

“Can classic population-  
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impacts of population  
decline?” *Finding evidence from  
strategic environmental policy analysis  
of four German regions*

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# “Can classic population-environment theories describe environmental impacts of population decline?”

*Finding evidence from strategic environmental policy analysis of four German regions*

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# FOREWORD

Wageningen, 04-01-2013

Perhaps the best part about writing a thesis, is writing the foreword. Although the name suggests differently, it is written at the *end* of a process, which makes it a testimony of the satisfaction of finished work. It has been a great relief to be able to finally present the results of months of work in a (more or less) coherent story. After all, it was some ten months ago that I started thinking about a topic for my thesis. The idea of writing a thesis about sustainable development and population decline had been wandering around in my head for some time and I decided to go for it. Population decline has had my attention for some time, following a bachelor thesis on the same topic, and I was especially curious to find out how the problematics of shrinking regions compares to the general notion in sustainability science that growing world populations are threatening sustainable development. When working on a research design, it then turned out that translating this idea to a workable research proposal would present a big challenge. And it is actually throughout most of this thesis that I have been struggling to find the right form and approach for researching the environmental effects of population decline. Besides that, the methods that I chose initially, turned out not to be workable in the way that I had expected. The lack of a body of literature around the specific topic further made it difficult to benchmark my approach with past research, as I had to scavenge through different types of literature to collect ideas and approaches from different disciplines. All in all, the challenge was tougher than I had expected. Still, while the process has been a continuous struggle, the topic itself has continued to intrigue me throughout the process. With new insights came new questions as well as new perspectives on my assumptions. While the research perhaps has not led to much spectacular conclusions, I always have felt that the research was relevant, if only because, to my knowledge, no similar research has been done before. This may perhaps also explain the emphasis that I have put on finding a suitable approach and methodology which, I guess, sometimes may have compromised the focus on results a little. This may, so to say, have been a “weakness of the flesh” of the author, as my main approach to problem solving is in thinking rather than acting first and solving problems later. Although thinking about what you are doing usually is a good idea, it sometimes also proved to be a trap for slowing me down. However, in the final stages, I finally felt that I was more on the right track, and the last stretches of the research were more satisfying, as I noticed that the different pieces were coming together.

Overall, the feeling of relief that I feel is not just gladness it is over. It is also satisfaction that the creative struggle between intentions and possibility has condensed in a final product that, in my opinion, provides some meaningful conclusions about interactions between population decline and environmental management. For that, I am very grateful and first of all, I would like to thank my supervisor, dr. Mendel Giezen, for his support. Although we did not meet regularly, the help I received when I was stuck often got me on the right track again to continue my work. There are also some others whom I would like to thank: Elise, Freddy and Menno for reading and commenting on my thesis. My family I would like to thank for their belief in me and their support. My housemates and members of my students association I would like to thank for lifting my spirits from time to time, it was surely needed. And it would be ungrateful not to thank God: it has been a great relief for me to be reminded from time to time that success and meaning in life does not depend on a thesis and that failure, in that way, does not exist. For the reader: I hope you will enjoy reading through the (extensive) pages of this thesis. And because I know that from time to time you won't, I hope even more that it will provide some new insights and new points of view that can be of value in your thinking about sustainable development.

# ABBREVIATIONS

DT – Demographic Transition

DWU - Dialog Wirtschaft und Umwelt Nordrhein-Westfalen

EKC - Environmental Kuznets Curve

EU- European Union

GDP – Gross Domestic Product

HDI – Human Development Index

IPAT - Impact = Population \* Affluence \* Technology

ImPACT – Impact = Population \* Affluence \* Consumption per unit of affluence \* Impact per unit of consumption

LEP - Landesentwicklungsprogramm or Landesentwicklungsplan

MVP – Mecklenburg-Vorpommern

NMVOG - Non-methane volatile organic compounds

NRW – Nordrhein-Westfalen

NUTS - Nomenclature des Unités Territoriales Statistiques (Nomenclature of territorial units for statistics)

PCDD - Polychlorinated dibenzodioxins

PCH - Polycyclic aromatic hydrocarbon

PPP – Public Private Partnership

PM10 – Particulate Matter: Particles with an aerodynamic diameter of less than 10 micrometer

PM2.5 - Particulate Matter: Particles with an aerodynamic diameter of less than 2.5 micrometer

SDT – Second Demographic Transition

STIRPAT - Stochastic Impacts by Regression on Population, Affluence and Technology

