medicine-drugs, biodiversity and (public) health. This kind of study can help to synthetize the real importance and dependence of human medicines on (terrestrial and aquatic) biodiversity, and ecosystem services and to put emphasis on the good behaviours and processes to politically promote and bad behaviours and processes to avoid in order to endeavour to sustainably protect at the same time biodiversity, health, traditional medicinal systems and pharmaceutical companies developing new drugs. Moreover, the issue related to access and benefit sharing is on the agenda at the highest levels of the environmental fora. The EU has recently released a regulation proposal in order to implement the Nagoya Protocol and to be allowed to ratify in due time (at the latest before the first COP/MOP on ABS which is foreseen during the second half of 2014). This context should be taken into consideration when studying the impacts of current ABS systems on biodiversity and the connections of those existing systems with the draft EU proposal.
Societal relevance	See frame above. In addition, 'traditional medicine' originating from biodiversity is often linked to cultural habits, that can bring themselves social coherence and health.
Potential for collaboration	Collaboration between medical doctors, agronomists, biologists, anthropologists, sociologists, etc. Collaboration between Agricultural, Environment, Consumers protection, Public Health, etc. Ministerial departments can be necessary and fruitful for the convergence of world biodiversity and health and medicine preservation. .
Other remarks?	See frame Societal relevance. In addition, health promoting situations bring financial benefits for the public health sector. New arguments regarding the ongoing large dependence of human new medicines on biodiversity richness can be among the important arguments for the "ignorant" public to preserve and ask for preservation of biodiversity. NB: similar studies and reasoning could be applied to natural compounds having pesticidal properties in agriculture

Fiche 4	
Name	Maud Istasse
Organisation	Federal public Service Health, Food Chain Safety and Environment
Expertise	Biodiversity (invasive alien species, exotic mosquitoes and impact on biodiversity and human/animal health)
Biodiversity – Public Health interest	Senior policy advisor in charge of the dossier relating to invasive alien species at federal level; Coordinator of the CIE/ICL expert group on exotic mosquitoes in a view of setting up a surveillance and control plan at BE level integrating human health, animal health and Environment. No scientific background but great interest in biodiversity issues and more largely, in integrating health/ animal health/welfare and environment.
Research need or idea	Study on the risk for Belgium and neighbouring countries of emerging diseases in human and animal health (domestic and wild fauna) caused by exotic animals playing as vectors or reservoirs, taking into account the impact of climate change, globalization and exotic animal trade. Current state of knowledge, investment and future requirements.
Argumentation	Different studies already demonstrate the importance of preventing and controlling emerging zoonotic diseases due to serious health implications they cause for human health but also animal health. The role of climate change, globalization and the exotic animal trade are highlighted as being at the core of this problem. In the context of globalization, the worldwide exotic animal trade (legal and illegal) is increasing with the risk it poses to: - biodiversity : e.g. poaching in the country of origin, introduction of invasive alien species in country of importation, alteration of ecosystem, … -animal health : disease transmission to other animals during the shipment, transmission in the country of importation to domestic and wild fauna, … -human health : transmission of exotic zoonosis For example, boas and pythons are high risk invasive species for human health since they bring different kind of zoonosis like salmonella or mycobacterium. "The majority (71.8%) of emerging zoonotic diseases globally originate in wildlife and the role that wildlife trade plays in disease emergence is increasing over time (Jones et al. 2008). A recent global review documented that 63 disease agents, including many human pathogens, have been transmitted via movement of wildlife (Travis et al. 2011)." (Jenkins 2012)

Scientific relevance	There are still gaps of knowledge in this field and gaps in integrating expertise from the relevant areas of work like environment (biodiversity, climate change), human health, and animal health (veterinary knowledge, animal welfare).
Policy relevance	Different initiatives were or are currently taken with regards to this thematic but not in an integrated way at first sight. On a legally point of view, different instruments already exist at EU or international level concerning surveillance of zoonosis (cf. directive 2003/99/EC which sets out legislative requirements for zoonosis monitoring and reporting). Commission is currently preparing a legal instrument on invasive alien species. CITES regulation already applies for what concerns the international trade of endangered species.
Policy relevance	All those instruments are not yet (or partially) interconnected even it is recognized that there is a need for enhancing a common approach in a view of preventing detrimental impacts on biodiversity and health. An integrated detection, assessment and response to animal-related threats as well as efficient surveillance systems should be developed. There are also surveillance projects already launched like the ECDC (European Centre for Disease prevention and control) but at the time being there are focused on exotic mosquitoes and vector-borne disease caused by this insect. In the context of the EU White Paper *"Adapting to climate change : Toward a European framework for action"* (2009), a Commission Staff working document on *'Human, animal and plant health impacts of climate change'* clearly highlights the need for further integrated approach in order to respond to these changes (ensure adequate surveillance and control of the health impacts and zoonoses…).
Societal relevance	Preventing any damage on health is one of the missions of a public authority.
Potential for collaboration	Collaboration between environment expert, biodiversity expert, climate change expert, veterinarians, epidemiologists, statisticians, economists, expert in drawing up mathematical models, …

Fiches (federal) policy needs

Fiche 5	
Name	Sabine Wallens + Delphine Perremans + Lucette Flandoy
Organisation	Federal public Service Health, Food Chain Safety and Environment
Expertise	Biodiversity/Business and biodiversity/ Ecosystem services
Biodiversity – Public Health interest	Professional interest in relation with the integration of biodiversity (more axed on the sustainable use of) and ecosystem services concerns by market actors (including business sector, companies, consumers, trade unions, NGO's).
Research need or idea	Studies illustrating links between (bio-)prospection for cosmetics ingredients, cosmetics production and use, biodiversity and public health, in particular the impacts and the dependencies on biodiversity and ecosystem services, including the new approach on access and benefit sharing concept ('ABS') and possible correlation with health. Cosmetics include "traditional" cosmetic products, such as make-up and perfumes as well as personal hygiene products such as tooth-care products, shampoos and soaps (EC consumer Affairs, 2012). In particular, studies synthetizing: - the positive and negative impacts and/or dependencies of traditional use and traditional knowledge about natural cosmetic products on biodiversity preservation (including ecosystem services). - the positive and negative (real and foreseeable) impacts and/or dependencies on biodiversity preservation (including ecosystem services) of the "industrialization" of (partly) natural cosmetics (i.e. of the interest of the business sector for traditionally known cosmetics, for new natural cosmetics prospection, research and development, leading eventually to extraction, modification and patenting of the most active compounds). - the positive and negative (real and foreseeable) impacts and/or dependencies on biodiversity preservation (including ecosystem services) of (non) voluntary ABS systems put in place and operationalized before the adoption of the Nagoya Protocol on Access and Benefit Sharing (case studies on various relevant countries and/or legal entities taking into account the potential connections with the new EU draft regulation on this topic). - the impacts and/or dependencies on local biodiversity and ecosystem services, and on the local and indigenous communities health that use that biodiversity, of the development of new cosmetics originating from traditional natural ingredients, in absence of ABS systems. - the potential correlations between the use of (partly) natural or synthetic cosmetics and the evolution of allergies in the population. - scientific investigation or development of totally natural cosmetics taking into account the potential correlation mentioned above. - the number and types of (partly) natural cosmetic products originating from biodiversity (explaining the various biodiversity phyla involved and clarifying if biodiversity is coming from ex situ or in situ conditions) in comparison to cosmetics based on artificial or petrochemical components Compare the development and production costs (and development time-consuming), the financial volumes of the marketed products of the respective cosmetic products, and identify the general future trends.

