MSc Program
Environmental Technology & International Affairs

The impacts of land use on biological diversity and ecosystem services and potential solutions in areas marked by strong anthropogenic influence – A case study on the Interurban Green Zone in Luxembourg

A Master's Thesis submitted for the degree of
“Master of Science”

supervised by
Dr. rer. nat. Ian McCallum

Nick Sinner, BSc

01425928

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Affidavit

I, **NICK SINNER, BSC**, hereby declare

1. that I am the sole author of the present Master's Thesis, "THE IMPACTS OF LAND USE ON BIOLOGICAL DIVERSITY AND ECOSYSTEM SERVICES AND POTENTIAL SOLUTIONS IN AREAS MARKED BY STRONG ANTHROPOGENIC INFLUENCE – A CASE STUDY ON THE INTERURBAN GREEN ZONE IN LUXEMBOURG", 128 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted the topic of this Master's Thesis or parts of it in any form for assessment as an examination paper, either in Austria or abroad.

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Abstract

Anthropogenic land use is one of the biggest drivers of global change. Population growth and economic development have driven urbanisation and agricultural expansion across the globe, with widespread negative consequences on the natural environment. Anthropogenic land consumption continues to degrade and destroy natural habitats and to fragment remaining wild areas. Increasingly intense land management practices affect ecosystems, degrade soils and change landscapes. The widespread loss of biological diversity puts vital ecosystem services at risk that humans' livelihoods depend on. Global environmental trends, especially climate change, are expected to exacerbate these negative trends.

Luxembourg, the smallest continental country in the EU, is leading among European countries with the highest degree of degraded and artificialised lands and has seen its biodiversity decline for decades. In 2021, the government put into effect a spatial planning instrument that grants protection against land take for the 'interurban green zone' (ZVI), a 15000 m^2 zone in the South-West of the country that is threatened by urbanisation.

This thesis provides an overview of the most important land use sectors in the ZVI (urbanisation, agriculture and biodiversity conservation) and highlights in detail the drivers and trends of biodiversity and land use in this region. This is complemented by a review of the relevant legislation and policy instruments pertaining to land use, biodiversity and spatial planning. Finally, drawing from two expert interviews in the areas of biodiversity conservation and spatial planning, long-term visions of sustainable land use in the ZVI are described, including the restoration of biodiversity, the safeguard of food security, societal resilience and the co-benefits stemming from sustainable land use in the ZVI. Then, possible instruments in the different sectors of urbanisation, agriculture and biodiversity conservation to achieve these visions are discussed, including an assessment of the legal policy framework concerning its fitness to guide sustainable land use and the achievability of political and legal targets.

Contents

Abbreviations

AggloLUX	Urban Agglomeration of Luxembourg, Strassen, Betrange, Walferdange, Findel and Howald.
AggloSUD	Urban Agglomeration of Esch-sur-Alzette, Schifflange, Foetz and Belvaux.
CAP	Common Agricultural Policy of the European Union.
CV	'Coupure Verte' – Green Cut.
EEA	European Environment Agency.
EU	European Union.
GEP	'Grand Ensemble Paysager' – Large Landscape Regions.
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services.
IPCC	Intergovernmental Panel on Climate Change.
MDDI	Ministère du Développement Durable et des Infrastructures.
MEA	'Ministère de l'Énergie et de l'Aménagement du Territoire'.
PAG	'Plan d'Aménagement Général' - Commun Development Plan.
PDAT	'Plan Directeur de l'Aménagement du Territoire' – Master Plan for Spatial Planning.
PDS	'Plan Directeur Sectoriel' – Sectoral Master Plan.
PNDD	'Plan National pour un Développement Durable' – National Plan for Sustainable Development.
PNPN	'Plan National concernant la Protection de la Nature' – National Plan concerning Nature Protection.

PSP ’Plan Directeur Sectoriel "Paysages"’ – Sectoral Master Plan "Landscapes".

SDG Sustainable Development Goal.

UNEP United Nations Environment Programme.

WWF World Wide Fund for Nature.

ZeRiA ’Zone Expérimental de Résilience Inter-Agglomérations’ – Experimental Zone for Inter-Agglomerational Resilience.

ZVI Zone Verte Interurbaine.

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Part I

Introduction

With the beginning of the agricultural revolution around 10,000 years ago, as the prevalent hunter-gatherer system began to be replaced with agricultural systems, the trend for humans to change their surrounding lands to accommodate their needs for food production and other provisional services emerged. The following centuries saw the rise and fall of many civilisations across the globe which cultivated and changed their environment in various ways. However, it was only from the 1700s (the industrial revolution) that a widespread change in land cover gained momentum which has been accelerating ever since. The face of the Earth of today – almost entirely explored, inhabited or exploited lands – is radically different from the world in 10,000 BC. The 'great acceleration' of global changes since the 1950s puts the Earth system and its natural stability at risk.

Land use – the way humans make use of the resource 'land' – is a primary driver of global change. Global land use change has accompanied the global population rise with the emergence of ever-larger cities and more and more cultivated lands for food and other resources but, at the same time, has been a key driver of environmental degradation. The destruction of natural ecosystems, their resources and their flora and fauna, to the pollution of soil, air and water and the change of regional and global climatic conditions, puts at risk the many contributions and benefits humans get from an intact environment.

Luxembourg as a wealthy Western European nation has emerged from centuries of ongoing land use changes as a country whose appearance is heavily changed through anthropogenic policies of development, urbanisation and industrialisation. Today, half of its land is occupied by agriculture, about a third is covered in forests and around 10% are used for housing and living. The natural environment is in an overall fragile condition, with habitats and natural areas fragmented and degraded by human infrastructure, groundwater and rivers polluted from agricultural and industrial emissions and species levels largely on the decline for several decades.

The subject of this thesis is the territory of Luxembourg, and more specifically, the region now legally recognised as the interurban green zone – an area of land in the South-West of the county that despite threatening urbanisation, economic expansion and fragmentation at its borders, has managed to remain relatively intact in its landscape and in its ecological functioning.

This thesis analyses the impact of land use and land use change within and surrounding the ZVI on the environment and especially on biodiversity and its ecosystem services, and draws upon the available literature and implicit knowledge from national experts to offer options for solutions and pathways towards an ecologically sustainable land

use regime within the ZVI that restores and conserves biodiversity and ensures the long-term provision of vital ecosystem services and other contributions necessary for human well-being in the face of global environmental changes and crises.

Therefore, the research question this thesis aims to address can be formulated as follows:

How do land use practices in Luxembourg and especially in the ZVI impact biodiversity and ecosystem services, how can they be conserved, restored and sustainably managed in the long term and how can trade-offs between different stakeholders, especially urbanisation, biodiversity conservation and agriculture, be minimised? What is the relevant legal and policy framework governing land use and its impact on biodiversity and ecosystem services and how effectively does it support the objectives of sustainable land use and biodiversity conservation?

Part II

Literature Review

1 Environment and Humanity in the Anthropocene

The United Nations' 2019 6th Global Environment Outlook provides an overview of the state of the global environment. Concerning air quality and pollution, some regional and sectoral improvements in air quality have been outpaced by rising pollution in others, particularly due to urbanization and the continued dependence on polluting fuels. Globally, air pollution is the single biggest threat to health. Global greenhouse gas emissions have risen while global mean temperatures have reached an increase of 0.8 to 1.2°C since pre-industrial times. If those current emission trends continue, it will narrow the window of opportunity to reach the Paris Agreement goals significantly. Climate change is a threat to humanity and a cross-cutting issue that affects every aspect of the planet, mostly by reinforcing unsustainable trends.

Biodiversity – "*the diversity of living things at the genetic, species and ecosystems level*" (UNEP 2019b, 8) – is declining rapidly. The natural world is disturbed through anthropogenic pollution, loss and degradation of habitats and through invasive species. The benefits of intact ecosystems are referred to as ecosystem services or nature's contributions to people. They regulate environmental processes, underpin human livelihoods and provide food and material, and have been declining for the last decades. The scale of the problem compels scientists globally to speak of a "*major species extinction event*" (UNEP 2019b, 8).

Oceans are faced with rising sea levels from increasing temperatures, disturbed temperature patterns and acidification due to enhanced uptake of carbon dioxide. They are degraded in biodiversity and ecosystem services through exploitation and pollution from human activities. Marine litter, including plastics and microplastics, is now found in virtually every part of the oceans. These trends threaten aquaculture and agriculture, resilience and human health.

The planet's land and soil have seen increasing desertification, land degradation and on-going deforestation. Supplying humanity with food is the largest driver of land use change with half of the habitable land being used for agriculture. Urban areas still only constitute a fraction of used land but their rapid expansion nevertheless puts pressure on local ecosystems, water and soil, and re-shaping micro-climates.

Finally, fresh water, a primary and indispensable resource for life, is under threat from increased consumption, pollution and the rising impacts of climate change. 70% of fresh water, on a global average, is extracted for agricultural use. (UNEP 2019b)

The magnitude of global change is illustrated by the concept of the 'anthropocene' – the name for a new geological epoch where human activities are the drivers behind changes in the Earth System – and the 'great acceleration', showcasing the accelerating trends since 1950 that are shaping the present and future. In socio-economic trends, human population, economic activity, energy consumption, transportation and fertilizer application have seen explosive rises, at the same time as greenhouse gas concentrations and global temperatures, land use change, biodiversity loss, and nitrogen pollution have seen exponential rises. (Steffen et al. 2015a)

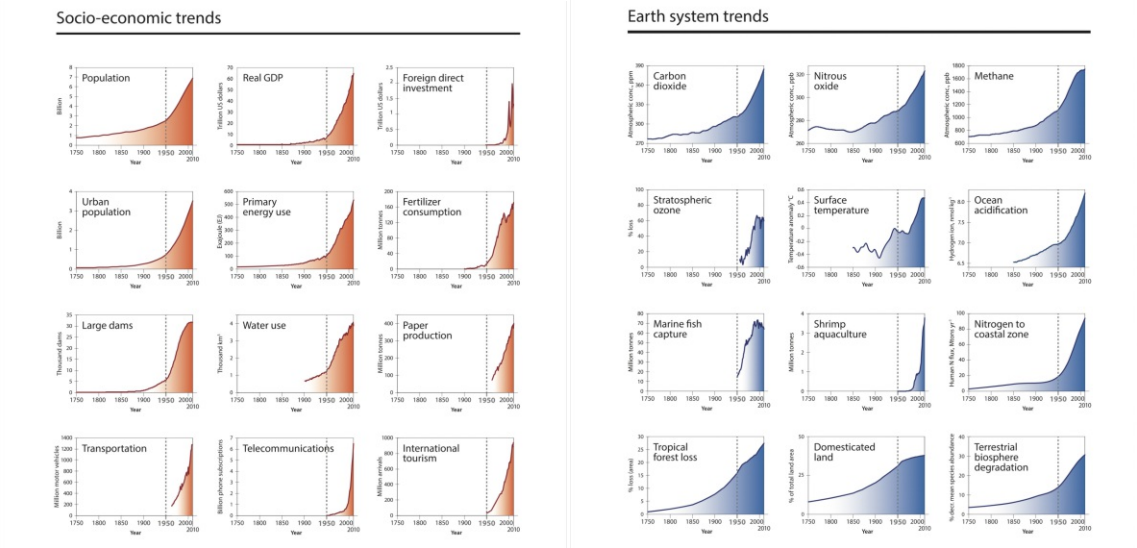

Figure 1: Global socio-economic and earth system trends show an unprecedented acceleration since the 1950s (Steffen et al. 2015a)

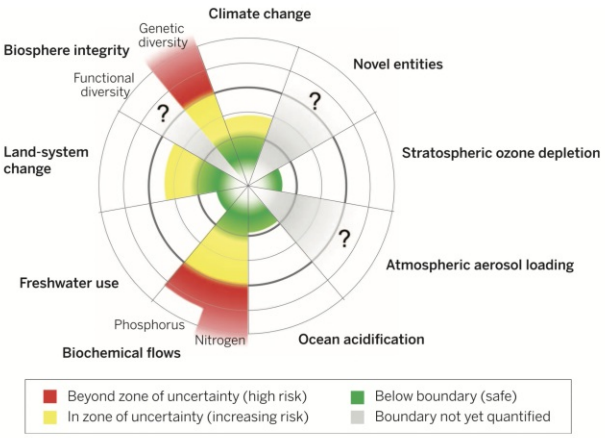

Figure 2: "*Current status of the control variables for seven of the planetary boundaries.*" (Steffen et al. 2015b, 736)

The dangers originating from these fundamental changes in the Earth system are described in the nine planetary boundaries, defined as: climate change, biosphere integrity, land-system change, freshwater use, biogeochemical flows (phosphorus and nitrogen), Ocean acidification, atmospheric aerosol loading, stratospheric ozone depletion, and novel entities. Each boundary is associated with control variables on the

basis of which is determined whether the boundary is exceeded or not. The authors state that each of these components of the Earth system have the capability to shift the planet away from its stable Holocene state in which human civilization has evolved and thrived into a state that may not be able to "*support contemporary human societies*" (Steffen et al. 2015b, 736). Especially the climate and the biosphere are recognized as "*core boundaries*" (Steffen et al. 2015b, 8), underpinning all other components and having the capacity to shift the Earth into a new state on their own. The variables for climate change, the biosphere, land, and phosphorus and nitrogen have all been assessed to exceed their boundaries, with the biosphere and the biogeochemical flows in the high risk zone, indicating that all these components as well as their interaction can destabilise the Earth system. Freshwater use, ocean acidification and stratospheric ozone depletion are currently within their "*safe operating space*" (Steffen et al. 2015b, 736), while atmospheric aerosol loading and novel entities have not been fully assessed due to their complexity. (Steffen et al. 2015b)

It is one of the monumental tasks of the 21st century for humanity to reduce their pressure on the planetary boundaries and maintain a liveable planet for the current and future generations. With the focus on land use, this thesis will contribute to research surrounding the land use change boundary and its implications on the biosphere boundary, including references to their interactions with the boundaries "climate" and "biogeochemical flows".

1.1 Global Environmental Policy Framework

1.1.1 Agenda 2030 for Sustainable Development and Sustainable Development Goals

The 2030 Agenda for Sustainable Development, adopted in 2015 by the United Nations, is the international community's common roadmap for sustainable development. Through 17 Sustainable Development Goals (SDGs), divided into 169 specific targets, the world's biggest challenges are addressed, from alleviating poverty and hunger, over equality, energy and work to the preservation of the natural environment. The Agenda's fundamental assumption is that all these challenges are interlinked and cannot be solved in isolation but through collective and collaborative action. The SDGs are the global framework, within which all countries organise their strategies for a sustainable future, and all respective agreements and policy instruments, at their base, are oriented towards the achievement of the SGDs by 2030. For this thesis, the Goals 11, 13 and 15 are of specific importance, covering sustainable cities, climate action and life on land. (United Nations, n.d.)

1.1.2 United Nations Framework Convention on Climate Change and Paris Agreement

The United Nations Framework Convention on Climate Change (UNFCCC) is a 1992 international treaty with the objective of "*[stabilizing] greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*" (UNFCCC, n.d.). The Paris Agreement, signed in 2015, covers virtually all countries of the world with the ambitious objective to limit global warming "*well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 ° C above pre-industrial levels*". Emission reductions are achieved based on Nationally Determined Contributions, voluntary commitments submitted by each signatory of the agreement. (United Nations 2016)

However, pledges by countries are falling short from the Paris Agreement temperature limits. All commitments submitted before the 2021 climate conference put the world on track to disastrous 2.7°C of warming by the end of the century and fail to reduce emissions in the coming decade. (UNFCCC 2021a)

1.1.3 Convention on Biological Diversity

The Convention on Biological Diversity (CBD) is an international agreement aiming for "*the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources*" (Convention on Biological Diversity, n.d.). Adopted in 2011 were the 20 Aichi Biodiversity Targets which provide an UN-overarching framework for biodiversity conservation, aiming to address drivers on biodiversity degradation, reduce pressures, ensure conservation and safeguard benefits from nature to people. However, most of the Aichi Biodiversity Targets for 2020 have not been or are projected to not have been achieved (IPBES 2019).

1.1.4 United Nations Convention to Combat Desertification

The 1994 United Nations Convention to Combat Desertification (UNCCD) is "*the sole legally binding international agreement linking environment and development to sustainable land management*" (United Nations Convention to Combat Desertification, n.d.). The objective is to combat the ongoing desertification, land degradation and droughts in "*arid, semi-arid and dry sub-humid areas*" (United Nations Convention to Combat Desertification, n.d.), which applies primarily to Africa.

Consistent with the Agenda 2030 Target 15.3, the strategic framework 2018-2030 of the UNCCD aims to achieve and contribute to Land Degradation Neutrality and, through that, restore resilience to populations and ecosystems, improve the situation of affected people and produce other environmental benefits. (United Nations Convention to Combat Desertification, n.d.)

2 Land Use and Land Use Change

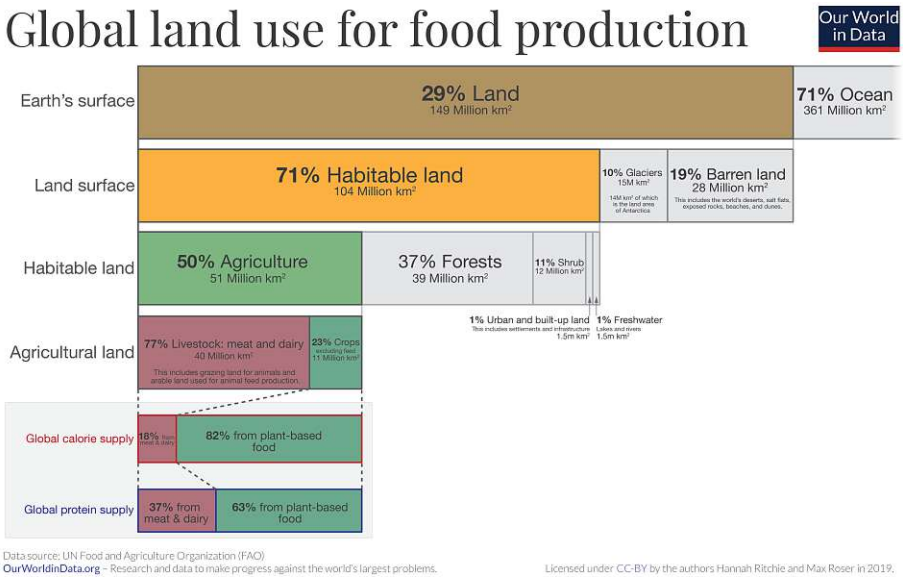

Figure 3: Global Land Use (Ritchie and Roser 2013)

71% of our world is composed of oceans and 29% of land. Only 71% of this land is habitable with the rest being barren land or glaciers. Half of the habitable land is dedicated to agriculture. Only 23% of agricultural land serves the production of crops intended for direct human consumption, whereas the other 77% directly or indirectly provide meat and dairy products in the form of grazing land, meadows or crops for feed production. (Ritchie and Roser 2013) Urban and built-up areas only make up 1% of total land cover. Another definition by Martino et al. (2016), also capturing suburbs and surrounding towns, leads to a figure of 7.6% of urban land. Either way, despite their small share of global land surface, densely populated urban areas have effects well beyond their physical boundaries, by affecting natural cycles, producing large amounts of waste and by altering micro-climates (UNEP 2019a).

In geological terms, the current land cover is a fairly recent development. In 10,000 BC, at the time of the agricultural revolution, the planet was covered in 60% semi-natural lands and 40% wild areas. In the year 0 BC, wild areas still formed 35% of land masses while the rest had been replaced by more semi-natural areas and around 3% of cropland and pastures. Even in 1700, heavily changed land (such as settlements, cropland and pastures) only makes up 10% of all land masses. From that point onwards until the present day, a profound and accelerating change of the face of the Earth takes place, leading to a planet where half of its habitable land is cropland, pastures or human settlements, at the expense of 63% of wild lands and 59% of semi-natural lands compared to 10.000 BC. Three quarters of the Earth's surface are considered "*significantly altered*" (IPBES 2019, 11). Current estimations indicate that humanity will continue changing land cover for its own needs. (Ritchie and Roser 2013)

In the following, the main indirect and direct drivers behind land use and land use change will be analysed, followed by the concrete pressures that result from these drivers and pressures. Later, in Section 2.4, these drivers and pressures will be linked to concrete impacts on the natural world.

2.1 Land Use Metrics and Terms

2.1.1 Land Use and Land Cover

Land use is defined as "*the way in which people use land. It can overlap with or completely change natural conditions such as plant cover, soils, mesoclimate and water balance*" (Spektrum 2001). It is distinct from 'land cover', which is merely descriptive and provides information about existing vegetation, infrastructure or water on the land. However, both terms are sometimes used interchangeably, leading to confusion. (Government of Canada 2015)

2.1.2 Land Consumption, Soil Sealing and Land Artificialisation

The terms land take and land consumption are mostly used interchangeably to describe the same phenomenon, referring to "*the change in the area of agricultural, forest and other semi-natural land taken for urban and other artificial land development. Land take includes areas sealed by construction and urban infrastructure, as well as urban green areas, and sport and leisure facilities.*" (EEA 2019b)The term 'land artificialisation' also appears frequently in the literature and in policy documents, and describes a similar concept as land consumption although its exact meaning is subject to discussion, given that, for example, meadows used for agricultural purposes are not necessarily more 'natural' than urban parks. Artificialisation could therefore happen at different levels or degrees of intensity, from managed semi-natural lands to constructed surfaces, with a corresponding loss of natural functions. (Junker 2020) Soil sealing, on the other hand, describes the conversion of land previously covered by natural or semi-natural land cover to constructed surfaces, streets or other impermeable surfaces, including the covering by asphalt or concrete. "*Soil sealing causes the complete and irreversible loss of all soil functions.*" (EEA 2019c, 125) When using these concepts as indicators, for example, a family home garden is included in the land consumption indicator but is not considered when measuring soil sealing. (Decoville and Feltgen 2018)

2.2 Indirect and Underlying Drivers of Land Use Change

2.2.1 Population Growth and Urbanization

Global population growth has been a leading cause for global land use change and will continue to be for the remainder of the 21st century although there are striking regional demographic differences. The developed world, gone beyond its industrial prime, might see a decrease in population until the mid-century and is therefore less in need of exploiting new land. Africa, on the other hand, will experience a profound

transformation of its land use regime with its population expected to double or even triple by 2050. This could lead to difficulties in providing food, housing and energy in developing nations, coupled with environmental degradation due to increased resource consumption. One important consequence of these dynamics is rural exodus and the growing urban populations.

The physical expansion of cities and the growth of urban population have increased the so-called "*teleconnections*" (UNEP 2019a, 205) between urban, peri-urban and rural regions. Cities increasingly rely on resources produced in rural areas and, inversely, the countryside depends on urban populations as customers of food, materials and other resources. In other words, the land consumption of cities and the environmental implications reach far beyond the physical borders. (UNEP 2019a, 204) Since 2007, more people are living in cities that in rural areas, and this number is projected to rise to 2/3 by 2050. (Ritchie and Roser 2018)

2.2.2 Economic Development and Technology

The globalisation of trade and rapid technological progress have shifted land use practices. The movement of goods from land resources has repercussions on land use especially in developing countries which are providing many agricultural products to the world.

On the other side, economic and technological advances overall are not having positive effect on land use practices and associated problems per se. The current prevailing economic paradigm "*generally [favours] expanding economic activity[, causing] environmental harm*" (IPBES 2019, 14), without accounting for the (often economic and financial) benefits and value of ecosystems. Rising incomes are driving increased land consumption (EEA 2019c). Particularly in land use, losses or degradation in land resources are compensated by increased (agricultural) inputs while disregarding and discounting the full and long-term economic, ecological and social implications. In addition, the complex issue of land use and degradation is often reduced to the price of food crops. This fails to account for the complexity of land and all the other ecosystem functions and services it entails. Nevertheless, the question of land consumption and scarcity has recently found its way into economic activities, leading to increased speculation and "*landgrabbing*" (UNEP 2019a, 226). (UNEP 2019a)

2.3 Direct Drivers of Land Use Change

2.3.1 Urbanization

Urbanization is a direct consequence of population growth over the last decades and centuries, with a share of global land masses of 4% in 1500 to 54% in 2016. Over half of the world population now lives in urban areas that constitute only 7.6% of the Earth's surface. (Ritchie and Roser 2018) (UNEP 2019a) Trends in urbanization differ widely across continents. For example, between 1975 and 2015, Europe's city population has remained constant while its urban areas doubled. At the same time, Africa's population tripled while its urban area surface quadrupled. (UNEP 2019a) While Section 2.2.1 covers the indirect impacts of urbanization on land use through economic and social feedbacks, this section analyses the direct land use change resulting from converting (semi-)natural lands to urban areas.

The expansion of urban areas primarily comes at the expense of agricultural lands, leading to a trade-off between the benefits of cities such as "*access to education, housing, clean water and electricity*" (UNEP 2019a, 214) and food production.

On the other hand, urbanisation leads to the loss of natural habitats, severe soil artificialisation and soil sealing, destroying and degrading biodiversity and disrupting natural cycles and local climates. (EEA 2019a). In contrast to their immense need for freshwater, organic waste and wastewater urban areas also contribute to water pollution (Foley et al. 2005).

Urbanization also has impacts beyond the built-up or heavily changed areas to adjacent lands. A major problem accompanying urbanization is urban sprawl, defined as "*the rapid expansion of the geographic extent of cities and towns, often characterized by low-density residential housing, single-use zoning, and increased reliance on the private automobile for transportation*" (Britannica, n.d.). While it creates individual benefits such as "*[affordable] single-family homes, with green surroundings and ample space between the houses*" (EEA and FOEN 2016, 25), it favours higher energy consumption for transportation and fragments existing landscapes, reducing the connectivity of ecosystems and exposing flora and fauna to increased pollution and noise (EEA and FOEN 2016).

2.3.2 Agriculture

Agricultural land accounts for roughly 50% of all habitable land on the planet today, with far-reaching consequences for both humanity and the natural world. Agricultural expansion has significantly affected habitats for wild flora and fauna by consuming or altering untouched landscapes on a global scale. A slight decrease in agricultural land by 1% since the start of the millennium has been more than compensated by agricultural intensification, bringing agricultural productivity to unprecedented levels. Although net land consumption has slowed, this does not account for the quality of current agricultural lands nor for the abandonment of degraded and unproductive lands. (UNEP 2019a)

Overall, crop production has risen by 28% between 1985 and 2005, although trends differ for different crop groups. The rise in productivity is largely due to the agricultural intensification and less to expansion of crop lands. On the one hand, increased inputs have produced higher yields – fertilizer application has risen by 500% over 50 years –, on the other hand, agricultural practices have allowed to harvest more often from the average crop area, thanks to "*increased multiple cropping, fewer crop failures, and less land left fallow*" (Foley et al. 2011, 337). Global land area for cereals has declined in the last years despite a rise in production, contrary to oil crops like soybean and oil palm who have seen sharp increases in both crop land area and yields in South America and South-East Asia. (Foley et al. 2011) In general, agricultural land has seen "*a net redistribution of agricultural land towards the tropics*" (Foley et al. 2011, 337) with very little or no expansion happening in the temperate latitudes, e.g. in Europe.

Today, crop land for primary food production occupies 23% of global agricultural land. On the other hand, 77% of all agricultural land is, directly or indirectly, supplying the production of meat and other animal products. (Ritchie and Roser 2013) Even without taking into account the land needed for pastures, 35% of crops produced are processed into animal feed (Foley et al. 2011). Meat and animal products are inherently less resource-efficient in providing energy and nutrients when considering e.g. the energy and water a farm animal consumes for its own survival. Globally, only 18% of human calorie intake come from meat and dairy, and only 37% of proteins, rendering the land area dedicated to livestock very inefficient (Ritchie and Roser 2013).

In addition, these products disproportionally contribute to greenhouse gas emissions from the food sector, mainly due to the land use change as well as emissions from farming (Ritchie and Roser 2020b). A recent study found that animal products are responsible for 57% of the sector's greenhouse gas emissions (Xu et al. 2021). While numbers of livestock populations have risen on average faster than human population since 2000, global pasture and meadow areas have declined, indicating an intensification of agricultural practices in this area (UNEP 2019a).

Although agricultural intensification, including increasing inputs, has improved food production overall, the negative impacts on the environment are of global scale and are becoming increasingly relevant. Expansion of agricultural land and homogenisation

and fragmentation of landscapes have degraded, destroyed and fragmented habitats across the globe, driving biodiversity loss (Foley et al. 2005). Soil quality is impaired by intensification practices such as excessive tilling, resulting, among others, in excessive soil erosion and the release of soil carbon into the atmosphere (IPBES 2018) (IPCC 2019). Fertilizer application is highly unequal between countries, from excesses in rich countries in Europe, North America and China to considerable shortages in developing countries. In the former, this leads to nutrient run-off from fields and penetration into the ground and water bodies, with negative environmental consequences. In the latter it leads to crop yield gaps, i.e. areas where crop production is underperforming in comparison to its possible optimum, putting unnecessary stress on land resources and leading to food shortages. (Foley et al. 2011)

Agriculture consumes 70% of the global withdrawn freshwater for irrigation with impacts on large water bodies and rivers in some parts of the world. In addition, it also withdraws water from groundwater reserves (Foley et al. 2005) (Foley et al. 2011).

In general, modern agriculture is built on short-term goals: while ever-increasing inputs have scaled up food production and temporarily mended environmental constraints, the ongoing degradation of ecosystems and their functions and services will be of much bigger impact and require a shift towards more sustainable practices (Foley et al. 2005).

Agriculture is facing a crucial challenge in the next decades. Given that the world population's need for food will likely be 50% higher that it is today and given that current trends indicate the world failing to keep up with this demand: how can agriculture reconcile the provision of sufficient and nutritious food for all of humanity while preserving intact ecosystems in the long run? (Foley et al. 2011)

2.4 Threats to the Environment and Society

2.4.1 Land Degradation

The IPBES (2018, 18) defines land degradation as "*the many human-caused processes that drive the decline or loss in biodiversity, ecosystem functions or ecosystem services in any terrestrial and associated aquatic ecosystems*".

Land degradation originates in anthropogenic activity, not natural processes per se. The phenomenon extents to aspects such as biodiversity degradation, soil degradation, forest degradation and deforestation or even land abandonment as a socio-economic contributor, where cultivation of crops is not economically or politically feasible anymore. A prominent example are agricultural lands where food production is still possible and economically viable but where most of the other ecosystem functions and services of the land are declining or depleted. (IPBES 2018)

Land degradation is a highly relevant, anthropogenically driven phenomenon, affecting 29% of global ice-free land area, in which 3.2 billion people are currently living (IPCC 2019, 7). It is also the leading cause of biodiversity loss (IPBES 2019). Indirectly, anthropogenic activities affect around 70% of the global ice-free area (IPCC 2019). Current trends of land degradation, combined with the exacerbation through climate change, could reduce crop yields by 10% by 2050 and are therefore likely to cause the world to miss its 2030 target of land degradation neutrality that is laid down in the UN Sustainable Development Goals (UNEP 2019a).

The primary driver of land degradation are "*high consumption lifestyles in more developed economies, combined with rising consumption in developing and emerging economies*" (IPBES 2018, 13). Rising patterns of consumption per person induce the replacement of natural ecosystems by crop lands and pastures, harmful agriculture and forestry practices, and in increased urbanization and infrastructural projects to satisfy growing demands. (IPBES 2018)

While land degradation is present in high income countries such as Europe or Australia as well as emerging or developing regions in South-East Asia, Latin America and Africa, the former are more resilient to its adverse effects because they are less reliant on agriculture and ecosystem services, and possess the financial and technological capacities to mitigate or adapt to these effects. Land degradation disproportionally affects "*people in vulnerable situations, including women, indigenous peoples and local communities, and lower-income groups*" (IPBES 2018, 25) even within national borders. (IPBES 2018)

2.4.2 Impacts on Soil

Land use and land use change impact the ecological functions of soils. Soil sealed with impermeable materials such as concrete and asphalt prevents water infiltration, the production of soil organic matter through soil organisms and disturbs nutrient cycles. The consequences are increased water run-off on surfaces or little to no carbon sequestration from the atmosphere. (EEA 2019c)

Soil can be subject to erosion where the top layer of soil is irreversibly lost due to water run-off, wind or losses through harvesting. Consequences are reduced productivity as well as the leaching of pollutants and excessive nutrients from fertilizers into adjacent water bodies. (EEA 2019c) Soil can also be compacted through heavy machinery or livestock. This results in "*increased soil density, a degradation of soil structure and reduced porosity*" (EEA 2019c, 125). Consequently, plant growth is impaired because of reduced soil pores size, water infiltration is compromised which can lead to soil erosion through increased surface run-off. (EEA 2019c) Finally, soil can be contaminated with heavy metals, persistent organic pollutants or herbicides and pesticides. This has not only a detrimental effect on ecosystem functions and services but also directly impacts human health through the food chain by contaminating agricultural soils and fresh water. (EEA 2019c) Assuring and protecting the quality of soil and all its ecological functions is of great importance because it is considered a non-renewable natural resource, as the time of its reformation far exceeds a human lifespan. (EEA 2019c)

2.4.3 Forests

Forests make up 38% of all habitable land, more than any other land cover type. The IPCC (2019) finds that over two thirds of forests are heavily changed and managed by human activities while the rest remains largely untouched. Despite their large extent, forests have seen an important decline in surface area since 10,000 BC, when they constituted 57% of all habitable land. They were forced to make way for agricultural land in the form of crop and grazing land.

Although almost every country experiences deforestation, and some of these losses are offset by reforestation or afforestation. In general, global deforestation peaked in the 1980s. Temperate forest loss dominated until the 1910s but while reforestation and forest growth is taking place in developed countries since 1990, tropical forests today are the almost exclusive victims of deforestation.The main direct drivers of deforestation are beef production, oil crops and paper and wood production. (Ritchie and Roser 2021)

2.4.4 Food and Fresh Water

Although food production per capita has risen by 10% between 1993 and 2013, roughly 1 billion people are suffering from undernourishment, and 1 billion people are impacted by micronutrient deficiency today. On the other hand, overweight and obesity are on the rise as well, affecting 2 billion and 500 million, respectively. (UNEP 2019a)

Our food mostly comes from land, only 6.7% of global protein supply comes from fish. The world is presented with a dilemma: the Global Environmental Outlook predicts that demand for food will approximately rise by 50% up until 2050 but, at the same time, current practices of maximising short-term profits and efficiency will not be able to meet the needs for crop land without compromising crucial ecosystem services, energy supply and other factors. (UNEP 2019a) Many agricultural lands are entirely orientated to maximise food production without supporting and preserving other ecosystem functions and services, which will eventually lead to a loss of natural habitats, biodiversity and the ecosystem services that guarantee the land's ability to produce food in the first place, such as pollinators. (IPBES 2018)

In contrast to the enormous problem of malnourishment, it is estimated that one third of all produced food is wasted or lost annually. In addition to the global hunger problem, it is also a considerable waste of resources, specifically 23% of fertilizer application and 24% of extracted fresh water, it puts unnecessary stress on already degraded lands, and accounts for 6% of annual global greenhouse gases (Ritchie and Roser 2020a). The developed world is responsible for a bigger share of this loss, with increasing relevance of the final stages of supply chains, such as retail and households, while losses in developing nations are linked to lack of infrastructure and storage. (UNEP 2019a)

Globalization and shifting diets have created a complex trade network of food. Up to 25% of all food products are not consumed in the country where they are produced. 80% of the world population are living in "*food-deficit countries*" (UNEP 2019a, 218) as of 2005. Especially developing countries with low-income are unable to scale up production and increase food security. Global food supply has been homogenized by relying on a number of key regions and crop species which are supporting most the world's population. While increasing efficiency and lowering food prices, this undermines the resilience of the global food system, leading to price volatility e.g. in the case of crop failures.