TFR – Total Fertility Rate

UK – United Kingdom

UN – United Nations

UNDESA - United Nations Department of Economic and Social Affairs

USA – United States of America

WCED – World Commission on Environment and Development



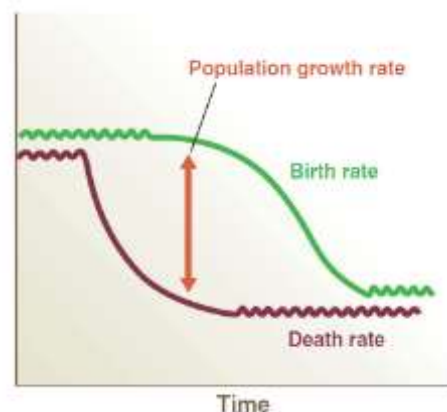
# INTRODUCTION

## Problem definition

According to the medium-fertility predictions of the 2010's UN population projections, global population may grow from a current 7 billion to about 10 billion at the end of the century (Bloom, 2011; UNDESA, 2011). This growth of the world population is expected to take place mainly in developing countries, creating both opportunities and challenges for the sustainable development there (Lutz et al., 2011). At the same time, changes in population structure in *developed* countries may also have potentially big effects on global sustainable development, due to the high share of the earth's resources that is being consumed in these countries (Lutz et al., 2011). If population indeed is a major determinant of sustainable development, it would be of major importance to understand the mutual and complicated interactions of these population changes with the environment, in order to facilitate a future development which "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). However, the direction of the interactions between population and natural resources, and how this affects the earth's carrying capacity in particular and the environment in general, remains under debate. Some views about population-environment-interactions may be seen as diametrically opposing each other, while others are more nuanced and relativizing the impact of population. These views are often grounded in theories that each offer own explanations about how population interacts with the environment (e.g. Marquette, 1997; De Sherbinin et al., 2007; Bloom, 2011).

These discussions about how human population interacts with environment interactions date back even further than Thomas Malthus's famous "Essay on the principle of population" from 1798. However, the debate around population and environment has often focused around population *growth*. Yet, if we look at population projections, it becomes evident that population growth does not tell the whole story about global population developments, both for the (forecasted) future and for today. According to Scherbov et al. (2011), the likelihood that the world population as a whole will reach its maximum this century is 88%. And by 2000, already 44% of the world's population lived in countries with below-replacement level fertility (Cohen, 2003). From 2050 to 2100, 123 countries may experience a decline of population numbers according to the medium projections of the UN (UNDESA, 2011). In the coming century, Europe as a whole will likely experience a decline in population (Lutz et al., 2001; UNDESA, 2011) and, related to this, intensified ageing (Lutz et al., 2008; UNDESA, 2011).

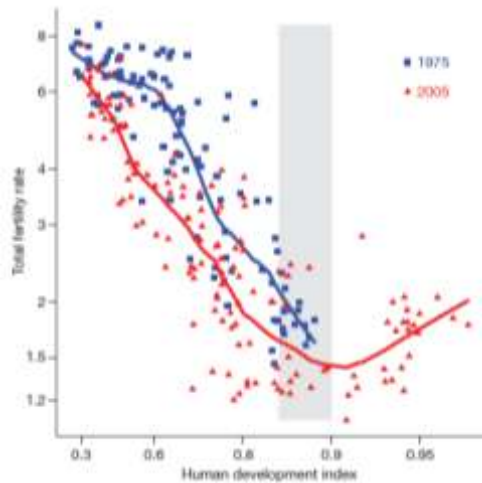
This demographic future of declining population, of which the first signs can be seen in developed nations like in Europe and Japan, can be explained with the help of two demographic models. The first one, is demographic transition (DT) model. This four stage model describes the development of populations from high mortality and fertility, via a consecutive decline of first mortality and then fertility, to both low fertility and low mortality (figure 1). In the process, this leads to an increased average age and total size of the population (Miller & Spoolman, 2009; Bloom, 2011; Lee & Reher, 2011). For Europe, this process started somewhere at the end of the 18<sup>th</sup> century with a marked decline of mortality, after which fertility could also be seen to decline drastically at the end of the 19<sup>th</sup> century (Reher, 2011). This transition pattern is often attributed to better child- and healthcare as well as better education and, later on, better contraceptive methods (Reher, 2011). Although this model shows how population growth will come to a halt after a



**Figure 1: Stylized model of the demographic transition. Because decline of birthrates follows after the decline of death rates, the demographic transition leads to an overall increase of population. Source: Bloom, 2011, p564**

transition period, the *decline* of population is, *not* explained by this model. Decline is better compatible with what Lesthaeghe and Van der Kaa have proposed to call the “second demographic transition” (SDT), which explains the demographic developments *after* a population has gone through the demographic transition. The SDT theory explains how social lifestyle patterns lead to fertility dropping below-replacement level (which is around 2.06 in developed nations), which eventually results in population decline (Lesthaeghe, 2010).