Argumentation	This kind of studies may already partially exist but probably not including the ABS aspects. Moreover, in order to stop the biodiversity degradation and loss, it is particularly important to determine the impacts and dependencies on biodiversity and ecosystem services of such activities as cosmetic products. Indeed, demand for natural ingredients and genetic resources used in the sector is expected to grow in the coming years either to develop fully natural products or as a marketing strategy. In 2006, the European market for cosmetics was valued at € 63,5 billion and a number of EU companies are market leaders. The natural products of most interest are derivatives of genetic resources (and therefore biodiversity) sourced from the wild (Beattie, 2005) and cosmetic industries also engage in screening to identify active compounds following the same R&D process of pharmaceutical companies (Laird and Wynberg, 2012).[1] The sector seems to be highly dependent on biodiversity but this should be further investigated, as well as the potential impacts and /or dependencies on biodiversity and ecosystem services and public health.
Scientific relevance	There are probably lacks and gaps of knowledge in this field. These studies can implicate scientific networking in the scientific community. Correlations between biodiversity, various ingredients (bio-)prospection, cosmetics production and use and health could be useful and relevant for the sectorial integration of biodiversity. Although synthetic cosmetic products are available for many purposes, the global need and demand for natural products is increasing. They tend to benefit indeed from a better image on the consumer side as they carry an image of healthiness.
Policy relevance	With the economic crisis, it is of particular importance to find synergies between different topics and could lead to mainstream biodiversity in several sectors. The possible correlation between cosmetic product, biodiversity and health is a good example. To integrate biodiversity in the particular cosmetics sector, it could be useful to have a solid scientific basis on the link between cosmetic products, biodiversity and (public) health. This kind of study can help to synthetize the real importance and dependence of cosmetic products on (terrestrial and aquatic) biodiversity, and ecosystem services and to put emphasis on the good behaviours and processes to politically promote and bad behaviours and processes to avoid in order to endeavour to sustainably protect at the same time biodiversity, health, traditional use and knowledge and the cosmetics sector developing new (partly or totally) natural products. Moreover, the issue related to access and benefit sharing is on the agenda at the highest levels of the environmental fora. The EU has recently released a regulation proposal in order to implement the Nagoya Protocol and to be allowed to ratify in due time (at the latest before the first COP/MOP on ABS which is foreseen during the second half of 2014). This context should be taken into consideration when studying the impacts of current ABS systems on biodiversity and the connections of those existing systems with the draft EU proposal.
Societal relevance	Although synthetic cosmetic products are available for many purposes, the global need and demand for natural products is increasing. They tend to benefit indeed from a better image on the consumer side as they carry an image of healthiness. Moreover, more and more consumers seem to have more specific attention on natural products such as cosmetics.
Potential for collaboration	Collaboration between agronomists, biologists, anthropologists, sociologists, toxicologists, etc. Collaboration between Agricultural, Environment, Consumers protection, Public Health, R&D, etc. Ministerial departments can be necessary and fruitful for the convergence of world biodiversity and health preservation.
Other remarks?	New arguments regarding the ongoing large dependence of human new cosmetics on biodiversity richness can be among the important arguments for the “ignorant” public to preserve and ask for preservation of biodiversity. NB: similar studies and reasoning could be applied to natural compounds having pesticide properties in agriculture

1 IEEP, Study to analyze legal and economic aspects of implementing the Nagoya protocol on ABS in the EU, 2012.

APPENDIX B: FICHES RESEARCH IDEAS

Fiche 1	
Name	Marius Gilbert
Organisation	Université Libre de Bruxelles
Expertise	Spatial epidemiology of animal diseases
Biodiversity – Public Health interest	Biodiversity and Emerging Infectious Disease (EID) with zoonotic potential.
Research need or idea	Testing the diversity/ stability hypothesis in the avian influenza epidemiological system.
Argumentation	The relationship between biodiversity and the emergence of emerging infectious diseases (EIDs) in domestic animals is poorly known. The example of avian influenza is illustrative. Low pathogenic avian influenza viruses (LPAIV) are naturally present with a high diversity of types and sub-types in the wild avifauna, and infect a high diversity of species with an infection that has a low clinical impact. Highly pathogenic avian influenza viruses (HPAIV) have a low diversity with epidemics usually involving only one sub-type, and usually affect a limited number of domestic species with a high clinical impact. So, it is a perfect system to study the diversity/ stability hypothesis in epidemiological systems, since losses in the diversity of viruses and hosts are associated in the field with epidemic instability. Although the major molecular mechanisms underlying the evolution of LPAIs into HPAIs (largely related to the amino acid composition of the cleavage site of the haemagglutinin), the ecological conditions under which LPAIV viruses evolve into HPAIV are not well known. But anecdotal evidences suggest that the conditions of intensive poultry farming may promote this transition, due to the high contact and viral replicative rates as well as host genetic homogeneity encountered in intensive poultry farms. Under laboratory conditions, converting an LPAIV into an HPAIV has been shown to happen through serial passage infections in chickens with homogeneous genetic origin, with LPAIV evolving into HPAIV through natural selection. However, how a higher diversity of hosts could interfere that evolutionary pathway in laboratory conditions, and how this could translate at the farm or at the landscape level remains completely unknown. Among genetic factors involved in breed susceptibility to disease, the interferon-inducible Mx protein is responsible for a specific antiviral state against influenza virus infection. Different Mx alleles have been reported that could be implicated to resistance or susceptibility to influenza virus replication, and so knowledge of their high allelic polymorphism and its impact is important when considering the potential for improvement of modern commercial flocks and protection against HPAI. Several studies analyzing a range of chicken lines and ancestral breeds for the relevant Mx codon (positive antiviral allele) revealed a high frequency of the susceptibility allele in contemporary meat-type (broiler) birds compared to egg-laying strains and found this difference is present already in ancestral breeds (Balkinson et al. 2007). High frequencies of the susceptibility allele could be readily reduced by future modern breeding techniques (Ko et al. 2002; Li et al. 2006). In this context, the hypothesis that we would like to test is that an increasing diversity of breeds could prevent the transition of an LPAIV into an HPAIV and potentially reduce the risk of HPAIV epidemics. Such project would need an interdisciplinary team of scientists to be assembled, including virologists, eco-epidemiologists, geneticists, specialists in farming systems and modellers.

Scientific relevance	A better understanding of the conditions of transition of an LPAI into HPAI and a strong support of the diversity / stability hypothesis in an important epidemiological system.
Policy relevance	If the hypothesis is confirmed, this could potentially lead to follow-up research to assess the technical feasibility of farming poultry with higher diversity of breeds at the farm level. In the longer run, this could promote the use of a higher diversity of breeds in poultry production systems.
Societal relevance	Reducing the risk of emergence of new HPAIV would reduce the economic and livelihood impact of HPAIV epidemics. In addition, it would also reduce the risk of transmission of HPAIV to people and its possible adaptation to human.
Potential for collaboration	The main collaborator at the Belgian level would be the CODA-CERVA (T. van den Berg, B. Lambrecht, S. Marché) for virology and transmission studies. Other potential partners could be the UCL (S. Vanwambeke) for landscape-scale studies and ULg (D. Desmecht) for genetic resistance studies. At the international level, main collaborators would involve a team of mathematical modellers (M. Tildesley and Matt Keeling), the Food and Agriculture Organization (FAO), and the Department of Livestock Development (Bangkok, Thailand), with whom we have a history of successful collaboration.