Fresh water resources are declining globally, driven by population growth and urbanization. The world is providing better access to safe drinking water, having provided 1.5 billion people with access to drinking water since 2000, but is moving away from environmental targets for water quality, namely chemical and organic pollutants, across most countries. (UNEP 2019b) Urban areas, industry and agriculture are all competing for water resources to satisfy their rising demands, while agriculture is responsible for a staggering 70% of freshwater withdrawals and for 90% of consumptive use (UNEP 2019b) (Foley et al. 2011). Land degradation, including soil degradation, changes water quality, quantity and flow and their reliability. Four in five people live today in areas where water security is not guaranteed. Food and water security are not isolated issues but they are tightly linked to and aggravated by land and biodiversity degradation, and climate change. (IPBES 2018)

2.4.5 Biodiversity and Ecosystem Services

The IPBES (2019, 10) concludes that "*[b]iodiversity (...) is declining faster than at any time in human history*". Around 1 million species are at risk of extinction, and current rates of extinction are "*at least tens to hundreds of times higher than the average rate over the past 10 million years and is accelerating*" (IPBES 2019, 24). While ecosystems are providing "*food, energy and materials*" (IPBES 2019, 10) at a larger scale than at any point in human history, their use and exploitation is not sustainably managed and "*nature's contributions to people*" (IPBES 2019, 10), especially those related to regulating and non-material benefits, are under threat. (IPBES 2019)

Land use and sea use change are the "*direct drivers of change in nature with the largest global impact*" (IPBES 2019, 12). The growth of agricultural land, urban areas and associated infrastructure have displaced, changed or diminished natural or semi-natural ecosystems, mainly forests, wetlands and grasslands. Other important drivers are "*direct exploitation of organisms; climate change; pollution; and invasion of alien species*" (IPBES 2019, 12).

Through a profound re-shaping of the Earth's surface, natural habitats have undergone crucial changes. Anthropogenic land use change reduces the quality and the intactness of wild ecosystems. The expansion of agricultural lands and urban areas leads to habitat fragmentation, disrupts the connectivity of ecosystems and creates ever smaller patches isolated from urban sprawl, roads or other infrastructure. Agricultural intensification induces the simplification of landscapes, reducing the variety of habitats (Emmerson et al. 2016). As a consequence, species population sizes are diminished and genetic pools reduced, reducing the resilience of affected species against further disturbances. (EEA 2019a) Similarly, for freshwater habitats, the withdrawal of water or the fragmentation of running water bodies impair the habitat's ecological functioning. (WWF 2020, 20)

As a consequence, altered habitats are, on average, 13.6% less rich in species than natural habitats, because many species are unable to adapt fast enough to the new circumstances. The impact of habitat loss and degradation is unevenly distributed across the globe, with a particular severe extent in the Mediterranean and tropical regions. (WWF 2020)

The overall and mostly negative trends can be summarized and visualized through a number of representative indicators: the Living Planet Index, tracking relative trends in vertebrate species population sizes, finds a 68% loss in population sizes since 1970; the Species Habitat Index measures the relative changes in suitable habitat availability to species, and finds a 2% decline since 2000, representing a strong and continuous decline; the IUCN Red List Index, assessing the survival probability of species, finds declines in many species or constant values but no upward trends at all; and the Biodiversity Intactness Index captures the relative loss in biodiversity in comparison to untouched ecosystems for a wide range of species, finding an 'intactness' of only 79%

compared to the recommended 90%. (WWF 2020) In addition to the loss of natural landscapes, land use change also has indirect effects on ecosystems by facilitating pollution from anthropogenic activities, predominantly agriculture, but also urbanisation, industry or mining. (IPBES 2019)

The ecosystem services that nature provides and that are fundamental to our societies and economies are directly dependent on biological diversity. As a consequence, the loss of biodiversity through habitat destruction and fragmentation and through pollution impairs nature's ability to guarantee these contributions. For example, the loss of soil biodiversity through erosion and nutrient loss reduces the land's ability to produce crops. Other trends like the increasing demand for natural resources exert continued pressure and induce continuous land use change, with negative impacts on ecosystem state and associated services. (Hasan et al. 2020)

2.5 Land Use and Climate Change

Climate change is both a driver and a result of anthropogenic land use practices.

The Agriculture, Forestry and Other Land Use sector, according to the IPCC (2019), is responsible for 23% of human-made greenhouse gas emissions. At the same time, land is also acting as a natural sink for these gases, currently removing more than is being emitted, although it is questionable whether this will be the case in the future (IPCC 2019). Only second to the oceans, top soil is the biggest global sink for carbon, currently holding more than double the amount of carbon that is stored in the atmosphere (EEA 2019a). Notably permafrost soils are large source of greenhouse gases at risk of being released into the atmosphere if current warming and lad degradation trends continue. Their release can lead to a positive feedback loop within the climate system, where continued warming and the release of greenhouse gases will reinforce each other. (EEA 2019a) Another important source of greenhouse gases is food waste and loss. (IPCC 2019)

Land use change also affects regional climatic conditions. The clearing of natural ecosystems and vegetation, especially forests, brightens the surface of the Earth, leading to a slight cooling effect. Forests and other vegetation play important roles in the hydrological cycle and the energetic balance of regions, and their loss can lead to substantial changes in these processes. Urban areas are especially vulnerable to climate change through the exacerbation of urban heat islands and heat waves. (IPCC 2019) Climate change acts as a driver of global change, with increasing frequency and severity of impacts as temperatures continue to rise. Land temperatures rise faster than temperatures over the oceans, almost twice the rate of the observed global temperature change.

Climate Change poses an inherent threat to land and biodiversity, and virtually all current unsustainable trends are aggravated by climate change. It also disproportionally affects already vulnerable regions and people. Land degradation, crop yields, extreme heat and weather events, water shortages, soil degradation and pests and diseases are all accelerated by climate change and precipitation patterns and climatic zones are undergoing fundamental changes. Consequences will be, among others, widespread economic costs and mass migration of millions of people by mid-century (IPBES 2018). Food security, already under stress from population growth, biodiversity decline and competition for land, will be additionally impacted by climate change. Crop yields could be reduced by 10% on average and up to 50% in certain regions due the cumulative impacts of a changing climate and ongoing land degradation (IPBES 2018). (IPCC 2019)

3 Functions and Benefits of an Intact Environment

The previous section has provided an extensive overview of land degradation, its drivers and the impacts on the environment and especially biodiversity and ecosystem services. In addition to the concept of planetary boundaries mentioned before, this section will give a brief insight into the concrete benefits arising from keeping biodiversity intact.

3.1 Ecosystem Services and Other Contributions

Ecosystem Services are defined in the Millenium Ecosystem Assessment (2005b, V) as "*the benefits people obtain from ecosystems*". More recently, the term "*nature's contributions to people*" (IPBES 2019, 10) has been used by the IPBES. Despite differences in wording and definitions, it is universally agreed that human livelihoods are inextricably dependent on ecosystem services, and that they cannot be replaced fully or at all (IPBES 2019).

Ecosystem services can be divided into four categories: provisioning, regulating, cultural and supporting services. Provisioning services constitute all services that produce goods for consumption or materials for a wide array of applications, such as food, fresh water, timber and fuels. (Millenium Ecosystem Assessment 2005b) Regulating services are responsible for stability and resilience of the natural environment and protect societies from disruptive events by regulating extreme climatic events, preventing floods, purifying water or containing diseases (Millenium Ecosystem Assessment 2005b). For example, the oceans and soil constitute the two largest sinks for atmospheric carbon, lessening the impact of anthropogenic greenhouse gas emissions on climate change (IPBES 2019). Cultural services are of intangible value and refer to the inspirational, recreational and mental health benefits that ecosystems can provide. (WWF 2018) Finally, all three categories are underpinned by supporting services which consist e.g. of essential natural cycles or soil formation assuring the consistent and reliable provision of the other three categories. A disturbance of the supporting services likely also entails a disturbance of the other three categories.(Millenium Ecosystem Assessment 2005b)

Provisioning services often have a more tangible (and economic) value than the other categories. Indeed, Millenium Ecosystem Assessment (2005a, 5) finds that primarily provisioning services like agriculture and aquaculture "*have been enhanced*" through anthropogenic action whereas most other ecosystem services have been depleted at the same time. Ecosystem services are not just a fundamental part of our livelihoods, they also provide real economic benefits. Globally, the contribution of nature's services to the economy have been estimated at US$ 125 trillion per year. (WWF 2018) On the other hand, critics have been condemning the economization of nature by assigning monetary values to ecosystems and rendering their existence negotiable rather than viewing them as fundaments to our civilisation (Spash and Hache 2021).

3.2 Resilience

The Stockholm Resilience Centre defines resilience as: "*the capacity of a system – be it a forest, city or economy – to deal with change and continue to develop; withstanding shocks and disturbances (such as climate change or financial crises) and using such events to catalyse renewal and innovation.*" (Stockholm Resilience Centre 2015b)

The systems in question are, in this context, socio-ecological systems, made up of human societies on the one hand and natural ecosystems on the other hand, under the assumption that humans and nature cannot be considered separately but must be regarded as an interconnected entity. Nature is altered by anthropogenic interference through farming, land use change or extraction, just as much as human societies are dependent on the ecosystem services that nature provides in the form of food, clean water or climatic stability. A change in the state of nature necessarily has an impact on human life and vice-versa.

The significant impact of humans on the natural world has led to a degradation of ecosystems and a partial loss of their services, threatening livelihoods. In the concept of the planetary boundaries, scientists have detected a risk that, through persisting anthropogenic pressure, the Earth system is at risk of moving into another state that is most likely unsuitable for humans to thrive in. To safeguard vital resources and services and stable living conditions, it can benefit to incorporate resilience thinking into the equation. The Stockholm Resilience Centre has elaborated a number of principles that support resilience in systems. These include inter alia: "*maintaining diversity and redundancy [of components] to compensate for the loss of some components*" (Stockholm Resilience Centre 2015a, 4-5) (e.g. biological diversity); accounting for connectivity between components, such as the migration of species between different landscape patches; considering the effects of slow mechanisms such as constant pollution of waterbodies leading to sudden eutrophication; or "*broadening participation*" (Stockholm Resilience Centre 2015a, 14) by involving stakeholders on many levels to raise awareness and foster engagement with a given problem.

Resilience thinking can be applied to land use, in order to increase a system's resilience towards different perturbations, such as natural disasters in the form of storms or floods on a more local scale, or broader phenomena such as climate change. A specific application is alimentary resilience, where components such as the resilience and adaptability of crops to disasters, pests and diseases, the volatility of global food markets and the preservation of supporting and provisioning ecosystem services are all considered at once to ensure food security for a small or large group of people in the long-term. (Junker 2020)

4 Sustainable Land Use and Biodiversity Conservation

Sustainable land use management cannot focus on individual issues but must consider the interplay of different interests and sectors, manage the different trade-offs that arise between them and exploit opportunities for synergies. It has been shown that an integrated approach can lead to faster recovery of biodiversity when e.g. conservation efforts are combined with sustainable practice changes along the global supply chains on the production and demand side. (WWF 2020) In the following, in order not to exceed the scope of this thesis, the impacts of land use on the natural environment as well as options for solutions will be assessed mainly through indicators and concepts related to biodiversity, including conservation status, protected areas and ecological connectivity, and the implications for society will be assessed through the framework of ecosystem services. This means that environmental factors such as pollution, air and water quality and greenhouse gases will be largely omitted from the analysis and will only be referenced where there is a direct connection to biodiversity or to concepts and measures discussed.

4.1 Biodiversity and Ecosystem Services

Foley et al. (2005) advocate for spatial planning strategies that foresee the co-existence of natural ecosystems and anthropogenically managed lands to assure that "*the services of natural ecosystems (...) are available across the landscape mosaic*" (Foley et al. 2005, 573). For example, the presence of wild pollinators in proximity of farms, the preservation of predator habitats for pest control, or green infrastructure in cities to prevent urban heat islands through shade and evapotranspiration can all contribute to safeguarding ecosystem services. This will also increase the resilience of ecosystems to mitigate the effects of pests and diseases, pollution or climate change.

4.1.1 Protected Areas

"*The International Union for Conservation of Nature (IUCN) defines a protected area as a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values*" (Borrini et al. 2013, 5). Under a given management strategy, ranging from minimizing anthropogenic interference over controlled anthropogenic use to active restoration, a given land and/or water area is designated and delimited in order to improve the state of biodiversity or other natural features such as landscape within its boundaries over a long period of time. (Borrini et al. 2013)

While protected areas are generally supporting biodiversity conservation, the simple establishment is not enough to guarantee success. It has been found, for example, that forests generally experience improvement in protected areas, while that is not necessarily the case in other habitats. Also, protected areas are often established in areas with a

higher diversity than in the surrounding area, making it difficult to assess the success of this measure due to a lack of comparable data. The management of protected areas also has crucial importance because it determines the degree in which pressures can persist within the area or at its borders. Globally, protected areas alone cannot lead to a reversal of biodiversity loss, not the least due to increasing conflicting demands for land. (Mora and Sale 2011) (Geldmann et al. 2019)

4.1.2 Ecological Re-Connectivity

Fragmentation of habitats is a major cause for biodiversity loss besides the loss of habitat area, as fragmentation reduces population sizes and hinders genetic diversity. The restoration of ecological connectivity through ecological corridors is a key feature to prevent biodiversity loss, and can also support the performance of protected areas if they are isolated patches between anthropogenically used land. As an example, ecological corridors contributing to ecological connectivity are wildlife crossings across highways. The corridors effectively increase the total area of habitat that is available to species, and allow them to migrate safely e.g. before the background of climate change.

In the long run, the objective is to create an ecological network, where protected areas and other areas relevant for conservation are well-connected across large distances and athropogenically used areas. Therefore, ecological connectivity must be ensured on the local, regional and even global level. (Hilty et al. 2020)

4.1.3 Nature-based Solutions and Green Infrastructure

The European Union defines nature-based solutions as "*solutions to societal challenges that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions. Nature-based solutions must benefit biodiversity and support the delivery of a range of ecosystem services.*" (EEA 2021)

With the extreme (land use) changes the planet has experienced through human intervention, the preservation of natural and spaces dedicated to biodiversity is limited by the land appropriated by humans for producing food, living and working. Therefore, in addition to preserving natural habitats, new solutions have to be implemented to conserve biodiversity and ecosystem services. They are attempts to "work with nature" rather than continuing its degradation in the pursuit of human development.

As an example for nature-based solutions, green infrastructure "*is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services such as water purification, air quality, space for recreation and climate mitigation and adaptation*" (Commission, n.d.-a). It builds on the premise that natural solutions can produce desired outcomes cheaper

and better than typical 'grey' infrastructure and serve a multitude of purposes rather than just a single objective. For this reason, green infrastructure should be incorporated into spatial planning by, for example, permeating cities with vegetation, parks and corridors for air circulation to mitigate the urban heat island effect where otherwise energy-intensive and costly air conditioning would be used. (Commission 2020)

4.2 Food and Agriculture

Given the the immense impact of agriculture through land use and land use change on the environment, agricultural production has to be reoriented and reimagined fundamentally. Further expansion of agricultural lands into natural ecosystems should be avoided, especially in biodiversity hotspots such as the tropics where it is the root for sweeping deforestation (Foley et al. 2011). The growing demand for food should instead be met "*through yield increases, shifts towards less land-degrading diets, such as those with more vegetables, and reductions in food loss and waste*" (IPBES 2018, 14). Agricultural practices in general must shift towards a sustainable use of land resources, including sustainable forestry, grazing and crop practices which can reduce or prevent land degradation, which in particular can also solve the current competition for land between food production and nature conservation. (IPBES 2018) (IPBES 2019). From food production to consumption, the balancing and diversification of production systems, genetic materials and diets support the resilience of the food system to crises, including to climate change (IPCC 2019). In the following, a few concepts will be elaborated that can play important roles in shifting agriculture towards more sustainable land use and reduce the impacts on the natural environment.

4.2.1 Agroforestry

Agroforestry is one of many attempts at more sustainable agricultural systems. The EEA defines agroforestry as: "*land-use system in which woody perennials are maintained or planted, in some form of spatial arrangement or temporal sequence, on the same land as agricultural crops and/or livestock.*" (EEA, n.d.) For example, an agroforestry system can combine orchards with where sheep are grazing beneath the fruit trees, or 'bocages', a mosaic of hedgerows and pastures, which have largely disappeared with agricultural intensification but are still present in temperate Europe. Agroforestry has proven beneficial to providing and preserving ecosystem services, including: climate change adaptation by providing shade to reduce local temperatures and preserve moisture in the soil, climate change mitigation through increased carbon content in biomass and soil, it reduces soil erosion through the trees' roots, conserves biodiversity by expanding the diversity of habitats and ecological niches which also combats pests and diseases, and it supports a healthy soil through dead biomass. For farmers, agroforestry can provide a diversification of agricultural products, securing their financial resilience and it can result in a higher input and resource efficiency because the land is optimally used. (European Parliament 2020)

4.2.2 Agricultural Extensification

"*Extensification can be defined as the process (or trend) of developing a more extensive production system, i.e., one which utilizes large areas of land, but with minimal inputs and expenditures of capital and labor. [This stands in contrast to] Intensification [which] seeks to increase the productivity on a given (or fixed) area of land by progressively increasing the inputs, including capital and labor.*" (Beranger, n.d.)

Through the reduction of external inputs, namely fertilizers or pesticides, environmental damages like water pollution or soil erosion are reduced. Practices such as tillage are minimised to counter land degradation. As a consequence, extensively managed lands are producing less per unit area than under intensive agriculture, but can still increase rentability for the farmer because of higher net returns and focuses on the 'production factor' land or, in other words, on the services the territory provides if ecological functions are kept intact. While intensification has led to homogenisation of agriculture and regards inputs as mere production factors, extensification looks at the land from a systems perspective that is managed by anthropogenic interference and where many inputs can be replaced by services the land can provide, e.g. pest control through biodiversity. By consequence, extensification favours diversification over homogenisation, heightening the resilience of the agricultural system. (Beranger, n.d.)

4.2.3 Dietary Changes

Willett et al. (2019) find that shifting diets away from red meat and starchy vegetables and by limiting other animal products such as eggs, poultry and dairy foods in favour of a more plant-based diet consisting of vegetables, fruit, legumes, grains and nuts has considerable benefits to the environment. Given their intensity in greenhouse gas emissions and their high share of emissions in the agricultural sector, reducing consumption of red meat remains critical to mitigate climate change and stay below warming of 2°C. Concerning land use, the study does not foresee significant change in crop land area when switching different diet scenarios, but determines that reducing the need for crops for animal feed in favour of crop production intended for direct human consumption can critically contribute to feeding humanity in the future by assuring supply with wheat, maize, rice and soybean. A trade-off is found for freshwater use, while fertilizer use would decrease with the adoption of plant-based diet. Finally, findings for biodiversity are also ambivalent, citing possible further pressure due to land use change entailed by a shift in dietary preferences.

4.3 Climate Change

Climate change mitigation and adaption focusing on land-related measures often have positive synergies with combatting land degradation and safeguarding global food provision. Action such as improved management of water, livestock, crop and grazing land or the enhancement of soil organic carbon are independent of land consumption

and land use change, and some options even reduce the demand for land such as cutting food losses and waste and dietary changes towards more plant-based foods. Diversification of agricultural practices and products makes the sector less vulnerable to climate change. These measures also contribute to reducing poverty and hunger, and can enhance ecosystem functions and services.

On the other hand, mitigation techniques such as reforestation, afforestation and bioenergy crops are bound to increase demand for land, especially if these are deployed at large scale and could induce more land degradation or put at risk global food security. In other words, these techniques are restricted by available land and could negatively affect biodiversity and ecosystems (IPBES 2019). (IPCC 2019)

4.4 Population and Urbanization

Lower population growth rates and consumption per capita of natural resources reduces pressure on land resources. (IPBES 2018) Sustainable urbanism should promote the densification of urban areas to reduce lans consumption but at the same time, densification has to be balanced with the conservation of urban biodiversity, ecological connectivity and ecosystem services through open spaces and green infrastructure such as parks. (IPBES 2019) Either way, to stop the degradation of natural habitats and of land, halting land consumption for urban areas and associated infrastructure is inevitable. From a regulatory point of view, this requires a construction limit on urban areas, transportation infrastructure, paired with densification requirements, the recycling of brownfields and exploitation of vacant lots, repurposing of existing structures and demolition of underused, vacant or unfit structures for renaturation. (Junker 2020)

4.5 Policy Framework

A headline finding of IPBES (2019, 16) is that only "*transformative change*" will be able to curb or reverse current trends in climate change, biodiversity loss and land degradation. Immediate economy- and society-wide action is required to address direct and indirect drivers of global change and to prevent the worst consequences. The Sustainable Development Goals are fundamentally dependent on nature and its resources and services, especially in the areas of "*poverty, hunger, health, water, cities, climate, oceans and land*" (IPBES 2019, 15). The consideration or disregard for this intertwinement in policies and research will decide whether the Goals will be reached or not.

With regard to land degradation, the complexity and the interconnectedness of drivers must be reflected through cooperation across different policy areas and different countries and regions to tackle both the consumption and production sides of land degradation, which will yield better results than isolated ventures. Many policies are still only targeting singular impacts or aspects of land degradation, ultimately failing to deal with the underlying drivers. Raising further awareness and improving information access for all stakeholders, notably for policy and decision makers is a critical leverage point. The current array of international environmental agreements provides a solid platform, on which further action can be built. (IPBES 2018)

4.6 Economic Considerations

On a global scale, economic incentives both on the production and consumption sides should be realigned to go beyond maximising financial profits and into account the value of nature and its contributions. This not only supports social and ecological welfare but often also creates economic benefits as well. For example, the concept of 'economic growth' could be abandoned as the dominant indicator of welfare and inequalities, overconsumption and environmental damage could be added to the equation to "*capture more holistic, long-term views of economics and quality of life.*" (IPBES 2019, 19). Possible tools include a taxation reform and improved monitoring. (IPBES 2019)

Part III

Methods and Materials

5 Methodology

In order to answer the aforementioned research question, after a brief country profile of Luxembourg, the legal and policy framework relevant to land use and especially its implications on biodiversity will be outlined, followed by a description of the ZVI ('zone verte interurbaine' – the interurban green zone) as the primary study area of this thesis.

Next, a thorough literature review on the state of the environment and on land use is performed, focusing on the European level, the national level in Luxembourg and the level of the ZVI. This review is primarily based on information and data gathered either directly through policy and legal documents at these three levels or through the reporting mechanisms established thereunder to monitor and improve their implementation.

This literature review is supported by two expert interviews with two national experts who were identified based on their work related either to land use in Luxembourg or to biodiversity in Luxembourg. The suitability of expert interviews for data collection is for example shown by Wernitz (2018).

The interview with Pascale Junker – deputy coordinator of the national spatial planning strategy of Luxembourg within the ministry for sustainable development and infrastructure between 2017 and 2020 – was conducted on 11.08.2021 as an in-person interview and focused on the most recent national policies related to spatial planning as well as the visions, concepts and instruments focused on sustainable land use practices in the ZVI and in Luxembourg. The second interview with Gilles Biver – acting director of the department for natural resources, water and forests in the ministry for environment, climate and sustainable development – was conducted on 02.09.2021 as a video-conference and focused on the environmental impacts and especially the implications for biodiversity related to land use in Luxembourg and in the ZVI. Preliminary questionnaires with guiding questions were sent to the interviewees a few days before the interview. Both interviews had a duration of approximately one hour and were recorded, transcribed and can be found in the Appendix together with the initial questionnaires.

From the interviews, the most important visions and long-term goals for sustainable land use were distilled and are discussed in Section 11, while the most important means to achieve these long-term objectives are elaborated in Section 12. Subsequently, their relevance to answer the research question is discussed in Section 13.

6 Luxembourg: Country Profile

The origins of Luxembourg date back to the year 963, when Count Siegfried purchased a castle on rocky hill today referred to as the 'Bockfiels'. This constitutes the foundation of what today is known as Luxembourg City, the capital of the Grand-Duchy of Luxembourg. Its strategic position and the fertility of surrounding lands evolved the inconspicuous castle into a centre of economic, religious and political importance by the 12th century with large territorial extension. During the 14th century, Luxembourg even produced three emperors of the Holy Roman Empire, before the country's prestige and wealth declined in the 15th century and fell into insignificance. Subsequently, it was alternatingly governed by the Habsburgs, France and the Netherlands, before it became formally independent after the Congress of Vienna in 1815, and de facto independent and neutral after the Treaty of London in 1867.

After being occupied twice by Germany during the World Wars, Luxembourg was a founding member of all major organizations for international cooperation, such as the United Nations, the NATO, or the OECD, and has maintained close cooperation with its neighbouring nations France, Germany and Belgium. It is also a founding member of the European Union – the former European Coal and Steel Community – due to its important steel production. Today, it is one of three European capitals beside Strasbourg and Brussels, harbouring, among others, the Court of Justice of the European Union, the Secretariat General of the European Parliament and the European Investment Bank. (Gouvernement 2020a) (EU 2020)

Luxembourg is governed as a "*parliamentary constitutional monarchy*" (EU 2020) by the prime minister as the head of government. The Grand-Duke as head of state only has formal rights and representative powers. (EU 2020)

6.1 Geography, Demography and Economy

Luxembourg became a important steel nation in the 19th century following its inclusion in the German 'Zollverein' which provided it with capital and labour, supported by the access to the river Rhine as an important trade route and the rapid expansion of the railway. The south of Luxembourg was an important source of iron ore that paved the way for its economic and industrial development.

A leading producer at the start of the 20th century, Luxembourg's steel industry declined since the 1950s in an attempt to diversify the national economy. Today, 88% of all wealth is generated through the service sector, and 1/3 alone through finance. (Gouvernement 2020e) Luxembourg counts towards the richest countries in the world with an estimated GDP per capita of 122.740 US$ PPP in 2021 (Wikipedia, n.d.-a). At the same time, it is also home to many inequalities, leading the European Union in the rise of poverty risk and being the runner-up in youth poverty risk. (Junker 2020)

As of 2020, Luxembourg's population of 626000 people consists of 48% of residents of foreign nationality, the largest communities consisting of Portuguese, French, Italian and Belgian nationals. (Gouvernement 2020c) Luxembourg, an especially the city of Luxembourg, continues to be very attractive for working and living, with relative population growth rates that exceed both other European countries and even the most populated districts of cities like London. This is primarily due to immigration trends rather than fertility rates, which have remained below the European average. Luxembourg's working population is supported by roughly 185,000 Belgian, French and German nationals who cross the Luxembourgish border everyday to work in the Grand-Duchy, making up 45% of the workforce. (Decoville and Feltgen 2018)

Luxembourg is famous for its multilingualism, originating in its close cooperation with neighbouring countries and other states. Administrative ('official') languages are Luxembourgish, French and German. English has been on the rise since decades due to Luxembourg's financial sector and its status as a European capital. (Gouvernement 2020b)

7 Legal and Policy Framework

In the following, an overview of the most important legislative and policy instruments will be given that concern land use in Luxembourg and in the ZVI, as well as conservation of biodiversity.

7.1 Overarching Strategy and Targets for Sustainable Development

On a four-year basis, Luxembourg produces a 'plan national pour un développement durable' (PNDD) – a national plan for sustainable development –, most recently in 2019.

While the first two iterations were based on self-defined targets, the third edition (PNDD3) whose development started in 2018, follows the Sustainable Development Goals, the corner stones of the United Nations' Agenda 2030. Nevertheless, Luxembourg retains its initial set of 10 national targets while assigning them to the respective relevant SDGs. Among those 10 targets, four are relevant for land use and biodiversity:

3. Promoting sustainable production and consumption. contributing to SDGs 2, 12 and 14 (Zero Hunger, Responsible Consumption and Production and Life under Water, respectively).

In terms of land use and biodiversity, this target mainly addresses agricultural policy. The government is aiming for 100% organic agricultural production by 2050 on the national territory. As an intermediate target, until 2025, 20% of agricultural lands should be cultivated organically. Modern "*cooperative and solidary*" (Stoldt Associés 2019, 34) forms of agriculture will be favoured to reduce transportation routes and to enhance self-sufficency, resilience and diversification.
Furthermore, Luxembourg will aim to reduce its food waste by half by 2030.

5. Planning and coordinating the use of the territory. contributing to SDG 11 (Sustainable Cities and Communities).

The PNDD3 references the revision of existing or the emergence of new spatial planning instruments that will guide the sustainable development of the territory. Since March 2021, the sectoral master plans for spatial planning are in effect, guiding different sectors of society, and the revision of the master plan for spatial planning is expected to arrive by 2023 in order to adapt the national strategy to the current challenges in Luxembourg's territory. Cornerstones will include a more stringent cap on land consumption, currently fixed at 1 ha/day.

7. Halting environmental degradation and respecting the capacities of natural resources. contributing to SDGs 2, 6 and 15 (Zero Hunger, Clean Water and Sanitation, and Life on Land, respectively.)

The 2018 law concerning natural protection is operationalised through a nature protection plan – the 'plan national concernant la protection de la nature' (PNPN) – that is updated every five years. The current iteration (PNPN2) strives to improve the condition of biodiversity, conserve and restore ecosystems and their services, and, specifically regarding land use, to reduce land consumption, landscape fragmentation and habitat loss. This plan will be elaborated in more detail in Section 7.3.

8. Protecting the climate, adapting to climate change and assuring sustainable energy. contributing to SDGs 7,13 and 14 (Affordable and clean energy, Climate Action and life below water)

Beside numerous engagements concerning the reduction of greenhouse gas emissions, Luxembourg will elaborate a climate adaptation strategy in order to anticipate and reduce the impacts of climate change on nature, agriculture, biodiversity and its territory, among others. Different spatial planning instruments, including the sectoral master plans, will support the adaptation strategy. (Stoldt Associés 2019)

7.2 Spatial Planning and Land Use

Table 2: Spatial planning legal and policy framework in Luxembourg

Role	Instrument	Effective since
Legal Basis	Spatial Planning Law	2018
Strategy	PDAT (master plan for spatial planning)	2003
	4 PDS (sectoral master plans)	2021
Implementation	PAG (Communal development plans)	differs between communes

The legal basis in spatial planning is the 2018 law concerning spatial planning. It is implemented through a number of binding and non-binding acts.
First, the overarching strategy is defined in the 'programme directeur d'aménagement du territoire' (PDAT) – the master plan for spatial planning – dating back to a governmental decision of 2003 . Given its age, the PDAT is currently in the process of revision to adapt it to the territory's challenges of today.
The spatial planning strategy is concretised through four 'plans directeur sectoriels' (PDS) – sectoral master plans for spatial planning – governing the strategy in the sectors transport, housing, landscapes, and economic activity (Gouvernement 2019). This is complemented by conventions for territorial cooperation between the state and the communes, as well as cooperation programmes with cross-border regions (Journal 2021a) The competences on the national level for spatial planning lie with the ministry for energy and spatial planning.

On the other hand, not all competences related to spatial planning are in the hands of the same ministry. The 'plans d'aménagement globaux' (PAG) – communal development plans – are established individually on the communal level and supervised by the ministry of interior (Gouvernement 2021). They define how each municipality may allocate and use the land within their communal borders by the declaration of specific zones with dedicated purposes and restrictions, such as urban, rural or mixed zones, economic zones, or green zones (Journal 2017).

Plan d'Aménagement Général – Communal Development Plan. As mentioned, the 'Plan d'Aménagement Général' (PAG) is a plan elaborated on the level of each commune, defining the land use of each municipality by classifying its territory into zones with different objectives and requirements. There are two overarching categories: first, the "*urbanised zones or zones destined to be urbanised*" (Journal 2017), and second, the "*green zone*" (Journal 2017). The first category includes all land reserved for habitation, from single homes to dense urban centres, for economic activity zones, commercial zones, military zones, airports, train stations and sports and leisure. On the other hand, the green zone covers zones destined for agricultural purposes, public parks, forests and natural vegetation in general. Construction in the green zone is generally prohibited save exceptions and requires an authorisation by the ministry for environment.

In contrast to the relatively new instruments of the PDAT and the PDS, the PAG is is a decade-old instrument that has governed spatial planning in Luxembourg since 1937. The framework of the PAG has since been redesigned in 2004 and in 2011. Thus, there are three different 'generations' of PAG in effect, depending on whether communes have already undertaken the modernisation procedure or not. (Gouvernement 2021) The PAG are of high importance for spatial planning and land use, because the provisions of the instruments higher up in the hierarchy must ultimately be transposed into the communes' PAG in order to take effect.

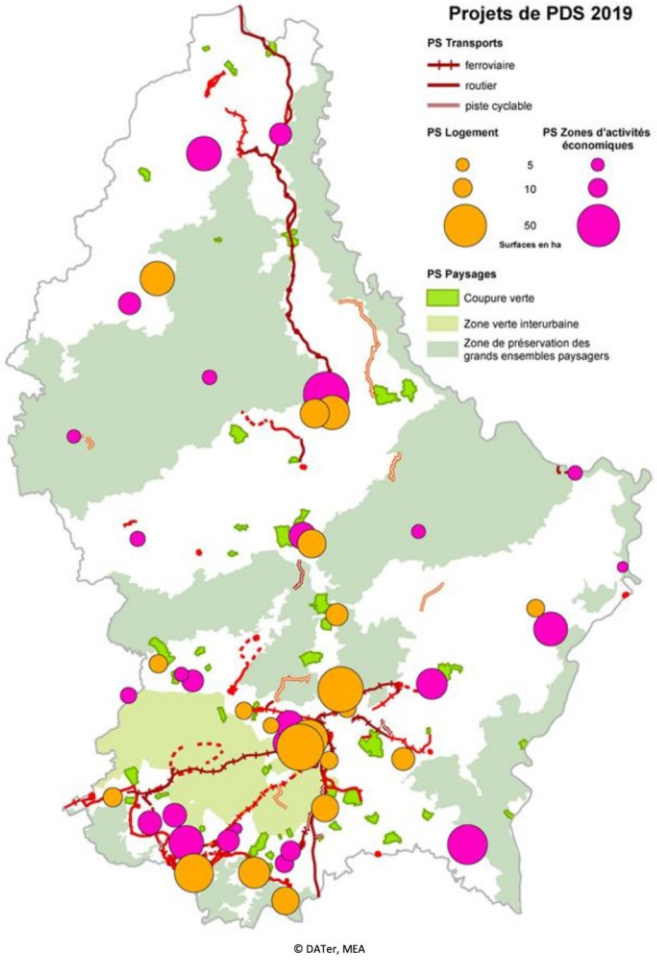

Figure 4: The provisions of the four sectoral master plans for spatial development: in red, priority transportation projects (rail, road and cycling); in orange, priority areas for housing; in pink, priority areas for economic activity zones; and in green, designated zones for landscape protection. (Département de l'Aménagement du Territoire 2019)

Plan Directeur Sectoriel – Sectoral Master Plan for Spatial Development. The four 'plans directeur sectoriels' or PDS – sectoral master plans for spatial development – are tools to implement the provisions of the PDAT. They cover the sectors transport, housing, economic activity and landscapes, and strive to promote a sustainable development

of the territory. For example, the PDS "logement" or PSL – concerning housing – provides for priority zones for urban development in order to lower land consumption and promote higher construction density, affordable prices and reduce the reliance on cars for commuting and leisure (MEA 2021a). Similarly, the PST and the PSZAE, responsible for transportation and economic activity zones, respectively, define zones for transportation projects of high priority to implement the national mobility strategy and foster economic activity in designated regions, while limiting expansion in others to preserve landscape integrity and reduce induced urban sprawl (MEA 2021c) (MEA 2021d). Finally, the PSP is responsible for preserving landscapes, therefore encompasses natural resources, and will be discussed in detail below (MEA 2021b). The four PDS entered into force on 1 March 2021.

Junker (2020, 21) summarises the aim of the four PDS as "*to protect sparsely urbanised regions against massive land take and to develop housing and employment in well-connected zones (...) while leaving open the options for infrastructural and transportation development*". Every PDS, is composed of a written part and a graphic part. While the written part defines the relevant zone types and lists all concerned zones of a given type, the graphic part depicts these to a scale of 1 : 2500 through the means of the official land register and serves as a basis for verification through local and national authorities for each individual project in relation to a given zone. The superposition of all all four graphical parts can be seen in Figure 4.

7.2.1 Sectoral Master Plan for Landscapes (PSP)

The 'Plan Directeur Sectoriel "Paysages" (PSP) is one of the four PDS and tasked with the preservation of landscapes, meaning that it has considerable importance in the conservation of natural resources, and acts as an "*urbanisation check*" (Junker 2021). More specifically, it aims to

1. "*define interruptions of urbanisation,*
2. *delimit interurban green zones and landscapes to be protected,*
3. *define a clear hierarchy between different levels of protection,*
4. *provide a regulatory framework for different zones,*
5. *define areas of connectivity,*
6. *ensure the establishment of a network of natural areas.*" (MEA 2021b, 6)

These provisions, in particular concerning the network of natural areas, are complemented by the national plan for nature protection, which will be discussed below.