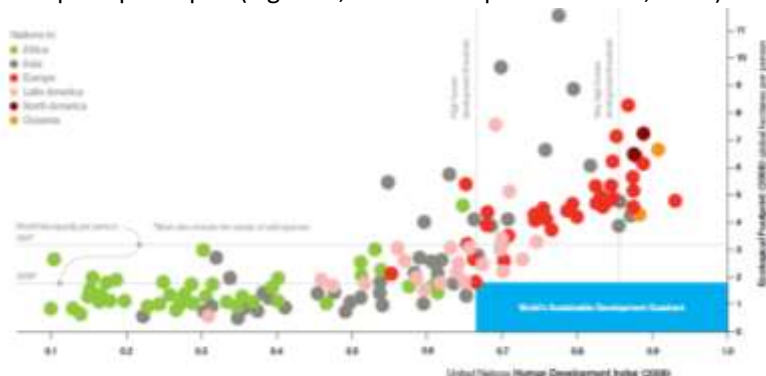
According to this theory, a Maslowian preference drift from material to immaterial values that takes place in the process of economic development that is associated with the later stages of the demographic



**Figure 2: Relation between fertility and human development (from Myrskylä et al., 2009, p 741). The most developed countries (HDI > 0.9) show a slightly higher fertility, although mostly still beneath replacement rate (TFR = 2.06)**

transition. Traditional communal values make way for self-realization of the individual. This coincides with a pattern of out-of-wedlock births, cohabitation, birth-postponement, increased female employment and a career-first mentality. In some cases, this leads to total fertility rates (TFR) dropping deeply below replacement levels (“lowest-low fertility”), to as deep as 1.1 in Ukraine (Lesthaeghe, 2010)). Others have named this SDT merely a different pattern of lifestyles related to the demographic transition (e.g. Coleman, 2004). A distinct transition or not, below replacement level total fertility rates (TFR) are nowadays a common phenomenon in most developed countries – although in the most developed countries (in terms of HDI) TFRs are actually *higher* than in slightly less developed countries (Figure 2, Myrskylä et al., 2009) and fertility rates have actually risen slightly in many European countries the past decade (Bongaarts & Sobotka, 2012). However, model predictions as well as professional judgment indicate that population decline due to below-replacement fertility will continue to become more widespread, affecting not only regions and nations, but in the long term even whole continents.

With population declining in more and more regions and countries, we may ask the question if this decline will also change existing economic and social structures (e.g. Coleman & Rowthorn, 2011). If such changes do occur and if they are of structural nature, and population decline will continue as predicted, it could alter the perspective of (global) sustainable development for better or worse. Although the population of the developed world –where population decline will take firstly - is not as numerous or does change as fast as the population in developing countries (Lutz et al., 2011; UNDESA, 2011), its impact on the global environment is comparatively much stronger, which is illustrated by a bigger ecological footprint per capita (Figure 3, Global Footprint Network, 2011). This means that both the absolute size of



**Figure 3: Higher HDI – characteristic of countries with lower fertility- tends to correspond with bigger global footprints. From: Global Footprint Network, 2011, p45**

this population and the individual (consumptive) lifestyles of people in developed countries have a relatively higher potential impact on the environment. While the impact of the population size in developed countries may be reasonably estimated by extrapolating population and consumption trends, it seems to be largely unclear how possible changes of economic and social structures in declining societies will affect the environment. What is more, it is not unlikely that such economic and

social changes will occur. There is a –not necessarily large, but still substantial- body of literature about population decline, which indicates that population decline and (associated) ageing may have profound economic and social effects (e.g. Bloom et al., 2010; Reher, 2011). It seems likely that such changes could also affect individual lifestyles and, through that, shape the environmental impact of the population. Still, I have not found a particular body of literature which digs deeper into what the consequences of these demographic changes and its associated societal changes could be for the environment.