Fiche 2 (The Fiche 2 is not distributed for copyright reasons but will confidentially be copied to BELSPO for inspiration)

Fiche 3	
Name	Françoise Symoens
Organisation	Scientific Institute of Public Health, Communicable and Infectious Diseases
Expertise	Medical Mycology
Biodiversity – Public Health interest	Microbiology, culture collection
Research need or idea	Impact of agricultural practices in the development of resistance mechanisms to antimicrobial drugs in fungal human pathogens
Argumentation	Despite advances in prevention, diagnosis and management, infectious diseases are the most common cause of death worldwide and the third most common in developed countries. The issues of antimicrobial resistance has been called one of the most urgent priorities. If the problem of antibiotic drug resistance is already widely recognized for community and hospital acquired bacterial disease it is not yet the case for antifungal drug resistance. The use of antimicrobial drugs in agriculture has a significant impact on resistance in human pathogens. This project will focus on the use of antifungal agents in agriculture leading to environmental dispersion of resistant strains. In the last decade, the emergence of resistance to azoles of the most fearsome human fungal pathogen Aspergillus fumigatus has been described in some European countries. This fungus is saprophytic and found in environment on decaying plant matter. This emergence of resistance may be due to the use in the field of DMI fungicide molecules (14 alpha demethylase inhibitor) in order to control phytopathogenic moulds to prevent spoilage,post harvest and preservation of material. The use of these molecules have important advantages: inexpensive, broad spectrum of antifungal activity. However, they have a long lasting stability in the environment, and another disadvantage of these molecules used in agriculture is their structural analogies with the medical triazoles, moreover fungicide pressure can induce genomic changes in Aspergillus.
Scientific relevance	The aim of the project is to perform in Belgium an inventory in different field conditions of the use of azoles fungicides, to assess the importance of resistance of A. fumigatus, to study the mutations present in the target site lanosterol alpha demethylase (Cyp51A gene) which catalyses a central step in the biosynthesis pathway of the ergosterol, an essential constituent of the fungal membrane. Moreover information and quantification of residual molecules in the environment (soil) will also be studied. This could provide useful data on relation between agricultural practices and resistance of A. fumigatus to triazoles.
Policy relevance	This topic is important, indeed data are already available on resistance in environment in other European countries, but until now no data are available for Belgium.
Societal relevance	According to denning, azole resistance in Aspergillus is now recognized as “a growing public health menace”, indeed reduced susceptibility is associated with an increase probability of failure of treatment to azole therapy. The annual incidence of invasive aspergillosis among immunosuppressed patients varies from 2 to 10% and patient with invasive aspergillosis with multiresistant azole isolate have quite 90% of mortality rate. This problem will greatly increase health care costs.
Potential for collaboration	Collaboration must be performed between Scientific Institute of Public Health, Medical Mycology, partners involved in agriculture (Liège University- Gembloux Agro-Biotech /Gent University), BCCM/IHEM Culture Collection

Fiches research ideas

Fiche 4	
Name	Étienne Thiry
Organisation	University of Liège (Faculty of Veterinary Medicine, Department of infectious and parasitic diseases, Veterinary Virology and Animal Viral Diseases
Expertise	Animal virology
Biodiversity – Public Health interest	Within a given ecosystem, a virome (a virome is "the genomes of all the viruses that inhabit a particular organism or environment") is shared by all living organisms in several viral sub-populations adapted by a long process of co-evolution. This concept will be simplified here to the virome of wild and domesticated vertebrates and human beings. The stability of this virome and all its components can be hypothesized as a factor contributing to the health of the vertebrates (including human being) participating in a given ecosystem. A breakdown of this equilibrium can be hypothesized as a factor contributing to emerging viral diseases.
Research need or idea	Most of the viruses infecting vertebrates are not yet identified. In the previous century, the focus was made on viruses of medical interest, causing pathology, in order to reduce the direct consequences of viral infection or to prevent new infections. Later, phylogeny analysis revealed that viruses evolved in close interaction with their respective hosts and this co-evolution was more associated with an adaptation of the viruses to their hosts leading often in a reduced virulence. Asymptomatic virus infections could be therefore considered as the rule. The use of genetic approaches allows more recently the discovery of "viruses without disease". Finally the new technology of deep sequencing (metagenomics) provides us recently the tools to make an exhaustive exploration of the virome, i.e. the entire viral population existing in a given organism, a given population or a given ecosystem.
Argumentation	When biodiversity is endangered, the stability of the ecosystems, that could be correlated to a "healthy condition", is also endangered. Any disequilibrium of the balanced and sophisticated interactions between viruses and their hosts can lead to disease. The role and place of viruses in the ecosystems need to be explored because the technological tools (metagenomics) are now ready to use. A longitudinal exploration of ecosystems containing wild and domesticated vertebrates and human beings could integrate the exploration of the virome(s). This exploration could provide data to estimate the conditions of steady state (no health issue) and disequilibrium (public health issues). The evolution of the virome(s) present in animal and human beings in given ecosystems could be associated with health issues in both animals and human beings. Furthermore, the interspecies transport of viromic elements could also be correlated to (re) emerging viral diseases. Practically speaking, the fecal virome(s) of selected vertebrates, domesticated animals (including companion animals), human beings could be analysed in selected eco-systems chosen for their representativity in a longitudinal study. This longitudinal spatio-temporal analysis should encompass the metagenomic analysis of the fecal virome(s), the recording of factors influencing the eco-systems and the measurement of the association of these factors and the modifications of the virome(s), a.o. Similar studies could be undertaken in invertebrates (potential vector of infections) and with microorganisms (bacteria, parasites) in the same ecosystems.
Scientific relevance	Deep exploration of the viral communities constituting a virome using the newly developed technology of metagenomics; identification of new combination of viral genomes; preparedness to emerging virus infections with appropriate scientific and technological tools
Policy relevance	Preparedness of early detection and control of emerging diseases
Societal relevance	Risk mitigation of new or modified infectious diseases
Potential for collaboration	The viral exploration should be part of a greater program encompassing the exploration of bacteria and uni- and pluricellular parasites: virology, bacteriology, parasitology, bioinformatics, environmental biology, animal biology, modelisation, human medicine, veterinary medicine, bioengineering
Other remarks?	We should be ambitious and therefore ready to compete at an international level in this new and challenging topic.

Fiche 5	
Name	Anne-Mieke Vandamme
Organisation	KU Leuven, Rega Institute, Clinical and Epidemiological Virology
Expertise	Virus drug resistance, Molecular epidemiology, Virus evolution
Biodiversity – Public Health interest	Emerging and re-emerging infectious diseases
Research need or idea	Setting up surveillance systems of emerging and re-emerging infectious diseases
Argumentation	Global warming will change local ecosystems, new diseases or disease only known from warmer climates will now also spread in our area
Scientific relevance	Changing disease burden, lack of proper expertise in our geographic areas
Policy relevance	Political responsibility for optimizing health of our citizens
Societal relevance	Changing disease burden has an impact on the society
Potential for collaboration	Set up a Belgian surveillance system
Other remarks?	Set up bilateral collaborations with Southern European countries that already experience these problems

Fiches research ideas

Fiche 6	
Name	Sophie Vanwambeke
Organisation	Université catholique de Louvain
Expertise	Medical geography, land science
Biodiversity – Public Health interest	Vector-borne and zoonotic diseases
Research need or idea	Impact of land use and land management on health
Argumentation	At the landscape scale, the risk of vector-borne and zoonotic diseases (VBZD) is heavily influenced by landscape management, including the management of natural/semi-natural areas and wildlife, especially in densely populated and intensively used spaces such as Belgium. This includes how landscape management is impacting VBDZ-relevant biodiversity, and also are current biodiversity-favourable landscape management impacting VBDZ-risk. While the link between VBZD and land cover has been investigated to some extent, with a heavy focus on the vector/zoonotic side of the system, the relationship between VBZD and land use and land management is largely unknown. Placing the focus on land use, unlike land cover, implies placing a major focus on the aspect of human exposure, and on how human societies shape the landscape and distribution of biodiversity. Land management may influence both aspects of the transmission system (human exposure and the wild transmission system). Indeed, recent evidence indicates that current forestry practices (Tack et al 2012) and landscape structure (Vanwambeke et al 2010, Li et al 2012) may favour the presence of tick vectors, but quantitative evidence on the effect of the increase of large mammals, for example, which have been increasing in number and in distribution dramatically, is lacking. Furthermore, landscape management influences the attractivity of the landscape for outdoor pursuits, potentially also including its effect on biodiversity. Landscape attractivity may influence the amount of contact people have with nature, as well as their exposure to VBDZ. Understanding the relationships between those elements must be done is a spatially explicit framework. The most immediate application of these questions in Europe is for tick-borne diseases, the main vector-borne and zoonotic diseases on the continent, but the same principles can be applied to any VBZD or VBD context.
Scientific relevance	Such studies rely on the creative use of innovative methods of representing land use and land management in ways that can be included in quantitative models addressing the risk of disease. Spatial analyses are also a major tool here.
Policy relevance	Any policy relevant to land use (of any sort) and land management (at any level), including for conservation purpose, may be interested by the outcomes of such research. This research would contribute at pin pointing the areas of highest risk, not just from the ecological point of view, but also from the point of view of human exposure.
Societal relevance	Better knowledge of places of high exposure and possible ways of managing these is highly relevant to society.