The PSP defines three types of zones with specific characteristics and objectives:

1. "*zones de préservation des grands ensembles paysagers*" (MEA 2021b, 12) – zones for preserving large landscape regions,
2. "*zones vertes interurbaines*" (MEA 2021b, 12) – interurban green zones, and
3. "*coupures vertes*" (MEA 2021b, 13) – green cuts.

First, a "zone de préservation des grands ensembles paysagers" (GEP) is defined as "*zone designating a little-fragmented landscape with a rich natural and cultural heritage as well as a high biological diversity*" (MEA 2021b, 12). The aim of the PSP is to achieve the "*conservation and coherent development*" (MEA 2021b, 8) of these zones.

Second, a "zone verte interurbaine" (ZVI) is defined as "*a zone designating a little fragmented landscape located between two settlements and threatened by expansive urbanisation*" (MEA 2021b, 12). The objective of the PSP is to "*safeguard, develop and connect open [landscape] areas situated between the biggest national agglomerations*" (MEA 2021b, 8) with the goal to prevent ecological fragmentation especially at its borders through invading urbanisation, to safeguard agricultural land and to improve the well-being and life quality of the population. The PSP also refers to the 2018 spatial planning law, laying out overarching objectives of the ZVI, namely "*[the preservation] of landscapes by ensuring their integrity and maintaining agricultural, (...), ecological, recreative and climatic functions of the territory* [as well as] *preserving ecological functions and services for the benefit of urbanised regions*" (MEA 2021b, 24).

Third, a "coupure verte" (CV) is defined as "*a zone reserved for the preservation of open space between settlements*" (MEA 2021b, 13). Its purpose is to prevent the negative consequences of urbanisation as well as the uncontrolled sprawling of cities and towns, especially in the form of "*urbanised strips*" (MEA 2021b, 8) between towns and across municipalities, through the establishment of open zones and their incorporation into landscape networks.

Only CVs can be superposed with any of the other zone types, i.e. there cannot be a zone classified both as GEP and ZVI at the same time. GEPs and ZVIs are subject to the same provisions concerning "*linear installations*" (MEA 2021b, 13,15). In general, new linear installations within the green zone that would produce new fragmentation are prohibited. There are, however, some derogations, including for new installations:

- that follow the route of existing installations;
- replacing existing installations provided that the old route will be restored to its "*natural pristine state*" (MEA 2021b, 13);
- ensuring access to sites for inert waste disposal and sand pits and stone quarries; and
- bicycle paths, foot paths and forest and rural paths.

For both zone types, an authorisation of construction under the listed exceptions has to be granted based on article 8 of the law for nature protection (Section 7.3.1). Both GEPs and ZVIs are also subject to the (almost) same provisions concerning urbanisation. In general, the extension of the zone destined to be urbanised is prohibited within, if it "*contributes to tentacular [urban sprawling] or the creation of new urban islands*" (MEA 2021b, 15). The PSP additionally provides for GEPs that the urbanisation zones may not be extended on top of plateaus or in areas with a slope greater than 36%. This has above all the purpose to conserve the optical quality of the landscape.

Again, the PSP provides for some exceptions in the case of:

- the installation of general supply infrastructure such as water, food or energy, as well as sanitary or rainwater collection infrastructure;
- the "*regularisation*" (MEA 2021b, 16) of existing constructions, i.e. densification instead of sprawling delevopment;
- 'trading' existing urbanisation zones for new zones, under the condition that – in compensation of the new urbanisation zones – the existing urbanisation zones are reclassified as green zones;

Finally, CVs are the most stringent category. First, only the zone type "zone verte" is allowed within a CV. As a consequence, new construction is generally prohibited within a CV. Again, the PSP provides for exceptions:

- shelters, facilities or other development projects smaller than 50 squaremeters;
- bicycle paths and footpaths;
- constructions destined to protect against floods;
- constructions related to the provisions in the plan directeur sectoriel "transports";
- expansion of existing infrastructure by no more than 0.5 hectares;
- the replacement of high-voltage lines and the construction of new ones for lack of alternatives; and

The PSP defines seven GEPs, only one ZVI and 47 CVs, that can be seen in Figure 5 (MEA 2021b)

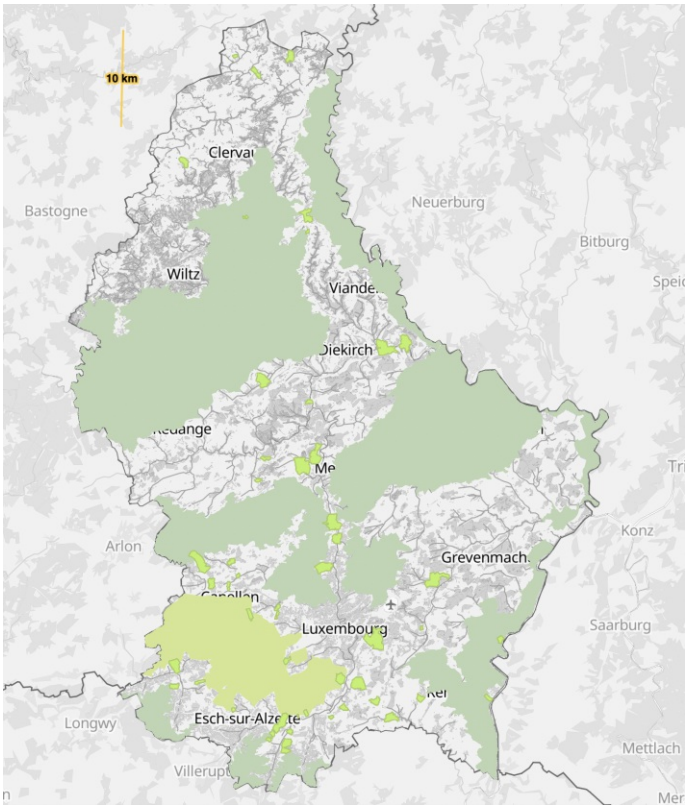

Figure 5: The distribution of GEPs (dark green), the ZVI (light green) and CVs (fluorescent green) across the Luxembourgish territory (Géoportail, n.d.-e)

Although the categories GEP and ZVI are subject to almost identical provisions, the expert interview with Pascale Junker gives more insight: the main difference lies in their "*vocation*" (Junker 2021): GEPs are characterised by their appearance as distinct landscapes, such as the Ardennes, the Moselle region or the Redange canton. A ZVI, on the other hand, is not necessarily defined as a distinct landscape but primarily through

human infrastructure. It is shaped both by agriculture within its territory and by the menace of urbanisation all along its perimeter, and delimited by highways, economic activity zones and railways. Historically, in the planning process leading up to the current PSP, there were two ZVIs considered, of which only one made it into the final document. The ZVI between Luxembourg City and Nordstad was scrapped due to advancing urban sprawl, and was replaced by two large areas of CVs. (Junker 2021)

The SEAs for all four PDS were carried out simultaneously to capture their interactions. Unsurprisingly, the provisions of the three PDS housing, transport and economic activity zones were found to have almost exclusively negative effects on environmental indicators such as biodiversity, the Natura 2000 network and land consumption. The only positive contributions were found for transportation projects related to the railway and tramway network expansion when assessing climate and air quality. For the ZVI, the particularly disruptive projects are the bypass routes around Dippach and Käerjeng and the already finished expansion of the railway link between Luxembourg and Pétange, but also the expansion of the highway between Luxembourg and Esch-sur-Alzette by a new bus line and a fast tramway route, and the new railway line between Luxembourg and Bettembourg.

On the other hand, the SEA supported the PSP's ambition to protect the natural features of the territory by predicting positive outcomes for almost all evaluated criteria, including biodiversity, the Natura 2000 network, land consumption, and the preservation of landscapes. (Oeko-Bureau 2018)

7.2.2 Targets

The PSP does not define concrete targets to be reached. However, on different levels, a number of (non-binding) targets have been set: the most recent target for land consumption in Luxembourg is 1 ha/day, as defined in the first national plan for sustainable development (PNDD1) (Junker 2020). On the European level, an objective of "*no net land take by 2050*" (Commission 2011, 15) is defined in the Roadmap to a Resource Efficient Europe. Similar ideas are found at the UN level, with SDG target 15.3 aiming to "*end desertification and land degradation [and to] strive to achieve a land degradation-neutral world*" (Ritchie et al. 2018). This is reaffirmed by the objective of the UNCCD (see Section 1.1.4) to achieve Land Degradation Neutrality by 2030.

7.3 Environment, Biodiversity and Ecosystem Services

Table 3: Biodiversity legal and policy framework in Luxembourg

Role	Instrument	Effective since
Legal Basis	EU Birds and Habitats Directives	1979 & 1992
	Nature Protection Law	2018
Strategy	PNPN2 (National Plan for Nature Protection)	2017

The foundation for environmental protection is the 2018 law concerning the protection of nature and natural resources. It covers all aspects related to the conservation, improvement and restoration of landscapes, biodiversity, ecosystems and their functions and services. The two main ways of implementation are either through "*general conservation measures*" (Journal 2021b) or through a network of protected sites, either following national designation or defined through the Natura 2000 network, derived from European Union legislation. This law is operationalised through the "plan national concernant la protection de la nature" (PNPN) – the national plan concerning nature protection – which is elaborated in a stakeholder exchange process between the ministry, the communes, the syndicates (unions) and others, and is subject to revision every five years. (Journal 2021b) The current second iteration, the PNPN2, covers the period from 2017 to 2021, and a third edition is in the process of elaboration. (MDDI 2017)

7.3.1 2018 Law Concerning the Protection of Nature and Natural Resources

While the law for nature protection governs most relevant aspects surrounding the natural environment in Luxembourg, only provisions relevant to land use will be discussed here in detail, and how they interact with the provisions of the PSP.

As discussed above, the law for natural protection governs all changes made to the green zone, where construction is generally prohibited, with a number of exceptions, subject to a ministerial authorisation, for e.g.:

- new constructions having a direct link to agriculture, food cultivation, forestry, viticulture, fisheries or similar activities;
- the renovation or expansion of existing constructions;
- new constructions if they serve a public purpose, like transport, communication, energy and especially concerning renewable energy installations;

The law provides for the establishment of natural protection sites, derived either from EU legislation or established in a national framework. The details of the EU Directives, which constitute the continent-wide Natura 2000 network, will be elaborated in Section 7.3.2. The "*zones protégées d'intérêt national*" (Journal 2021b) – protected zones of national interest – may be established to safeguard natural reserves, species and habitats, landscapes and ecological connectivity. In contrast to the Natura 2000 network,

the declaration of a protected zone of national interest can impose a wide range of limitations or interdictions related to construction and activities. linear infrastructure. land use. destruction or plantation of vegetation species. hunting or fishing. transportation. the usage of fertilizer, pesticides and herbicides. forestry. and leisure activities. National protection zones may also be declared within Natura 2000 areas.

Of importance for land use and spatial planning is the compensation scheme. When construction work

- entails destroying protected biotopes or habitats falling under the EU nature directives;
- when the land use of forest is changed; or
- when the integrity of a Natura 2000 site is threatened,

the project owner is forced by law to pay a tax that equals the value of the affected ecosystem. This value is estimated through a mandatory ecological report and established based on so-called 'eco-points'. Different species, habitats, trees or ecosystems all have a different value in eco-points based on a previously established classification.

The tax revenue then benefits lands from a so-called "compensation pool" (Journal 2021b), containing a number of ecological sites, owned and managed by the public. These sites are then conserved or restored, effectively to compensate for the damage caused by the construction project. (Le Gouvernement du Grand-Duché de Luxembourg 2021) The monetary value of an eco-point is currently fixed at 1 Euro (Biver 2021).

7.3.2 EU Nature Directives

The Birds Directive and the Habitat Directive, established in 1979 and 1992, respectively, are the two main pillars of nature and biodiversity protection in the European Union. The Birds Directive aims to protect all 500 wild bird species that are found throughout the EU, among different approaches by conserving their habitats and the quality of habitats through so-called 'Special Protection Areas'. It also regulates the hunting of different bird species. (Commission, n.d.-d) The Habitats Directive protects over 1000 animal and plant species as well as 200 habitat types through a network of 'Special Areas for Conservation', with a view to conserve biodiversity on a broad scale. Both types of areas are incorporated into the "*Natura 2000 ecological network*" (Commission, n.d.-f), a continent-wide network of sites protected and managed for conservation, to achieve the goals of the Directives. For simplicity, the different areas will be referred to commonly as Natura 2000 areas, without referencing the exact Directive under which they have been established.

Under both Directives, following scientific assessments, the Member States submit a list to the Commission of proposed areas relevant to the conservation of the vulnerable and endangered bird species and the habitats and species covered by the respective Directives. These areas are verified by the Commission based on their aptitude to contribute to conservation of the network and, in case of approval, are added to the Natura 2000 network. (Commission, n.d.-b) Member States are required to regularly report on the monitoring of the species and habitats covered by Natura 2000 sites. Although there are different reporting categories for the Birds and the Habitats Directive, they are frequently summarised as 'good', 'poor', 'bad' or 'unknown' conservation status. (EEA 2020).

An important characteristic is the actual management of the Natura 2000 areas: each site may continue to be used by humans for agriculture or the exploitation of natural resources. The contribution towards conservation is achieved through management plans that Member States have to establish individually. (Commission 2019) As mentioned above, while Luxembourg's nationally protected sites are subject to more stringent restrictions, the Natura 200 network follows a more "*participative*" (Biver 2021) approach.

7.3.3 National Plan Concerning Nature Protection 2017-2021 (PNPN2) – Targets and Measures

The "plan national concernant la protection de la nature 2017-2021" (PNPN2) – national plan concerning nature protection – is the primary policy instrument in order to achieve the objectives of the nature protection law. The current second iteration was published in 2017 and covers the period until the end of 2021. It contains the government's short-term objectives in terms of nature protection, the tools it plans to adopt to reach these objectives, as well an evaluation of the precedent plan and a review of the state of the national environment. The PNPN is, as defined by law, elaborated by the ministry in a cooperative process with the municipalities and other relevant stakeholders.

The PNPN2 lays its focus on biodiversity, following the Nagoya Protocol for a strategic plan 2011-2020 under the Convention on Biological Diversity, and the European Biodiversity Strategy 2020. It defines seven core objectives, of which four are relevant for this thesis because of their direct connection to land use and spatial planning:

1. Implementation of biodiversity legislation Under this objective, the PNPN2 wants to improve the conservation status of species, and aims to achieve a good/stabilised or improved conservation status for:

- 100% of habitats and 50% of species under the Habitats Directive or a national plan, and
- 50% of species under the Birds Directive.

2. Preserving and restoring ecosystems and their services The PNPN2 aims to install green infrastructure and to restore at least 15% of degraded ecosystems, most notably semi-open landscapes as well as pastures, moors and dry grasslands, in order to increase their resilience and their capacity to provide habitat for species protected under European or national provisions.

3. Reducing land consumption and landscape fragmentation The PNPN2 foresees a "*considerable [reduction]*" (MDDI 2017, 12) of land consumption. To this end, "*biodiversity objectives [should be] integrated [into urbanisation]*" (MDDI 2017, 12) and green infrastructure should be expanded. Also, the most important bottlenecks of ecological connectivity should be addressed.

4. Strengthening the contribution of agriculture and forestry to the conservation of biodiversity In the sector of agriculture, the PNPN2 provides for "*at least 10% increase of zones in meadows and grasslands, arable land and permaculture [that are] covered by biodiversity conservation measures*" (MDDI 2017, 12), in order to protect species and habitats from the effects of agriculture and to preserve ecosystem services that support it.

In order to achieve these objectives, the PNPN2 lays out a number of instruments. Among these instruments, the most relevant to the above-mentioned objectives will be presented below:

Restoration. Semi-open landscapes will be restored by the planting and maintenance of orchards and bocages. Similarly, pastures, moors and dry grasslands are restored through brushing (the removal of bushes and undergrowth) and "*reconversion*" (MDDI 2017, 16).

Natura 2000 network and national protected areas. As provided in the Birds and Habitats Directives, the PNPN2 foresees establishing a management plan for each Natura 2000 site in order to achieve good conservation status for all habitats and species. The government's approach is to, on the one hand, compensate landowners for participating in these management plans or, on the other hand, acquire ecologically valuable areas or reclassify them as national protected areas.

In addition, in order to protect the "*core zones of the Natura 2000 network*" (MDDI 2017, 20), to safeguard ecological connectivity or to conserve other important species or habitats, protected zones of national interest are established, with an objective of 40 additional sites until the end of 2021.

Ecological connectivity. The PNPN2 determines the 'bottlenecks' of ecological connectivity in forests and in water bodies where, on the one hand, further projects of transportation or urbanisation should be prohibited and, on the other hand, seven projects of primary importance in the form of wildlife crossings will be executed to alleviate fragmentation in the short-term.

There should also be an increased focus on green infrastructure and an "*ecological approach*" (MDDI 2017, 23) in urbanisation and spatial planning in order to foster ecological connectivity and preserve ecosystem services, however, the plan does not specify exact measures.

Agriculture. The PNPN2 provides a number of measures concerning agriculture and how it can contribute to biodiversity conservation: the government focuses on "*agricultural extensification through voluntary contracts*" (MDDI 2017, 24) which are either financed through the EU's Common Agricultural Policy or through national biodiversity subsidies. It also prompts further research into the topic of extensification. In addition, it aims to increase the surface of land covered by these biodiversity contracts or EU funding schemes up to 10.000 ha in order to improve the conservation of species and habitats, especially in open landscapes. Finally, a strategic study concerning the potential and possible objectives of agroforestry in Luxembourg is commissioned, which can have positive effects to diversification, the strengthening of ecosystem services or the prevention of soil erosion. (MDDI 2017)

7.4 Agriculture

The agricultural policy of Luxembourg is part of the Common Agricultural Policy (CAP) of the European Union, which is one of the first and few sectors where policy is established on the Union level. It also makes up around a third of the entire European budget. The CAP is organised into two 'pillars': the first pillar with around three quarters of the CAP budget is responsible for income support to farmers and market measures, while the second pillar aims for rural development. (Commission, n.d.-e)

Under the first pillar, farmers are required to follow a baseset of environmental protection standards in order to profit from income support. Since 2013, 30% of these direct payments are linked to biodiversity conservation, prevention of soil erosion and carbon sink preservation. Income support is not linked to production volumes. (Landwirtschaftsportal 2018). Under the second pillar for rural development, voluntary schemes are offered that offer farmers additional payment in exchange for implementing measures that protect the environment and the climate. Currently at least 30% of

payments under the second pillar must be dedicated to this end. (Commission, n.d.-c) The exact schemes for environmental protection in rural development are elaborated by Member States based on regional circumstances and challenges. In Luxembourg, they cover organic farming, reduction of pesticide and fertilizer application, extensification measures, reservation of farmland for biodiversity purposes, maintenance of hedgerows, and promotion of rare domestic livestock species. Participation in these schemes runs for a duration of five years. (Landwirtschaftsportal 2020)

8 "Zone Verte Interurbaine" – The Interurban Green Zone

The PSP, in force since March 2021, provides for a single zone of the type "zone verte interurbaine", which is the "*[ZVI] between the urban agglomerations of the City of Luxembourg and the 'Région Sud'* " (MEA 2021b, 19). Decoville and Feltgen (2018) and Junker (2020) use the abbreviations AggloLUX and AggloSUD, referring to the agglomerations consisting of Luxembourg, Strassen, Betrange, Walferdange, Findel and Howald on the one side, and Esch-sur-Alzette, Schifflange, Foetz and Belvaux on the other side. In the West, the 15000 hectares big ZVI is delimited by the Luxembourgish-Belgian Border, and in the South-East by the river basin of the Alzette. Along a majority of its borders, the ZVI is threatened by economic activity zones and highways. (Junker 2020).

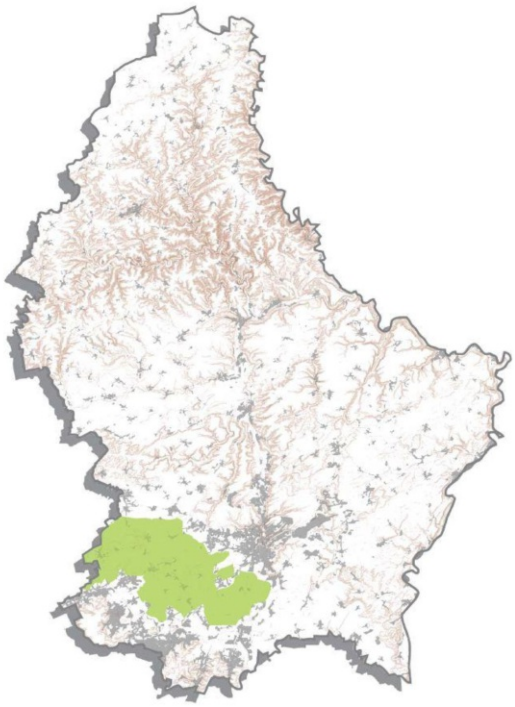

Figure 6: The location of the ZVI (green), surrounded at its borders by the AggloLUX and AggloSUD (urbanised areas in grey) (Le Gouvernement du Grand-Duché de Luxembourg 2014)

The region's land cover is characterised by a flat, extensive hilly landscape with hedge

rows and avenues, the northern part adjacent to AggloLUX marked by more open forest lands where the forest is present in isolated patches rather than continued strips. agl and Zeyen + Baumann (2013) emphasise the continuity of this landscape all from the Belgian border to the Alzette. On the other hand, its land use is dominated by agricultural land with a number of forest managed for forestry. In contrast to the urban agglomerations in its vicinity, the region of the ZVI is relatively sparsely populated, with a number of towns spread evenly across the landscape. However, the centralistic development of the Grand-Duchy around the City of Luxembourg has created intrusive settlement strips driven by transportation axes, threatening the integrity of the ZVI from both the North and the South and even from within, as the creeping merging of the towns Dippach, Reckange-sur-Mess and Käerjeng show. (agl and Zeyen + Baumann 2013)

Figure 7: The town of Dippach, located within the ZVI, with the town of Bertrange in the background, belonging to AggloLUX (Wikimedia Commons 2017)

The ZVI is shaped by 'rurbanisation', the exodus from urban centres and suburbs towards rural areas in pursuit of larger homes for a lower price, home gardening and the general comfort and quality of life of the countryside, while still working in the neighbouring agglomeration of Luxembourg City and increasingly also in the AggloSUD. (Wikipedia, n.d.-b) This creates a region like a mosaic of natural landscapes, offices, agricultural lands, residential buildings, commercial centres and natural retreats. "*Despite these human pressures, [the ZVI] concentrates Natura 2000 areas, urban quiet zones, meadows, moors and permanent grasslands, water areas and ponds, ecological compensation areas. (...) The ZVI is the space of all contrasts*" (Junker 2020, 98).

As noted in the PSP, the justification of the ZVI's legal status is its relative coherence and low fragmentation as well as its potential to provide agricultural land, ecological connectivity and a good quality of life on the one hand, and on the other hand, to prevent further erosion especially at its borders through urbanisation and linear transportation infrastructure. The SEA for the PSP underpins the necessity and the justification of the ZVI, finding, on the one hand, positive effects on biodiversity, landscape, the Natura 2000 network, land consumption and other environmental factors, and, on the other hand, states that the absence of the PSP would lead to increased land consumption and higher loss of biodiversity. (Oeko-Bureau 2018)

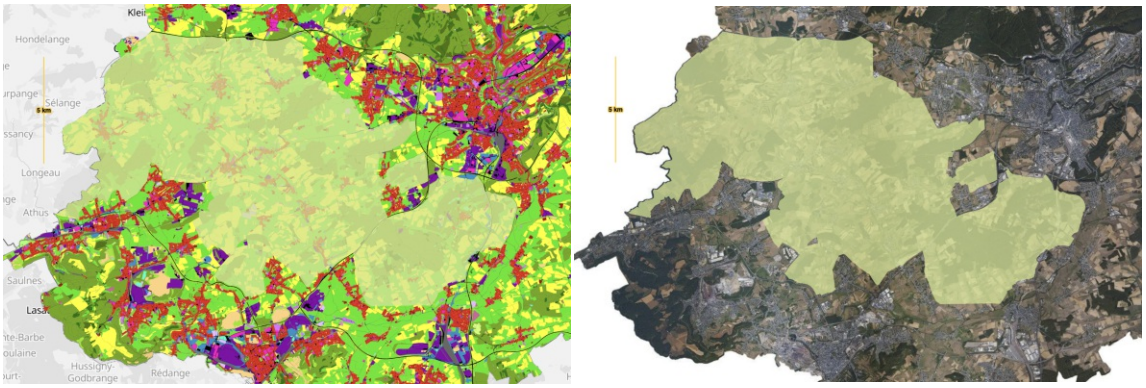

Figure 8: Left: land use in and around the ZVI (purple and red shades indicate urban areas, green and yellow shades indicate (semi-)natural lands, incl. agriculture); Right: aerial view of the ZVI from official orthophotos (Géoportail, n.d.-b)

9 State of the Environment in the EU, in Luxembourg and in the ZVI

9.1 Biodiversity and Ecosystem Services

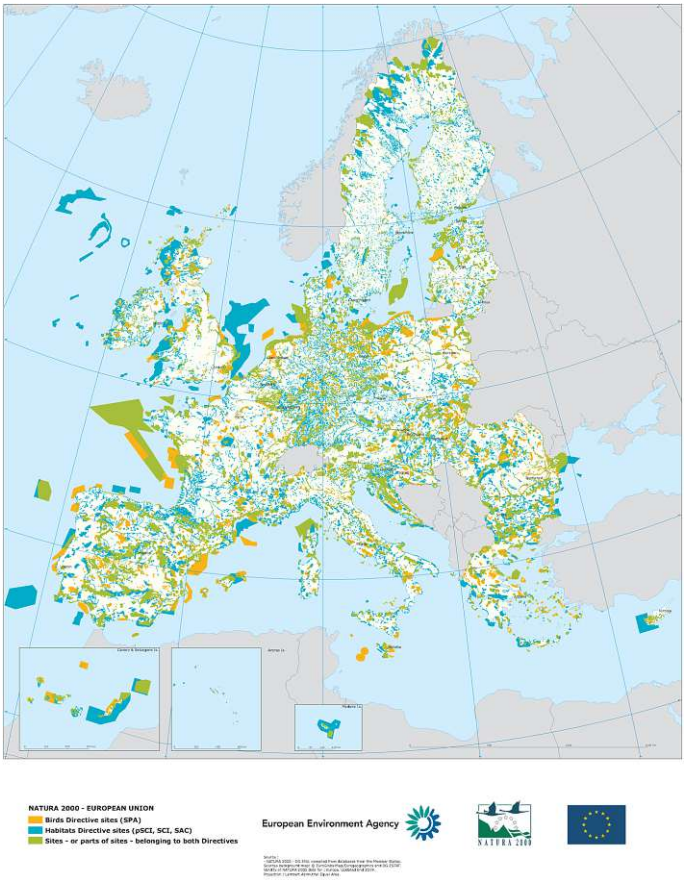

Figure 9: Designated Natura 2000 areas across the European Union (European Environment Agency 2020)

The EU is a forerunner in establishing protected areas for conservation and working towards ecological connectivity through the Natura 2000 network. It currently "*covers [a considerable] 18% of the EU's land area*" (EEA 2019c, 78). The Natura 2000 sites are not per se "*pristine areas, stripped of human impact*" (EEA 2019c, 77) but they can also be subject to economic activities, most notably forestry and farmland. This, however, generally increases pressure on ecosystems, along with the designation of the sites in the first place: over three quarters of registered sites are smaller than 100 ha, and only the most sparsely populated regions of the EU are home to the largest sites. Therefore, the conservation status within a given site often strongly depends on the respective management plan. Unfortunately, the data coverage on management of sites is very lackluster and incomplete.

The effectiveness of the Natura 2000 network is assessed under the Birds and Habitats Directives, where Member States are required to report on their conservation progress. On the EU level, under the Habitats Directive, 63% of protected species are in an unfavourable (poor or bad) conservation condition and 27% in a favourable situation. Similarly, only 15% of protected habitats are in a favourable condition, with wetlands such as bogs, mires and fens, followed by grasslands, scoring lowest in the assessment. (EEA 2020) (EEA 2019c) Under the Birds Directive, 47% of bird species are in a good state of conservation, although another 39% are in a poor or bad situation (EEA 2020). Overall, the report finds little evidence for positive development in the species and habitats covered by both Directives over the last 10 years and biodiversity on European level continues to be depleted (EEA 2019c).

Common bird populations have declined 11% since 1990, farmland birds leading before forest species with a 35% decline. Similarly, common grass butterfly species have declined 39% between 1990 and 2017 in the 15 Member States that are monitoring them. The leading cause of this decline is habitat loss and degradation. Birds and butterflies are viable indicators for changes in the state of ecosystems and in other species due to their sensitivity to environmental change. Finally, insect populations are also under rapid decline: the EEA (2019c, 85) cites a 2017 study finding a "*more than 75% [decline] over 27 years in total flying insect biomass in protected areas in Germany*".

The contribution of the Natura 2000 network to conservation is still difficult to assess, among other things due to a lack of comparable information on species and habitats inside and outside its coverage. Nevertheless, it has been found that habitats and an important number of species, who are covered to a high percentage by Natura 2000 areas, are generally in a better conservation state that those covered only to smaller degrees. (EEA 2020)

The EEA finds that "*agricultural intensification, intensive forest management, land abandonment and urban sprawl*" (EEA 2019c, 83) are the main drivers of biodiversity loss by decimating, degrading, simplifying and fragmenting natural ecosystems. Beyond their direct impact on the territory, these drivers associated with land use change have indirect impacts on species and habitats through increased pollution by fertilizers and pesticides and disturbance through noise and light pollution. To a lesser extent, invasive species and climate change are to blame.

Ecosystem functions and services have all been shown to decline in the last 60 years. However, concrete evaluation of ecosystem conditions is lacking "*because of the complexity of the interactions and interdependencies between them*" (EEA 2019c, 88), and because ecosystems may hide positive or negative effects of impacts in the short term due to their systemic resilience. Biver (2021) states that a nomenclature for ecosystem services has not been established, making it difficult to track changes.

Finally, despite the existence of great genetic biodiversity in animals and plants in Europe, a big share of this diversity is considered at risk and many livestock and crop species have already been lost from negative environmental impacts but also from intensification of agriculture. This undermines the resilience of the food system in the EU against crises like climate change. Also, the loss of pollinators poses a threat to food security, as 1/3 of the mass of food consumed by Europeans directly depends on the pollinating ecosystem service. (EEA 2019c)

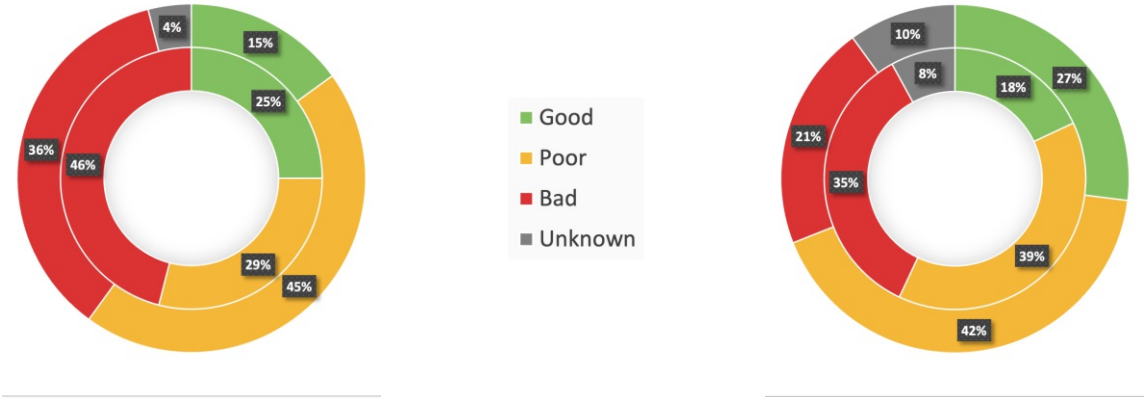

Figure 10: Conservation status for habitats (left) and species (right) under the EU Habitats Directive. The outer ring represents assessment at the EU level, the inner ring represents data for Luxembourg (own representation)

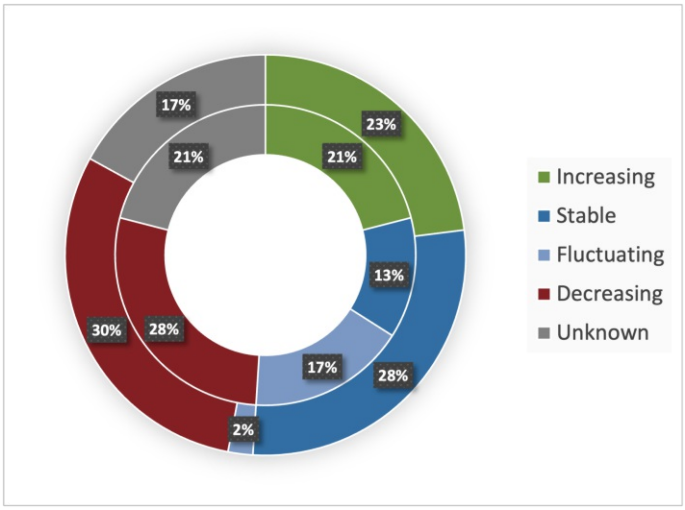

Figure 11: Short-term trends for bird populations under the EU Habitats Directive. The outer ring represents assessment at the EU level, the inner ring represents data for Luxembourg (own representation)

Luxembourg. The primary causes for loss of biodiversity are "*the loss and degradation of natural habitats, and the fragmentation of landscapes due to the expansion of urbanisation, transportation infrastructure and (...) agricultural practices*" (in French) (MDDI 2017, 11), which is consistent with European wide trends. More specifically, the simplification and homogenisation of landscapes affect specialised species in particular and reduce the complexity of species diversity, and the fragmentation and the net reduction of habitat area negatively affect species' populations. Habitats are affected directly through "*destruction or alteration*" (MDDI 2017, 74) Pressures are distributed virtually everywhere across the territory. (MDDI 2017)

Consistent with European trends, pollinating species such as bees and butterflies are declining since decades. (MDDI 2017) Based on the reporting under the EU Nature Directives, 75% of Luxembourg's habitats are in a non-favourable state. Open and aquatic landscapes are in a considerably bad condition. While the state of habitats has barely changed since previous assessments, open landscapes continue to be degraded, especially meadows as the most widespread open habitat. (MDDI 2017) This finding is confirmed by Biver (2021), adding that about 80% of wetlands have been destroyed. On the other hand, it is highlighted that the forest ecosystems are in a "*stable state*" (Biver 2021).

Species have a 74% non-favourable conservation status and similarly to habitats, species associated with open landscapes as well as aquatic habitats are in a particularly bad conservation state. This trend continues into the assessment of bird species under the Birds Directive, where 66% of species are not in a stable or improved conservation state despite some singular improvements for rare species targeted by specific measures in the past, and the poorest state of conservation is again focussed around open habitat types such as bocages and lean grasslands.

The main pressure is agricultural exploitation, and the threats are a loss of habitat in net surface and a degradation of habitat quality. Localised measures (late mowing, extensification) have preserved isolated habitats but were unable to counter the overall diminution of populations on the national level. (MDDI 2017) Additionally, Biver (2021) mentions the emergence of urbanised areas as habitats for species, and highlights that species, especially birds domestic to open landscapes in decline, have been observed to have found "*substitute habitats*" (Biver 2021) in small towns or in parks in urban areas following the degradation of their original habitats.

As of 2017, Luxembourg has exceeded the target of protected areas covering at least 17% of its national territory, with having classified 27% of its national territory as Natura 2000 sites (EEA 2019c) (Decoville and Feltgen 2018). In addition, many core areas of the Natura 2000 network as well as other relevant habitats are classified as protected zones of national interest, which in total amounts to 51% of the territory being covered by one or the other form of protected sites (Biodiversity Information System for Europe, n.d.).