This can point to two things. It could be possible that population decline is not regarded as having a profound effect on environmental impacts in developed countries. Discussions about the general effects of population decline seem to point to this view. When the effects of population decline are discussed in papers or reports, environmental impacts are often only briefly mentioned. And if they are mentioned, the impacts of population decline on the environment are mostly evaluated as irrelevant or simply positive (see for example an article about the consequences of population decline by Coleman & Rowthorne, 2011). Such thoughts are understandable, because current environmental problems are often ascribed to the increasing intensity of human activity within the natural environment, which would imply that population decline would tend to reduce environmental stress. However, when these statements are made without reference to, or knowledge of, actual environmental impacts of decline, they could turn out to be dangerous misconceptions.

Alternatively, it could be assumed that the dynamics of population-environment relations for cases of growth are not fundamentally different from cases of decline. In that case, traditional population-environment theories would be sufficient to explain population-environment interactions in case of population decline. This would mean that decline, rather than being a whole new entity that requires theory building and intensive empirical research on its own, is nothing but the reverse of growth, and its consequences can reasonably predicted from particular theories. In this thesis, I will put this second assumption to the test. Can an indication be given whether current population-environment theories, adapted to a context of decline, can indeed explain population-environment dynamics in declining areas? And if so, which theory offers the best explanation? This would not only offer a chance to test the applicability of main population-environment theories for population decline in developed nations, but would, in the process of research, also be a chance to obtain a basic understanding of which population-environment interaction processes could shape the environmental future of developed nations.

## Delimitation of research focus

While these questions are certainly of importance, they are of such a grand scale and general broadness that any practical research in the form of a master thesis should break down these “grand questions” in some way. “Environment” is a very broad topic, which means that drawing a picture of the condition of this environment would require initiating an intensive research project in order to obtain relevant indicators. This would require time and resources that are not available for a master thesis. In my opinion, there might be a ‘smart’ solution to this problem. By looking at experiences of environmental management of government institutions throughout the years, the processes that are taking place in territories with population shrinkage may be compared with the processes that are predicted by core population-environment theories. If there is no trace of such causalities found in environmental management experiences, then this is a strong indication that such theories do not suffice to describe actual developments, which would indicate the existence of a knowledge gap. If the theories *do* show to be applicable in conditions of decline, new insights may be obtained as to which theory provides the best explanation.

Another delimitation of the research is that a choice is made to focus on declining *regions* instead of declining *nations*. While the problem definition mainly talks of the relevance of population decline for the global scale (which would fit better with an analysis on national scale), in current times, population decline is mainly confined to particular regions *within* these developed nations.

Although some European countries already experience a net declining population, the decline of *regional* populations has been a much more common phenomenon in the past decades. As Coleman & Rowthorne (2011) point out, “*Regional and urban decline, relative or absolute, has always accompanied regional and*

*urban growth in other parts of the same country*" (p 218). The same authors point out that the existence of 'shrinking' regions within the context of countries that were experiencing net growth, is just an indication of "*adjustment to changed realities of comparative regional advantage*"(p 219), which means that their ground cause is often not low fertility, but bad economic prospects. But even if such shrinking regions are situated in a context of national growth, the processes and mechanisms that are taking place in such regions may provide the best available real-life indication of how society will change when population decline becomes an increasingly global phenomenon. Viewed this way, cases of regional population decline offer micro level study material, which can serve as an analogy to explore what the effects of population decline on a larger scale might be (Thomas, 2010; Axinn & Ghimire, 2011). Although strictly this means that results will also only be applicable to regions, these regions could also serve as an experimental 'microcosm' for the wide scale population decline which is yet to come.

Before proceeding to the research itself, some final words of caution should be made. Both the focus on environmental management experiences and on regions show that the research of environmental effects of population decline in developed nations is not a straightforward undertaking. Environmental management experiences are only a derivative of 'real' environmental changes; they reflect the perceived environmental quality from an institutional viewpoint and are therefore only a proxy. Also the focus on regions is not without its problems: regions will not be fully substitutable for nations because the specific regional characteristics can both influence the demographic profile and the environmental issues at play (Coleman & Rowthorne, 2011). Additionally, the lack of literature on the subject does not help, which gives no clear precedent of this type of research. Therefore, I will throughout the thesis strongly reflect on the methodology that has been used. This should help to clarify why the applied methods are relevant, and show to which extent the findings can be extrapolated to 'real' environmental impacts of wide-sale decline. Although this makes the research rather theoretical in scope, it is in my opinion vital to elaborate clearly on the methods in order to show the relevance of findings, but also to explore methodological foundations for possible future research about environmental impacts of decline on larger scales.