Potential for collaboration	There are ongoing collaboration with Belgian and international partners. In Belgium we collaborate on these topics with M. Gilbert (ULB), looking into spatial modelling and landscape characteristics favouring spread, with the Research Laboratory for Vector Borne Diseases, Queen Astrid Military Hospital (P. Heyman, C. Cochez), ARSIA (E. Dion), ITM (M. Madder). Internationally, our group has many successful collaborations past or ongoing, such as with the members of the EDEN and EDENext networks (ww.edenext.eu) and others such as the Norwegian Veterinary institute (S. Jore), the University of Zaragoza (A. Estrada-Pena). We see great potential in collaboration with social scientists investigating the decision-making process in land management and the relationship between access to green spaces and health. Indeed, this represents occasions for exposure to VBDZ, but both view points on nature have rarely been combined. Interested members of the CoP BPH are Ann Van Herzele (INBO).
Other remarks?	Li S., Heyman P., Cochez C., Simons L., Vanwambeke S.O., 2012, A multi-level analysis of the relationship between environmental factors and questing Ixodes ricinus dynamics in Belgium. Parasites and Vectors, 5:149 Li S., Hartemink N., Speybroeck N., Vanwambeke S.O., 2012, Consequences of landscape fragmentation on Lyme disease risk: a cellular automata approach, PLoS ONE, 7(6): e39612. Tack, W., Madder, M., Baeten, L., Vanhellemont, M., Gruwez, R. & Verheyen, K. 2012. Local habitat and landscape affect Ixodes ricinus tick abundances in forests on poor, sandy soild. Forest Ecology and Management, 265, 30-36. Vanwambeke S.O., Šumilo D., Bormane A., Lambin E.F., Randolph S.E., 2010, Landscape predictors of tick-borne encephalitis in Latvia: land cover, land use and land ownership. Vector-Borne and Zoonotic Diseases. 10(5): 497-506.

Fiche 7

Concept note Biodiversity and Public Health (Veerle Versteirt et al. (Avia-GIS))

A sharp increase in distribution and emergence of vectors and vector-borne diseases have been observed over the past years, closely linked to rapidly evolving global changes (Genchi et al. 2011). Invasive and indigenous mosquitoes and the pathogens they transmit are expanding in many European countries due to several environmental, climatic and socio-economic factors. As driving forces, increased global traffic of man and goods together with changing ecoclimatic circumstances are often mentioned (Medlock et al. 2012).

Nature restoration on the other hand is often considered to have a negligible importance when dealing with vector-borne diseases and particularly mosquito-borne diseases. However, recent studies in Greece have provided a proven link between newly created wetland (Nature2000) sites and the increase in autochthonous malaria (pers. comm. Dr. Van Bortel). Moreover, as well in the UK as in Spain, these wetlands are under surveillance due to nuisance problems and the intricate risk they pose concerning West Nile virus, Sindbis and Usutu transmissions.

The transmission of mosquito-borne pathogens is furthermore highly dependent on mosquito population dynamics (see Cailly et al. 2012). As mosquitoes are very climate sensitive, environmental conditions trigger their dynamics and consequently affect disease spread. Understanding this vector–environment relationship thus is essential for the control of mosquito populations and the prevention of diseases (Juliano 2007). However, only a few climate-driven models exist that predict variations in mosquito abundance under different climate change scenarios over a sufficient time frame (Cailly et al. 2012).

Since 2005, the updated Sigma plans (2005–2030) were implemented to develop controlled flooding areas in Flanders, protecting the inland from severe flooding of the Scheldt and side rivers. This project is a major wetland creation initiative. One of the outcomes of the project is to serve the local community and region through providing increased opportunities for countryside recreation, contributing dramatically to the richness of local biodiversity and wildlife habitat, and improving the local quality of life as an outdoor space for human well-being.

However, the expansion of existing wetlands, their creation from arable land, and the creation of new saltmarsh to alleviate coastal erosion and flooding have become important issues as the environment sector adapts to the possible impacts of climate change. Many of these newly (re-)created wetlands in Belgium should meet the standard as described for Nature 2000 sites.
In Australia, the USA and UK, such projects are always supported by information for wetland managers on mitigation of a mosquito problem in an environmentally sensitive way through wetland and vegetation management.

However, in most other temperate regions this information system is lacking and the problems that could occur (high population densities of Culicidae) are being ignored. In highly populated, urbanized and/or industrialized areas such as Flanders and the Scheldt estuary, risk for outbreaks and nuisance further increases as hosts, vectors and pathogens are in closer contact.

We would therefore propose to develop a general model to predict mosquito abundance over several years and to identify the main determinants of mosquito population dynamics in wetland areas. Target species are those that are disease vectors of public health importance: Coquillettidia richiardii, Culex pipiens, Aedes vexans and Ochlerotatus caspius. All these could play a role in the transmission of West Nile virus and some are also associated with Rift Valley Fever (RVF), Sindbis and Usutu virus.
For instance, in the case of RVF it has been demonstrated that consecutive population dynamics of Aedes and

Culex species are essential elements in RVF outbreaks. All mentioned viruses are of medical and veterinary importance as most are involved in zoonotic transmission, affecting both humans and animals. For example, West Nile virus circulates in migratory birds coming from Africa through various routes and can infect both humans and horses (with deadly cases each year in Europe). As horses are susceptible hosts, economic losses can be considerable. An effective model would assist in the risk assessment of each area and could define periods in which (increased) surveillance and control would be appropriate.

In addition to building a predictive model, the socio-economic impacts of the creation of such wetlands could be queried by a social scientist which could feed the risk assessment and could implement not only the positive and negative effects of wetland restoration as well as the peoples opinion on nuisance, control and surveillance activities. In the end, management and balanced natural development plans should be created taking into account all aspects of biodiversity and the risks posed by pest insects.

References

Cailly P., Tran A., Balenghien T., L'Ambert G., Toty C. & Ezanno P. (2012). A climate-driven abundance model to assess mosquito control strategies. Ecological Modelling 227: 7-17.

Genchi C, Mortarino M, Rinaldi L, Cringoli G, Traldi G & Genchi M (2011) Changing climate and changing vector-borne disease distribution: The example of Dirofilaria in Europe. Veterinary Parasitology 176:295–299.

Juliano A.J., 2007. Population dynamics. Journal of the American Mosquito Control Association 23, 265–275.

Medlock JM, Hansford KM, Schaffner F, Versteirt V, Hendrickx G, Zeller H & Van Bortel W (2012) A review of the invasive mosquitoes in Europe: Ecology, public health risks, and control options. Vector-Borne and Zoonotic Diseases 12:435–447

Fiches research ideas

Fiche 8	
Name	Liesbet Vranken
Organisation	KU Leuven
Expertise	Agricultural, Environmental and Natural Resource Economics and Policy Valuation of Ecosystem Services Resilient bio-productive open spaces in Flanders Environmental Information and Food Consumption Behaviour
Biodiversity – Public Health interest	Biodiversity and Food Biodiversity and Nature Experience Biodiversity and Natural Hazard Protection
Research need or idea	Mapping the demand for ecosystem services and biodiversity taking into account public, ecological and health preferences for nature development and conservation
Argumentation	Societies face the need to increase resilience against internal and external shocks such as demographic and climatic changes. These shocks will increase the demand for nature experience (e.g. recreation), for protection against natural risks (e.g. flooding, landslides, fire, droughts), for genetic resources to cope with climatic changes (e.g. droughts), for genetic diversity to improve agricultural production. There are however (spatial) trade-offs and complementarities among the functions and services provided by nature/ecosystems. Therefore, it is important to gain insights on where it is optimal to develop and conserve natural areas.
Scientific relevance	Where to develop and conserve natural areas has been studied in different disciplines and hence different goals are typically taken into account. Ecologist may focus on where it is optimal to develop natural areas to increase biodiversity, while health practitioners might focus on where to develop natural areas to limit the spread of vector-borne disease. However, there is a need to bring these insights together and build a decision support unit that can help optimize land use taking into account different preferences (public, health, ecological), trade-offs and complementarities in the demand for ecosystem services and biodiversity. To determine and map the demand for ecosystem services and biodiversity, an indicator and survey based approach should be followed which requires to combine different experiences and skills (GIS, econometrics, survey design, ...).
Policy relevance	Spatial planning relevance: develop methodology that learns policy makers where to develop and conserve (semi-)natural areas, green open spaces, etc
Societal relevance	Organise landscape in such a way that different societal preferences are met.
Potential for collaboration	VITO, INBO, SADL – KULeuven, Division Nature Landscape Forest – KULeuven, RWO – Flemish Government