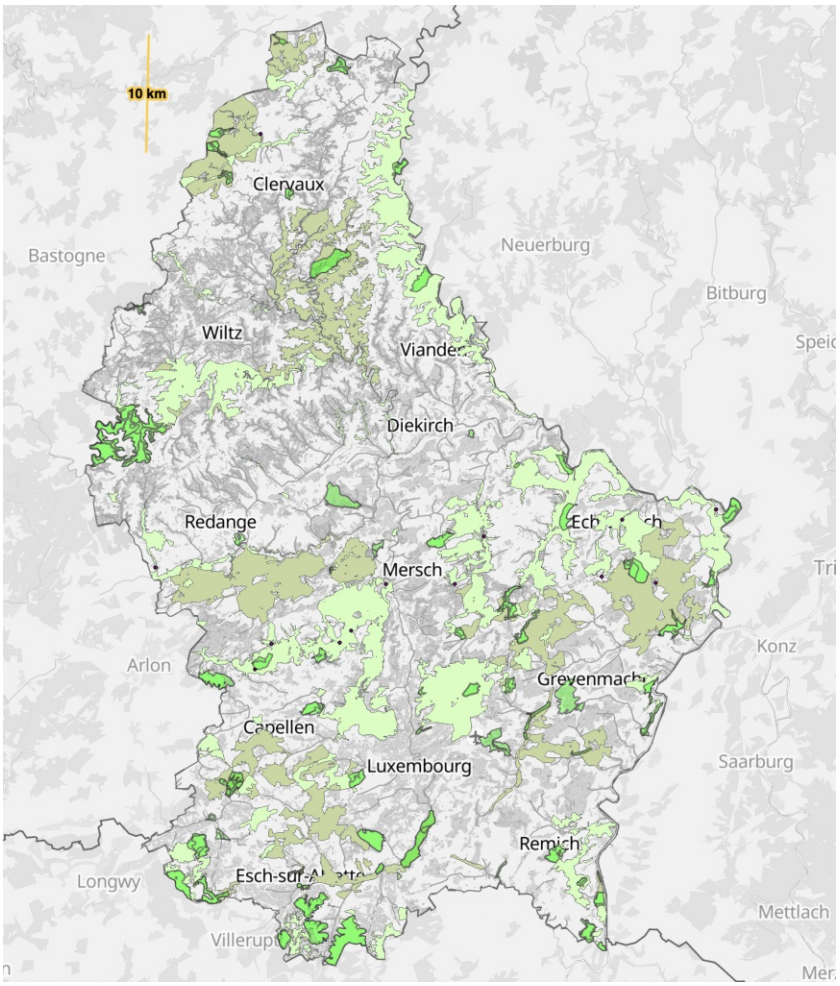

Figure 12: Natura 2000 network (dark and light green) and national protection sites (fluorescent green) in Luxembourg (Géoportail, n.d.-c)

ZVI. In the ZVI, Biver (2021) summarises that biodiversity trends are generally following national trends, especially the decline in open habitats. Nevertheless, the remainder of the wetlands as well as the meadows present a considerable diversity of species. The core of the ZVI is composed of a series of Natura 2000 areas covering mainly forests established through the Habitats Directive, which is expanded through superposed protected areas under the Birds Directive, adding the neighbouring meadows and wetlands to the network. This high incidence of protected areas is based on the assumption that the ZVI is indeed an important region for biodiversity. The prevalence of forests as protected areas can be traced back to the high opposition from agriculture to establish open landscapes and other agriculturally relevant lands as protected zones while forests, especially in Southern Luxembourg, are often in public possession anyway, in contrast to open landscapes.

Biodiversity is under pressure from land use dynamics within the ZVI: on the one hand, urbanisation tendencies within the ZVI lead to a loss of land dedicated to natural habitats, but, on the other hand, the intensification of agriculture puts pressure on the zone. The impact of agriculture on biodiversity has grown without a significant change in surface

area but merely through the change of land use practices, such as increased fertilizer and pesticide input, mowing and plowing. Biodiversity is also under pressure from increasing demand for recreational services, which is satisfied through the expansion of forest and cycling paths, better accessibility of natural areas and construction of homes farther away from towns in search for quietude, leading to the disturbance of fauna, especially in the breeding season.

Along with the loss of biodiversity and the degradation of habitats, ecosystem services have been lost to a certain degree. For example, the measured loss of butterflies and bees points towards a reduction of the ecosystem service "pollination". Similarly, the pollution of water sources, rendering them unusable for drinking water, creates a measurable loss of an ecosystem service, and the straightening of waterbeds have reduced the rivers' ability to retain water and prevent urban areas from floods, as it was most recently seen with the floods of July 2021. However, the exact diminution of ecosystem services (as well as their values) is unknown due to a lack of nomenclature and classification. Although countries have started mapping their ecosystems, e.g. through the CORINE land cover programme, neither national nor European authorities have managed to assess the loss of ecosystem services and the monetary loss they represent. (Biver 2021)

9.2 Climate Change

Between 2009 and 2018, when the global mean temperature rose by about 0.9°C, the land temperature in Europe rose by 1.6-1.7°C. Extreme temperatures, like daily maximums, are rising faster than average temperatures, with eight and nine EU countries breaking daily and nightly temperature records between 2015 and 2019, respectively. Southern Europe is generally impacted more severely by decreases in precipitation, frequency and intensity of droughts, slowing forest growth and an extended season and severity of forest fires. While Northern Europe is currently experiencing an increase in precipitation and forest growth, and less droughts, it has also seen increases in heavy precipitation events and floods. The entire continent is affected by sea level rises, and by northward migration of species due to shifting climate regions, although climate change is happening faster than species are moving and adapting to new environments. In Luxembourg, since 2015, records have been broken for all-time high temperatures and the warmest night recorded. (EEA 2019c)

9.3 Freshwater

Although this thesis does not focus on freshwater, it is still important to give a brief overview of the state of freshwater bodies because they, too, are affected through land use. The most important assessment of overall water quality is done through the Water Framework Directive. As of 2019, only 40% of EU surface water bodies are in a good ecological status. Geographically, surface waters achieve less good ecological status in densely populated regions compared to sparsely populated Member States. Particular

pressure is exerted on wetlands. Similarly, the conservation status of habitats and species, as mentioned above, is continuously unfavourable. 40% of surface waters are under pressure from hydromorphological pressure, impacting habitats and species through anthropogenic modification of beds, banks and river course.

On the chemical side, the situation is cautiously improving, with organic pollutants, nitrogen surplus, ammonium and nitrate decreasing. Nitrate, the most slowly decreasing chemical, remains the most widespread substance affecting groundwater bodies. Still, 74% of groundwater bodies achieve good chemical status, as opposed to only 38% of surface water bodies. Water abstraction from groundwater bodies has been declining, with now 89% achieving good quantitative status. (EEA 2019c)

In Luxembourg, only 2% of surface water bodies are in a good ecological state due to biodiversity loss, hydromorphological changes and the interference in the watercourse. All surface water bodies are in a bad chemical state due to pesticides, heavy metals and especially a country-wide contamination with PAHs. 66% of groundwater bodies are in a bad chemical state due to pesticides and nitrates but they present a good quantitative state. In general, despite efforts made in the past 20 years, the condition of Luxembourg's water bodies is not predicted to improve sufficiently in the near future. Additional pressure is caused through soil sealing, altering water penetration and watercourses. Climate change will cause stronger seasonal differences in precipitation in the coming decades, increasing floods in winter and shortages in summer. (MDDI 2017)

Junker (2021) and Biver (2021) both note that the pollution of groundwaters and waterbodies with nitrates originating in fertilizer application have rendered a number of water springs unsuitable for drinking water. This is a tangible example of the loss of ecosystem services due to anthropogenic actions.

10 Land Use in the EU, in Luxembourg and in the ZVI

The EEA reports that, since the year 2000, the land cover of Europe has not changed fundamentally. In general, trends of land use change have slowed down on European territory over the last decades (EEA 2019c). Arable land or permanent crops cover 25% of the European territory, 17% are made up of pastures, forests cover 34% of Europe and less than 5% are sealed or artificialised. Artificialisation is the most prominent trend in land use change, with 7% expansion of area between 2000 and 2018. (EEA 2019a) Land artificialisation is projected to increase by 0.7% until 2050. Fourth fifths of this expansion come at the expense of often very productive agricultural land, whereas forest cover has remained constant in recent decades. (EEA 2019c)

The EEA points out that not only population growth but also rising living standards and more resource-intensive lifestyles are driving urban expansion, which will grow by 11% until 2050. As of 2019, 72% of EU citizens live in urban agglomerations. (EEA 2019a)

The highest losses of agricultural lands between 2012 and 2018 happened in Czechia, Hungary, Spain and southern Portugal, while northern Portugal, the Baltic countries and Finland saw the biggest increase. Although forest area has been stable, it has been further fragmented, especially in eastern and southern European countries. The "*felling/growth ratio*" (EEA 2019c, 124) is estimated to be below 100%, indicating a growth in forests across Europe, although there is a considerable data gap. (EEA 2019c)

The ongoing urbanization entails rising habitat fragmentation in all EU countries without a sign of imminent halt or reversal. The increase of new unfragmented meshes across Europe has fallen to 2.6% between 2012 and 2015 from an initial 6.2% between 2009 and 2012, indicating a slowing of fragmentation trends. Poland, Bulgary, Greece and Hungary have seen an important rise in absolute fragmentation while Switzerland and the Benelux remain the most fragmented countries monitored in relative terms. The rise in fragmentation was most prominent in rural areas. Natura 2000 areas are also subject to fragmentation, however, at a much slower rate than non-protected areas. (EEA 2019c)

Although the EU plans to achieve land artificialisation neutrality by 2050, only 13% of land consumption consists of land recycling or densifying urban areas.

Soil sealing was 1.48% of the entire European territory in 2015, with slowing rates in recent years. On soil erosion, the EEA concludes that water is responsible for the loss of topsoil at 1.6 the rate of its formation, before even accounting for the contributions of wind and harvesting practices. 28% of European soils (EU-28) are considered compacted, with extremes in the Netherlands of nearly half of all soils. Contaminants, although heavily regulated in the EU, can still contribute to soil degradation, especially with the advent of novel substances such as persistent organic pollutants. The degradation of soil mainly impacts soil organisms and soil organic carbon (SOC) content. Land use intensification has led to a decline of soil biodiversity such as "*earthworms, springtails and mites*" (EEA 2019c, 129), which negatively affects ecosystem services. Additionally, a loss of carbon in soils deprives organisms of their main energy source and contributes to the greenhouse effect. European forest soils currently act as a strong carbon sink, whereas croplands have balanced fluxes and grasslands are net emitters. The strongest sink and reservoir for carbon are peatlands, however, they are at risk of losing up to a third of their SOC content by 2100. (EEA 2019c)

Currently, its organic carbon content is growing but this is highly uncertain, especially under climate change. Soil organic carbon is disproportionately present in Sweden, Finland and the UK due to large forest cover and critical wetland regions. (EEA 2019a)

Luxembourg. With an area of 2586 km^2, Luxembourg is the smallest country in the world "*that is not a European microstate or island country*" (Hallman, n.d.), and the second-smallest EU member state after Malta. The northern part of the territory ('Éislék' in Luxembourgish or 'Ösling' in German) is marked by the rough terrain and hills of the Ardennes. The southern part ('Guttland') is characterised by a flat landscape of "*countryside, forests and, in the south, mining regions*" (Gouvernement 2020d). The largest river is the Moselle, bordering the country in the South-East.

Climatically, Luxembourg is characterised by relatively mild winters and balanced summers, with precipitation evenly distributed across the year. The Ösling is relatively cold and humid, and has comparatively lower temperatures than the Gutland, with highest temperatures and lowest precipitation levels along the Moselle river. (agl and Zeyen + Baumann 2013)

The continuing attractivity of the city of Luxembourg for living and working determines the population distribution and continues to shape the Luxembourgish territory. Luxembourg City and its suburban municipalities contain a far higher share of national employment than of national population, followed by AggloSUD. Efforts to redistribute the growing population towards different municipalities to reduce the importance of AggloLUX have largely failed, although an uncoordinated urban exodus has happened due to rising housing prices. (Decoville and Feltgen 2018) Population densities have increased in almost all municipalities, though faster in the South than in the northern half of the country, paired with widespread increasing (sub-)urbanisation especially across the southern half of the country. The working population continues to have importances distances for commuting, which tend to increase the further away people live from Luxembourg City. (Decoville and Feltgen 2018) The importance of public transport in commuting remains low, and the dominance of cars and roads contributes to landscape fragmentation (Junker 2020).

In 2016, land use in Luxembourg was 50% agricultural land and 35% forests, while 9.8% of the territory was used by residential areas and a total of 14% of land was artificialised. This is a considerable change from 93% of agriculture and forestry, 3.1% urban areas and 6% artificialised land since 1972. (Oeko-Bureau 2018) (Junker 2020) In terms of land cover changes in natural and semi-natural landscapes, the PNPN2 finds that, in the long term between 1962 and 1999, 80% of wetlands, 58% of orchards, 35% of grasslands and moors, 55% of solitary trees and 29% of hedge and tree rows have been lost, while bushes and secondary forests as well as herbaceous wastelands have increased by 43% and 64%, respectively. Forest cover has largely remained unchanged. Agricultural land has decreased by 7%, though an intensification of activities has been measured. Landscapes of Luxembourg are the most fragmented in Europe. (MDDI 2017)

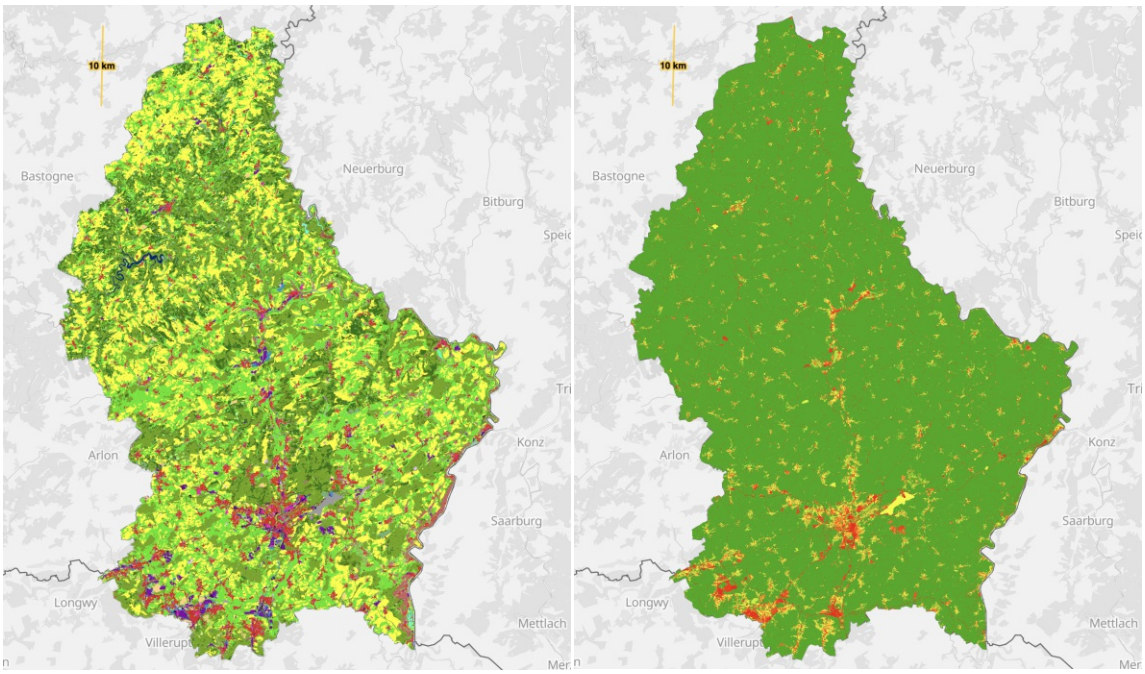

Figure 13: Left: Land use in Luxembourg, with shades of red and purple indicating urban areas and industrial and economic activity, and shades of green and yellow indicating natural, semi-natural and agricultural areas; Right: soil sealing in Luxembourg, degrees of sealed surfaces from green (0%) over yellow to red (100%) (Géoportail, n.d.-a)

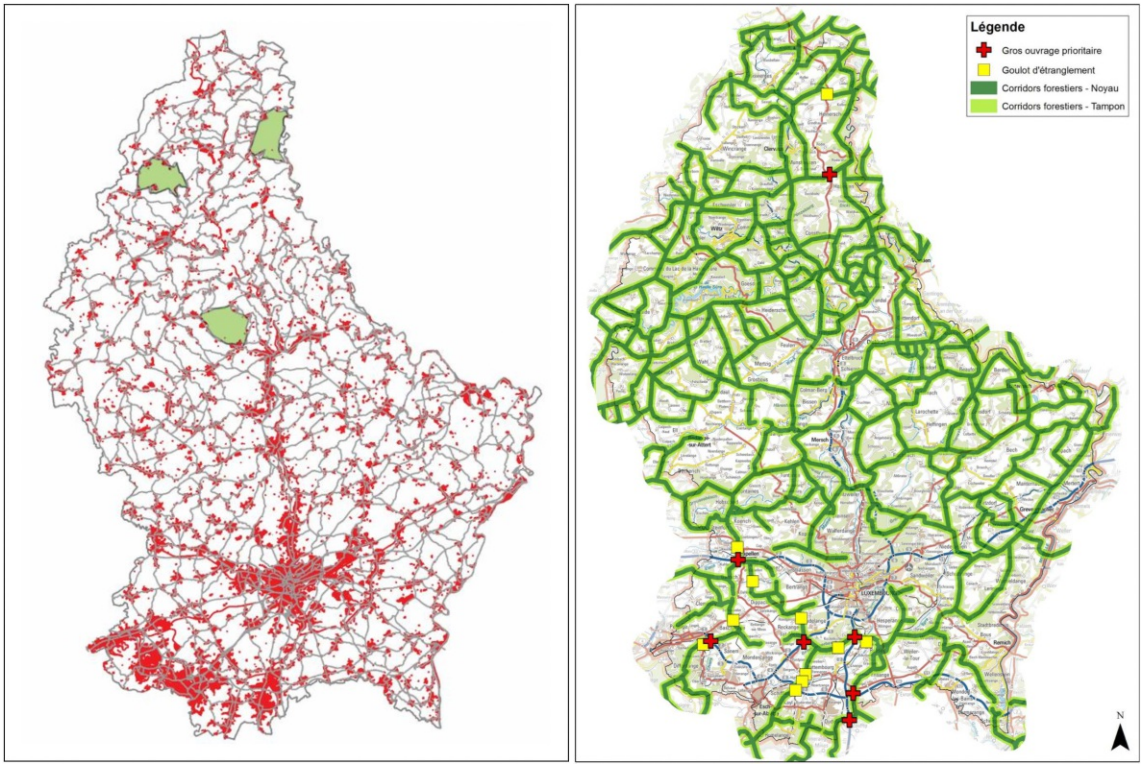

Figure 14: Left: landscape fragmentation from urban areas (red) and transportation infrastructure (grey lines), with the three larges unfragmented areas in green (MDDI 2018); right: bottlenecks (red) and priority projects to restore ecological connectivity (yellow) in the ecological forest network (green) (MDDI 2017)

The land consumption rate has slowed down recently to between 0,3 and 0,5 hectare per day . (Decoville and Feltgen 2018) (MDDI 2017) Junker (2020) also attributes this trend to "*the fact that the big land consuming projects (airport, highways,...) have been achieved*" (Junker 2020, 41). Recent analyses have shown that housing construction has become more dense and, therefore, consumed less land per unit, and that reconstruction on previously artificialised land has increased. However, this is more driven by the exploding prices for land rather than due to regulatory approaches. (Decoville and Feltgen 2018) In terms of soil sealing, rates have also slowed at the same time as population growth has sped up, supporting the claim of urban densification. Current hotspots of relative soil sealing are less the already urbanised municipalities and more rural towns which have either grown due to expanded housing space or due to economic activity zones. (Decoville and Feltgen 2018)

Despite a slowing of land consumption trends, Luxembourg remains leading among the European countries with the highest share of artificialised land and landscape fragmentation. Overall, the biggest drivers of land consumption are housing and office spaces, while the areas lost to urbanisation are primarily agricultural lands or forests. At least part of ongoing land consumption can be traced back to the wealth of Luxembourg in general, which e.g. allows citizens to afford single-family homes with larger gardens. This is supported by the fact that Luxembourg is among the European countries with the largest housing surface per resident. (Junker 2020)

ZVI. In the mosaic structure of the ZVI, the alternation of open landscapes and forests has remained rather constant over the years, however, Biver (2021) points out that the majority of wetlands formerly present in the open land have been largely degraded to a minimum. The ZVI is characterised by a high prevalence of arable land and green grasslands. The latter is linked to a high occurrence of dairy farms which use these grasslands to produce hay for feed.

Within the ZVI, an increased demand for housing space away from the dense urban areas, especially in the towns Dippach, Reckange-sur-Mess and Bettembourg, puts considerable urbanisation pressure on the land of the ZVI. (Biver 2021) The towns of Dippach and Reckange-sur-Mess present tendencies of urban sprawl, forming strips of urbanisation that risk to split the ZVI in half. The highway between Luxembourg City and Esch-sur-Alzette, as well as the trainline between Luxembourg and Pétange are already established fragmentation lines within the ZVI. (Géoportail, n.d.-b)

At its borders, the relatively well-preserved zone is threatened by adjacent highways, urbanisation pressure from both neighbouring agglomerations and a strip of economic activity zones in the South. (Géoportail, n.d.-b)

However, while land cover in the ZVI has not dramatically changed within the ZVI, the most notable change has been in the intensification of agricultural practices, with widespread negative consequences for biodiversity. (Biver 2021) The ZVI is home to six Natura 2000 sites under the Habitats Directive, which are superposed and expanded by a single large coherent Natura 2000 site under the Birds Directive, the third-largest Natura 2000 site with 5739 hectares or roughly a third of the ZVI's surface area. Three more stringent national protected areas are declared within this Natura 2000 site, with an additional four sites planned to be protected as well as proposed by the PNPN2. Finally, a larger number of green cuts, defined in the PSP, are located either within the ZVI or at its borders, providing for checks to the urbanisation pressure. (Géoportail, n.d.-d)

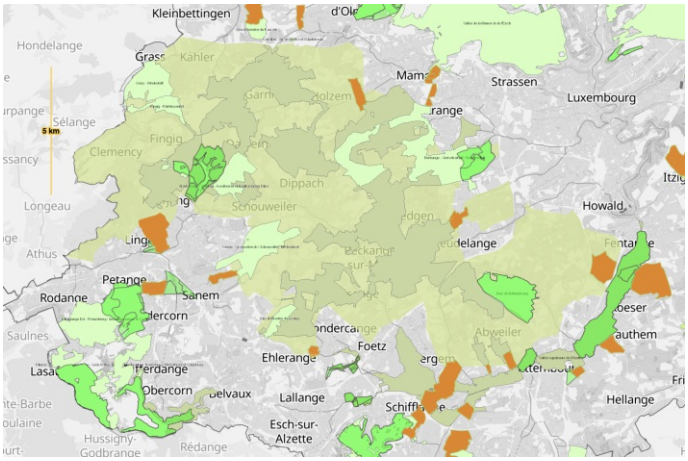

Figure 15: Visualisation of the different provisions to halt urbanisation in the ZVI and to reserve space for natural habitats: the Natura 2000 areas (dark and light green), superposed with a number of protected areas of natural interest (fluorescent green), and completed with green cuts (orange) from the PSP (Géoportail, n.d.-d)

The PNPN2, through elaborating the ecological networks of forests on the territory, finds that the South-West of Luxembourg is particularly affected by bottlenecks of ecological connectivity, and all but one wildlife crossing deemed of high priority are located in that region, with four bottlenecks and two wildlife crossings located within the ZVI. Biver (2021) confirms this finding, stating that priority has been given to many projects that ecologically reconnect the South-West of the rest of the country.

Part IV

Results and Discussion

11 Visions and Scenarios for the ZVI

This section discusses possible scenarios and visions for the future development of the ZVI with respect to land use and land cover. The information is largely derived from the two expert interviews, supplemented with facts from the Materials and from the literature review. In the next section, these visions and scenarios will be further developed by concrete recommendations given by the experts. The content provided by the expert interview with Pascale Junker pertains to a more integrated approach from the view of spatial planning, with special regard to agriculture and food production, whereas the expert interview with Gilles Biver approaches land use in the ZVI from a biodiversity perspective. (Junker 2021) (Biver 2021)

11.1 Experimental Zone for Inter-Agglomerational Resilience (ZeRiA)

Following the national spatial planning policy, the ZVI should aim to preserve its "*agricultural functions*" (MEA 2021b, 24). From a societal and economic perspective, Junker sees the opportunity to expand on the ZVI's agricultural potential beyond the provisions of the PSP to provide the neighbouring agglomerations with locally produced food and other vital ecosystem services. The new concept of the 'ZeRiA' – short for "zone expérimentale de résilience inter-agglomérations" (Junker 2020, 98) or experimental zone for inter-agglomerational resilience – uses the ZVI as its foundation and expands its vocation and its opportunities. Specifically, Junker envisions the ZeRiA as a zone to increase Luxembourg's alimentary resilience. The concept of resilience has been defined in Section 3.2 as a socio-ecological system's ability to withstand perturbations: in this case, alimentary resilience means that the re-territorialisation of Luxembourg's food production reduces its vulnerability to food market fluctuations and natural disasters, increasing society's protection against food shortages and high prices.

The need for increased alimentary resilience is justified above all in the light of an impending "*resource rarefaction*" (Junker 2021) in virtually all domains, such as energy, water, soils, crops and seeds, and before the background of climate change through which society will have to reduce transportation routes for food and the provision of other goods in general. Raising alimentary resilience also entails:

Self-sufficiency. The average land area needed per capita to feed a person is estimated to be approximately 2000 m^2, under a conventional meat- and dairy-containing diet. Junker (2020) finds that Luxembourg almost fully possesses the territory to feed its entire population based on this assumption. However, currently, the Grand-Duchy

functions as a sort of "*clearing house*" (Junker 2021) for agricultural goods and especially for dairy products: fish, meat and proteins (mostly soy) are imported to support dietary preferences and the dairy agriculture, while, on the other hand, the largest majority of outputs in the form of milk and dairy products are exported again. Two different forms of biomass, of scales exceeding orders of magnitude of Luxembourg's consumption, are traded but the local benefits on Luxembourg's territory remain minimal. (Junker 2021) Through a re-territorialisation of food production paired with dietary changes, the domestic territory could be repurposed to feed the Luxembourgish population directly and decrease dependencies on imports for vital products as well as transportation costs, price volatility and greenhouse gas emissions. Especially the dietary shift can increase land use efficiency, as the land requirements for plant-based food are much smaller than for animal products, as described in Section 2.3.2, and it would reduce the greenhouse gas emissions intrinsic to animal products and from transportation.

Social Cohesion. Junker (2021) argues that increasing resilience is vital to our society because the vulnerability of our current system does not only put food security itself at risk but it can also destabilize society. In the face of a shortage of food, water or other vital goods, humans may quickly abandon societal order and cooperation when the survival instinct takes over. In addition, Junker criticizes that there is no political framework regulating the stocks of emergency food reserves, while there is a European directive providing that member states must have reserves of fossil fuels lasting up to 90 days. The food on Luxembourgish supermarket shelves is estimated to last only four days in the case of an emergency. (Junker 2021)

Adaptation to Climate Change. A warmer climate, dryer summers and wetter winters, heavier and more frequent precipitation events and extended drought periods all put serious stress on crop plants. Agriculture therefore has to be adapted to climate change, e.g. by resorting to crops that grow under more extreme conditions. Plants that are currently domestic to lower latitudes may be suited for cultivation in Luxembourg as climatic zones shift towards the poles. The unprecedented speed of climate change makes natural adaptation of crop species impossible, but requires strategic planning to secure food supply. (Junker 2021) The reterritorialisation of food production increases resilience in the face of climate change because the supply of energy and nutrients can be assured on the local territory and under domestic governance.

11.1.1 Cornerstones of Implementation

The ZeRiA's final objective is to make society resilient to climate change and ensure its stability and food supply under uncertain circumstances. To put this vision into action, the interlinkages with different sectors and domains must be considered, not just to ensure its success in the long-term but also because important co-benefits can be achieved for resource efficiency (land, transportation fuel, ...) and nature conservation.

Circularity. Junker (2021) makes the point that the ZeRiA must be a circular economy of resources in order to achieve alimentary resilience. A prime example is Luxembourg's current complete dependence on imported nitrogen fertilizer. The ZeRiA presents an opportunity to capture the organic waste accruing in the neighbouring agglomerations, to process it through composting and biomethanisation, and to apply the resulting nutrients onto the agricultural lands of the ZVI with the vision to feed the region and the agglomerations with local produce. This allows the circular use of the primary nutrient nitrogen and can also counter the overconsumption and excessive application of synthetic nitrogen to fields and the soil, leading to severe decreases in biodiversity and increased water pollution. The unsustainable use of and pollution with nitrogen is one of the quantities that has far exceeded its planetary boundary, putting the stability of the Earth system at risk (see Section 1).

Energy. Biomethanisation does not only provide nitrogen under an assimilable form for plants but also produces energy under the form of CH_4 which could be used to power tractors or other machinery. (Junker 2021) It also reduces overall greenhouse gas emissions, as the emissions released upon combustion are fully or partially offset by the photosynthesis of the crops at the source of the organic waste.

11.2 Biodiversity and Ecosystem Services

Junker (2021) specifies that she "*did not see the ZeRiA from a biodiversity perspective*" but the vision and the co-benefits it entails, as well as the correct implementation would provide considerable improvements for biodiversity, as well as ecosystem services. The latter are a fundamental pillar for agriculture in the first place, as established by the IPBES (2019), underpinning the vision of the ZeRiA, and should therefore be given special consideration. In addition, the "*[preservation] of ecological [and] climatic functions*" (MEA 2021b, 24) is a fundamental objective of the ZVI and therefore must be pursued in its own right.

This is largely addressed by the PNPN2. It is difficult to make regional predictions for biodiversity, as the biodiversity strategy mostly refers to the national level. Given the lack of specific targets and strategies relating to the ZVI, it has to be assumed that developments in biodiversity trends are and will continue to be largely similar to those on the whole territory.

Fresh Air and Water. The ZVI can serve as a "*reservoir for fresh air for the two [neighbouring] agglomerations*" (Junker 2021), if the ecosystem services of the zone are kept intact and adequate infrastructure and urban planning allows winds of fresh air to penetrate the urban centres. This is one of the ways a combination of preserving natural areas through regulation and green infrastructure incorporated into urbanisation safeguards vital ecosystem services (see Section 4.1.3)

The circular use of nitrogen and other nutrients to support the reterritorialised agriculture would reduce the nitrate pollution of Luxembourgish rivers and water bodies which currently renders many water springs unsuitable for drinking water, posing a considerable risk for future drinking water supply in combination with varying availability under climate change. (Junker 2021)

Climate Change Mitigation. A dietary shift away from animal products, especially meat, reduces greenhouse gas emissions from feed production and land use change. The re-localisation of food production reduces emissions due to transportation.

European Ecological Network. Given its vocation in the PSP and put into the context of the PNPN2, the ZVI aims to enhance and restore ecological connectivity and maintain the coherence of natural habitats despite the widespread fragmentation. Ultimately, it will will act as one of many building of the continental ecological network that represents one of the cornerstones of the European strategy to restore biodiversity.

Biver (2021) states that the government hopes to (re-)establish the national ecological network by 2030 by designating 30% of the national territory as protected sites, of which 10% should underlie more stringent restrictions. Pursuant to the EU Biodiversity Strategy to 2030, Biver hopes to halt the loss of biological diversity by 2030 and to move to a path of general amelioration of biodiversity, not just within the ZVI. The EU Biodiversity Strategy for 2030 also establishes the long-term goal "*that by 2050 all of the world's ecosystems are restored, resilient, and adequately protected.*" (Commission 2013, 3)

12 Means to Achieve the Visions for the ZVI

Table 4: Overview of the options for action in the ZVI elaborated in Section 12, categorised in four themes

Agriculture	Biodiversity	Spatial Planning	Policy Principles
Extensification & Diversification	Protected Areas	Resolving Conflicts of Interest	Collaboration vs Regulation
Agroforestry	Ecological Corridors	Limited Reach of Spatial Planning	Valuing Nature & Territory
Locality & Seasonality			Public Awareness
Dietary Changes			Preemptive, collaborative and long-term resilience over reactive and individualist action
Economic Profitability & Scalability			

12.1 Agriculture

Agroforestry. Junker (2021) suggests agroforestry as a possible form of agriculture, together with aspects of urban farming, to achieve alimentary resilience and food security.

As elaborated in Section 4.2.1, the combination of trees and crops provides shade, habitat and protection, leading to improvements of the local water and carbon cycles, while protecting crops like wheat from wind and soil from erosion. Agroforestry is not an unknown concept in Luxembourg. There are a great number of bocages that still define the landscapes although they have been degraded and simplified across Europe in favour of intensified agriculture. These agricultural systems don't have to be strictly separated from settlements but there could be a fluid transition between the urban agglomerations and the countryside, using available land to its full potential, from facades to fallows to renaturated industrial brownfields, in order to grow food. Land efficiency could be increased through greenhouses on top of existing buildings or new multilevel greenhouses. (Junker 2021)

Locality and Seasonality. Alimentary resilience can only be based on local and seasonal crops, not on foreign plants like bananas or strawberries outside their seasonality. Imports and exports of food, especially of animal products and animal feed should be reduced to reduce transportation costs, dependence on the global food market and biodiversity impacts. (Junker 2021)

Extensification and Diversification. Extensification and diversification practices, such as leaving fields in fallow or having an increased variety of cereal crops or seed stocks all improve the food system's resilience to disruptions. (Junker 2021) Extensification reduces agricultural inputs, leading to lower environmental damages, while diversification takes into account the systemic vulnerability of streamlined food production and prepares for future disruptions through natural disasters or in the supply chain. Many of these practices constitute a reorientation towards more traditional agriculture "*that our grand-parents knew*" (Junker 2021).

Dietary Change. Although Luxembourg is hypothetically able to feed its population through its own territory, this will only be possible through a dietary shift away from excessive meat consumption, which requires much more land than other forms of agriculture. (Junker 2021) By extension, agriculture also has to diversify beyond the predominance of dairy products in order to reduce its dependence on soy imports and to improve the yield per land area. In order to compensate for the reduction of animal-based proteins, a shift towards production of more legumes would ensure the supply of proteins. In addition, the renunciation to fertilizer and soy imports has positive implications both for local and global biodiversity. (Junker 2021) A plant-based diet also greatly reduces greenhouse gas emissions from food production.

Economic profitability and scalability. The ZeRIA concept can only successfully provide food for a considerable portion or even the entirety of the neighbouring agglomerations if agriculture happens at large scale and economic profitability. Growing vegetables and fruits in "*home gardens*" (Junker 2021) is not the solution, because it is far from economically competitiveness. The goal is to achieve an "*industrialised [scale] in the most positive meaning*" (Junker 2021), in order to, for example, provide organic vegetables for the entire population "*and not just for the 10% who can afford it*" (Junker 2021). Biver (2021) argues, the national agricultural policy should reorient itself to discourage mass production and encourage regional, ecological and organic farming. The financial and economic security of farmers must be guaranteed as they opt to adopt more ecological practices. This is done already through voluntary income support schemes under the European Common Agricultural Policy. In addition, in Luxembourg, a subsidy has been established that favours the planting of climate resilient tree species and sustainable management and extraction over clear cutting.(Biver 2021)

12.2 Biodiversity Measures

From a land use perspective, biodiversity conservation measures entail either a land use change from anthropogenically used land to more natural areas or the change in land use intensity through a shift of practices. The change in land use intensity, in the case of the ZVI, is largely related to a change of agricultural use, which has been covered in the section above. In this section, solutions will focus on which land and areas are (not) reserved for biodiversity purposes rather than how intensively they are managed.

Protected Areas. Sustainable management of areas and biodiversity conservation can be enacted through the designation either of Natura 2000 areas or of protected sites of national interest. While the framework for the former is passed down by EU legislation and constitutes a softer, more cooperative approach between all stakeholders, the establishment of national protection zones allows the legislator to put restrictions on a given site, e.g. prohibiting the application of fertilizer or pesticides. In general, stricter restrictions on a site lead to faster and better results. Natura 2000 areas are generally bigger in surface than national zones, which is not least due to political opposition to more stringent restrictions. A third option for public authorities is to purchase lands and subsequently put them under strong restrictions, although this is a costly endeavour due to high land prices and the need for constant management on site. (Biver 2021)

As mentioned in Section 4.1.1, protected areas are a fundamental tool to preserve biodiversity, but they are not necessarily sufficient to halt its degradation. The management of these sites and the imposed restrictions play a crucial role in defining their success, for example in the Natura 2000 network which, at its base, allows a great range of human activities on site. Luxembourg has gone down the route to impose protected zones of national interest within important zones of Natura 2000 areas, in order to further support biodiversity conservation (Biver 2021). While protection sites are generally accepted to support biodiversity, the exact extent of their benefits remain difficult to assess, due to a lack of complete monitoring both on the national and the European level (EEA 2020).

Ecological corridors. Ecological corridors can take many forms but they are usually wildlife crossings going over or underneath highways to remediate fragmentation effects. Bottlenecks of ecological connectivity are especially frequent in the South-West of Luxembourg and are being resolved in order to reconnect the region to the rest of the ecological network. However, their implementation is limited on the one hand by costs and on the other hand by the lack political will: wildlife crossings are often only realised together with maintenance work on road infrastructure rather than for their own sake. (Biver 2021)

On the other side, ecological connectivity can only be successfully promoted by halting the urban sprawling that is at the core of habitat fragmentation. A prime example of this is the route along the towns Dippach and Reckange-sur-Mess that cuts through the ZVI with ongoing construction of housing along this route.

Finally, ecological connectivity cannot halt in front of human infrastructure but must be incorporated into urban areas through hedges, meadows, waterbeds, across rural-urban frontiers and across administrative borders. "*This is why planning instruments such as the PDS are important, as they can [guide] this ecological reconnectivity [on an overarching scale]*" (Junker 2021).

12.3 Spatial Planning

Resolving Conflicts of Interests. One of the missions of national spatial planning is to ensure "*the welfare of any citizen anywhere on the national territory*" (Junker 2021). The national spatial planning strategy is, therefore, required to consider multiple (conflicting) interests and work interdisciplinarily.

However, Junker (2021) also makes the point that "*things have changed*", referring to the ongoing and future impacts of the climate crisis and the "*resource crisis*" (Junker 2021). There should be a prioritisation between vital goods and services, and activities that are non-vital or "*accessory*" (Junker 2021), as well as a distinction between common interests and private interests. By the example of the planned bypass route in Käerjeng, Junker (2021) considers this project a mere satisfaction of individual interests, while disregarding the (economic) costs of the project that are borne by the public, in terms of landscape fragmentation, emissions, fossil fuel dependence and traffic. (Junker 2021)

Limited Reach of Spatial Planning Instruments. Biver (2021) argues that spatial planning instruments such as the PSP only have limited leverage in preventing biodiversity loss because the larger part of pressures results from an intensification of land use practices rather than land consumption. As shown in Section 2.3.2, agricultural intensification processes are driving biodiversity loss through land degradation, and softer agricultural practices as presented in Section 12.1 have a bigger leverage especially in heavily changed areas such as the ZVI, where the abandonment of anthropogenically used land and further dedication of land to protected areas is not an option.

12.4 Policy Principles

Collaboration vs. Regulation. Biver (2021) elaborates on different approaches to achieve improvements in the conservation status of species and habitats: on the one hand, stricter measures such as restrictions of certain activities on a site are more effective in producing results in a shorter time frame, but they require more financial and administrative resources to establish and maintain, and also face stronger opposition from political groups and society. On the other hand, cooperative approaches such as voluntary subsidy programmes or cooperation programmes between the state and the municipalities benefit from larger public acceptance and can therefore be rolled out at a larger scale, but tend to be slower and less effective.

Public Awareness. Both Junker (2021) and Biver (2021) note that a lack of awareness for the environmental emergency are hindering the options for solutions at hand. It is crucial to persuade society of their existence because they determine and limit the options for future action that society has, and they make clear that the business-as-usual scenario is out of the question. (Junker 2021) Biver (2021) differentiates between different forms of awareness: he finds that biodiversity loss is well known among the population but the consequences of biodiversity loss are little understood. Additionally, failing to see the 'big picture' leads people to believe that their own impact on the environment is not 'the problem'. When pursuing their own interests – be it construction projects, roads or family homes –, people fail to realise that the continuous loss of ecosystems through individual impacts is the primary source of the problem and not just a marginal phenomenon. Additionally, the value of biodiversity and their services, as well as the costs and implications of their loss are poorly understood and not even properly quantified, which distorts and reduces the value of preserving nature when different stakes are weighted against each other.

Valuing Nature and Territory. Junker (2021) criticises the prevalent mentality that "*biodiversity has to have a [tangible] benefit*". At the base, the intrinsic value of biodiversity should suffise for it to be conserved ("*The beauty of a field full of flowers is priceless*" (Junker 2021)). However, also the real (and economic) benefits of biodiversity in the form of numerous ecosystem services, including the adaptation to climate change, the protection against natural disasters, against pests and diseases, are not represented and accounted for, not the least because their monetary value is difficult to quantify. (Junker 2021)

Biver (2021) finds that, when concrete situations arise where personal interests would be pitted against the interests of biodiversity, personal interests are valued much higher than the preservation of e.g. a bat's habitat. The valuing of ecosystem services and their perception is difficult given the lack of a nomenclature and classification system even among experts and authorities.

Preemptive, Collaborative and Long-Term Resilience over Reactive and Individualist Action. The challenges of climate change, the resource rarefaction and the loss of biodiversity cannot be separated from rising global inequalities. Therefore, solutions have to include everyone and leave no one behind. Junker (2021) argues that the relocalisation of food production can become a community project, where locals can actively take part in working the fields, in planting and harvesting crops and can profit accordingly by e.g. receiving a share of the harvest. Involvement strengthens the tie to territory and food and contributes to resilience.

Although it can be beneficial to be inspired by agriculture from "the old days", such as fallow or crop diversification, interest especially in young people can be sparked if these methods are combined with modern state-of-the-art technology, e.g. by configuring and managing greenhouses via mobile apps. This collaborative approach fosters acceptance and support of a collective target within society and ensures the long-term sustainability of the project.

On the other hand, "*survivalist*" (Junker 2021) approaches, like bunkers in New Zealand to evade environmental crises exclusively available to a wealthy minority, should not be pursued, first, for the sake of equity and second, because it is a "*continuation of the battle against nature*" (Junker 2021) that cannot be sustained over long periods of time. The ZeRiA vision for the ZVI is the exact opposite: it is a harmonic coexistence with nature, where ecosystems provide the services and goods humans need for their survival and their thriving. (Junker 2021)

13 Discussion and Conclusion

13.1 Discussion of Results

The findings in this thesis indicate that, despite the negative developments over the past decades in land use and their impact on biodiversity and ecosystem services, visions has been developed on how a sustainable interaction with the resource 'land' could be enacted. This starts with the common understanding that a limit to land degradation and consumption is necessary to preserve vital land-related resources (Land Degradation Neutrality), over concrete endeavours to restore nature which has been degraded (EU and Luxembourg Biodiversity Strategy) to long-term visions of harmonic cooperation between humans and nature on their territory (ZeRiA).

13.1.1 Visions and Scenarios

Visions for a sustainable management of the ZVI are, in this thesis, mainly addressed in the form of the ZeRiA as proposed by Junker (2021). Beside the provisions that urbanisation and further land consumption are legally prohibited by the PSP, the ZeRiA is based on the assumption that land use practices in the ZVI must be reoriented to align both human needs and environmental integrity. This goes beyond the concept of conservation of biodiversity and also looks at the resilience of socio-ecological systems – the interactions between human societies and their natural environment – in the face of global environmental change. It makes the argument that vital and basic human needs like housing and food security can very well be sustainably preserved under the condition that nature and its contributions to people, underpinning these vital functions, are conserved and restored.

The ZVI possesses an important potential to both provide food security through local food production and conserve biodiversity through shifting agricultural practices towards a more ecological approach. This can be realised through innovative forms of agriculture such as agroforestry, efficient systems of greenhouses or agricultural extensification. By involving the local population in the cultivation of these croplands, the acceptance of the project and the economic involvement increases the system's resilience in order to make Luxembourg fit for the environmental crises. In addition to food security, the project would also greatly support other ecosystem services such as clean water, fresh air and recreation.

All of this is in line with the legal objectives of the ZVI under the PSP, and presents only one of many options that could lead to their achievement. However, the ZeRiA is more than that: it is a coherent concept of sustainable land use which not only considers the societal and ecological challenges of the region but also approaches them from a systemic point of view, considering their interlinkages as well as their interactions with the outside of the system 'ZVI'. On the other hand, there is the vision to 2030 and 2050 laid down in the EU and Luxembourgish Biodiversity Strategies, looking to establish and restore the ecological network across the country and Europe to preserve biodiversity, habitats and species, and the ecosystem services that are at the base of agricultural production and the ZeRiA concept.

13.1.2 Implementation

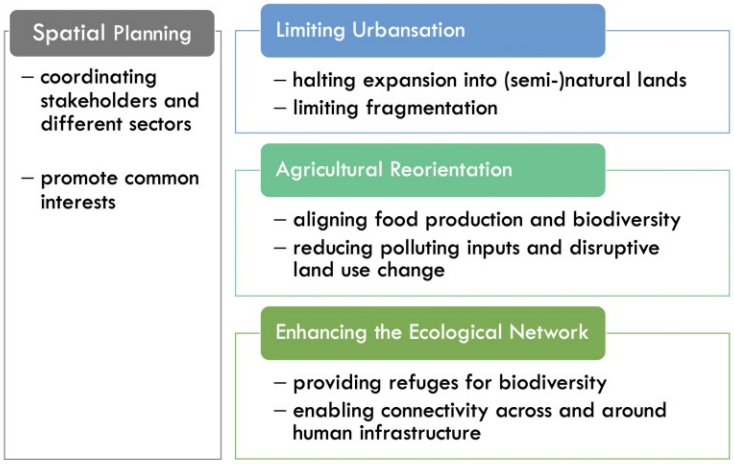

Figure 16: Overview: measures in the three sectors urbanisation, agriculture and biodiversity to achieve the visions for the ZVI. Spatial Planning acts an overarching area for guidance and coordination.

The findings of this thesis indicate that environmental damages and specifically biodiversity degradation due to unsustainable land use in the ZVI can be solved through action in three different, complementary sectors: limiting urbanisation, restoring the ecological network, and aligning agricultural practices with biodiversity conservation. In addition, national spatial planning provides a systemic view of the situation, considers all involved stakeholders and steers the territorial development in the common interest of the country (see Figure 16).

Limiting Urbanisation and Infrastructural Expansion. The *de facto* cap on further urbanisation within the ZVI, imposed by the PSP, has not been further elaborated in this thesis because it is already in legal effect, but it is nevertheless a fundamental cornerstone for protecting biodiversity and ecosystem services but also to the maintenance of agricultural land, because it halts further land take and the continuous erosion at the borders of (semi-)natural lands.

The ZVI is, on the other hand, still subject to infrastructure projects including road projects and railway expansion, which have been determined to have strong detrimental effects on biodiversity in Natura 2000 areas and therefore weaken the conservation effect. Therefore, the objective of halting urbanisation and urban sprawl will only be partially achieved, at least in the short-term. On the other hand, the PSP provides a very good foundation to halt land artificialisation *in principle*. It remains in the hand of local and national authorities to govern these loopholes wisely and in concordance with the conservation aim in the ZVI.

Restoring the Ecological Network. The establishment and restoration of the national and continental ecological network is a key feature in the Luxembourg and European Biodiversity Strategies through combining protected areas and measures enhancing connectivity. Protected areas are generally accepted to provide positive contributions to biodiversity conservation. It is however also recognized that their effectiveness is difficult to assess and depends on their management. Generally, policymakers are confronted with the trade-off between areas that are small, expensive, and of low public acceptance but produce good results through stringent restrictions, and vast areas that have low restrictions in return for a cooperative stakeholder approach where sustainable management can hardly be ensured everywhere.

While all Natura 2000 sites in Luxembourg have been established and have been subjected to a management plan, the authorities are still in the process of putting important core Natura 2000 sites or other important sites under stricter national protection. The ecological network is expected to be finalised by 2030, curbing biodiversity loss. Whether this will also be achieved on the European level remains uncertain.

An inherent shortcoming of protected areas is the fact that they are designed around human infrastructure, and, therefore, are not always able to compensate for the anthropogenic drivers that drive biodiversity degradation but focus more on the islands of intact habitats remaining. This also extends to the ZVI which has seen a considerable reduction of its surface area and the loss of a second ZVI since the inception of the concept almost a decade ago, simply because urbanisation and fragmentation have since progressed in big steps.

As building back infrastructure is not an option in the foreseeable future, the effectiveness of protected areas remains constrained although still important. By consequence, human infrastructure then has to accommodate the needs of biodiversity. This is done through ecological corridors such as wildlife crossings across highways and other 'stepping stones' that make heavily artificialised areas less hostile for flora and fauna. Urbanism has already started to go further and is implementing green infrastructure that serves both the needs of humans and of plants and animals.

Agriculture. With a share in total land area of 50%, agriculture is a key player in national land use strategies. The limitations to urbanisation within the ZVI and the public reluctance to repurpose agricultural lands into protected areas, assure that this share will not change drastically in the near future. This also means that spatial planning strategies focusing only on urbanisation as well as protected areas will only ever cover up to 50% of the national territory, while missing the influence on land use that is taking place on agricultural lands.

Given its share of land and the widespread impacts on natural systems, agriculture remains the most important sector for biodiversity conservation in the ZVI, and also in Luxembourg. In the long run, new forms of agriculture, such as agroforestry, must replace the current system of agricultural intensification to reduce land use pressures. This can be done through a continuous shift in practices such as extensification and diversification, and will gather support from the population if farmers are able to sustain their livelihood during this transition e.g. through targeted subsidies and income support that incentivise ecological practices.

The biodiversity-related targets for agriculture in the PNPN2 for 2021 of 10% increase of agricultural lands covered by these schemes is a step in the right direction but constitutes only a small step towards the ecological reorientation of agriculture. Similarly, the commissioning of a study on agroforestry shows that the widespread adoption of more ecological agricultural systems is still far away.

This must also be steered by the European Union, as the common agricultural policy is decided directly at this level. The currently outstanding reform of the CAP provides an opportunity and an obligation to do so, given the fact that the following reform can only be expected in 2027, shortly before the 2030 biodiversity targets must be reached.

The Role of Spatial Planning. Spatial planning plays a crucial role in land use. It guides the management of the resource 'land' through a multi-stakeholder lens and in the common interest of the country. In the case of the ZVI, the PSP's inception has brought the ZVI as a coherent entity into existence and has prompted this thesis' research into sustainable land use within the ZVI's perimeter. This demonstrates the fundamental importance of a national, supra-regional and supra-communal spatial planning strategy in the endeavour of nature protection.

It is the national spatial planning strategy's responsibility to coordinate between all the stakeholders that have an interest in the territory, ranging from social question such as housing and food, over technological questions such as energy and transportation, to economic interests and finally to ecological needs in the form of biodiversity and ecosystem services.

It is also the task of spatial planning to weigh the different stakes against each other. Especially the ecological component has been weighed much less than economic and development interests, leading to ever-expanding urbanisation and exploitation of land resources. The balancing of different interests needs to be reevaluated to ensure the possibility to halt nature degradation and to prevent repercussions on food security, among other things. Special attention should be paid to the time dimension, where short-term welfare improvements can have long-term losses of welfare, and to the dimension of justice, so that individual interests are not undermining the collective interest. The ongoing redesign of the PDAT will hold the opportunity to steer this rebalancing and to complete the Luxembourgish spatial planning framework.

13.2 Conclusion and Outlook

This thesis has presented a number of visions and scenarios together with options for action for a more sustainable and ecological approach to land use in Luxembourg with the aim to preserve biodiversity and ecosystem services. They center around the three sectors of urbanisation and infrastructure, ecological network and protected areas, and agriculture. It has been found that the discipline of spatial planning plays an important role in deciding how different areas of land are used and subsequently can influence especially the areas of urbanisation and of protected areas. Its scope is however limited when looking at agriculture, where practices and land use intensity are the crucial factor.

The combination of limiting urbanisation and especially urban sprawl and reserving lands as biodiversity refuges, together with a reorientation of the agricultural system are necessary to preserve biodiversity and ecosystem services in the ZVI without systematically eliminating the anthropogenic use of the land resources. The two expert interviews in this thesis were conducted with experts in spatial planning and biodiversity, respectively, but the results have shown that the biggest area for action lies with agriculture. The author therefore recommends further research into sustainable land use in the ZVI to focus on this sector and to research the interactions with the other sectors.

While a great amount of information are available both on the decline of nature and on options for remedy on the continental and national level, there is a gap of information on the state of biodiversity within the ZVI that should be filled in order to pursue the ecological objectives laid down in the PSP.

All policy documents analysed in the scope of this thesis that are aiming to improve biodiversity and ecosystem services in the ZVI are supporting action in the right direction but they are not necessarily sufficient to achieve the long-term visions. While technical and policy tools are widely available, a lack of progress and ambition can still be attributed to a lack of political will and societal awareness. Considerable effort is needed in the near future to make ecological sustainability and conservation tangible and relevant for

a broad public and to foster the implementation of more ambitious policies. A mindful handling of our natural resources and their preservation are not an end to their own but are at the fundament of our civilisations. The call for increased widespread and rapid action to counter global negative environmental trends is also not arbitrary but increases our chances of returning within the planetary boundaries and preserving a state that will allow humanity to continue to thrive on this planet we call home.

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A Annex

A.1 Questionnaire Expert Interview Pascale Junker (in Luxembourgish)

1. Ist-Zoustand vun der ZVI an d'Visioun vun der ZeRIA

   (a) ZeRIA ass ee Konzept an een Numm fir d'ZVI, deen Dir a Ärem Buch opgestallt hutt. A wéi enger Hisiicht ass d'Konzept „ZeRIA" ënnerschiddlech vun der „ZVI", wéi se am PSP beschriwwe gëtt?

   (b) D'Grands Ensembles Paysagers (GEP) ënnerleien am PSP quasi deene selweschte Restriktioune wéi d'ZVI. Wat ënnerscheet d'ZVI genau vun den GEP?

2. Problemer um Wee fir d'ZeRIA ze realiséieren

   (a) „Trade-Off" Natur-Landwirtschaft: an Ärem Buch argumentéiert Dir fir méiglechst vill „surface agricole utile" ze erhalen, fir dass Lëtzebuerg säin Eegebedarf u Liewensmëttel besser selwer decke kann. Wéi kann een dat mat enger intakter Biodiversitéit verbannen, virum Hannergrond dass d'Landwirtschaft am meeschten zu Biodiversitéitsverloscht bäidréit a méi nohalteg Forme wéi Bio-Landwirtschaft ee méi héije Landbedarf hunn?

   (b) De PSP gesäit generell gutt Schutzmoossname fir d'ZVI vir. Exceptiounen an och d'Provisioune vun deenen aneren dräi PDS schwächen dat awer of. Wéi staark sinn déi negativ Konsequenzen op d'ZVI, z.B. mat Verweis op de Contournement Dippach/Bascharage?

   (c) Wéi gutt ass dat allgemengt Verständnis fir d'Konzept an d'Visioun vun der ZVI op Gemengen- an nationalem Niveau?

   (d) Wéi gutt/schlecht ass d'Situatioun bzgl. Daten iwwert d'ZVI, zB iwwert Biodiversitéit, Landverbrauch, etc? Vill Date gi jo éischter op nationalem Niveau verëffentlecht.

   (e) Wéi wäert de Klimawandel d'Situatioun speziell vun der ZVI veränneren a ginn dës Implicatioune genuch eescht geholl?

3. Léisungen (technesch, ekologesch, politesch) fir d'Visioun vun der ZeRIA ze erreechen:

   (a) Wat fir konkret Moossnamen a Projete kënnen d'Biodiversitéit an der ZVI restauréieren?

   (b) Wat fir eng Roll spillen d'Natura-2000-Netzwierk an aner protegéiert Arealer? Wéi kënnen déi méi effektiv ginn?

(c) Ginn et änlech Regioune wéi d'ZVI, déi als best-practice-Beispill dénge kënnen?

A.2 Transcript Expert Interview Pascale Junker (in Luxembourgish)

NS: Nick Sinner (Interviewer)

PJ: Pascale Junker (Expert)

NS: Voila, mir hunn d'ZVI, déi am PSP definéiert ass, an dann do dergéint oder do drop steet nach d'ZeRiA als Konzept. Kanns du mol eng Kéier kuerz oder besse méi laang erklären, wat d'ZVI genau fir dech ass, a firwat dass du do nach sou ee Konzept drop gebaut hues an a wat dat sech ennerscheed.

PJ: Also d'ZVI, wat se genau ass, steet am Règlement Grand-Ducal, dee lo d'application ass fir de PSP. Deen ass d'application vum 1. März dëst Joer un. Dee war an der Ausaarbechtung, wéi ech mäi Buch geschriwwen hunn, wat dee Konzept vun der ZeRiA – wéi soll ech soen – promulgéiert, an d'Ronn geheit pour discussion – dat war eigentlech mäi But. Dat heescht wat ass d'ZVI? Dat ass eigentlech genau dat, wat am Réglement Grand-Ducal steet a wéis du och am Questionnaire weis – wat warscheinlech do bausse fir d Leit bësse schwéier ze stoen ass, dat ass den Ënnerscheed tëscht GEP, ZVI a Coupure Verte, an do verweisen ech nach eng Kéier op de Règlement Grand-Ducal, deen di Ënnerscheeder opzeechent an och d'Vocatioun vun all espace, an ech verweisen och op mäi Buch, wou ech och op den Historique vun deene Saachen aginn. Grands ensembles paysagers, dat muss ee sech flächeg virstellen. Wann een zu Lëtzebuerg vu Fläch schwätzt, ass dat sws ëmmer schonn ëmmer relativ, mee och zu Lëtzebuerg schwätze mer vu flächegen Ensemblen, an di GEP hunn eng characteristique vun engem Landschaftsbild, wat passt, dat ass op der Musel anescht wie an den Ardennen anescht wéi am Réidener Kanton. Dat ass di Notioun vun der Typologie vum Espace och. Bei der ZVI ass di Typologie manner prägnant. Et ass di eenzeg Zone an dem ganze PSP vun dësem Typ am Land, an et ass eng Zone, déi déi characteristique huet – se huet e Paysage, dee lo net alle Critère vun enger Landschaft an hirer Delimitatioun entsprécht, mee se huet ee Landwirtschaftleche paysage a wat se exzeptionell mécht ass, datt se vu engem Ekosystem hier, am meeschten Drock huet vun der Urbanisatioun an dat gläich, kann ee bal soen, ob hirem ganze pourtour. Dat ass dat, wat se eemoleg mécht. Et ass eng Zone, si ass jo definéiert als zone verte interurbaine – d'Definitioun vun der Zone verte, juridiquement, kënnt vum Naturschutzgesetz. Déi Zonen, déi ausgewise ginn am PSP, déi ënnerleien all enger Zone verte, déi sinn an de zones vertes. D'GEP sinn an enger zone verte nom Naturschutzgesetz, d'zone verte interurbaine och. Di heiten ZVI – vum Planungshistorique hier, waren der ëmmer zwou ugeduecht. Et war ëmmer eng ugeduecht tëschtent Nordstad a Stad, do war och en ugeduecht. Déi ass awer verklengert ginn, well den urban sprawl an de éparpillement urbain do scho sou grouss ass, datt se vum Biodiversitéit- a vum ekologeschen Zesummenhalt ëmmer méi schmuel

ginn ass, mee se ass ersat ginn duerch zwou grouss Flaatschen vu coupure vertes, déi am PSP och lo existéieren. Dat heescht déi eenzeg ZVI – du gesäis och am Réglement Grand-Ducal wat jo lo de texte legal ass, d'ZVI ass na emmer dran am pluriel, mat „s". Am richtege Liewen an am PSP existéiert awer just déi eng, déi tëscht deenen zwee groussen Agglomerationsräim Agglosud an Agglocentre ass. An net nëmmen dat, si ass souwuel – wéi soll ech soen – si ass timidement als paysage definéiert, mee si ass haaptsächlech duerch d'infrastructure humaine definéiert, delimitéiert, wat anescht ass wéi d'GEP. An déi infrastructure humaine sinn och d'Autobunnen – si ass delimitéiert nërdlech a westlech duerch zwou Autobunnen, och Zuchnetzer, an dann d'Ballungszentren, déi ech genannt hunn, an dann och eng couronne vun zones d'activites economiques, éischter südlech. Hei hat ech et opgelëscht:
„ . . . coincée entre 2 fronts d'urbanisation, une couronne de ZAE et 3 autoroutes, grignotée par la nouvelle voie ferroviaire Bettembourg-Luxembourg." „Délimitée par la Minette au sud-est, la frontière belge à l'est, le bassin inondable de l'Alzette."
Also dat ass bëssen hir Enstehungsgeschicht an hir Delimitatioun. Wat ech och nach wollt dobäi soen: déi ZVI diskutéieren ech guer net a mengem Buch. Fir mech ass déi integral an tel que wéi de PSP se an e Gesetz ëmschreift an hir force legale gëtt, ass se ze realiséieren. Wat d ZeRiA proposéiert ass eppes méi wie d'ZVI, mee net eppes géint d'ZVI. D'ZVI soll existéieren – et muss een och ëmmer soe bei sou Plans Sectoriels, fir déi auszeschaffen, dat si Generatiounswierker, et ass elo keen dee do lo nach eng Kéier dorunner fusche geet – mee wat ech wëll soen ass, datt ee kënnt an der descriptif, wat d'ZVI – di dote spezifesch well se tëscht deene Ballungsräim läit, wat se méi kéint maachen, dat fannen ech eeben interessant an ob een dat kéint noschéissen. A wat mir virschwieft huet a mengem Buch ass aus hier eng zone experimentale ze maache fir eng résilience. Lo kann ee soen en résilience inter-agglomerations, et kann een awer och soen eng résilience alimentaire. Mäin Haaptpunkt war: wat virgesinn ass: an der ZVI ass d'fonction agricole, viticole a sylvicole erhalenswaert, mee ech gesinn ee bessert Zesummespill tëscht den Agglomeratiounsräim an där Zone fir d'alimentation vun deenen Agglomeratiounsräim an der Perspektive vun enger rarification des ressources au sens large – sief dat Energie, sief dat Waasser, sief dat matiere, Som, gesonde Buedem – an an der Perspektive vum changement climatique an an der Perspektive, dat mer musse wahrscheinlech an der Zukunft, wa mer wierklech resilient wëlle ginn, méi kuerz Weeër maachen, fir wou mer eis Liewensmettel hierkréien an eisen Approvisionnement au sens large wëllen hierkréien.

NS: just eng Fro: dat heescht Resilienz huet hei wierklech domat ze dinn, Ressourcen um eegenen Territoire rëm méi ze schätzen an och méi ze notzen, eebe fir hei Iessen ze produzéieren, an dat direkt selwer ze consomméieren. Dat heescht, dat ass am Fong am Géigesaatz dozou, dass mer soe, mir kucke wou am beschte wéi eng Planzen oder wéi eng Iesssaache kënnen ugebaut ginn, an datt dat opmannst villäicht europawäit alloquéiert gëtt, fir dass et méiglech effizient ass.

PJ: Dat hänkt lo dovun of, wat fir eng Definitioun een hëllt vu résilience. Mäi Buch hunn

ech genannt eng „science populaire et un essay“. Mäi Buch ass e Buch wat opfuerdert, Saachen ze etudiéieren. “Ass et machbar?” Sou gesinn ech och de Konzept vun der ZeRiA. Ass et machbar a wéi ass et machbar? A wéi äntwert et op d’besoins, déi d’Leit hunn? A wann een dat wëll weiderdreiwen, déi ZeRiA, da muss een ausgoe vun der Definitioun vun der ZVI an dat nächst, wat ee muss maachen ass eng Definitioun vu résilience, well do ginn et der vill. An déi Definitioun vu résilience, déi mär eebe virgeschwieft hat, war eng Definitioun mol géif ufänke mat enger résilience alimentaire, an do verweisen ech op eng Definitioun, déi existéiert, déi ee Groupement a Frankräich definéiert huet – les greniers d’abondance – an déi hunn eng Definitioun vu résilience alimentaire ginn, déi ech relativ applikabel fannen och fir sou kleng Länner wie mir. A mengem eegene Memoire hunn ech de Stéckstoffbilan vu Lëtzebuerg hiergestallt, well mir fir ganz vill Saachen ofhängeg sinn. Mir sinn zum Beispill och fir eis production alimentaire 100% ofhängeg vun der Importatioun vu syntheeteschem Stéckstoff. Mir hu keng Fabrik hei, mee mir hunn een immens héije Verbrauch am Europavergläich wéi Dänemark an Holland, wat d‘Champione sinn, well déi ganz vill Schwéngsindustrie hunn a ganz grouss Exportateure vu Liewensmëttel sinn. Mir hunn déi Dependance och, mir hu keng Perspektive, datt mir jee eng Kéier een Haber-Bosch hei op Lëtzebuerg lokaliséieren, an dobäi kënnt, datt déi ganz Industrie extrem carbon-intensiv ass, an et och villäicht net di voie à poursuivre ass. Wat ech soe fir d‘ZeRiA ass: ech gesinn di Ballungsräim, ech gesinn, datt mir ënnert dem Klimawandel verschidden Approvisionnementer musse relokaliséieren, well mer net mi kennen duerch d’Welt fuere, fir Wueren ze kafe oder weider kënne Sushi ze iessen oder weider kënne Weess aus Russland importéieren oder weider kënnen engrais aus Russland oder Ukrain oder soss Finnland importéieren, a well déi Wueren ëmmer méi deier ginn. Et ass een ekonomeschen Calcul, ier et ee Calcul ass iwwert d‘survie vun deene Ballungsräim. A wat et unique mecht, ass datt a sou Ballungsräim ganz vill déchets organiques ufalen an et eng reell Opportunitéit gëtt, fir de cycle des nutriments ze reterritorialiséieren. Dat heescht déi Stied iessen immens vill, hunn 30% gaspillage alimentaire, geheien immens vill Iessen wech an et huet kee Wäert, deen déchet organique – bon, zu Lëtzebuerg ginn immens vill Efforte gemaach mat compostage a biométhanisation – mee et huet kee Wäert Décheten duerch d‘Welt ze schécken. Et wär am beschten, mir géifen déi an d‘Fertilitéit vun eisem eegene sol nieft eiser Hausdir zeréckféieren, fir datt mir aus där Fertilitéit och eis selwer laangfristeg kéinten ernären. An dat war meng Iddi hannert der ZeRiA. Dat wat mir iessen, wat zu 80% importéiert ass, di Biomass, déi hei an d‘Land erakënnt, déi vill méi grouss ass wéi d‘Land Biomass jee kéint generéieren, eis zu eegen maachen an ee Virdeel aus deem Dreck maachen. Net ze gesinn als Biomüll – „oh, wat maache mer lo?“ –, mee mir stiechen alles a compostage an biométhanisation an huelen den digestin aus der biométhanisation an maachen eng réintroduction vun deenen nutriments an déi Felder an der ZeRiA. Wann ee biométhanisation ass den Stéckstoff vill méi assimilable vun de Planze, wéi wann een e géif kompostéieren, a wann ee biométhaniéiert, huet een net nëmmen d’nutriments, déi een hannen rëm rauskritt ënnert enger forme assimilable duerch Planzen, mee et huet een och d Energie ënnert Form

vun CH4 an dat ass och vläicht eng piste fir d'Trakteren unzedreiwen, Zären am Wanter ze hëtzen a weider an d'Liewensmettelprod ze stiechen. Op jidder Fall, wat ech soen: eng ZeRiA kann net resilient sinn, ouni circulaire ze sinn, an déi Circularitéit fir mech kann, wann een an enger ressource rarifikatioun ass, net anescht sinn wéi lokal.

NS: Zum Stéckstoff: et gëtt immens vill Stéckstoff – engrais allgemeng – importéiert. Wat geschitt de Moment mat deem Offall? De Moment gëtt deen da jo net benotzt, fir op d'Felder ze maachen oder fir biométhanisation, wat geschitt de Moment domadder?

PJ: Et gëtt deels gemaach. Et ass och eppes, wat d'Leit vergiess hunn: Lëtzebuerg war an den 80er joere no de Petrolskrisen – 80er, 90er Joren – bal bis d'Joer 2000 en europäsche Champion an der biométhanisation pro Kapp. Wéi mer haut e Champion sinn an der photovoltaïque pro Kapp. Well och Subventiounspolitiken dohannert stinn. Mee déi Technologie, fir lo rëm zréck ze kommen ob d'Biométhanisation, déi ass dono bëssen d'Baach agaangen, well dono d'crises pétrolieres vun de 70er, 80er Jore vergiess gi sinn, an aner Saachen d'relève geholl hunn: d'Éolienne, d'Photovoltaïque, a well dat och relativ komplizéiert ass mat der biométhanisation. De Moment ass et zB sou: deels si Biooffäll net autoriséiert fir an d'Biométhanisation andirigéiert ze ginn. Zum Beispill ginn et Quota, wéi vill Energieplanzen sollen ugeplanz ginn, fir kënne biométhaniséiert ze ginn, fir datt de wäertvolle Buedem, dee mer hunn, net soll geholl ginn, fir Mais ze züchten, fir an d'Biogasanlag ze maachen. Oder mir hunn Déchete wou Hormonen dra sinn, wou d'Pëll vun de Fräe, wou Nanoparticule dra sinn, déi mer net obedéngt wëlle rëmfannen an eisem Iessen. Dofir ginn et do verschidde Restriktioune. Wat elo den engrais synthétique, also den Dünger, dee mir massiv kafen, ugeet: du seess Offall – jo an deem Sënn, datt mir eis Felder iwwerdüngen, datt eise Buedem et net hällt, datt mir méi ginn, wéi d'Planzen kënnen assimiléieren, an den Indicateur vun där Surconsommatioun sinn d'Nitraten am Waasser, wou Lëtzebuerg e puer Mol condamnéiert ginn ass an eng astreinte hat, well mer déi Directive EU Nitrates net erfëllt hunn. A well mer do monumental Efforte musse maachen, fir den Nitrategehalt vum Waasser erofzebréngen. Dat ass och ee vun de Grënn, firwat souvill Quellen de Moment zu Lëtzebuerg fir Drénkwasser net kënne benotzt ginn.
An dat sinn alles schwéierwiegend Saachen, well wa mer wëssen: dee ganze Plädoyer, deen ee ka maachen, hänkt dovunner of, wéi vill een Bierger, d'Consommateuren a d'Decideuren kann dovun iwwerzeegen, datt et eng Urgence gëtt. Wa mer d'Leit net iwwerzeegen, datt et eng Urgence gëtt, da kanns du der de Mond fusseleg rieden, dann hunn och Bicher kee Wäert, dann huet alles kee Wäert. Du muss d'Leit fir d éischt iwwerzeegen, datt et Engpäss ginn, dat et Choixe ze maache ginn. A wann déi Pëll bis geschléckt ass, da kanns de soen: bon vun 10 Saache kenne mer der lo just nach 3 maachen. Woufir huele mer dann eist argent public, eise wäertvolle Buedem, wat maache mir domat? ZVI, sou wéi de Moment definéiert, well eeben déi fonction agricole préservéieren, mee si wëll och, well di Ballungsräim doniewt leien, dee Raum préservéieren, réservéieren fir rekreativ Zwecker a loisir. An do muss een

dann oppassen: dat ass natierlech legitim, mee wéi ass dat kompatibel mam Erhalt vun der Biodiversitéit – dat ass schon eng Contrainte – mee wéi ass dat kompatibel och mat de Frequentatiounen? De Moment huet dee Ballungsraum een immense Problem: d'Leit wëlle Velospisten, d'Leit welle mam VTT an de Bësch, all déi Saachen, do muss ee Choixe maachen. Mee fir rëm op dat zréck ze komme, wat mir léif ass, dat ass di fonction alimentaire. Et ass villäicht e bësse romantesch, mee ech soen mer, datt wann een d'Bierger kéint beweegen, sech selwer anzespaanen a sou ee Maraichage péirurbain, datt daat och rekreativ kéint sinn. An ech well domat soen: net di kleng Jardins communautaires an di dräi Tomaten, well dat total onekonomesch ass, mee wann een dat kéint op eng échelle industrielle – am positive sens du terme – eropzéien. Ech stelle mer Zäre vir, déi net esou ausgesi wéi a Spuenien déi Wise vu Plastik, mee Zäre, wou een, à un coût abordable, Biogeméis kéint hierstellen fir d'gesamtpopulatioun, an net fir 10% dei sech Bioiesse kënnen erlaaben. Ech stelle mer vir, datt déi Jonk da géingen am Summer 2 Méint a Bongerte schaffen an der ZeRiA. Dee maraichage, dee misst absolument commercial an industriel sinn. Natierlech, jidderee kann Tomaten ob sengem Balkon ziichte, mee déi Tomat ass sechs mol méi deier, wéi wann een se am Cactus kaaft hätt, souguer wann de Cactus sain eegene Gaart hätt. Et geet wierklech drëm, an eng Fonction de résilience ze kommen, dat heescht esou vill Quantitéit ze ziichten, dat een Agglolux an Agglosud domat kéint ofdecken. Do froen ech mech: an iergendeen eng Kéier ee calcul économique maachen, wéivill Fläche e bräicht, wëssend datt Fläch di grouss Contrainte zu Lëtzebuerg ass, an datt een dann Zären op e puer Stäck maachen, Agriculture périurbaine maachen, urbaine maachen, Diecher misst matbenotzen, Fassade misst matbenotzen, Brooche misst matbenotzen, friches industrielles, wann de Buedem bis assainisséiert ass, matbenotzen, etc., fir datt dat effektiv kéint um Teller vun de Leit landen.