Fiche 9	
Name	Liesbet Vranken
Organisation	KU Leuven
Expertise	Agricultural, Environmental and Natural Resource Economics and Policy Valuation of Ecosystem Services Resilient bio-productive open spaces in Flanders Environmental Information and Food Consumption Behaviour
Biodiversity – Public Health interest	Biodiversity and Food Biodiversity and Nature Experience Biodiversity and Natural Hazard Protection
Research need or idea	Analyse how environmental information provision (standards, labelling, educational campaigns, etc..) can alter consumer behaviour in order to maintain biodiversity and produce sufficient food for the world population to live a long and healthy life.
Argumentation	Current food consumption patterns put a lot of pressure on biodiversity. However, consumers are often not aware of effects of their consumption on biodiversity. Providing information on the ecological (decreased biodiversity, climate change, ...), social (unsufficient food to feed the world population) and health (negative impact of overconsuming meat, fats, sugar) impact of consumption behaviour might alter consumer's behaviour.
Scientific relevance	Although the attitude of most consumers towards environmentally superior food products is positive, the share of sustainably produced food in total consumption has remained low. This gap between consumer attitude and their actual buying behaviour has been known as the attitude/behaviour gap. A number of current shortcomings in the food market contribute to the existence of this gap. First, the multitude of existing labels as well as their high degree of diversity makes them less effective in the food market than theory predicts. Second, the lack of transparent and factual information yields uncertainty at the consumer level turning the consumers' buying decisions into a costly search. Moreover, the existing labelling schemes do not necessarily provide an indication of the overall environmental impact because they emphasize only one single environmental aspect. As a result, the consumers who are willing to consume sustainably produced products may even be forced to use overly simplified heuristics which in the end can be less sustainable given that trade-offs between environmental impacts exist and occur frequently. Therefore, there is a need (a) to study whether the introduction of more complete, easy-interpretable and standardized environmental information provisioning can actively decrease the barriers towards sustainable consumption (b) to gain insight into the effect of introducing health claims jointly with environmental information.
Policy relevance	How could environmental (biodiversity) information provisioning alter consumption behaviour through for example information campaigns, certification schemes (labelling, branding, ...)
Societal relevance	Feed world population so that more people can live a long and healthy life while at the same time maintaining biodiversity and conserving the environment
Potential for collaboration	VITO, INBO, SADL – KULeuven, Division Nature Landscape Forest – KULeuven, RWO – Flemish Government

Fiches research ideas

Fiche 10	
Name	Prof Herwig Leirs / Dr. Katrien Tersago
Organisation	University of Antwerp / Evolutionary Ecology Group
Expertise	Population Ecology and Ecology of Infectious Diseases
Biodiversity – Public Health interest	Host and non-host species richness and its effect on pathogen diversity and pathogen transmission processes
Research need or idea	Focuses: Impact of non-host species richness on pathogen transmission rates of rodent-borne pathogens Land use management and consequent rodent species diversity and distribution homogeneity Impact of host diversity levels on pathogen diversity, pathogen interactions and consequent pathogen evolutionary potential Main research needs: - Joining of existing geolocated datasets of detailed local species richness and species distribution homogeneity in Belgium and epidemiological infection patterns in humans, pets or cattle - Based on above spatial maps: Monitoring plan for local pathogen richness related to local reservoir host and non-host species richness - Focused experimental studies of dilution mechanisms for (vector-carried or directly transmitted) rodent-borne infections and pathogen co-infection patterns
Argumentation	Rodents host many zoonotic pathogens that can harm human health. Some of these pathogens are transmitted directly towards humans (e.g. Hantavirus, Leptospira, Orthopox viruses), others need intermediate hosts like ticks (e.g. Borrelia sp., Babesia,…). It is now believed that for both the indirectly and directly zoonotic pathogen systems a dilution effect exists. This effect has been observed when increased non-host or non 'suited' host diversity leads to decreased transmission rates and prevalence among rodent reservoir hosts and consequent decreased infection risk towards humans. It is however still unclear which mechanisms exactly play a role in the occurrence of such a dilution effect, particularly so for directly transmitted pathogens. Understanding those factors that decrease pathogen transmission risk toward humans will be of relevance to public health institutes and their guidelines. On the other hand, increased local diversity in host populations may also affect local pathogen diversity, patterns of co-infection and the evolutionary potential of local pathogens. This is a field that has not yet been investigated for many of the emerging or re-emerging pathogens in Europe.
Scientific relevance	Both questions are universal and a current focus of research within the field of infectious disease ecology. Rodents are not only a main reservoir for pathogens, they also serve as a good study model for other vertebrate hosts.
Policy relevance	Public health institutes will be able to better address guidelines for zoonotic infection risk reduction.
Potential for collaboration	Pest management, institute of Public Health/ epidemiology, nature governement/ land management, different groups working on zoonotic pathogens and relevant hosts
Other remarks?	It would be interesting to be able to join groups working on rodents/ large mammals, birds and different vectors at fixed localities for disentangling local host-pathogen networks and interactions.

Fiche 11	
Name	Francis Turkelboom, Ilse Simoens, Ann Van Herzele
Organisation	INBO, Research Group Ecosystem Services + Ecosystem Management + Wildlife management
Expertise	Social science, biodiversity-ecosystem services relationship, ecosystem management, policy instrument
Biodiversity – Public Health interest	Biodiversity – physical, mental and social health and well-being
Research need or idea	The contribution of diversity of habitats, landscape and species for nature experience and physical, mental and social health.
Argumentation	On one hand, increased urbanisation and modern life- and work style result in increasing time people spend inside and makes that most people are largely disconnected from the surrounding landscape. On the other hand, we know from the literature that active experiencing nature (e.g. walking, photography, gardening or camping) and passively experiencing nature from your living or working place has a positive impact on physical, mental and social health. This is the case for all the potential 'cultural services' of ecosystems, which are listed in the adapted CICES classification for Belgium (see below). The proposed focus for research is the contribution of diversity of habitats, landscape and species to nature experience and physical, mental and social health and well-being. In this field, there are 2 important research questions: 1. What is the contribution of biodiversity to nature experience and quality of living? Depending of the kind of nature experience, different characteristics of the landscape are demanded and preferred. As a result, some landscapes are preferred more than others, and people are willing to drive significant time to visit certain locations or to look at certain wild species. By means of interviews the relation between nature experience and biodiversity can be identified for the Belgian context. In a next step, the beneficial impact on physical, mental and social health and well-being can be investigated. 2. When society starts investing in desired landscape elements, what are the opportunities for biodiversity? Society does invest in 'valuable' landscapes (e.g. subsidies for hollow roads, heath, pollard willow), while private land owners invest in beautiful gardens or work place surroundings. While they are not meant for biodiversity (at least not in the first place), they usually provide opportunities for specific biodiversity. By case studies and literature, it can be investigated how these human-made landscapes, provide chances for certain of biodiversity. Small modifications in these landscapes could possibly result in huge differences for biodiversity.
Scientific relevance	So far these questions are studied at ad-hoc basis and by separate disciplines. Interdisciplinary and transdisciplinary research on these topics could result in identifying in mutual 'win-win' conditions.
Policy relevance	Improved understanding of the relationship between biodiversity versus physical, mental and social health and well-being will enable to use financial instruments for land restoration in a more targeted way: more benefits for users, while creating chances for biodiversity. These could led to smarter 'instruments (e.g. PES - Payment for environmental services)
Societal relevance	Society will benefit by improved 'cultural services' from ecosystems.
Potential for collaboration	Research organisations with the following expertise: landscape design, health science, social well-being