NS: Elo man ech et nach e bësse méi komplizéiert: mir schwätze lo vill iwwert surface agricole, déi mer wierklech benotze musse, fir déi résilience alimentaire ze erreechen, wann dat eist Zil ass. Dann hu mer d'Landwirtschaft op där anerer Säit, déi de Moment eng extrem grouss Pressioun op d'Biodiversitéit an d'Natur allgemeng ausübt, als Problem Nummer 1 quasi. Besonnesch wa mer d'Biolandwirtschaft vun haut kucken, do brauchs de méi surface, fir dat selwescht ze produzéieren. Och wanns du lo seess, du bass keng Expertin an der Biodiversitéit hei zu Lëtzebuerg: wéi gesäis du dee Problem, deen Trade-Off tëscht deenen zwou Saachen, wann een och bedenkt, datt natierlech d'Ekosystem Servicer mussen intakt bleiwen, fir datt dat Ganzt iwwerhaapt fonktionnéiert?

PJ: Also dat weess du jo lo genau sou gutt wéi ech, datt et der Biodiversitéit zu Lëtzebuerg schlecht geet – a wéis du och an dengem Questionnaire freess, wéis de Donnée kanns fannen – d'ZVI ass do keng Exceptioun, si huet just ee stärkeren Drock vun der Urbainsatioun a vun der Industrialisatioun. Wanns de lo gesäis déi Plans Sectoriels, déi Couronne de zones d'activité économique, déi si prägnant, massiv, südöstlech vun der ZVI. Et ass esou, d'FAO an och natur&emwélt zu Lëtzebuerg sinn sech eenz, wa se

soen: wann ee well eng gewësse suffisance alimentaire fir säi Menage maachen, brauch een 2000 m2 op de Kapp, fir ze iessen. Mee do geet et da lass: wéi wëlle mer iessen? Alles steet a fällt domadder. Dat heiten ass ee régime carné. Mäi Buch beweist, datt mer déi nach just hunn, mee d'Spezifitéit vu Lëtzebuerg ass, datt d'Populatioun rasant an d'Luucht geet, sou séier wéi an engem Entwécklungsland mat enger Natalitéit vu sechs Kanner pro Fra, an dat ass nëmmen immigratiounsbedingt zu Lëtzebuerg, contrairement zu engem Entwécklungsland, wou et fertilitéitsbedingt ass. Dat heescht mir hunn déi nach, an dowéinst gesinn ech eebe do och déi immens Opportunitéit: Lëtzebuerg huet nach ëmmer genuch Fläch, fir sech kinnten ze ernähren, awer: da musse mer vum régime carné erof, well dat brauch vill vill méi Fläch; wa mer da wëlle Bio iessen, da muss een och de Rendement vun der Bioagriculture versichen eropzesetzen, wat guer net sou einfach ass, an dee ganz grousse Punkt sinn d'Nutriments, a wéi ech virdru gesot hunn ass et essentiell, datt mir déi Nutriments lokal behalen an zréckféieren an de Buedem, well et ass net circulaire, vum Buedem emmer nemmen däi Weess, dain Raps, däi Mais erauszehuelen an dem Feld näischt zréckzeginn anescht wéi syntheteschem Dünger wou et eng Contrainte gëtt, also dat Organescht rëm rabrengen, a wat ech do och exzeptionnel, scho bal fantastesch fanne fir Lëtzebuerg, dat ass déi Opportunitéit, déi mer net saisisséieren, doduerch datt mer eng wahnsinneg Biomass – [bal] all eist Iessen – importéieren an exportéieren eng aner wahnsinneg Biomass an ordres de grandeure, déi vill vill méi grouss si wéi Lëtzebuerg. Lëtzebuerg exportéiert esou vill mëllech a seng agriculture ass esou laitière – eng insignifikativ Quantitéit vu Mëllech, déi Lëtzebuerg generéiert, gi lokal consomméiert. Do ass Biomass, Kéi, gréng Wissen, déi mobiliséiert gi fir en Exportproduit, deen da fort ass mat de ganzen Nutriments an der ganzer Biomass, déi dat duerstellt. Dat heescht eisen Territoire gëtt exportéiert, déi Biomass an déi Surface, wann ee wëllt. Op där anerer Säit importéieren mer Iesse, wat net dat selwescht ass wéi Mëllech. Mir importéieren vill Fleesch, alles wat Fëschproduite sinn, alles wat Protéine sinn a mir importéieren immens vill Soja fir déi Kéi, fir Mëllech, déi mer exportéieren. Dat heescht vun engem agriculture point de vue si mir sou ee clearing house a lokal kréie mer guer näischt mat. Et geet eis awer esou eppes vu laanscht d'Nues, an dat ass dat, wat ech mengen wate en an engem Szenario vu résilience sech einfach guer net méi kann erlaaben. D'autant plus datt alles wat ech gesot hunn, dee Sojaimport, engrais synthéthique-Import grav Repercussioune op d'Biodiversitéit huet. Et ass jo sou datt Planzen déi di Nitrates, also déi Stéckstoffdünger liicht ophuele, si méi kompetitiv wéi Planzen, déi dat net maachen. Dat ginn dann da sou gring Wissen, déi donkelgring sinn, a just nach Gras dran hunn, dat ass eng gutt gedüngte Wiss. Déi ass schéin, déi ass wonnerbar, d'Kou ass frou, et ass lecker, a si kritt ee Proteingehalt, deen ass Wahnsinn a si mécht dann 30 Liter Mëllech den Dag. Perfekt. Mee Biodiversitéit? Nee. An dat ass dat, wat ech mer geduecht hunn, an ech soen et nach eng Kéier: d'ZeRiA hat ech net an enger Biodiversitéitsperspektiv gesinn, mee dat ass déi Agriculture, déi een net misst maachen an der ZeRiA. Déi Résilience alimentaire ass dat net. Dat ass wierklech vill méi de cycle des nutriments rëm hierstellen tëscht Stad a Land, deen cycle lokal territorialiséiere, fir kënne Liewensmëttel, déi mer brauchen – mir

maachen do lo keng résilience alimentaire baséiert op Sushi oder op Fraises – just wa se saisonal sinn. Ech menge souwisou dat eng Sociétéit nemme résilient ass, wa se vill méi sobre a vill méi einfach, decomplexifiéiert, vill méi manuell ass, a wann d'Leit rëm Buedem ënnert den Neel hunn, da kënne mer vu résilience schwätzen. Dofir muss een de Leit eng Visioun ginn, an d'Leit mobiliséieren an hinne Loscht dru ginn, an du kanns eebe lo net soen: „am Summer ginn all d'Studenten eraus a si maachen ee Kartoffelacker" do kriss de d'Leit net, mee wanns de hinnen awer seess: „Hei lauschter, ech hunn eng super Zär, ech hu meng App hei, ech configuréieren meng Humiditéit, mäi goute à goute, a meng Temperatur an ech ginn awer elo an d'Vakanz" oder meng Tomate gi vun engem Computer agesammelt, datt een da villäicht ee Projet hätt.

NS: Fir da lo nach eng Kéier kuerz op d'Landwirtschaft zréckzekommen: wann ech dat lo richteg verstann hunn, grosso modo, ass et ongeféier méiglech, amt dem Territoire auszekommen, dee mer hunn, fir och ee gudden Deel vun Leit ze ernähren, an den Trick ass amfong einfach, eng net ze intensiv oder eng nohalteg Landwirtschaft, déi am Einklang mat der Biodiversitéit ass?

PJ: Do ginn et ganz vill Notiounen, dat weess du och: du kann ee schwätze vu Precision Farming, do kann ee schwätze vu durable – deen ass scho guer net gutt, dat heescht alles an näischt. Agriculture intensive, dat ass och elo een neien Term, dee geet an d'Richtung économique: wéi méi Rendement op manner Surface mat manner Moyens? Dat ass an deem Sënn och net schlecht, mee déi Notioun, déi nach bei der résilience alimentaire misst dobäi kommen, ass d'valeur nutritive vun deene Saachen. Wa mer vun enger agriculture carnée erofkomme wëllen: de Mënsch brauch Protéine, fir gesond ze bleiwen, da misste mer dat duerch légumineusen ersetzen, dat heescht och iwwert déi Notioune muss ee schwätzen. Mir wëlle jo lo hei keng Bananen ziichten. An et musst een déi Agrikultur esou gestalten, datt se adaptéiert ass un de Klimawandel. Verschiddene Saachen, déi traditionnell hei kultivéiert gi sinn – muss een nach dobäi soen, Lëtzebuerg ass esou kleng, datt een net ka vun enger traditioneller Agriculture schwätzen. Mir hu puer Variétéite vu Céréalen, effectivement, an och vun Uebst a Geméis, awer soss hu mir keng wierklech Typologie, déi anescht ass wéi dat, wat an der Belge an de selweschte Latituden ass. Mee wat elo mam Klimawandel kënnt, dat ass datt Variétéiten méi aus dem Süden wéi d'Mirabelle de Nancy oder d'Mirabelle de Metz totalement adaptabel sinn fir hei. Mir mussen eis adaptéieren vun der Agriculture hier wat ënnert méi dréchene Summeren a méi naasse Wantere méiglech ass. Mir kënnen net stoen bleiwen a soen: „Mir hunn awer eis Grenzen", nee dat geet net. D'Klima an d'Biodiversitéit decidéieren anescht fir eis. Déi Saachen adaptéieren sech, leider ass de Klimawandel sou séier, datt Planze sech net méi zur Zäit adaptéiert kréien, an datt een do misst immens flexibel bleiwen an immens no mat der Recherche zesummeschaffen, fir dat ëmmer erëm ze adaptéieren a keng Ernteausfäll ze kréien, dorëms geet et. Wat mir virgeschwief huet fir esou eppes wéi fir d'ZeRiA ass, dat dann effektiv ze kombinéieren en termes d'agroforesterie. Wéi kann een esou Zären op méi Stäck maachen, héich maache well mer d'surface net hunn, een Iwwergang vun der Stad an dem Land méi

fléissend maachen, déi Zäre sinn och op Dicher vun de Stied, Bongerte gi bis an d'Stied eran, d'Bongerte sinn an der ZeRiA. A wéi kann een déi Infrastrukture kombinéiere mat Felder, déi beschiet ginn duerch Beem an déi e bessere cycle du carbone a cycle de l'eau hunn, well se eebe Beem an Hecken hunn, an doduerch, hoffen ech mer, och besser geschützt sinn viru Stuerm a virun Erosioun. Lëtzebuerg huet en immens groussen érosion du sol-Problem, wat schlecht ass fir d'Biodiversitéit, wat schlecht ass fir de Rendement agricole, mee wat och schlecht ass fir de Mënsch, wann dee ganze Bulli, wéi op verschiddene Plateauë, rof an d'Agglomératioune rullt. Wat grujeleg ass en termes géologiques, ass wann ee gesäit, datt dee fruchtbare Buedem, deen heiansdo dausende, wann net honnertdausende, Millioune Joer gebraucht huet, wann deen einfach an d'Mier ofleeft, zesumme mat den Nitraten, déi Lëtzebuerg och an d'Mier exportéiert. Do kommen dann och sou modern Saachen dobäi, déi ech interessant fannen, wéi: wéi kann een Zäre kombinéieren mat Aquaculture? Aner hunn dat gemaacht: den IFSB, den Institut de Formation Sectoriel du Bâtiment zu Beetebuerg, experimentéiert de Moment dat. Eng polyculture ënnert Zäre ze maache mat Photovoltaïque an Solaire Thermique, fir Hëtzt an der Zär hierzestellen. D'Ofhëtzt vum Gebäi an d'Zären eranzeschécken am Wanter, an dat Ganzt at Aquaculture ze kombinéieren, an dat ass keng einfach Saach.

NS: Vu mir aus dat lo keng richteg Fro mee een Kommentar oder eng Schlussfolgerung: déi ZVI, och wann si an engem legale Plang dran ass, deen ech mat Landschaft an Natur befaasst: hat d'ZVI hat wierklech ni d'Vocatioun, datt si lo ee Biodiversitéitshotspot kéint ginn, oder net méi wéi déi aner Regiounen am PSP?

PJ: Ech muss soen, ech muss et selwer noliesen, fir datt ech keng Dommheete soen, mee du kanns et och selwer noliesen: „services écologiques" steet dran, mee den Text – du gesäis och, dat ass säi Vir- a säin Nodeel – den Text ass wierklech oppen. Wann den Text seet „fonctions écologiques" – a „climatiques" steet och dran, dofir sinn ech selwer verantwortlech, dat stoung net dran, dan hunn ech draschreiwe gelooss –, da kann een doranner nach ganz vill maachen, wa gesot gëtt, de Moment huet d'ZVI d'fonction agricole an écologique a climatique, déi se protégéiert, dann huet een eng avenue mat där ee ka schaffen, et ass net ausgeschloss.

NS: Fir lo nach eng Kéier beim Text konkret ze bleiwen: ech sinn eeben och duerch de Plang gaangen, an ech hunn och fonnt, datt et relativ breet gefächert gehaale gëtt, also et ass elo keen, dee lo eng ganz genau Road Map molt, wéi dat soll ausgesinn. Grondsätzlech heescht et jo, keng linear Fragmentation méi duerch Infrastruktur, och grondsätzlech keng Urbanisatioun méi, mee dann hu mer op där enger Säit déi Exceptiounen, déi drastinn, op der anerer Säit, wat wahrscheinlech nach méi schlëmm ass sinn déi Saachen, déi duerch déi aner Plan Sectoriel virgi sinn, zum Beispill lo de Contournement Dippech/Käerjeng. Dee fällt jo ënnert de Plan Sectoriel Transports. Wéi schlëmm oder wéi schlecht gesäis du dee Moment d'Situatioun fir dat, wat de PSP soll erreechen an der ZVI, mat deene Contrainte a mat deene Schlupflöcher? Ech mengen, mir hate scho bëssen iwwert de Contournement geschwat, do kann ech mer eppes

drënner virstellen, mee bei deenen Exceptiounen, ass dat extrem obskur formuléiert. Villäicht ginn et de Moment och guer keng konkret Beispiller dozou, mee villäicht hues du do ee Kommentar dozou.

PJ: Als coordinatrice adjointe vum aménagement du territoire hunn ech ee Kommentar an als personne privée hunn ech och ee Kommentar. An der éischter Fonktioun : ech hunn eebe matgeschafft un deene Pläng, et ginn der véier, wéis de richteg seess, an déi hunn 20 Joer Planung gebraucht. Dat wat eis spezifesch hei interesséiert, d'ZVI, do ass ee Contournement dra mat zwou Varianten. Ech fannen et perséinlech net gutt, awer legal ass et total kompatibel mam Text. Et ass schwéier ze beweisen, dass du mat engem Contournement d'fonction agricole, viticole, écologique, climatique direkt a Gefor setz. Du kanns dee Contournement kompenséieren, sou wéi d'Gesetzgebung et virstellt, wanns du een Agréff mëss, a wann et festgestallt gëtt, muss de kompenséieren. Et ass awer elo sou, an der RIE, dat ass de Rapport d'incidence environnementale vun deene PSPen, ass dee Contournement roud ausgeschloen. Firwat? Well en a Protektiounszone läit. Wann ech mech richteg erënnere, souguer an enger FFH mengen ech, oder um Bord vun enger.

NS: FFH ass Natura 2000?

PJ: Jo Natura 2000 a Vullenhabitater a Vulleprotektiounsgebieter. Dat heescht de Rapport environnemental – also et gëtt jo eng Évaluation environnementale stratégique gemaach, déi ass gemaach ginn – déi warnt, datt et do Problemer ginn, datt een dann do déi néideg Précautiouns- a Remédiatiounsaarbechte muss maachen – well et ass just eng vun deenen zwou Contournementsvarianten, déi roud ausschléit, et ass d'Nordvariant, d'Südvariant manner. Voilà, de Staat huet verschidden Aufgaben, an den Aménagement du Territoire huet och verschidden Aufgaben, an eng Aufgab vum Aménagement du Territoire ass de « bien-être de tout citoyen à n'importe quel endroit sur le territoire national ». Do gehéieren och déi Leit dozou, déi zu Dippech wunnen, an déi vu moies bis owes eng Schlaang Autoe virun der Dir stoen hunn, déi berechtegt kënne soen : „meng qualité de vie ass net déi selwescht, wéi déi di dohannen an der Cité wunnen a wou keen Auto doduerchfiert". Dat heescht dat ass och eppes, wat d'Geriichter ze tranchéieren hunn, a wat guer net sou einfach fir en Decideur ass ze tranchéieren. Et däerf een dann do ni sech just mat engem Brëll un déi Fro sëtzen, et musse en ëmmer pluridisciplinaire an intérêts multiples kucken.
Mäi perséinleche Point de vue ass, datt d'Saachen änneren. Mir hunn eppes, wat souguer d'Chamber vu Lëtzebuerg als crise climatique agestuft huet, de Moment. Och do, fannen ech, kann een ni just de Klimabrëll undoen. Et musse en d'Klimakris, an där d'Mënschheet stécht, ëmmer zesumme kucke mat den Inégalitéiten, déi eropginn, an och mat der Ressourcekris, a wann een déi Saache well abordéieren, musse ee fir mech den Ënnescheed maachen tëscht Saache, Fonktioune, Servicer, déi vital sinn, a Fonktioune, Servicer, Aktivitéiten, déi accessoire sinn. A fir mech ass dat Vitalt d'Iessen, d'Drénken, sech logéieren, Energie, an dono – dat ass e bëssen d'Pyramide de Maddox vun de Besoins élémentaires, déi d'Mënschen hunn – an dono kommen aner Saache

wéi déi Aarbecht hunn, déi een ëmmer wollt hunn, sou vill Reese, sou vill Liesen, sech z'instruéieren, seng relations humaines an esou weider. An ech fäerten, och vum ekonomesche Standpunkt, datt et einfach net méi justifiable ass, fir honnert Riverains ze beglécken, datt se keng Autoe méi virun der Dir hunn, wann d'Gesellschaft insgesamt immens héich Käschte vun engem neie Contournement huet, en termes d'infrastructure ee stranded asset – well eng Strooss ass haut e stranded ass, well eng Strooss fossil Energie braucht fir gebaut ze ginn, Asphalt mat sech bréngt, an eng Strooss ëmmer nëmme méi Verkéier mat sech bréngt – ob dat lo eng motorisation électrique oder fossile ass ass mol dohinnergestallt – dat heescht fir mech muss een een Ofstréch maachen tëscht engem bien commun positif an engem intérêt privé positif. An ech fäerten, datt dee Contournement méi dem intérêt privé nëtzt a ee bien commun négatif duerstellt, en terme de fragmentation, de nuisance, de coupure, d'émissions, de dépendance fossile, de création d'embouteillages an de non-mobilité.

NS: D'Zäit fänkt elo schon un, e bësse knapps ze ginn, dofir géing ech elo nach eng, zwou Froën prioritiséieren. Wat mech géif interesséieren: ginn et best-practice Beispiller vun enger Zone wéi der ZVI, déi iergendwou um europäesche Kontinent oder och soss schon emgesat goufen oder emgesat ginn, déi als Inspiratioun gedéngt hunn, oder villäicht kéinten déngen?

PJ: Ech hu ech mech vu kenger inspiréiert, wéi ech dat do geschriwwen hunn, anescht wéi les greniers d'abondance, déi hunn ee manuel gemaach, ech weess net méi richteg, wéi deen heescht – «guide de la résilience alimentaire »–, deen ech en tant que matériel pédagogique phenomenal gutt fannen. . .

NS: . . . an en ass och an dengem Buch zitéiert. . .

PJ: . . . jo, ech hu mech wierklech dovunner inspiréiert, well e mech inspiréiert huet. Ech hunn dat gelies an ech hunn dat sënnvoll fonnt. Mech interesséiert den Erhal vun de fonctions vitales, d'continuité vun de fonctions, services vitaux, an dorënner fällt fir mech d'résilience alimentaire sans discussion, well wa mir bis eng Kéier net méi kënnen iessen, eng coupure d'électricité hunn an eng pénurie d'eau, da gi mir zu Déieren. Dann iwwerliewe mir keng dräi Deeg, an ech fannen et schued, datt mir iwwert esou Saache kee gréisseren Debat hunn, well dat geet ganz séier. Dat sinn dräi Deeg, da si mer een un deem anere sengem Hals. Et gëtt eng europäesch Direktiv, déi seet: all Land muss eng Reserve vun combustibles fossiles hu vun 90 Deeg, dofir baue mir dann déi Tanklageren. Et gëtt keng Directive européenne oder nationale, déi seet, wéi vill Deeg Reserve Liewensmëttel mir sollen hunn, mee et gëtt eng Estimatioun, déi seet: dat, wat Lëtzebuerg maximal op sengem Territore an de Rayonen huet, geet am best-case scenario duer fir 4 Deeg.

NS: Dat ass net esou laang. Dat erënnert mech drun: ech hat eng Prof d'lescht Joer, si huet eis vill Saache bäibruecht, a si sot och, datt si mëttlerweil am Fong eng Reserve doheem huet, oder du kanns bal soen ee Krisekit, mat Aliments an an all Richtung. Deemols, dat war dunn Dezember 2019, wéi si dat gesot huet, a mir hunn dat e bësse

belächelt, an am Mäerz 2020 stounge mir du virum Cactus an der Schlaang.

PJ: Mee dat ass et eeben: mäi Projet ZeRiA ass ee projet collectif, well ech genau dat dote fäerten, datt et eng survie individuelle, « et le plus fort gagne » gëtt. Déi räich kafe sech ee Bunker an Neuseeland, well Neuseeland deklaréiert ginn ass als een „node of persisting complexity“. Et ginn elo Lëschte vu Länner, wou ee sech soll réfugéieren, fir der Ressourceknappheet an der guerre civile an de Krankheeten an de Pandemien an dem ganzen negativen bien commun ze entkommen, do geet ee sech eng Insel sichen, wann een d'Moyens huet. Dat kann et jo net sinn.

NS: Oder et flitt een an de Wetall.

PJ: Voilà, oder sou. Eise Planéit, d'Äerd, muss eis dach méi wäert si wéi dat, an och eis eegen Kanner an eis eege survie. Et kann ee jo awer méi kreativ an méi ee frëndleche Projet fannen, a méi jouissif. Wa mir et fäerdeg bréngen, virun eiser Hausdir – ech wunnen zu Beetebuerg, ech huelen dann owes de Velo, ech ginn nach e puer Uebstbeem schneiden, dat ass meng contribution, mäi service volontaire alimentaire, deen ech ginn, an ech gi rémunéréiert duerch eng corbeille de fruits, déi ech all Woch do an do ofhuelen, oder iergendwéi sou eppes. Dat inspiréiert mech vill méi, wéi mer lo meng Konserven a mäi Schaf mussen ze leeën.

NS: Dat ass och präventiv am Géigesaatz zu reaktiv op eng Kris.

PJ: Jo, an och: ech fannen et naiv, dee survivalism. Wéi soll dat da goen, deng Reserve si jo fini, ech ka mer dat einfach guer net virstellen. Ech fannen dat och schued, Energie ranzestiechen. Et ass genausou wi Energie a Geoengineering stiechen. Dat ass einfach eng continuation de la lutte contre la nature. ZeRiA ass een appel, mat der Natur ze schaffen, Biodiversitéit oprecht ze erhalen, pour sa valeur intrinsèque, well mir iwwerleeën jo ëmmer: „Biodiversitéit, déi muss mir eppes bréngen, fir datt ech se erhalen“. Dat fannen ech och scho bësse schued. D'Beauté huet och eng valeur, ee Feld voller Blummen «is priceless ». Mee och d'Biodiversitéit : wann een da wierklech muss räsonnéieren en terme „wat bréngt et eis ?“ : et ass eng adaptation au changement climatique, et schützt eis virun esou vill Desasteren, déi d'Natur ka bréngen, en terme dat se de Wand ofbrécht. Ee Weessfeld, ënnert engem staarke Wand läit platt, gëtt naass, muuscht. Näischt méi. Schon alleng d'Céréalen ze erhalen vis-à-vis immens ville Krankheeten, déi kommen duerch de Klimawandel, well een ze séier gëtt, well d'Planzewelt sech net kann adaptéieren, ass ee Service, deen d'Biodiversitéit eis ka ginn, wa mer se gesond halen, dee mer net gesinn, mee dee mer musse gesinn, a wou och d'Recherche gefuerdert ass.
Deen aner grousse Bénéfice, deen d'Biodiversitéit eis bréngt, ass d'Disponibilitéit vum Waasser, wou Lëtzebuerg en immens grousse Problem wärt kréien a schonn huet. Wann een d'Rapporte liest vum Waasserwirtschaftsamt, kréie mir de Spëtzeverbrauch vum Waasser laangfristeg einfach net gedeckt. Do kënnt de Problem dobäi, datt mer souvill verschmotzt hunn duerch Nitrater, an duerch Pestiziden, deen einfach net méi mobilisabel ass, an de Problem vum changement climatique, dee mécht, datt d'Waasser entweder

ze kuerz ze vill do ass, oder ze laang net genuch. A wéi mécht een Agrikultur a sou enger Gegebenheet? Dat ass eng Agrikultur, déi eis Pappen net kannt hunn. A wann ech dat och soen, fannen ech, et gëtt eng immens Opportunitéit, eise jonke Leit dee savoir-faire erem bäizebrengen, Saachen, déi eis eeler Leit woussten ze moderniséieren, well esou séier wéi de changement climatique elo geet, dat huet nach ni iergendeen an der Humanitéit, Zivilisatioun kannt. Wat kënne mir vun deenen ale Fassonge, sech ze adaptéieren, léieren – zB fréier gouf et jachère, fréier hues de vill méi verschidde Céréale gehat, verschidde Variétéite vu Céréalen, du hues deng semance-Opbewarung anescht gestalt wéi haut. Mir hunn zu Lëtzebuerg keng Bank vu semancen. Dat sinn alles Saache, wou ech och d'Recherche opfuerderen, wou ee kéint wonnerbar Saache maache, mee et gëtt net erkannt, well mer et net intérieuriséiert hunn, datt mer an enger Kris sinn, an datt de Maartpräis fir sou Saachen eigentlech misst puupegal sinn. Ze soen, et ass ze deier oder et mécht ekonomesch kee Sënn, ass dat nach dee richtege Benchmark? Ech weess et net.

NS: Jo, op där enger Säit kanns de opmannst higoen an all déi Saachen richteg monetariséieren, dass se dem Wäert entspriechen, dee se bréngen, wat kuerzfristeg sécher sennvoll ass. Mi generell, wéis de eebe soss, musse e sech iwwerhaapt d'Fro stellen, ob alles muss monetariséiert sinn, an ob ee verschidde Saachen net einfach grondsätzlech ëmmer muss erhalen oder förderen, ouni dat a Fro stellen, sou wéi een intakt oder stabilt Klima fir eis all.

PJ: Wat d'Biodiversitéit ugeet, ee Service, deen d'Leit kréien, dee se mol guer net bemierken, ass dat déi ZeRiA oder ZVI, wéi se lo existéiert, ee Frëschloft-Reservoir ass fir déi zwee Agglomeratiounsräim. An da verweist een och ëmmer op den Aménagement du Territoire an den Urbanisme, datt et ee Feeler wär, eng urban Front ze maachen, Héichhaiser ze bauen, zu där ZeRiA hin. Dat muss opbleiwen, dat muss porös bleiwen, fir datt di kal Loftstréim kënne fonktionnéieren, déi meechtens éischter West-Oste sinn, oder Süd. Dat betrëft lo méi d'AggloCentre wéi d'AggloSud, mee dat ass awer eppes, och mat der qualité de l'air, wat een direkte Service Richtung Ballungsräim bréngt.

NS: Dat erënnert mech e bëssen u Wien an Éisträich, an da Graz, wat zimmlech an de Bierger läit, allen zwee immens vill Traffic, awer Wien huet eng immens gutt Loft, well do duerch de Kanal vun der Donau gëtt immens Loft beschleunegt an doduerch gëtt alleguer den Dreck quasi weggeblosen, a Graz ass wéi ee Kessel. D'Source vun der Pollution ass am Fong ähnlech, awer du hues ganz aner Gegebenheeten an der Situatioun.
An nach eng lescht Fro, déi mecht interesséiert: bon, mir hu scho vill driwwer geschwat, mam Bewosstsein fir d'ZVI a fir d'Potential, fir dat ze realiséieren, a fir dat wierklech virunzedreiwen och all di Visiouen, iwwert déi mer lo geschwat hunn: ech verstinn datt dat op alle Fall am Aménagement du Territoire op nationaler Ebene natierlech immens vill diskutéiert gouf, dat bezitt sech jo dann awer och op dat, wat d'Gemengen maachen, wat lokal Akteure maachen. Wéi grouss ass do Iwwerhaapt d'Loscht oder d'Iddi, fir do wierklech eppes ëmzesetzen? Wann ech op Google sichen, fannen ëmmer just : „ZVI, dat ass di do Grenz an eisem PAG".

PJ: Jo, dat ass eng ganz gutt Fro. Fir a mengem Hut vu fréierer Coordinatrice adjointe de l'Aménagement du Territoire ze schwätzen: iwwert déi ganz Planung vun de Plans Sectoriels waren d'Gemengen ëmmer matabegraff. Verschidde Gemengen, do ware puer Generatioune vu Gemengenhäupter, déi domat befaasst waren, a mir hu jo och eng Consultatioun gemaach vun de Gemengen, an deem Sënn, datt mer eis immens vill Méih ginn hunn. Mir hunn all d'Pläng de Gemengen rausgedréckt an zur Verfügung gestallt an dohinnerbruecht. All Gemeng huet di ganz Supporten, souwuel d'Partie écrite wéi d'Partie graphique, rausgedréckt geliwwert kritt vun eis, fir kënne Stellung ze huelen, an déi meescht hunn och Stellung geholl, an et musse ee soen, de PSP war dee, wou vill Observatioune komm sinn, well en sou flächeg ass, a well eeben all Gemeng domat betraff ass, a well se dat ëmmer percevéieren als ee frein de l'urbanisation, wat e jo och deels ass. Et musse en dobäi soen: et gëtt den Aménagement du Territoire national – an e wëll sech och grenziwwergräifend, e plangt jo och zesumme mat den Noperen – mee et gëtt den aménagement communal, dee vun engem anere Ministère géréiert gëtt, dat ass de Ministère de l'Intérieur, wou déi Planung iwwert PAGen a PAPe fonktionnéiert. D'Plans Sectoriels gi vun de Gemenge bei enger Modificatioun vun hiere PAGe transposéiert, dat heescht di Restriktiounen, déi Preskriptioune vun de Plans Sectoriels ginn an de PAGen an herno an de PAPe transposéiert. Si kënnen och transposéiert ginn via d'Plans d'Occupation du Sol (POS), déi dann rëm vum Aménagement du Territoire initiéiert ginn.

NS: Du sees „transposéiert". Wat heescht dat genau?

PJ: Dat heescht déi Delimitatioune, déi an de Plans Sectoriels sinn, déi musse bei enger Modificatioun vum PAG opgeholl ginn, an am PAG kann näischt gemaach ginn, wat contraire ass zu de Bestëmmungen aus de Plans Sectoriels.

NS: Dat heescht d'Plans Sectoriels sinn am Fong iwwert de PAGen?

PJ: Jo, juridiquement mussen se duerch PAGen emgesat ginn, fir kënnen aktiv ze ginn. Se mussen transposéiert ginn an de Gemenge-PAGen. An et gëtt lo keng Gemeng opgefuerdert, hiere PAG neizemaachen, fir d'Plans Sectoriels opzuehelen, mee bei Modificatioune mussen d'parties graphiques vun de Plans Sectoriels respektéiert ginn.

NS: Nach eng Kéier d'Fro zur Motivatioun. . .

PJ: Jo, d'Motivatioun vun de Gemengen: ech hunn do ze wéineg Erfahrung. Et ginn immens vill Gemengen, déi hannert Contournementsprojete stinn. Dat musse en och verstoen, wann een Ettelbréck kuckt, oder Hesper, dat ass keng einfach Saach. Voilà, vun dohir géing ech soen, datt do eng geschlosse Front do ass, och wat Logement ugeet. De PSP, dat ass méi diffus, well déi GEP immens vill Gemengen uginn. Wéi lo den acceuil war vun der ZVI weess ech net genau, ech ka mer awer virstellen, datt e favorabel kéint sinn. Well déi ZVI, oder villäicht och iergendwann d'ZeRiA mat enger composante alimentaire an de résilience, äntwert op Saache wéi Man & Biosphere, wat

och vum Prosud am Süden dee Statut vun der UNESCO säit Oktober 2020 huet. Dat sinn sou Saachen, déi awer relativ kohärent sinn. Oder och wann ee kuckt: an der AggloSud ginn et jo ganz grouss Chantieren fir ee Quartier mixte entstoen ze loossen – ob Esch, Schëffleng oder Terres Rouges. Dat sinn alles Quartieren, déi deels autofräi wëlle sinn, a déi deels och déi connectivité écologique wëllen favoriséieren, eppes wat ech an der ZeRiA och als onëmgänglech fannen. Dat ass zwar eppes, dat äntwert lo net op d'Fro vun de Gemengen, mee ech wollt awer och soen, wat bei der ZeRiA immens wichteg ass, dat ass datt Lëtzebuerg phänomenal ass an der Fragmentation vu sengem Territoire – wat normal ass, well mer minikleng sinn, a mat engem Weltrekord am PIB, dee sech nidderschléit a méi Autoen, méi Deplacementer, méi Aktivitéiten. Dat heescht mir hunn eisen Territoire esou morceléiert, datt mir méi – an do och d'Fro vun de Contournemente – einfach net méi kënne verkraften. Dat ass och de rôle vum PSP: entgéintzewierken deem morcèlement territorial, an aus eisen Ecosystemer réserves naturelles ze maachen, déi [aktuell] sou grouss si wéi een Nuesschnappesch. An d'Iddi ass, dat och an d'Stied ze bréngen, well déi connectivité écologique, di geet iwwert alles. Du kanns net op eemol virun enger Stad soen zu engem Fräsch oder zu all deenen Déieren, déi Migratiounsweeëer hunn : „Stopp, lo muss du hei ronderëm déi Stad goen!". Di Porösitéit an déi reconnectivité écologique, déi musse e maache fir Waasserweër, fir Bëscher, fir Wisen, fir Hecken, an dat muss rural-urban-iwwergräifend sinn, souguer administrativ Grenzen iwwergräifend sinn. An do gesinn ech awer och eng Méiglechkeet, an ech mengen datt dat och e Schwéierpunkt vu vill Gemengen ass, dat muss dann och gemengeniwwergräifend sinn. An dofir sinn eebe sou Planifikatiounsinstrumenter wéi d'Plans Sectoriels wichteg, well di iwwer d'Gemengeplanung rausginn, an déi eenzeg eigentlech sinn, déi di reconnexion écologique [guidéiere kënnen]. De réseau écologique ass geduecht, datt dee vum mouchoir de poche bis op de Kontinent geet, soss ass et kee réseau écologique. All maille ass wichteg, fir datt et ee réseau écologique gëtt, a mir mussen eis mat eisem mouchoir de poche an ee kontinentalt Netz vu connectivité écologique aspeisen.

NS Dat ass jo dat, wat d'Natura 2000 Network bësse probéiert ze maachen. Do kënnt et awer immens vill drop un, wéi gutt datt déi Site gemanagt sinn, well dat si jo lo net obedéngt ofgeschnidden Arealer, mee do ass och Landwirtschaft deelweis dran, Bëscher, déi genotzt ginn, dat heescht do kënnt et extrem drop un, wat mer genau domadder maachen.

PJ: Genau, a wéi staark oder wéi schwach d'Restriktioune sinn.

NS: Tipptopp. Ech denken, datt mer sou zimmlech alles beschwat hunn, wat ech mer virgestallt hat, dowéinst si mer lo méi oder wéineger zum Schluss. Ass elo nach iergendeppes vun Dir aus, wats Du géifs soen, fir ze complétéieren?

PJ : Jo, also wéi gesot: Lëtzebuerg ass de Champion an der Fragmentatioun, an den Aménagement du Territoire huet a sengem cahier de charges oder a senger Missioun de „bien-être des résidents partout sur le territoire national", an och den

développement tentaculaire – wat e bëssen d'Géigemedaille ass vun der Fragmentatioun oder zesummegeet mat der Fragmentatioun – ze stoppen. An fir lo rëm zréck ze kommen op d'ZeRiA: ech fuere vill Velo, a mech erféiert et all Kéiers erëm, wéi deen développement tentaculaire net gestoppt gëtt. Wann ech d'N13 kucken, di vu Südosten op Nordwesten duerch d'ZeRiA geet, do gëtt a lénks a riets dauernd gebaut, dat ass eng Pärelketten, déi wierklech déi ganz ZeRiA eigentlech brécht. An eng Säit, déi méi zu der AggloSud hin tendéiert, an eng, déi méi zu der AggloCentre tendéiert, well dat ass wierklech eng coupure écologique des communautés vun der ganzer ZeRiA. Wann ech da gesinn, datt souguer Lëtzebuerger Agrikulturterritoire geholl gëtt, fir esou Saachen ze bauen wéi Motorworld, ee Glastuerm, an deem een Autoen exposéiert niewt der Autobunn, dat ass d'Géigebeispill vun deem, wat ech proposéieren als résilience alimentaire. Dat ass, wou ech fanne, wou nach ganz ganz vill ze maachen ass, och an de Gemidder vun de Leit a vun de Gemengepäpp, well schlussendlech ass et och eng autorisation communale, déi dat méiglech gemaach huet.

NS: well dat scho geplangt ginn ass, ier de PSP a Kraaft getrueden ass?

PJ: An desem Fall, jo.

NS: Gutt, da soen ech villmools Merci fir den Interview, an da kann ech elo d'Opnam stoppen.

A.3 Questionnaire Expert Interview Gilles Biver (In Luxembourgish)

1. Ist-Zoustand vun der Biodiversitéit an der ZVI
   (a) National Date beleeën, dass den Zoustand vun der Biodiversitéit zu Lëtzebuerg schlecht ass. Wéi gutt ass d'Datesituation iwwert d'ZVI?
   (b) Wéi effektiv ass de legale Kader vun der ZVI fir zu enger Verbesserung vun der Biodiversitéit bäizedroen?
   (c) Wéi staark beaflosst de Klimawandel d'Biodiversitéit zu Lëtzebuerg an an der ZVI?
2. Léisungen, fir d'Biodiversitéit an der ZVI ze restauréieren
   (a) Wat fir konkret Moossnamen a Projete kënnen d'Biodiversitéit an der ZVI restauréieren?
      i. Wat fir eng Roll spillen d'Natura-2000-Netzwierk an aner protegéiert Arealer? Wéi kënnen déi méi effektiv ginn?
      ii. Wéi effektiv si Kompensatiounsmesure mat Eco-Points?
   (b) «Trade-Off» Natur-Landwirtschaft: wéi kann een dës zwou Funktiounen an der ZVI vereenen, wann ee bedenkt, dass Landwirtschaft déi gréisste Gefor fir Biodiversitéit zu Lëtzebuerg ass, a méi ëmweltfrëndlech Landwirtschaft z.B. Biolandwirtschaft oft ee méi héije Landbedarf huet?
   (c) Wéi gutt ass dat allgemengt Verständnis fir d'Konzept an d'Potential vun der ZVI op Gemengen- an nationalem Niveau?
   (d) Wéi eng Mesure wäre fir deen nächsten Plan national concernant la protection de la nature (ab 2022) néideg, fir speziell an der ZVI eng Verbesserung vun der Biodiversitéit ze bewierken?

A.4 Transcript Expert Interview Gilles Biver (in Luxembourgish)

NS: Nick Sinner (Interviewer)

GB: Gilles Biver (Expert)

NS: Ech géif da mol ufänke mam Zoustand vun der Biodiversitéit. Ech hu mech schonn informéiert: den Zoustand vun der Biodiversitéit zu Lëtzebuerg ass am allgemenge schlecht, wa mir déi Indicateuren vun den EU-Direktiven kucken an esou. Ech hunn nach net richteg ee Bild dovunner, ob et iwwerhaapt Donnéeë ginn, wéi d'Biodiversitéit an der ZVI ass. Ech weess, dass déi oppen Habitater – paysages ouverts heescht dat, mengen ech – an engem zimmlech schlechten Zoustand sinn par Rapport zu deenen aneren Habitater, a wann ech mech lo net ieren, dann ass d'ZVI relativ oppen. Do ginn

ech dovunner aus, datt d'Biodiversitéit do nach méi schlecht ass wéi villäicht op anere Plazen. Wann der wëllt, kënnt Dir eng Kéier kuerz erzielen, wat Dir dozou wësst a wat et do fir Donnéeë ginn.

GB: Generell, effektiv, ass d'Situatioun wierklech schlecht, muss ee soen, fir eng ganz Rei vun Déieren a Planzenaarten an eng ganz Rei vun Ekosystemer. Ech weess elo net, wéi wäit Dir lescht Detailer hutt – mir hunn effektiv och ee Basisdokument zesummegestallt en vue vun engem nationalen Naturschutzplang – den drëtten – well deen zweeten elo um Enn vun dësem Joer och ausleeft. Doduerch schaffe mer un engem drëtten. Do hu mer ee Basisdokument, wou mer déi ganz Infoen nach eng Kéier opbereeden an textuell nach eng Kéier Stellungnam huelen.
A fir dat einfach ze resuméieren: op landeswäitem Niveau ass et effektiv esou, datt ee schonn feststellt, datt di Habitater an di Aarten, déi an der Agrarlandschaft liewen, schonn déi sinn, deenen et am schlechtste geet. Zousätzlech kommen awer och all déi dobäi, déi op aquatesch oder fiicht Liewensraim ugewise sinn. Dat ass elo och net weider verwonnerlech, well, wann een elo kuckt, wéi d'Landnotzung an och iwwerhaapt d'Ekosystemer sech entwéckelt hunn, geet een am Moment dovunner aus, datt mer eng Zerstéierung vu quasi 80% vun de Fiicht-Liewensraim haten tëscht de 60er Joren an haut. Et ass normal, datt wa mer di Liewensräim zerstéieren – déi kleng Biotopen, déi mer dann an deene Liewensräim zerstéieren, datt déi dann och verschwonne sinn. Do ginn et schonn effektiv dramatesch Réckgäng. Jee no deem, wéi eng Indicateuren ee kuckt, huet een awer de Moment Zuelen, déi op d'mannst rezent – domat mengen ech déi lescht 10-12 Joer – beleeën, datt de Bëschliewensraum eigentlech stabel war an eng ganz liicht Amelioratioun opweist, an dat ass wierklech de Contraire am oppenen Liewensraum, dat gesäit een do ganz anescht.

NS: Lo wëll ech direkt eng Kéier nofroen: dir sot, datt déi paysages ouverts gekoppelt sinn un d'landwirtschaftlech Notzung...

GB: Genau. Also lo net nëmmen exklusiv, mee an eise Géigenden [schonn] – dat ass an anere Géigenden an Europa anescht. Mir maachen een Ënnerscheed tëschent „geschlossene Liewensraim" – dat ass net dee Wuertgebrauch, mee et schwätzt een éischter vu Bëscher – an offene Liewensräim, do schwätzt een éischter vu wat bei eis op d'mannst net d'Bëscher sinn. Dat sinn da landwirtschaftlech genotzte Flächen, an a ganz wéineg Kéieren dann och fiicht Liewensräim, déi net onbedéngt landwirtschaftlech genotzt ginn. Wann ech soe „landwirtschaftlech genotzt", dann ass och alles, wat Wäibau ass, mat dobäi. Een anere Liewensraum, deen ëmmer méi Fläch hei am Land anhëlt, ass natierlech den urbane Raum, wou mer am Moment verschidden Tendenzen feststellen, wou mer eis nach net ganz fokusséiert hunn. Klassesch gouf et ëmmer déi Ënnerscheedung tëscht Bësch, oppen – also landwirtschaftlech genotzt –, fiicht Liewensräim a fielseg Liewensräim. Sécher wäert et an Zukunft net oninteressant sinn, eng fënneft Kategorie, den urbane Raum, mat bäizesetzen, well dee mëttlerweil weesentlech méi Fläch anhëlt wéi d'Fielsen oder wéi d'fiicht Liewensräim.

NS: Wann Dir sot, urbane Liewensraum als Kategorie: dat heescht, et consideréiert een och einfach all déi Aarten, déi an engem urbane Setting kënne liewen?

GB: Absolut. Also de Moment stelle mer fest, datt eng Rei vun Aarten, déi op den Agrarliewensraum eigentlech ëmmer ugewise waren, déi do ganz staark zréckginn, an déi mëttlerweil am urbane Liewensraum een zweete Liewensraum, een Ersatz-Liewensraum erëm fonnt hunn. Ech sinn eigentlech vu Formatioun hier an hunn och laang geschafft am Beräich vun der Ornithologie, also Vulleschutz, also kennen ech mech mat Vulleschutz bësse besser aus, mee trotzdem beleet dat awer ganz flott, datt et Aarte ginn, wéi de Gaarderoutschwanz, de Bluthänfling, déi mëttlerweil a méi héijen Densitéiten an den Dierfer virkommen – lo net an de Stied mee villäicht souguer an de Parken an de Stied – wéi se dat an der oppener Gewaan maachen, wou se säit Joerhonnerten, Joerdausende virkommen. A lo kommen se do, wou d'Siidlunge vun de Mënsche sinn, a méi héijen Densitéite vir wéi ausserhalb.

NS: Wat jo net onbedéngt heescht, datt et héich Densitéite sinn. Dat weist jo just einfach, wéi schlecht den Zoustand vun deenen oppene Liewensräim ass.

GB: Jo, wann ee seet „méi héich", dann ass dat ee relativen Aspekt. Et ka jo sinn, an der Agrarlandschaft, datt do d'Densitéiten vun deenen Aarte ganz ganz niddreg sinn an an deenen urbane Raim eebe just méi héich wéi am offene Liewensraum. Wou awer den Optimum wär, dat ass natierlech ëmmer schwéier ze soen.
Voilà, dat ass zu de generellen Tendenzen, wou mer de Moment sou dru sinn, wéi een dat graff ka resuméieren. Ech kann Iech déi Saachen och eng Kéier schécken, da kënnt Dir dat eng Kéier kucken, dat completéiert dann dat, wat ech elo just gesot hunn.
Wann ee lo déi ZVI kuckt, ass déi mengem Verständnis no, wéi ech se kucken – ouni elo déi genau Statistik ze hunn, wéi vill Fläch dovunner urbaniséiert ass, wéi vill agraresch benotzt ass, wéi vill Bësch ass – géing ech et effektiv als eng oppe Landschaft bezeechnen, déi duerchwuess ass mat enger Rei vun klengerem oder mëttlere Bëschmassiver. Am contraire zu engem Gréngewald, zu engem Mamer Äischdall, wat fir mech Bëschmassiver sinn, wou [just] bëssen Oppeland ass, do si mer hei eeben tëscht der Südmetropol an dem urbaniséierten zentrale Beräich bis Bartreng, Stroosse weider bis eriwwer op Hesper. Dee ganze Beräich ass fir mech Oppeland, duerchsat mat landwirtschaftleche Flächen, an et sinn awer eng Rei Bëschmassiver, déi sech sou duerchzéien. Wann een d'Kaart aus enger Distanz kuckt, erkennt ee sou Korridore, eng Ceinture vu Bëscher, déi sech eigentlech vu Kënzeg a Käerjeng zitt bis Beetebuerg, wou een ëmmer rëm där Bëscher huet, wat u sech enger spezielle geologescher Schicht, der ligne de massignot, entsprécht, wou een dann och eng liicht Cuesta an der Landschaft erkennt. An do sinn eebe vill Bëscher, deelweis souguer ganz vill Eeschebëscher, an déi bréngen awer eng zousätzlech Diversitéit an di dote Landschaft mat eran. Nërdlech a südlech dovunner huet een dann, oder hat ee fréier di ganz vill Fiichtzonen op deem schwéiere, leemege Buedem. D'Bëscher sinn nach do, mee déi Fiichtzonen, déi sinn awer op ee staarke Minimum mëttlerweil reduzéiert. Sou, datt een awer ka soen, datt an där doten Zone, der ZVI, eigentlech déi Constaten,

déi ee landeswäit gemaach huet mam Réckgang vun den Aarten am Offeland änlech leider och do muss feststellen, datt een awer an de Bëscher och duerchaus interessant Bëscher huet, mee am Offeland huet een awer trotzdeem nach ëmmer Reschter vu zones humides, also sou klengere bis mëttlere Fiichtzonen, déi et awer duerchaus interessant maachen. D'Landschaft ass och staark markéiert duerch een héije Grénglandundeel, et ass net nëmmen eng klassesch Akerlandschaft, et ass scho vill Grénglandotëschent, mee eeben do, wou et méiglech ass, wou et méi dréchen ass, datt och geakert ka ginn. Mee do, wou Grénglandass a wou et och méi fiicht gëtt, ass d'Aartevielfalt awer scho ganz interessant. E bësse kann een och sou resuméieren, datt d'Kärstéck vun där ZVI eigentlech enger Rei vun Natura 2000 Gebidder entsprécht. Mir hunn eng Rei vun Natura 2000 Gebidder, déi do jo gemellt sinn, oder nogemellt gi sinn. Dat sinn eenzel Bëschmassiver, déi bei Kënzeg ufänken a bis Beetebuerg sech erofzéien. Dann hu mer doriwwer gelagert ee gréissert europäescht Vulleschutzgebitt, dat di Bëscher als Kärstéck beinhalt, plus dann Fiichtzonen oder di Graslandschaften, déi do drunner grenzen. Dee Lias bezeechne mer jo als Vulleschutzgebitt. A wa mer soen, dat ass een europäescht Vulleschutzgebitt, dat bedeit jo awer, datt mer do ee gewëssen Hotspot vun Aarten hunn, deen nach méi héich ass wéi op anere Plaze am Land. D'ZVI ass lo net den ultimativen eenzegen Hotspot, sécher huet se hier Problemer an hier Réckgäng bei enger Rei Aarten, mee nach ëmmer ass se besser wéi aner Siten.

NS: Dat ass och sécher dann de Grond, firwat datt se dee SNStus dann iwwerhaapt krut, soss hätt et jo kee Wäert gehat, esou eng ze designéieren.

GB: Genau. Also et se ass net fir Zielaarten vum Trockenrasen an och net vu ganz groussen Fiichtgebidder, mee et ass di typesch Landschaft, déi ech als Mosaik géif bezeechnen, aus Offeland, duerchsat mat ganz vill mat Eeschebëscher an do wou et bësse méi oppen ass, Fiichtgraslandschaften. Als dat géif ech et bezeechnen. Déi Aarten, déi op dat ugewise sinn, déi fënnt do awer nach an appreciablen Densitéiten.

NS: Wa mer lo iwwert d'Pressiounen oder d'Gefore schwätze fir d'Biodiversitéit besonnesch an deem Raum: wann ech dat richteg verstanen hunn, dann sinn d'Landwirtschaft an einfach d'fragmentation des habitats déi gréisst Geforen zu Lëtzebuerg?

GB: Grad dës Regioun ass duerch eng Rei Saache markéiert: op där enger Säit huet een deen Drock ¬– wéi den Numm et scho seet – datt se tëscht deenen urbaniséierte Metropole läit, wou am Moment déi Gemengen wéi Dippech, Recken-Mess, bis Beetebuerg, alleguerten ee grousse Boom mat sech bréngen. Ech si villäicht bësse méi al wéi dir, mee ech mierken, wéi déi Dierfer sech entwéckelt hunn. Dat waren awer zum Deel kleng, staark corporal gepräägten Dierfer, där hier Bevëlkerung mëttlerweil awer eng ganz aner ass. Leit, wou warscheinlech de gros dovunner an der Stad schafft, villäicht an engem manneren Deel a méi zouhuelend an der leschter Zäit och an der Südmetropol schaffen oder ugrenzend, mee et ass natierlech awer eng Zone déi am

Moment staark sollicitéiert gëtt, fir do Wunnen ze goen, wéinst der relativer Proximitéit tëscht deenen Zonen. Awer bësse kënnen am Gréngs wunnen, mee awer kënne schnell op deenen aanere Plaze sinn. Dat heescht, grouss Pressioune sinn am Moment do ouni Zweifel d'Urbaniséierung, mee dat ass awer net den Haaptgrond, firwat datt déi Agraraarten sou staark verschwonne sinn. Ganz kloer läit dat un der landwirtschaftlecher Notzung a wéi déi sech ännert. Bei den typesche Graslandschaften ass awer een Trend dohinner, fir déi Graslandschaften an der Landwirtschaft eeben anescht ze notzen. Grasland gëtt méi oft geméint, et gëtt méi gedüngt, Gras gëtt gären ëmgeplout, fir et nei unzeséinen, fir just déi Graszorten oder déi Kraider dran ze hunn, déi een dann och wëll hunn. Akerlandschafte ginn awer och méi gedüngt, et gëtt méi cibléierten Asatz vun diversen Pestiziden, dat ass landeswäit de Fall, an dat ass awer hei genausou de Fall. Ganz ganz naass Flächen kann een nach net sou notzen, ausser et géif ee se wierklech drécheleeën, awer an deenen doten Zonen ass dat och eigentlech elo verbueden, fir Fiichtgebidder dann dréchen ze leeën, sou dass di doten lo protegéiert sinn, mee et ass awer den Drock vun deene Leit, déi do wunnen, Drock fir Terrainen, fir bebaut ze ginn, Drock an der Landwirtschaft, et ass awer och ee Fräizäitdrock do. Wann ech soen, datt ëmmer méi Leit do wunnen, da wëllen déi Leit sech iergendwou erhuelen, dee Faktor vun der Naherholung ass do ganz wichteg. Et gesäit ee ganz sécher haut méi Leit an deene Bëscher, wat nach méi markéiert ass elo an der Covidzäit, wou d'Leit dee Besoin hunn, sech an der Natur ze erhuelen, well et soss keng aner Fräizäitnotzungen goufen. Mëttlerweil mat den Impfunge geet et jo ee Stéck besser. Mee et mierkt een awer, wéi Fräizäitdrock an deene Bëscher, an deenen Naturgebidder awer och immens zougeholl huet. An deene leschte Jore souwisou a mam Covid nach eng Kéier däitlech. Méi Fräizäitdrock bedeit jo dann och méi Stéierungen fir d'Fauna, bedeit awer och eng Demande vun ëmmer méi Ereechbarkeet vun diverse Plazen, dat bedeit Ausbau vu Velospisten, dat bedeit méi Accessibilitéit an de Bëscher, bedeit awer och datt Leit, déi wierklech wëllen eleng sinn, ëmmer méi wäit a méi entleeën Flächen era ginn. Dat heescht de Stéierungsfaktor vun der Fauna hëlt do awer schonn zou. Grad an enger Brutsaison kann dat fatal Folgen hu fir de Reproduktiounserfolleg vu Aarten. Dat heescht, eng Aart, déi stéierungufälleg ass, an ëmmer erëm vun hirem Nascht opflitt, an doduerch méi Energie verbraucht, déi se net anescht erëm kann zréckgewannen, an doduerch manner Erfolleg huet, hier Klenger opzezéien, wat och hier Grënn huet, firwat d'Densitéit oder d'Unzuel vun deenen Déierenaarten och schwënnt. Mee bon, den Fräizäitdrock ass sécher grouss, mee de landwirtschaftlechen Drock ass an där heiten Zone mindestens equivalent.

NS: Wat interessant ass, oder wat et schwiereg mécht, dat Ganzt mat deem Instrument vun der ZVI ze léisen, well d'Landwirtschaft grad sou wéi déi ekologesch Funktiounen doranner mat abegraff sinn. D'Urbaniséierung an och d'Verkéiersinfrastruktur, déi gi jo am Fong rausgehalen duerch de PSP, awer d'Landwirtschaft am Fong net.

GB: Jo, de Plan Sectoriel Paysages seet eigentlech mat sengem Numm immens vill aus: et geet méi ëm d'Landschaft wéi ëm d'Landnotzung. A lo hänkt et nach dovunner of,

wéi definéiere mer Landnotzung? Fir Landnotzung kann ee verschidden Definitiounen hunn: ass d'Landnotzung éischter eng Utilisation oder eng Occupation? Anescht kéint een och soen: ech mengen, dass d'Landnotzung mat der Urbaniséierung déi lescht Joerzéngte och geännert huet, awer ech mengen méi frappant war d'Intensivéierung vun där Notzung, déi déi selwecht bliwwen ass. Wann ee seet: dat wat landwirtschaftlech virdru genotzt war ass och weiderhin an der selwechter Affektatioun bliwwen, et ass weiderhin nach landwirtschaftlech Fläch oder op d'mannst grouss Deeler dovunner, wann ee mol eraushëlt, wat elo rezent urbaniséiert ginn ass. Déi Flächen, déi virdrun an haut landwirtschaftlech gi sinn, do huet sech un der Notzung net eppes geännert, mee un där Intensivéierung, där Aart a Weis vun där Notzung, dat huet éischter eppes domadder ze dinn, wéi déi landwirtschaftlech Betriber ausgeriicht sinn. Haut gesäit ee jo ganz wéineg Kéi op de Weeden, et ass jo éischter sou, datt d'Kéi just nach am Stall stinn op ganz ville Plazen, an dass eeben d'Gras erageholl gëtt ënnert der Form vu Silo. Déi mannste Bauere maachen nach Hee, déi meeschten méinen hiert Gras bis zu fënnef mol oder méi oft am Joer, an et gëtt eeben a Siloform erabruecht a verfiddert. Dat ass eng Intensivéierung vun eigentlech där selwechter iwwergeuerdenter Landnotzung. Et ass net sou dat Phänomen, wat ee villäicht op anere Plazen an Europa feststellt, zum Beispill an Osteuropa, wou plazeweis een abondant war vun der landwirtschaftlech Fläch, wou landwirtschaftlech Fläche verbuscht sinn, oder souguer Bësch drop gewuess ass. Dat hu mir lo hei net sou, op d'mannst net an der ZVI. Dat huet ee bei eis am Land effektiv och op Plazen, bei Jonglënster, wou sou dréchen Häng verbuscht sinn, well se net méi genotzt ginn, well se net méi rentabel waren, an dat war eng Ännerung vun der Landnotzung. Et war eng Aufgabe vun där landwirtschaftlech Notzung, dat ass manner hei de Fall, hei ass éischter de Problem vun der méi oder souguer ze intensiver Notzung.

NS: Wat jo da ganz kloer ass, ass datt d'Biodiversitéit an d'Landwirtschaft, déi sinn do an engem Tauziehen – d'Landwirtschaft ass ee grousse Faktor, firwat dass d'Biodiversitéit erofgeet. Fir datt mir déi erëm kënnen reconciliéieren, muss sech eppes un der Landwirtschaft änneren. Wat fir Zenarien a wat fir Instrumenter kënnen do implementéiert ginn, villäicht lo à court terme an à long terme, wat ännert sech un der Landwirtschaft, fir dass d'Biodiversitéit besser gëtt?

GB: D'Ausriichtung vun der nationaler Agrarpolitik misst méi interessant gestalt ginn, fir manner Mass ze produzéieren, mee méi regional an idealerweis biologesch Produite ze produzéieren. Et muss einfach méi interessant ginn, dee biologesch Landbau an och déi regional Vermaartung dovunner muss méi interessant gestalt ginn. Leider ass och dës Regioun een deels staarke Grénglandstanduert, dee vill Mëllechbetriber huet, deelweis stelle se sech zwar éischter zu Fleeschbetriber ëm oder et si Mixte-Betriber, mee et sinn awer och vill Mëllechbetriber hei, an déi schaffen eebe méi intensiv, an do geet et drëms, un deene Schrauwen ze dréinen, fir ze kucken, wéi kréien ech eng Notzung méi interessant gestalt, datt si och sech dozou bereet erklären, fir datt et einfach ekonomesch Sënn mécht. Et muss sech einfach ekonomesch fir déi landwirtschaftlech Betriber rechnen, anescht do ze wirtschaften. Dat ass éischter eng Ausriichtung vun

eiser nationaler Agrarpolitik, vill méi dat wéi lo ee Raumplanungsinstrument. Elleng nëmmen mat der ZVI – se ass schonn ee Schlëssel –, mee mat där ZVI hält een awer déi Landschaft an enger änlecher Situatioun wéi lo, mee dat ass awer an enger éischter iwwergeuerdenter landschaftlecher Approche. Wann ee lo wëll eppes un der Landwirtschaft, un der präziser Intensitéit änneren, da muss een éischter un enger Agrarpolitik schrauwen, wéi dass een hei un engem Landesplanungsinstrument do géif méi schrauwen. Wat mer hei jo méi assuréieren mat enger ZVI ass jo méi ze kucken: „wéi gi Stroumleitunge, Stroossen hei gebaut, wéi entwéckelen sech d'Dierfer hei an dësem Raum?". Dat ass sécher och eng ganz wichteg Froestellung, mee et ass net déi, déi eleng d'Äntwert gëtt, fir datt de Réckgang vun der Biodiversitéit sech inverséiert.

NS: Dat heescht, zum Beispill déi Iddi, datt ee géif der Landwirtschaft Fläch wechhuelen, fir déi fir d'Biodiversitéit ze reservéieren, dat ass éischtens net onbedéngt de Schlëssel, fir de Probleem ze léisen, an läit och warscheinlech guer net als Optioun um Dësch?

GB: Läit ganz sécher net um Dësch. Also natierlech wär dat eng Léisung, fir lo ze soen mat deenen verschiddene Méiglechkeeten, déi de Staat huet, soit keeft en d'Flächen sou wéi en se kann kafen, oder en enteegent souguer, fir dann do Biodiversitéit domadder ze restauréieren, mee da brauch een herno nach ëmmer Leit, déi dann déi Flächen geréieren, an ob een dann do ee Gäertner schéckt? Deen ideale Modell wär secher nach ëmmer deen, datt een méi ekologesch Landwirtschaft op der Plaz halen, an net muss dohigoen an Terraine wechkafen. Natierlech, den Terrainskaf kann ee Schlëssel sinn, also et ka schonn eng Decisioun sinn, fir ze soen: „mir, de Staat oder d'Gemenge, kafen elo Terrainen, fir do elo Naturschutz ze maachen, well et aneschters net geet". Dat ass och eng Solutioun, déi ëmmer méi ugaange gëtt – bon, d'Terraine sinn natierlech immens deier, dat muss een och soen, Expropriatioun fir Naturschutz ass nach ni gemaach ginn, muss een och fairerweis soen, dat ass just gemaach gi fir Stroossebauten a sou Projeten. Et wär virstellbar vläicht, mee ech mengen awer net, dass iergendee Politiker sech géif dorunner trauen, ze soen, mir maachen dat elo, mir expropriéieren lo, fir d'Biodiversitéit ze schützen. Déi méi soft approche ass natierlech, déi Terraine kafen ze goen, oder eeben – dat ass eeben och nach eppes wat mer och hunn – datt niewent deenen europäeschen, méi groussen a soften Naturschutzgebidder och méi kleng a mi streng national Naturschutzgebidder ausgewise ginn mat enger Reglementatioun, wou dann zum Beispill drasteet, datt ee keng Pestiziden däerf benotzen, et däerf een net méi düngen, dat si scho Méiglechkeeten, déi een huet, fir eeben hei national Naturschutzgebidder auszeweisen. Eng Rei vu Gebidder si jo als solch ausgewisen, woubäi de Gros an dëser Regioun awer éischter Bësch ass, deen ausgewisen ass. Am Moment ass an der ZVI net schrecklech vill vun nationalen Naturschutzgebidder ausgewisen, dat meescht si Bëscher wéi de Beetebuerger Bësch, oder dat Bouferdanger Mouer, wat da wierklech ganz alt Holz ass, an awer och nach landwirtschaftlech genotzt gëtt.

NS: Firwat ass dat sou staark markéiert vu Bëscher a sou wéineg oppe Paysagen?

GB: Dat ass eng gutt Fro, mee d'Äntwert ass einfach: et ass vill méi einfach, Bëscher auszeweisen als national Schutzgebitt wéi Offeland, well den Drock immens grouss ass, deen d'Landwirtschaft awer do exerzéiert. An d'Bëscher gehéieren oft dem Staat oder de Gemengen, déi méi séier bereet sinn, fir Bëscher ze schützen fir d'Naherholung vun hire Leit. Am Moment ass d'Naherholung, d'Rekreatioun fir d'Leit am Offeland nach net esou staark gefrot, vun de Gemengen och. Klassesch ass et bei eis am Land esou: iwwer d'Hallschent vun de Bëscher gehéieren der ëffentlecher Hand, sprëch de Gemengen an dem Staat, an am Offeland ass dat awer wäitaus ëmgedréint. Do gehéieren manner wéi 10% der ëffentlecher Hand. Dat wäert an der ZVI net vill anescht sinn.

NS: An doduerch huet ee keen Hiewelaarem, fir méi séier Moossnamen dropzemaachen, fir Saachen ze veränneren?

GB: Jo. Et ass kloer, do wou Gemenge mol klenger Fläche kafen, an da Weieren uleeën oder Blummewisen uleeën, do kënnt ee ganz séier zu Resultater. Also de Schlëssel ass ganz kloer dat iwwer d'Proprietéit oder Schutzgebidder auszeweisen.

NS: Majo da bleiwe mir mol bei deene Schutzgebidder, bei deene protegéierten Arealer: dat heescht, vum europäeschen Niveau hier kréie mer dat Natura 2000 Network, wou duerch déi Direktiven verschidden Regiounen als solcher ausgewise ginn wéinst den Habitater, wéinst den Aarten, déi do virkommen, an dann hu mer op där aner Säit natierlech och national d'Méiglechkeet, fir protegéiert Arealer auszeweisen, a wann ech dat richteg verstanen hunn, da sinn déi och vill méi streng, wärend Natura 2000, do kënnt et immens op de Management un, oder op déi Mesuren, déi ëmgesat ginn, fir wéi eng Resultater dann herno rauskommen.

GB: Genau dat. Bei nationalen Naturschutzgebidder, déi an der Regel ëmmer ee gutt Stéck méi kleng sinn, do huet een eng Reglementatioun, wou dann dra steet: dëst an dëst ass alles verbueden, wéi zum Beispill : et dierf ee keng Nolebeem oder keng Beem, déi net heihinner gehéieren, méi uplanzen, oder seet een eben, de Pestizidgebrauch ass hei verbueden, oder et däerf net gedüngt ginn. Dat si sou Aussoen, déi een a sou Gebidder mécht, an domadder erreecht een natierlech dann och seng Resultater. An deenen Natura 2000 Gebidder ass et éischter sou, dass et fir eis als Staat an och fir d'Gemengen vill méi einfach ass, an deene Gebidder Suen zur Verfügung ze stellen, fir do Ëmsetzungen ze maachen. Also mir cibléieren schonn, datt dee gréissten Deel vun de Gelder an d'Schutzgebidder fliésst – an d'Natura 2000 Gebidder an national Gebidder – a manner ausserhalb. Natura 2000 ass méi participativ, fir mat Privatleit ze schaffen, ass bësse méi verbindlech fir d'Gemengen, a méi staark verbindlech fir de Staat. Déi benevole Approche, déi fräiwëlleg Approche ass do natierlech vill méi wichteg an bei nationalen Naturschutzgebidder ass dat natierlech vill méi streng. An doduercher, well et vill méi streng ass, gëtt et manner akzeptéiert, an doduerch, datt et manner akzeptéiert ass, ass et vill méi schwiereg, déi och auszeweisen. Déi ganz Prozedur bedeit immens vill Negotiatiounen mat all deene Leit, mat deenen diverse Vertrieder vun diverse Gruppen, an do duerch ass dat vill méi schwéier.

NS: Ech hunn nach net ganz verstanen: wat si lo déi konkret Mesuren, déi an den Natura 2000 Gebidder ëmgesat ginn?

GB: Ahjo pardon! Ëm alles, wat Bëscher ass, këmmert sech eis Natur- a Bëschverwaltung, ëm d'Gestioun, déi dann och Obligatiounen huet, fir datt déi dann och ganz naturno a ganz schounend ass an eise Bëscher, dat sinn déi Moossnamen, an de Gros, grad hei an der ZVI – ech hu lo net déi genau Zuelen, mee ech ginn awer dovunner aus, dass iwwer dräi Véierel vun de Bëscher wäerten ëffentlech Bëscher sinn, déi de Gemengen oder dem Staat gehéieren, dat ass generell am Guttland de Fall, dass grouss Deeler vun de Bëscher der ëffentlecher Hand gehéieren, wärend et am Éislek genau ëmgedréint ass, do gehéieren di mannste Bëscher der ëffentlecher Hand. Dat heescht, mir hu schonn eng relativ appropriéiert Gestioun an de Bëscher, déi ass wierklech ganz korrekt, mir hu souguer eng Rei vun Naturbëscher, dat heescht wou keng Gestioun méi stattfënnt a sech iwwerlooss ginn, et sinn eebe just nach Visiteuren do, wéi de Beetebuerger Bësch, oder awer och nach den ënneschte Bësch bei Bartreng, wou guer keng Exploitatioun méi stattfënnt, wouduerch de Bësch dann ganz naturno geréiert, oder eebe grad net geréiert ass, am Sënn vu sech selwer iwwerlooss sinn. Am Offeland gëtt da ganz vill mat Biodiversitéitsmoosnamen, oder mat Agrarëmweltmoosnamen geschafft, mir hu Biodiversitéitprogrammen, dat sinn dann Subsiden, déi de Landwirt da kritt, wann e sech engagéiert fir fënnef Joer ganz ekologesch op där jeeweileger Fläch, déi en dann do ugëtt, ouni Pestiziden an ouni Dünger ze schaffen, a da kritt een eeben dofir eng interessant Primm fir domadder kënne ze schaffen. Dat si sou Incentiven, déi et sou ginn, fir da mat de Privatleit am Offeland ze schaffen. Et muss een awer och soen, datt déi lescht Joren eng ganz Rei vu Gemengen eng Rei Projeten matgemaach hunn, wou lo ee ganzt Netzwierk vu sou klenge Weieren an Dëmpelen ugeluecht ginn ass, wou dann eeben d'Amphibie kënne quasi vu Weier zu Bësch zum nächste Weier wanderen, et ass wierklech ee ganze Reseau vu Stepping Stones eeben ugeluecht ginn vu Fiichtgebidder, fir dass d'Amphibie sech do kënnen an der ZVI austauschen.
Dat si mol sou eng Rei vu Moossnamen, wou mer am Gaange sinn. Als weider Moossname, wou mer scho bei Korridore sinn, hu mer och Bëschkorridore designéiert, wou mer och am Moment probéieren, un déi ganz Zerschneidungseffekter vun den Autobunnen erunzegoen. Wann der lo iwwert d'Diddelenger Autobunn fuert, do ass eng Wëldbréck, déi gebaut ginn ass, déi nei TGV-Streck, déi laanscht d'Diddelenger Autobunn geet, déi dann soll de ganze Beräich Réiser bis bei de Krautemer Bësch bis op déi aner Säit an déi ZVI ran – déi ganz Bëscher Kockelscheier, Beetebuerger Bësch – wou da geplangt ass, eng wieder Wëldbréck do ze bauen, fir dann do südlech vu Leideleng och iwwert déi Autobunn ze kommen. Dee ganze Vernetzungsaspekt vun deene Bëschmassiver ass awer och een immens wichtegen, vu do aus geet et da wieder iwwert de gréissere Bëschkorridor Richtung Stengefort beim Wandhaff, wou och eng Wëldbréck geplangt ass, an och an deenen nächste Jore soll gebaut ginn. Dat heescht, deen isoléierten Südweste vum Land soll eigentlech rëm méi ugebonnen ginn duerch déi Bëschmassiver un de Westen, an un de Südosten vum Land. Dat si sou verschidde Moossnamen, beispillhaft, déi mer de Moment uginn, fir déi Thematiken, déi mer am

Südwesten hunn, och unzegoen.