Cultural services of CICES-Be classification (version 30/10/2012)

Division	Group	Class	Examples of ESS Class	Examples of activities
Natural environment suiable for outdoor activities	***Outdoor activities - non-rival***	Green environment suitable for daily outdoor activities	Neighbourhood green, fallow land, shading trees, parks, natural play areas, drove, cemetery, playground, dikes	Playing, local meeting, daily displacements by foot or bike
		Landscape for outdoor recreation	Woods, beaches, agricultural landscape, pick-nick spots in nature, riverbanks	Walking, jogging, cycling, horse riding, mountain biking, surfing, canoeing, motorized activities, pick-nick, nordic walking, outdoor tourism
		Natural landscapes and species for nature experience	Area of outstanding natural beauty, natural springs, lakes and rivers, rare species, natural smells & noises	Eco-tourism, bird watching, nature photographing, landscape painting, photography, spiritual activities, eco-therapy, nature education, reintegration programs for youngsters
		Landscape and biodiversity suitable for research	Ecological patterns, pollen, tree rings, genetic patterns	Ecological research activities
	Outdoor activities - rival	Species and biological products for hunting, fishing & collecting	Locations suitable to fish, hunt, and collect wild plants, berries, nuts, mushrooms, honey	Hunting, angling, beekeeping, collecting natural products
		Area for land-consuming recreation	Pastures for keeping and riding horses and ponies, private gardens, golf courses, green schoolyards, camping's, children's farm, zoological garden, botanical garden, safari parks	Recreation by raising and riding horses; relax and playing in gardens, camping, golf, nature and farm education
		Area for professional and volunteer outdoor activities	Farms, gardens, nature reserves, public gardens, community shared/supported agriculture, sheltered workshop in green environment, public places to compost	Outdoor work for farming, foresting, (hobby)-gardening, nature conservation, collective composting; reintegration of youngsters and persons with a handicap
Natural surroundings	***Natural surroundings around residential areas***	Natural surroundings of houses, offices and schools	Green/blue view from residence, schools, offices, elderly homes	Living, working and learning in a green environment
		Natural surroundings of therapeutic institutes	Green/blue view from hospitals, psychiatric institutes, revalidation centres	Recovering from mental or physical illness
	Nature for cultural and symbolic values	Cultural and symbolic landscapes and species	Typical cultural landscape (e.g. heath, pine forests, hedgerows, …) and species (e.g. stork, sky lark)	Living in a typical environment

Fiche 12	
Name	Ann Van Herzele et al.
Organisation	INBO
Expertise	Ecosystem services, strategic communication, risk assessment, decision-support methods
Biodiversity – Public Health interest	Translation of scientific knowledge for policy and planning practice
Research need or idea	Designing integrated decision support methods for policy uptake of scientific knowledge on health related ecosystem services.
Argumentation	Internationally the focus of ecosystem services valuation is mainly on monetary values. We believe that health can also be an important end point for ecosystem services, especially for policy making. Of course we need to develop concrete methods for this based on best available knowledge and best practices for policy uptake.
Scientific relevance	While there is a growing base of knowledge concerning the health benefits and risks of biodiversity, this knowledge appears to be insufficiently translated into practice. Converting evidence into practice is a process that requires concerted attempts with different kinds of effort, and should therefore be addressed in an integrated, inter-and transdisciplinary manner.
Policy relevance	In order to take up scientific knowledge into concrete policy practice, methods need to be developed that allow the knowledge to become suitable for policy purpose and allows joint knowledge development as an integral part of the policy planning process.
Societal relevance	Society benefits from scientific knowledge being applicable for policy practice in order safeguard public health and also societal groups can be valuable partners in this joint effort as key stakeholders.
Potential for collaboration	Potentially this research can benefit from close collaboration with all partners in the Community of Practice Biodiversity – Public health, both science, policy makers and stakeholders, depending on the specific case studies.
Other remarks?	Van Herzele A., Bell S., Hartig T., Camilleri Podesta M.T., van Zon R. 2011. Health benefits of nature experience: the challenge of linking practice and research. In: K.Nilsson et al. Forests, Trees and Human Health. Springer. Pp. 169-182. Bell S., van Zon R., Van Herzele A., Hartig T. 2011. Health benefits of nature experience: implications of practice for research. In: K.Nilsson et al. Forests, Trees and Human Health. Springer. Pp. 183-202. Van Herzele A., de Vries S. 2012. Linking green space to health: a comparative study of two urban neighbourhoods in Ghent, Belgium. Population and Environment 34: 171-193. Keune H., Morrens Bert, Springael Johan, Loots Ilse, Koppen Gudrun, Colles Ann, van Campenhout Karen, et al. (2009), Policy interpretation of human biomonitoring research results in Belgium: priorities and complexity, politics and science. In: Environmental policy and governance, 19:2(2009), p. 115-129 Keune H. (2012), Critical complexity in environmental health practice: simplify and complexificy, In: Environmental health, 11:S19 http://www.ehjournal.net/content/11/S1/S19 Wittmer H., Berghöfer A., Keune H., Martens P., Förster J. and Almack K. (2012), The value of nature for local development, In: Wittmer H., Gundimeda H. editors (2012), The Economics of Ecosystems and Biodiversity in Local and Regional Policy and Management, Routledge, page 7 – 32.

Fiche 13 ((The Fiche 13 is not distributed for copyright reasons but will confidentially be copied to BELSPO for inspiration)

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 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)

** 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.*

Policy Brief: the need for a community of practice on
Biodiversity and Public Health in Belgium

References

1. Chivian E. and Bernstein A. (Eds.) (2008), *Sustaining Life. How Human Health Depends on Biodiversity,* Oxford University Press, New York.
2. COHAB: Co-operation on Health and Biodiversity, http://www.cohabnet.org/
3. European Commission – DG Environment (2011), *Biodiversity and Health,* Science for Environment Policy Future Briefs, Issue number 2, October 2011, University of the West of England (UWE), Bristol, UK, http://ec.europa.eu/environment/integration/research/newsalert/future_briefs.htm
4. Hartig, T. et al. (2011). *Health benefits of nature experience: Psychological, social and cultural processes.* In Nilsson, K. et al. (Eds.), Forests, trees, and human health (pp. 127-168). Dordrecht: Springer.
5. Sala O.E., Meyerson L.A. and Parmesan C. (Eds.) (2009), *Biodiversity Change and Human Health: From Ecosystem Services to Spread of Disease,* Island Press, Washington
6. WHO – World Health Organisation (2006) *Ecosystems and Human well-being: Health Synthesis* – A report of the Millennium Ecosystem Assessment. WHO, Geneva. http://www.maweb.org/documents/document.357.aspx.pdf
7. Wittmer H., Berghöfer A., Keune H., Martens P., Förster J. and Almack K. (Forthcoming 2012), *The Value of Nature for Local Development,* In: The Economics of Ecosystems and Biodiversity (TEEB) Report for Local and Regional Policy Makers, Earthscan, Oxford, UK, http://www.teebweb.org/ForLocalandRegionalPolicy/tabid/1020/Default.aspx
8. Arumugam M., Raes, J., et al. (2011), *Enterotypes of the human gut microbiome,* In: Nature Volume: 473, Pages: 174–180, (12 May 2011), DOI: doi:10.1038/nature09944
9. Science (2011), *Breakthrough of the Year, The Runners-Up,* In: Science 23 December 2011: 1629-1635.
10. McMichael A.J. (2009), *Human population health: sentinel criterion of environmental sustainability,* In: Current Opinion in Environmental Sustainability 2009, 1:101–106
11. European Commission (2011), *Proposal for a Regulation of the European Parliament and the Council establishing Horizon 2020 - The Framework Programme for Research and Innovation (2014-2020),* European Commission, COM(2011) 809 final, 2 December 2011, Brussels.
12. Belgium's National Biodiversity Strategy 2006-2016, http://www.biodiv.be/implementation/docs/stratactplan/national_strategie_biodiversity_en.pdf
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
15. Meessen B., Kouanda S., Musango L, Richard F., Ridde V. and Soucat A. (2011), *Communities of practice: the missing link for knowledge management on implementation issues in low-income countries?,* Tropical Medicine and International Health, volume 16 no 8 pp 1007–1014 august 2011, doi:10.1111/j.1365-3156.2011.02794.x
16. Wenger E. and Snyder W. M. (2000), *Communities of Practice: The Organizational Frontier,* In: Harvard Business Review, January-February 2000, pg 139 – 145.

Authors

Bauler Tom (*Université libre de Bruxelles*), Ceuterick Melissa (*Organisation for Tropical Studies*), Coosemans Marc (*Institute of Tropical Medicine*), Decaestecker Ellen (*KULeuven-Kulak*), De Pelsmaeker Martin (*Flemish Land Agency*), De Somviele Bert (*Vereniging voor Bos in Vlaanderen*), De Vreese Rik (*Vrije Universiteit Brussel*), Gilbert Marius (*Université libre de Bruxelles*), Flandroy Lucette (*Federal Public Service (FPS) Health, Food Chain Safety and Environment*), Franklin Anne (*Royal Belgian Institute of Natural Sciences*), Gryseels Machteld (*Brussels Environment*), Hartig Terry (*Uppsala University*), Heyman Paul (*Military hospital Belgium*), Huyse Tine (*KULeuven*), Keune Hans (*Belgian Biodiversity Platform, Research Institute for Nature and Forest (INBO)*), Lambin Eric (*Université Catholique de Louvain*), Leirs Herwig (*University of Antwerp*), Loots Ilse (*University of Antwerp*), Mathijs Erik (*KULeuven*), Martens Pim (*Maastricht University*), Nemery Ben (*KULeuven*), Obsomer Valérie (*Université catholique de Louvain)*, Peeters Alain (*RHEA*), Prieur-Richard Anne-Hélène, (*DIVERSITAS*), Segers Hendrik *(Belgian Biodiversity Platform, Royal Belgian Institute of Natural Sciences)*, Symoens Françoise (*Scientific Institute of Public Health*), Tack Jurgen (*Research Institute for Nature and Forest (INBO)*), Tack Wesley (*Ghent University*), Van Damme Patrick (*Ghent University*), Van den Broeke Elke (*Flemish Government, Environment, Nature and Energy Department*), Vander Aa Beatrijs (*Research Institute for Nature and Forest (INBO)*), Van Gils Wim (*Natuurpunt*), Van Helden Jacques (*Université libre de Bruxelles*), Van Herzele Ann (*Research Institute for Nature and Forest (INBO)*), Van Ranst Marc (KULeuven), Vanwambeke Sophie (*Université catholique de Louvain*), Volckaert Filip (*KULeuven*), Wittmer Heidi (*UFZ, Germany*)

CONTACT

For more information
http://www.biodiversity.be/health

Hans Keune
h.keune@biodiversity.be
Tel: +32491621405

Fiche 15	
Name	Alain Peeters
Organisation	RHEA
Expertise	Agriculture, Biodiversity, Ecosystem approach, Food quality
Biodiversity – Public Health interest	Biodiversity is destroyed at a fast rate in developing countries (South America, Malaysia, Indonesia, Kenya, …) by the conversion of species-rich ecosystems (forest, grasslands, mangroves,…) for food and agro-fuel products (palm oil, soybean, shrimps, fish farming, flower, vegetables…). In oceans, over-fishing depletes the resources and destroys food chains. These products are used in Belgium in livestock feeding, in the food industry, in the energy industry,….. They often induce unfavourable characteristics of the fatty acid composition of human food (meat, dairy products, bakery, …). The unfavourable characteristics of fatty acids have a very negative impact on human health. Degradation of Belgian citizen health has significant implications on social security expenses. On the other hand some agricultural systems have positive impacts on biodiversity and on the quality of food products. It is the case of livestock systems based on grass in Europe. These positive effects should be quantified. There are important research needs for several research projects on: - the negative impact of biodiversity destruction in developing countries for food and agro-fuel productions on the health of Belgian citizens through consumption of food products; - the positive impact of biodiversity on the health of Belgian citizens through consumption of animal products produced on the basis of grasslands in Belgium; - the indirect effects of the two options on social security expenses in Belgium.
Research need or idea	Studies are needed for quantifying and valuing the whole chain from species-rich ecosystem destruction in developing countries or in oceans, by unsustainable agricultural systems, to the feeding of livestock and the quality of food in general in Belgium, to the impact on public health and possibly to the costs for the Belgian social security and the State budget. The research wants to quantify the hidden cost of biodiversity destruction along this chain. It should produce different types of figures including for instance the cost of the destruction of one ha of the Brazilian rainforest for the Belgian social security. It will contribute to estimate the social security costs that should be included in the product price for sending a clear signal to consumers (Ekins et al. 1994). It will compare the effect of sustainable agricultural systems (ex.: grass-based meat and dairy products in Belgium) and of imported products from unsustainable systems on human health and social security costs in Belgium.
Context	Since 1962, imports of animal feed and especially soybean and soybean cake increased a lot in the EU and in Belgium. Brazil, Argentina and the USA are the main export countries for the EU-27. Palm oil production is concentrated in Indonesia (49% of global exports) and in Malaysia (40% of global exports). On a total production of 35.6 Mio tonnes, the EU imports 13.8%. The European Union is a major importer and imports were recently stimulated by mandating partial substitution of fossil fuels by biofuels for electricity generation. Shrimp farming is often developed in biologically rich mangrove forests and estuaries where it causes pollution and depletes wild fish stocks. Mangrove destruction increases the vulnerability of coastal regions in relation to storm damage and erosion. It destroys breeding habitats of wild fish, other aquatic species and birds, including loss of critical spawning and nursery areas of fish and shellfish. Culture ponds for shrimp and fish accounted for the destruction of 20–50% of mangroves worldwide in recent decades (Primavera 1997). That induces species losses and ecosystem degradation. Most stocks of large predatory fish stocks have already disappeared. Wild fish is an essential source of omega-3 fatty acids in human nutrition.