NS: Dat ass warscheinlech déi ee warscheinlech och am PNPN gesäit, mat de corridors écologiques, an dann huet ee besonnesch am Südwesten eeben déi Ënnerbriechungen, wou d'Connectivitéit net méi ginn ass, an dat sinn eeben déi Punkten, wou da lo Wëldbrécken iwwert d'Autobunnen opgebaut ginn. Wat fir aner Projeten ginn nach gemaach nieft Wëldbrécken? Ech hu lo d'Gefill, dass Wëldbrécken déi wichteg Instrumenter sinn, fir zum Beispill d'Transportinfrastruktur ze iwwerbrécken. Anescht, wann een d'Connectivitéit kuckt, da geet ee villäicht duerch d'Dierfer a kuckt, dass an den Dierfer Hecken a Beem stinn, fir d'Connectivitéit ze verbesseren?

NS: Jo, also d'Connectivtéit ass net nëmmen op landeswäitem Niveau, Connectivitéit fënnt natierlech op villen Niveauen statt, dat ka wierklech am ganz klenge Raum sinn, einfach vum Duerf, wéi dat ugebonnen ass, mat enger Bamallee an enge Heck, bis dohinner datt eng ganz Wëldbréck gebaut gëtt, an alles dotëscht gëllt och. Do wou et méiglech ass, sinn och elo schonn eng Rei vu Projeten gemaach ginn zesumme mat Ponts et Chaussées, fir Ënnerféierungen ënnert de Stroossen ze maachen, fir Amphibien, datt déi déi méi einfach kënne kräizen, eng Rei vu Connectivitéitprojeten si schonn ugaangen. Dat kéint een natierlech nach wesentlech méi verdéiwen, mee et ass ëmmer eng Saach vun Zäit a Geld, wat een ëmmer grad mécht, meeschtens ass dat dann, wou eppes frësch oder nei gemaach gëtt, da profitéiert een dovunner, fir dann do och nach aner Saachen an Amenagementer dohinner ze maachen,. Et ass all Kéiers esou, datt wann iergendzwousch een Autobunnsprojet ass, een TGVs-Projet ass, da gëtt profitéiert, eng Wëldbréck ze bauen. Mir sinn nach ni enzwousch higaangen an hunn eppes Gréisseres enzwousch gebaut aus eenzeler Iwwerleeung just fir dat. Meeschtens ass ëmmer am Zesummenhang mat engem anere Projet, oder ganz oft.

NS: Dat kléngt bëssen erniichternd, wann ee bedenkt, datt esou ekologesch Projete musse un aner Infrastrukturprojeten gekoppelt sinn, fir datt se iwwerhaapt stattfannen.

GB: Leider schonn, mee dat ass bëssen d'Realitéit, déi do matspillt.

NS: Jo, do hunn ech mat der Madame Junker vill doriwwer geschwat, einfach wéi dass den Aménagement du Territoire an d'Landesplanung ëmmer muss all d'Interessen vun de Leit verbannen, a wann da verschidde Saache méi héich geschätzt ginn wéi anerer – meeschtens ginn déi ekologesch Saachen bësse vernoléissegt, huet een d'Gefill, da kënnt zum Beispill raus, sou wéi och am Plan Sectoriel fir d'Transports ass, quitt dass mer lo di ZVI definéiert hunn, aus deem anere Plang fir den Transport huet een dann awer virgesinn, dass zum Beispill nach ee Contournement queesch duer d'ZVI gemaach gëtt ronderëm Käerjeng, Dippech.
Wéi gesitt Dir dat? Jo, mir hu verschidden Interessen, déi um Terrain sinn, déi villäicht net matenee schaffe mee géinteneen, ass dat iwwerhaapt ze justifiéieren dass mer lo soen: mir brauchen dee Contournement wéinst dem Wuelbefannen vun de Leit an deene Géigenden, well et ze vill Loftverschmotzung gëtt, an dann op der anerer Säit de bien

commun vun der Biodiversitéit, dee villäicht méi grouss ass, an net grad sou lokal. Wat sinn Är Gedanken dozou?

GB: Ech mengen, Dir hutt et elo schonn resuméiert. Et ass natierlech e bësse speziell. Et muss ee jo awer soen, wann een zäitgläich mat enger Rei Instrumentarien duerch eng Prozedur geet, wou sech déi Instrumentarien zum Deel widderspriechen. Et ass scho speziell, dass ee seet: mir wëlle lo hei een Instrumentarium „ZVI“ maachen, an zäitgläich musse mer dann awer och Leit duerch déi kanaliséieren. Wou gi mer dann? Mir ginn net duerch déi Dierfer, mir wëllen enzwousch anescht dann ee Contournement opbauen. All Contournement bedeit natierlech grousse Flächeverbrauch, an zäitgläich mierkt een dann och erëm, wann ee Contournement do ass, „da kënne mer jo lo nach baue bis bei de Contournement“. Dat ass ëmmer déi Saach, déi iwwerall ass, an dohier ass dat schonn bësse widderspréchlech fir ze soen: enger Säit musse mer lo hei déi vun Iech genannte Contournementen – an do sinn der warscheinlech nach, déi wäerten an deenen nächste Joerzéngte kommen – leider si sou Flächeverbräich onwidderrufflech, also et geet ee kaum eng Strooss zréckbauen. Et kann een natierlech effektiv d'Fro stellen: verfeelt domadder eng ZVI net hire But? Et ass natierlech sou, sou ee Contournement u sech, wéi deen deen Dir lo grad genannt hutt, meeschtens kritt een déi nach – déi Zerschneidungseffekter, déi se hunn – kritt een nach opgefaangen, an deems een dann Unterführunge mécht a Brécken driwwer mécht, alles dat geet, fir déi Déieren driwwer wech ze schleisen. An awer huet een awer een direkte Flächeverbrauch, deen een ëmmer nëmme schwéier ka kompenséieren an ophiewen. Wéi geet et kompenséieren? Eist Land wiisst net, dohier gi mer aner Liewensraim da besser gestalten, oft sinn et Liewensraim déi souwisou schonn ëmmer gutt waren a da villäicht rezent verschlechtert gi sinn, da gi mer déi rëm opbesseren. Domadder maache mer fir de Bilan vun der Biodiversitéit nach ëmmer net schrecklech vill. Dat ass mol dat eent, datt ee kompenséiere muss. Dat zweet ass, datt sou Stroosse nach ëmmer Effekter hunn, déi wäit iwwert dat erausginn, wat just den direkte Flächeverbrauch ass. Dat heescht eng Strooss ass net just déi Meter carrés oder déi Hektaren, déi se verbraucht, mee déi Stéierung, déi se lénks a riets huet op Liewensraim mee souguer op de Mënsch. Deen een, dee lo villäicht de Verkéier am Duerf hat, deen ass entlaascht doduerch, dass de Verkéier lo net méi duerch d'Duerf geet, mee deen deen um Bord vum Duerf gewunnt huet, an deen lo de Contournement hannert säin Haus kritt, deen huet elo méi Verkéier. Et ass schonn bëssen eng Verlagerung vun der Situatioun op een anere Punkt, deen ëmmer zu Laaschte vun der Natur geet. Bon, ech mengen, Dir hutt et virdru richteg resuméiert. Et ass scho bësse speziell, dat hätt ee villäicht misse klären, ier een di Instrumentarien lassléisst, dass déi net sech géifen op deene Plaze sou bäissen.

NS: Wat mech nach interesséiert: nach eng Kéier zu de protegéierten Arealer: et gesäit een um Geoportail, wann ech mer dat sou ukucken, dass déi protegéiert Arealer, sief et Natura 2000, sief et national Arealer, extrem komesch Forme kréien, wéi kleng Nuesschnappecher iwwert den Terrain verdeelt sinn, an do froen ech mech: wéi gutt ass d'Connectivitéit tëscht deenen Arealer de Moment iwwerhaapt? Wann ee dohinner geet

a ronderëm déi mënschlech Infrastruktur definéiert, fir déi net ze stéieren, wier et dann net méi sënnvoll, iergendwann och mol ze soen: mir mussen iergendwou zréckbauen, oder carrément soen: déi hei ganz Fläch ass lo een protegéiert Areal? Natierlech mat där ganzer politescher Prozedur, déi kënnt, mee fir d'Connectivitéit u sech: kann een déi iwwerhaapt erhalen oder restauréieren, doduerch datt een ëmmer just ronderëm d'Infrastruktur geet, déi vum Mënsch gebaut ass?

GB: Nee, et ass natierlech ganz schwéier, mee et ass oft déi eenzeg kuerzfristeg Moosnam, déi een iwwerhaapt nach gemaach kritt. Et muss een awer wëssen, datt bei eis am Land den droit de propriété ganz staark verwuerzelt ass, an och d'Geriichter ginn deem staark Recht an d'Politik réischt. Wann ech gesot hunn, et ass ganz rar datt een expropriéiert gëtt, et ass ganz rar, dass iergendeppes wechgeholl gëtt. Beispill aus enger anerer Regioun: beim Gréngewald. Wou gesot ginn ass, mir baue lo d'Nordstrooss an et kënnt nach een Tram, mee als Kompenséierung maache mer dann deen Chemin repris CR119 zou, mee en ass bis haut nach net zougemaach ginn, obwuel et eng Moossnam war, déi festgehale gi war, mee se ass awer ni duerchgezu ginn, well sech einfach keen traut, un déi Saach erunzegoen. Et ass wierklech ëmmer ganz schwéier hei am Land, eppes wechzebauen an ze soen: lo maache mer mol eppes prioritär fir d'Biodiversitéit. Also ech wär frou wann et sou wär! Mee dat hunn ech lo sou awer nach net erlieft an deenen bal 20 Joer, datt ech hei täteg sinn.

NS: Wourunner, mengt Dir, hänkt et am meeschten? Dat ass elo eng zimmlech detailléiert Fro, an wann déi lo ze vill an de politeschen Hinanhier geet, da kënne mer et och wechloossen. Et ass kee Bewosstsinn do fir de Wäert vun der Biodiversitéit oder ass kee Bewosstsinn do fir d'Gravitéit vum Problem? Oder ass et, well d'Leit denken: „oh, deen enge Bam, do kënnt et net drop un. . . "

GB: Et ass genau dat. Also engersäits dach. De Problem – d'Aartestierwen – ass jidderengem bewosst, wat dat als Konsequenz huet, denken ech, ass de Leit scho vill manner bewosst. D'Leit sinn och villäicht manner mat der Natur verknäppt, sou datt se mol net wëssen, wa do fortkënnt. Fir si kënnt do héchstens ee Bam fort, an hu lo net onbedéngt strong feelings fir dee Bam oder déi mannste Leit hunn dat. Wann dat dee Bam ass, wou si grad mol gären heiansdo drënner op där Bänk do setzen, dann ass en hinne ganz wichteg, mee generell ass d'Mentalitéit bei eis am Land nach ëmmer déi, datt de Mënsch wäit iwwert dem eenzelen Bam oder Déier steet. Fir ganz vill Leit – dat ass ee Sproch, deen ech ëmmer rëm héieren – „jo wéi, ass lo dee Bam, déi Fliedermaus, dee Vull lo méi wichteg wéi ech?" Dat ass eppes, wat ech ganz oft héieren. D'Fro ass jo net iwwert déi eng Persoun an deen ee Bam, a fir déi géinteneen ofzeweien. Et geet jo vill méi ëm ee Gesamtgefüge, wou dat do lo zesummenhänkt. An dat ass eeben bëssen de Problem: jidderee gesäit ëmmer sou grad seng Iddi, déi da grad déi allerbescht ass, an déi da muss duerch exerzéiert ginn. Et ass schonn e bësse sou een Egozentrismus dohannert, wou een da säi klenge Besoin als wichtegste gesäit an dee priméiert do iwwert all aneren. An och dat Gefill vun: „jo, mee heen dohannen huet dat jo dierfen virun 10 Joer, da wäert ech dat jo och dierfen". Ech

mengen schonn, dass den Aarteschwund ee Bewosstsinn ass, ech mengen, dass d'Leit och mëttlerweil verstan hunn, dass dat keng gutt Saach ass an datt dat Konsequenzen huet, mee dat ass eppes awer ëmmer nach relativ abstrakt, net gräifbar ass. Am Moment beschreiwen d'Leit dat dann héchstens als „jo, ech gesi manner Päiperleke wéi soss", an dat läit zum Deel leider och dodrunner dass d'Leit guer net wësse, wat verschwënnt. Als jonken Naturinteresséierten léiert een d'Saachen da kennen, an dann iwwert d'Joren, Joerzéngten mierkt een op eemol dann: „dat doten huet ofgeholl". Mee dat Wëssen, dat Gefill wat bannendran an engem ass, fir dat engem aneren ze vermëttelen an ze soen „hei, esou war et, sou vill Feldlerchen sinn et fréier ginn an haut ginn et der nëmme méi sou vill". Dat eent ass just eng Zuel, an et ass ee Gefill, wat een dobäi huet. An dat ass just nach dat eent. Wéi vermëttelen ech deem da lo, datt dat wichteg ass, dass méi Feldlerchen do sinn? Éischtens well déi Feldlerchen eng valeur intrinsèque hunn, mee zweetens awer och just een Indicateur an engem Gesamtgefüge sinn an einfach weisen, wéi vill ass dee ganze Liewensraum méi schlecht ginn, wéi vill ass d'Liewensqualitéit domat och fir de Mënsch méi schlecht ginn. Dat ass eeben dat, wat hei mengen ech ausschlaggebend ass. An doduercher bedéngt, dass kee Grondverständnis dofir do ass, dass d'Akzeptanz ganz geréng ass – Klammer op: wéini sinn d'Leit fir Naturschutz begeeschtert? Meeschtens dann, well se Angscht huet, dass dat si lo stéiert, wat do lo kënnt. Biergerinitiativen, déi sech grënnen, ass manner wéinst deem eenzelen Déier oder Bam, et ass meeschtens, well et si lo stéiert, datt do lo ee Contournement oder wat och ëmmer hannert hiert Haus kënnt. Et ass hiert gutt Recht, ech kann dat alles och novollzéien, mee et gëtt da mat Argumenter geschafft – op ee mol sinn dann déi Déierenaarte gutt genuch. Ech hunn dat awer méi wéi eemol erlieft, datt genau déi selwecht Leit an engem anere Fall zu deene selwechten Aarte gesot hunn: „dat ka jo net sinn, dass déi lo méi wichteg ass". Also ech hunn déi selwecht Leit scho gesinn soen: „hei musse mer lo den Neimerder schützen", an an engem nächste Projet gesot hunn „et kann net net sinn, dass den Neimerder méi wichteg ass wéi d'Leit". An dat beschreift et. Et ass einfach: wat ass elo meng Volontéit? Wat hunn ech lo decidéiert fir mech, wat méi wichteg ass? Voilà, dat generell zur Astellung vun de Leit par Rapport zur Biodiversitéit, an ech mengen well dat net méi déif verwuerzelt ass, dat Gefill vun engersäits enger gewesser Trauregkeet, dass d'Qualiteit vun deene Liewensraim erofgeet, zum aneren awer d'Erkenntnis an d'Akzeptéieren vum Fait, datt d'Ekosystem Servicer, déi een och verstoppt elo kritt, awer eeben net gesäit, net ëmmer ass et fir eis gräifbar, spierbar. Spéitstens déi nächst Generatiounen kinnte kréien oder eeben net méi kënne kréien, dat gëtt wäit ewech gedréckt, an doduercher traut sech am Fong och keen, déi Decisiounen ze huelen, un déi Saache erunzegoen. An déi di sech trauen, déi scheitere meeschtens a spéitstens bei deenen nächste Walen, da kréien se dann de Retourziedel a kréien virgeworf, dass dat eeben net gewënscht war vun de Leit. Esou extrem ekologesch Positiounen anzehuelen ass eiser Gesellschaft awer an der breeder Gesellschaft net akzeptéiert. Kuckt einfach nëmme mol déi Diskussiounen, wou mer rëm hunn, zu Fliedermais. Et geet jo net, datt iergendwou hei Leit puristesch sinn par Rapport zu Fliedermais, et geet just drëm, datt déi Fliedermais Indicateure sinn vun enger gudder

Liewensqualitéit, a wann een déi Fliedermais an hier Liewensraim dropmécht, mécht een och ee Stéck Liewensqualitéit drop, an sou gëtt dat net empfonnt. Fir déi Leit ass hier Liewensqualitéit jo, datt si hire Projet duerchzéien, dee si lo do grad wollte maachen, dat kann ee Bauprojet sinn, dat kann ee Stroossebauprojet sinn, dat kann ee PAP sinn, eng Cité sinn, dat kënnen divers Saache sinn, mee jidderee gesäit do ëmmer just säi Projet als dee wichtegen, dat ka jo net sinn, datt do lo e Bam, een Déier stéiert. Mee datt et ee Cumul ass vun Déieren a vu Beem, déi ëmmer rëm fortkommen, déi net ëmmer rëm kënnen enzwousch anescht rëm hisetzen, dat gëtt net verstanen. Et ass einfach ze komplex fir d'Leit fir ze verstoen.

NS: Mir komme lo schonn zimmlech zum Schluss vun der Zäit. Ech hätt lo nach eng, zwou Froen: also direkt lo mol fir unzeknäppen: Dir hutt scho vun den Ekosystem Servicer geschwat. Wéi staark mécht sech de Verloscht vun deene Servicer elo scho bei eis – ech kann dat lo net onbedéngt ob d'ZVI bezéien – mee national, wéi staark gesi mer do schonn de Verloscht vun deene Servicer? Ech denken un d'Pollinators, déi gi jo scho erof säit Joerzéngten, aner Servicer, déi kënne villäicht bësse kompenséiert ginn – bei der Landwirtschaft duerch méi Input – mee, wéi wäit ass et scho moossbar, dass di Servicer wierklech schonn zerstéiert ginn?

GB: Nee, also fir eppes moossen ze kënnen, fir een Delta festzestellen, muss een et jo eng aner Kéier gemooss hunn. Et muss een eng Methodik festgeluecht hunn an et chiffréiert hunn. Di mannsten europäesch Member Staten hunn et fäerdegbruecht. Di meeschte Länner hunn identifizéiert: wat hu mir vun Typpen vu Ekosystem Servicer, baséierend op deene Kartéierungen, déi et ginn – déi eng schaffe mat deem CORINE Land Cover, vun dorausser extrapoléieren se eppes, anerer hu vläicht mol bësse méi detailléiert Kartéierungen, mee et ass jo ëmmer eng Definitiounssaach. Wéi eng sinn déi Servicer, déi lo wichteg sinn a wéi ee Facteur setzen ech lo op wéi ee Service? An dann déi och chiffréieren, dat heescht eng ekonomesch Valeur op deen eenzele Service setzen. Opmannst fir Lëtzebuerg hu mir do nach näischt Festes operluecht, bon dat kënnt sou lues a lues ëmmer méi, virdrun hu mer vun de Kompenséierunge geschwat, doduercher datt mer lo gesot hunn: en Ekopunkt ass lo gläich en Euro, domadder hu mer eng ekonomesch Valeur op en Ekopunkt gesat, an domadder kreéiert een dann eigentlech ee Wäert fir eppes, deen och moossbar ass, wann eppes zerstéiert gëtt. Dat heescht ech ka ganz genau soen: „wat kascht dat mech, wann ech een Hektar Bongert oder Buchebësch wëll zerstéieren?"Da weess ech ganz genau, wat dat mech kascht. Aus Ekopunkt-Iwwerleeung iwwersat gëtt dat da sou vill Euro. Wéi vill dee Buchebesch oder dee Bongert-Hektar mir oder der Gesellschaft nach zousätzlech niewent dem Käschtepunkt, deen ech einfach lo muss als Ekopunkt bezuelen, nach geliwwert huet, dat hu mir eigentlech esou nach net quantifizéiert. Dat kann een alles quantifizéieren, wann ee sech do op eng Nomenclature, ee Schlëssel festleet, kann een dat maachen. Mir hunn dat op alle Fall nach net gemaach, do gouf et Initiativen virun e puer Joer, fir dat emol unzefänken, fir iwwerhaapt ee Mapping ze maachen, also dat kartografesch duerzestellen: „wou ginn et wéi eng dominant Servicer, wéi se erhale sinn", a wat e

mat méi Leit egschwat huet, wat et zu méi Sträitgespréicher gefouert huet. Dat war net einfach: natierlech Vertrieder vun der Landwirtschaft hunn hier Servicer méi wichteg gesinn wéi déi vum Tourismus zum Beispill, ee Bëschmann oder Bëschfra gesäit Servicer vun Holzproduktioun als méi wichteg un wéi den Tourismus, deen d'Rekreatioun an de Bëscher gesäit. Dat ass einfach dat, wat mir net festgeluecht hunn. Bon, ee Réckgang vun Ekosystem Servicer – jo, natierlech, vu dass eis Ekosystemer zréckgaange sinn, oder verschiddener op d'mannst, ass et kloer, dass do och Servicer mussen ofgeholl hunn. Klassescht Beispill wier, wa mer kucken, wat mir bei eis am Land fir Quellen hunn, déi fir Drénkwaasserzwecker genotzt goufen oder nach ginn. Wann ee lo seet, di sinn esou vill Quellen, déi sinn elo belaascht mat Pestiziden oder mat Närstoffer, an déi kënne lo net méi fir Drénkzwecker genotzt ginn, dann hu mer do ee konkreten ekonomesche Verloscht. Ech hunn Är Fro sou verstanen – ekonomesch Verloschter. Et ginn natierlech aner Wäerter wéi ekonomescher, déi ee Service kann hunn: Rekreatioun kann och een ekonomesche Wäert hunn. Dee kann ganz wäit goen: wat ass mäi Wuelbefanne wäert fir mäin Employeur, wann et mir besser geet, wann ech mech gutt erholl hunn, weekends an ech war an de Bësch trëppelen? Dat geet wäit nach iwwert den ekonomesche Wäert, deen an deem Holz do stécht, eraus. Dat hu mir fir eis lo net alles beziffert. Och wann ee lo seet: „wat ass d'Wäertegkeet vun de Pollinators?" Mir kennen do graff Schätzungen op europäeschen Niveau, ech menge 15 Milliarden Euro bréngen d'Pollinators eis järlech, dat ass schonn eng Schätzung, eng Héichrechnung, do kann ee warscheinlech mat verschiddenen Approche erugoen, wat do lo di Wäertegkeet ass, villäicht sinn do verschidde Sparten nach guer net ofgedeckt – villäicht ass et dat duebelt, villäicht ass et just d'Hallschent, mee bon, et ass mol eng Zuel am Raum. 15 Milliarden ass jo net näischt fir déi Pollinators. Fir op Är Fro zréckzekommen: mir hunn do lo keng ekonomesch Zuelen drop, mee mir hu kloer Servicer, déi gelidden hunn an déi hänken zum Deel och deenen zesummen, déi ech virdrun opgezielt hunn, also all Servicer, wou mer kréien, déi aus iergendwelleche Fiicht-Liewensraim kommen, déi – wat lo ganz aktuell kéint sinn mat eiser Staarkreensituation – alles wat iergendwou kéint natierlech Waasser zréckhalen huet schonn staark gelidden, also de Service „natierlech Waasserretentioun" huet staark gelidden, an deems mer all eis Baachen staark begradegt hunn. Pollinators hu mer gesot, Bëschservicer – bon, d'Ekosystem Bëscher sinn relativ gutt, sou dass déi Servicer, déi de Bësch eis liwwert lo net onbedéngt sou katastrophal de Moment och sinn.

NS: Et verwonnert mech och net, mee wéi gesot, ech hunn et schwiereg, iergendwellech Donnéeën ze fannen, déi iwwerhaapt mol quantifizéieren an a wéi engem Mooss verschiddene Servicer existéieren, wéi wäit se zréckgaange sinn, a wéi eng Impakter dat op d'Gesellschaft huet. Dat ass immens schwiereg, oder et ass nach net gemaach ginn, soe mer mol sou.

GB: Ass net gemaach ginn. Et ass versicht ginn, mol iwwerhaapt Servicer festzeleeën, wou se sinn – dann ass mol een Ist-Zoustand festgehalen – wann een dann an e puer Joer seet: „lo mol kucken, wéi sech dat verännert huet", dann ass deen Service entspriechend zréckgaangen, do kann ee jo dann och graff rechnen, wat dat ekonomesch

bedeit, mee ech mengen, dass dat awer och fir grouss Diskussioune suergt. Wat flott gewiescht wier, wat sech ëmmer bëssen erhofft ginn ass, datt einfach op europäeschen Niveau eng Nomenclature festgeluecht gi wär: „wéi sinn d'Ekosystemer an hier Servicer ze kartéieren a wéi sinn se ze monetariséieren?" Mee bon, et ass kloer, dass een Ekosystem Service X bei eis am Land op där selwechter Fläch warscheinlech eng aner Wäertegkeet huet wéi a Griicheland. Egal wéi féiert dat ëmmer zu gréisseren Diskussiounen, an d'europäesch Kommissioun huet et och net fäerdeg bruecht, do eng Nomenclature virzeleeën, obwuel se dat och versicht huet, mee do war bis elo nach kee Konsens fonnt ginn. Also national hu mer net net fäerdeg bruecht, a sou ass warscheinlech nach vill méi schwéier, op europäeschen Niveau. Ech weess, ech denken, et fënnt een net schrecklech vill Zuelen.

NS: Sou, lo probéieren ech zum Schluss ze kommen. Nach villäicht ee Bléck an d'Zukunft: d'Zil ass jo am Endeffekt op laang Dauer, d'Biodiversitéit rëm an ee gudden Zoustand ze bréngen. Et ass net nëmmen ee holistescht Zil, mee dat ass och an den EU-Direktiven néiergeschriwwen. Wéi realistesch ass dat oder a wéi engem Horizont kënne mir eis erwaarden, dass mer rëm op eng riicht Spuer kommen, besonnesch wann ee bedenkt, dass elo d'Klimakris an den nächsten Joerzéngten ëmmer méi staark, ëmmer méi séier wäert do matspillen. Dat ass elo méi eng perséinlech Aschätzung vun Ärer Säit, well Dir ee Gefill fir déi ganz Prozeduren an di ganz Komplexitéit vum Problem hutt. Et géif mech einfach interesséieren, wat Dir dozou sot.

GB: Jo, dat ass natierlech een Thema fir sech, besonnesch mam Klimawandel. Klimaadaptatioun ass schonn ee ganz wichtege Sujet bei eis, mir sinn am Moment amgaangen, all Weichen ze stellen, fir déi ganz Klimaadaptatioun notamment vun de Bëscher, mee awer och dee ganze Sujet, wat de Klimawandel mat sech bréngt, a wat sinn Adaptatiounen, déi mer musse maachen, fir dass mer méi gewappnet sinn op Hëtzten, méi gewappnet sinn op Dréchenten, méi gewappnet sinn op Staarkreenevenementer, méi gewappnet sinn op Iwwerschwemmungen, wou ëmmer méi bewosst gëtt. Natierlech, Héichwaasserevenementer, wéi mer elo haten, d'Dréchente vun deene leschte Joren, dëst Joer manifestement net. Et sinn eng Rei Pisten, déi mer lo ustriewen: national hu mer zum Beispill Primmen agefouert, am Bëschberäich fir manner op Produktioun an awer méi op d'Valorisatioun vum bestoende Bësch, wou weider eng Exploitatioun ass vun de private Bëscher, deenen ee Subside ze ginn, eng Monetariséierung eigentlech vun engem Service, wou si hëllefen bei der Klimaadaptatioun. Do si mer e bësse bei den Ekosystem Servicer: mir setzen eigentlech ee Wäert op eppes drop, wou mer net genau wëssen, wat dee Wäert ass, mee doduerch, dass mer ee Subside dropsetzen, gi mer der Saach awer op eemol ee Wäert, andeems ech soen, wéivill eppes kascht, ginn ech der Saach ee Wäert. Hei ass et d'selwecht bei där Primm „Klimabonus Bësch", déi mir elo agefouert hunn, wou am Moment grousse Succès huet, déi hu mer lo réischt dëst Joer lancéiert, an déi Zuele wäerte mer dann och lo ufroen, wéi vill Bëschbesëtzer lo matgemaach hunn. Et ass eng net oninteressant Pist, well mir bréngen et mat där Primm fäerdeg, datt d'Leit sech decidéieren, amplaz net adaptéiert Bamzorten anerer hei ze

planzen, ze favoriséieren. An och net méi mat engem Kahlschlag ze schaffen, mee mat engem Prinzip vum Dauerbësch, sou dass méiglechst soll ëmmer Bësch stoe bleiwen, dass ëmmer nëmmen eenzel Stämm erausgeholl ginn, doduerch huet ee manner Recolte, mee et huet ee méi Bësch do stoen, Bësch, mat deem ganze Schied, mat där ganzer Loftfiichtegkeet, déi de Bësch eeben huet, mat där ganzer Waasserretentioun, mat deem ganze Waasserfilteren, an all deene Servicer, déi de Bësch liwwert, fir dann do och matzemaachen, a sech sou och ze wappne géint de Klimawandel. Dat ass mol dat, wou mer awer quasi d'Hallschent vum Bësch vum Land kéinten ofzielen, wann d'Leit do matmaachen. Ech mengen net, datt all d'Privatleit do matmaachen, mee awer wa méi wéi d'Hallschent scho mol géing matmaachen, da géinge mer schonn eng grouss Surface vum Land domadder nohalteg gestalten. Déi ëffentlech Bëscher gi souwisou schonn esou geréiert, sou datt mer am Bëschberäich eigentlech eis Hausaufgabe gemaach hunn, fir an di nächst Zukunft ran. Et ass och wichteg, wëssend dass de Bësch lues op eppes reagéiert, an op Negatives awer leider ganz séier ka reagéieren, net an eisem Interêt. Mir hunn och aner Initiativen lancéiert wéi den Naturpakt, fir d'Gemengen ze beweegen, all Rechter a Flichten, déi d'Gemengen hunn, generell méi ekologesch ze orientéieren, an deems mer ee Moosnamekatalog festgehalen hunn – genannt Naturpakt – an do ginn d'Gemenge bewäert no engem eenheetleche Schlëssel an do kann och vergläichen: „wéi ekologesch sinn déi Gemengen?" An do hu mer beim Klimapakt gutt Erfarunge gesammelt, an hoffen, dass dat mam Naturpakt genausou wäert stattfannen, dass d'Gemengen sech dann engagéieren, fir ee bessere Score ze erreechen. Si hu jo da jo eng Bewäertung, an déi gëtt all puer Joer frëschgemaach, op Demande kann se all Joer frëschgemaach ginn, oder op d'mannst all dräi Joer muss déi da frëschgemaach ginn, dat heescht si ginn nei evaluéiert, an dotëscht probéieren se sech dann ze verbesseren an all deenen Interêten, notamment wat d'Klimaadaptatioun och ass, dat heescht méi Beem am urbane Raum planzen, fir all déi se planzen, kréien se dann Punkten zougeschwat, fir all déi Biotopen, déi se kaaft hunn, geréiert hunn, fir all déi Bëscher, déi se geréieren, fir alles dat kréien d'Gemengen da Punkten a stinn dann am deem Scoring do ëmmer besser, an da kréien se dann entweder keng Medaill, oder eng Bronze-, Sëlwer- oder Gold-Medaill a kënnen dat dann och op hier Bréiwer, d'Entrée vum Duerf schreiwen, sou wie der dat villäicht scho mol gesinn hutt, wann dir an Dierfer erafuert, do ginn et déi Panneauen „Klimagemeng", an dat selwecht soll eeben och lo mam Naturpakt kommen, an do sinn awer scho vill Gemengen, déi lo schonn ugeklappt hunn an do lo wëlle matmaachen. Dat Naturpaktgesetz ass dëse Juni gestëmmt ginn a wat da lo Enn Juli, Ufank August a Kraaft [getrueden ass]. Dat heescht, mir probéieren, Partner ze gewannen, fir déi méi ekologesch orientéiert Upassung ze maachen. Et geet drëms, Bewosstsinn ze schafen, bei deene verschiddene Secteuren, eng Wäertegkeet och op déi Natur ze setzen – an ech sinn net grousse Fan dovunner, fir engem Bam ee Wäert ze ginn, mee am Moment schéngt et awer ee wichtege Wee ze sinn, well dat ass de Wee, wéi se et verstinn. An iergendenger vager Zukunft kee proppert Waasser méi ze hunn, dat versteet kee sou richteg, et mécht bësse Suergen, mee ech kann et net spieren. Wann ech awer lo soen, an 10 Joer muss du de Liter duebel sou deier

bezuelen wéi haut, well et kee proppert Waasser méi gëtt, a mir mussen et méi deier opbereeden, op eemol, da versteet jiddereen et. Da kann een eppes dropsetzen, mat eppes vergläichen, wat ee kennt, an där ganzer Saach dann ee méi héije Stellewäert ginn. Dat sinn eeben déi Saachen, wou ech mer awer lo eppes erhoffen an Zukunft. Een Datum dropzesetzen? Ech wär natierlech frou, wa mer konform zur europäescher Biodiversitéitsstrategie bis 2030 den Aarteschwond definitiv gestoppt hätten, ech wär frou war mer e virgëschter gestoppt hätten, dass mer eis do kloer sinn, ech wär frou wa mer en 2010 gestoppt hätten, mee mir striewen awer lo mol un, an deenen nächste fënnef Joer wieder nach mat Naturschutzgebidder gutt virunzekommen. Lescht Joer si mer gutt virukomm, hoffen, déi nächst Joer wieder gutt virunzekommen, an dass mer spéitstens bis 2030 de Reseau komplett stoen hunn, eng adaptéiert Gestioun an deene Gebidder och hunn, a wann dat sou stattfënnt, dann hu mer 30% vum Land an Naturschutzgebidder ausgewisen, dovunner 10% a méi strengen – de Moment si mer bei 4% méi strengen – an domadder dann der Biodiversitéitskris déi néideg Kehrtwende ze ginn. Ech mengen, dass mer wëssen, wat mer musse maachen, ech denken och, dass mer lo net sou ganz sou schlecht ekonomesch do stinn, dass mer déi Saachen och kéinte maachen, mee mir brauchen awer een Ëmdenken vu verschiddenen anere Secteuren a vun de Leit insgesamt. Ouni dat Ëmdenken gëtt et schwéier, datt ech mech hei zu enger Prognostique ausschwätzen. Ech géif lo gäre soen „2030 si mer definitiv um Wee vun der Amelioratioun“, ech soen nach net, dass d'Biodiversitéit da rëm total restauréiert ass, mee 2030 wär et gutt, wa mer effektiv kéinte soen: „lo hu mer rëm signifikant Amelioratioun“ an an deenen nächsten Jore hätte dann de Réckgang definitiv gestoppt. Dat wär dat, wat ech ustriewen – also ech hu keng Loscht, ee Prognostique ze ginn, dass mer deen réischt 2050 restauréiert hunn, dat fält mer lo schwéier, dat ze soen, och wann et villäicht realistesch ass, mee ech wëll net, dass et sou ass, soe mer mol sou.

GB: D'selwecht bei mir. Ech soen Iech villmools Merci! Et war extrem interessant, all déi Äntwerten ze kréien. Vill Saache decke sech och mat deem, wat ech mat der Madame Junker beschwat hunn, natierlech déi Saachen, déi méi op d'Biodiversitéit ginn, ergänzen dat. Ech si lo gespaant, wann ech dat a menger Aarbecht zesummeschaffen, zu wat fir Schléss ech da kommen.