Context/ Argumentation	Von Witzke and Noleppa (2010) estimated that the EU imported the equivalent of 35 million ha of 'virtual land' (land necessary for producing a given tonnage of commodity on the basis of regional yields) in 2007/2008. This area is equivalent to about twice the size of the Utilized Agricultural Area (UAA) of Germany. Soybean and soybean cake imports reveal the protein dependence of the EU and Belgium for animal feeding. As a consequence of relatively cheap feed imports. Beef meat consumption and the permanent grassland area decreased. The expansion of soybean cropping has environmental negative impacts: in Argentina and Brazil, it is leading to deforestation, biodiversity losses (e.g. direct and indirect deforestation of the Amazonian and the Atlantic forests, conversion of species-rich grasslands of the Pampa, the Campos and the Cerrado in South America) and GHG emissions (Fearnside 2001). All these biomes are species-rich and include a high proportion of endemic species. The case of palm oil is similar in Indonesia and Malaysia. These imports have negative consequences on human health of Belgian consumers. Human health remains a concern in Belgium despite the increase in life expectancy. Cardio-vascular diseases, inflammatory and auto-immune diseases (allergies), and obesity can be induced by unfavourable characteristics of fatty acids in animal products. Compared with grain-fed (soybean and cereals) beef or milk, grass-fed beef or milk are lower (about 4 times) in total fat, lower in saturated fatty acids (Couvreur et al. 2006) linked with coronary heart diseases (CHD), higher in conjugated linolenic acid (CLA) (cis-9 trans-11) (Dhiman et al. 1999) that is anti-cancer, higher in vaccenic acid (which can be transformed into CLA) (Duckett et al. 2009), and higher in total omega-3. In human organisms, omega-3 fatty acids protect against vascular diseases (induce elasticity of blood vessels and blood fluidity). Grass-fed beef or milk has also a healthier ratio of omega-6 to omega-3 fatty acids (1.7 versus 5-14). Omega-6 fatty acids in excess can prevent omega-3 from playing their role in cardio-vascular protection and provoke pain and inflammatory diseases like asthma and arthritis. Excessive consumption of omega-6 fatty acids induces increased development of fat tissue from childhood, obesity, an increase of inflammatory and auto-immune diseases (allergies), dementia and some cancers (Simopoulos 2002). These differences in beef and milk content is explained by the fact that grass is rich in omega-3 and poor in omega-6 (grazed grass omega-6/omega-3 ratio = 0.4; grass or legume hay and silage ratio = 0.7) while cereals and maize silage (ratio = 14) and soybean meal (ratio = 5) have very different characteristics (Simopolous and Robinson 1999). Cholesterol levels are not the only factor increasing the risk of coronary heart disease. The stearate that is abundant in soybean oil is a saturated fatty acid that does not affect blood cholesterol, but may increase blood levels of fibrinogen and, consequently, the risk of heart attack (Baer et al. 2004).
Argumentation	Obesity is induced among other by the consumption of energy dense food (ex.: cereals, bread, pasta, rice), sugar (ex.: bakery products, sweets, soda), saturated fatty acid (ex.: grain-based animal fat), a high omega-6/omega-3 ratio and reduced physical activity levels (World Health Organization 2012; Simopoulos 2002). Obesity can itself induce diet-related chronic diseases, including type 2 diabetes, cardiovascular diseases, hypertension, stroke and certain forms of cancers. Obesity occurrence is increasing in developed countries, with 31% of the population in the USA, 23% in the UK, 12% in Belgium (but only 3% in Japan) being considered to be obese (OECD 2011). Palm oil has interesting technological properties that are similar to butter. These properties make it adapted for margarine. It is largely used in mayonnaise, pizza and bakery for instance. It is cheap. On the other hand, it contains about 50% of saturated fatty acids that increase the risk of coronary heart disease (CHD) for consumers (Brown and Jacobson 2005). The World Health Organization has stated that there is 'convincing evidence' that palmitic acid increases the risk of cardiovascular disease. It advises that 'intake of foods rich in myristic and palmitic acids should be replaced by fats with a lower content of these particular fatty acids' (WHO 2003).

Argumentation	Belgian way of life, production and consumption patterns have thus destructive impacts on remote continents' biodiversity. Belgian permanent grasslands can be intensively or extensively managed. Extensively managed grasslands are usually higher in biodiversity than intensively managed plots but even intensively managed permanent grasslands sustain higher biodiversity levels (ex.: soil life, vegetation, birds) than annual crops, for instance forage maize that is the complement to soybean feed. Replacing soybean and maize silage by grassland forages in livestock feeding result in higher biodiversity in Belgium. Replacing palm oil by butter (produced on the basis of grass) in the food industry would have a similar effect. Developing sustainable fishing techniques and sustainable management of fish stocks would ensure the protection of biodiversity and ensure the provision of an omega-3 rich source in human nutrition.
Research need or idea	Studies are needed for quantifying and valuing the whole chain from species-rich ecosystem destruction in developing countries or in oceans, by unsustainable agricultural systems, to the feeding of livestock and the quality of food in general in Belgium, to the impact on public health and possibly to the costs for the Belgian social security and the State budget. The research wants to quantify the hidden cost of biodiversity destruction along this chain. It should produce different types of figures including for instance the cost of the destruction of one ha of the Brazilian rainforest for the Belgian social security. It will contribute to estimate the social security costs that should be included in the product price for sending a clear signal to consumers (Ekins et al. 1994). It will compare the effect of sustainable agricultural systems (ex.: grass-based meat and dairy products in Belgium) and of imported products from unsustainable systems on human health and social security costs in Belgium.
Scientific relevance	Global ecosystem approaches developed fast in the last ten years or so. Fluxes of energy and nutrients are increasingly described and analysed, but they still need to be better known and studied (Koellner 2011). Most studies focussed on the translation of fluxes of commodities from agriculture, forestry and fisheries into a virtual flow of land, freshwater and marine ecosystems (Koellner 2011; Würtenberger et al. 2006) or on the translation of these fluxes into CO2 (Davis & Caldeira 2010), energy and nutrient fluxes. Many studies are now developed on the impact of global trade on biodiversity, for instance on the rainforests of Indonesia, Malaysia and Brazil. Very few studies have focussed on the consequences of global trade (and fluxes of energy and nutrients) and biodiversity destruction on consumer health. The assessment of the benefits induced by biodiversity for citizens or of the negative impact of biodiversity destruction on citizen's quality of life is a present concern of many researches including in the TEEB process. This research will though develop an original approach by focussing on one of the most important benefit for Belgian citizens: their health! The research will also contribute to the development of a new method of biodiversity and ecosystem services valuation, by a transcontinental approach of the soil-plant-animal-consumer chain. This Life Cycle Assessment will generate original data on the link between biodiversity, human health and social security expenses. The impact of consumption products on the cost for social security has already been done for at least one product: tobacco. The methodology of this project can be partly inspired by this case study, although its approach is wider.

Policy relevance	This research is relevant for the following federal policies: - Public Health policy - Food Quality policy (Belgian Federal Agency for the Safety of the Food Chain (FASFC)) - Public Finance reduction - Trade policy, World Trade Organization (WTO) negotiations - Agricultural policy, CAP (in close collaboration with the Regions) - Environmental policies (pollution reduction) (in close collaboration with the Regions) Generally speaking, the research is related to present and future policies taking into account the 'sustainability' dimension. The research will define policy options for reducing the impacts of Belgian patterns of consumption. It will explore possibilities to decrease imports and to increase the food self-sufficiency of the Belgian agricultural system. That will lead to the identification of policies that could improve citizen health.
Societal relevance	Belgian citizens do often not perceive that their consumption patterns may contribute to ecosystem degradation and biodiversity loss in remote countries. For instance, they do not understand that the consumption of pig and poultry meat causes rainforest destruction. The results of this research will contribute to raise awareness on these topics. Some Belgian citizens are though aware of global environmental problems linked with global trade and would like to improve the impact of their way of life on tropical ecosystems, but Belgian consumers are still mainly looking for cheap products regarding food, flowers, clothes, and other commodities. These two contrasted attitudes are not compatible. The integration of the value of ecosystem services in commodity prices and a sustainable management of ecosystems and biodiversity has a cost! It must be quantified. The research programme is directly related to citizen's welfare (health) and to biodiversity conservation. It is related to the impact of diseases induced by bad quality feeding on absenteeism in administrations and private companies and thus on labour productivity. An ecological footprint labelling could help to better information Belgian consumers. Even more importantly, the cost of social security expenses and ecosystem degradation and biodiversity loss should be included in prices for sending a strong signal to consumers. Human health implications of bad quality food can also be a strong argument that can orient consumer's consumption decisions.
Potential for collaboration	The following administrations, research units and NGOs could be potentially associated at different levels to the project: - Belgian Federal Public Service Health, Food Chain Safety and Environment - Belgian federal agency for the safety of the food chain (FASFC) - Belgian Scientific Institute for Public Health (known as WIV-ISP) - Belgian Federal Public Service Social Security - Research Units in Economy - FNRS contact group 'Nutrition, feeding and health' - Food2Know Centre of Excellence, Laboratory of Animal Nutrition and Animal Product Quality, University of Ghent - Pharmacognosy, Bromatology and Human Nutrition, ULB - WWF
Other remarks?	As suggested in previous sections, integrating the tackling of such different important problems can help to try to solve each of them and, consequently, at the same time at a faster and cheaper rate.

Contact:
Dr Hans KEUNE
h.keune@biodiversity.be
http://www.biodiversity.be