Taking into account the problem definition and the delimitations of the research, this has led to the following research questions:

## Research questions

### Main research question

"To which extent can population-environment-dynamics as experienced by regional environmental policy and management in developed regions facing population decline be explained by existing population-environment theories?"

### Sub questions:

- **SRQ1:** What would traditional population-environment theories look like if they were applied to situations of population decline?
- **SRQ2:** How can causal mechanisms that connect population decline to environmental impacts recognized from the experiences of regional environmental policy and management?
- **SRQ3:** Which are possible causal mechanisms describing how population decline can affect the environmental performance of developed regions?
- **SRQ4:** To which population-environment theory do these causal mechanisms relate?
- **SRQ5:** Which (developed) regions possess characteristics that allow meaningful analysis of causal mechanisms that connect population decline with environment?
- **SRQ6:** Which indications of causal mechanisms that connect population decline to environmental impacts can be identified in the selected regions?
- **SRQ7:** Are the indications of causal mechanisms in the selected regions strong enough to indicate a development that matches with either one of the associated core theories?

# RESEARCH METHODS

*In the following section an overview will be given of the main methods that were applied during the research. This overview will be complemented by a more complete, in-depth elaboration of the methodology in three of corresponding main sections of the research.*

## Literature research

The first step of the research (SRQ1) means gaining insight into the main population-environment theories. A literature review has been conducted to explore these core population-environment theories, by looking for articles and books that can clearly be placed in either tradition and extrapolating their meaning to situations of population decline. This involved a search for literature describing the characteristics of the theories. Also for answering SRQ3, a literature review was used. This second literature review, on which more emphasis was put, involved a broad search for possible mechanisms through which population decline can affect environmental management. With the findings of these two searches combined, it becomes clear how evidence for specific population-environment theories can be found from environmental management experiences.

Primary sources for this literature were peer-reviewed (scientific) articles, but also books, reports, college material and internet articles were included.

## Application of the 'syndrome approach'

In order to answer SRQ2, this research works from a particular research approach; the syndrome approach. This approach helps to translate any causal mechanisms that connect population decline to a particular impact, as found in literature, to concrete indicators with which policy documents can be analyzed. Because the application of this approach has implications for how the literature review of SRQ 3 is structured, this approach is introduced before this second literature review.

## Typical case study

In order to observe how the core population-environment theories manifest themselves in the dynamics of declining regions, a case study was conducted. Four regions were selected which have been subject to population decline for a longer or shorter period of time. These regions were then analyzed, to reveal how environmental policy has evaluated environmental issues in the region, by looking for indications of causal mechanisms that can be ascribed to a particular core theory. By evaluating the occurrence and intensity of these indications, as well as their (implicit or explicit) relationship with demographic development, it was tested which theory has the most explanatory power. This places the research more into Lakatosian research tradition, where the value of a theory is largely dependent on its ability to explain findings in new contexts and comparison with explanatory power of other theories (Hancké, 2009).

By selecting different regions that have been subject to decline for a longer or shorter period, as well as analyzing management experiences across a certain period of time, this case study allows to capture the development of processes across time. While ideally this demands that the regions are both similar in character as well as typical for the 'average' declining region in order to provide generalizable findings, it will turn out that these demands cannot be met. This means that a contextual understanding of the regions and deductive reasoning were needed to interpret the findings of this case study.

## Analysis of strategic environmental policy documents.

As input for answering SRQ 6 and 7, an ex-post analysis of environmental policy and environmental evaluation reports was used. The main focus was on reports that evaluated the current status of the environment and environmental management as well as provided insights into what the focal points were of environmental policy. This meant that mainly the long-term, strategic-, evaluation- and vision-documents were used for analysis. The focal points of the analysis were determined by the literature study, which provided specific topics in which population decline might have affected environmental policy and management. For each region, multiple of such reports were analyzed to cover the broadness

of these environmental and organizational topics. The reports were then scanned for indicators of the causal mechanisms that link environmental problems and management problems to the effects of population decline. If population-environment theories have value for explaining population-environment dynamics in declining regions, we should see that as decline sets in, and progresses through time, the indicators for the population-environment theories will show up more and get a more central role in the documents. If one of the theories is dominant over the other, an increasing dominance of indicators for the one theory over the other should be observed. In practice, this meant that documents were scanned for indicators, after which for each case study region an overall, qualitative assessment was given on its occurrence and intensity. An overview of the research process and which parts of the process are treated where, can be found in figure 4.

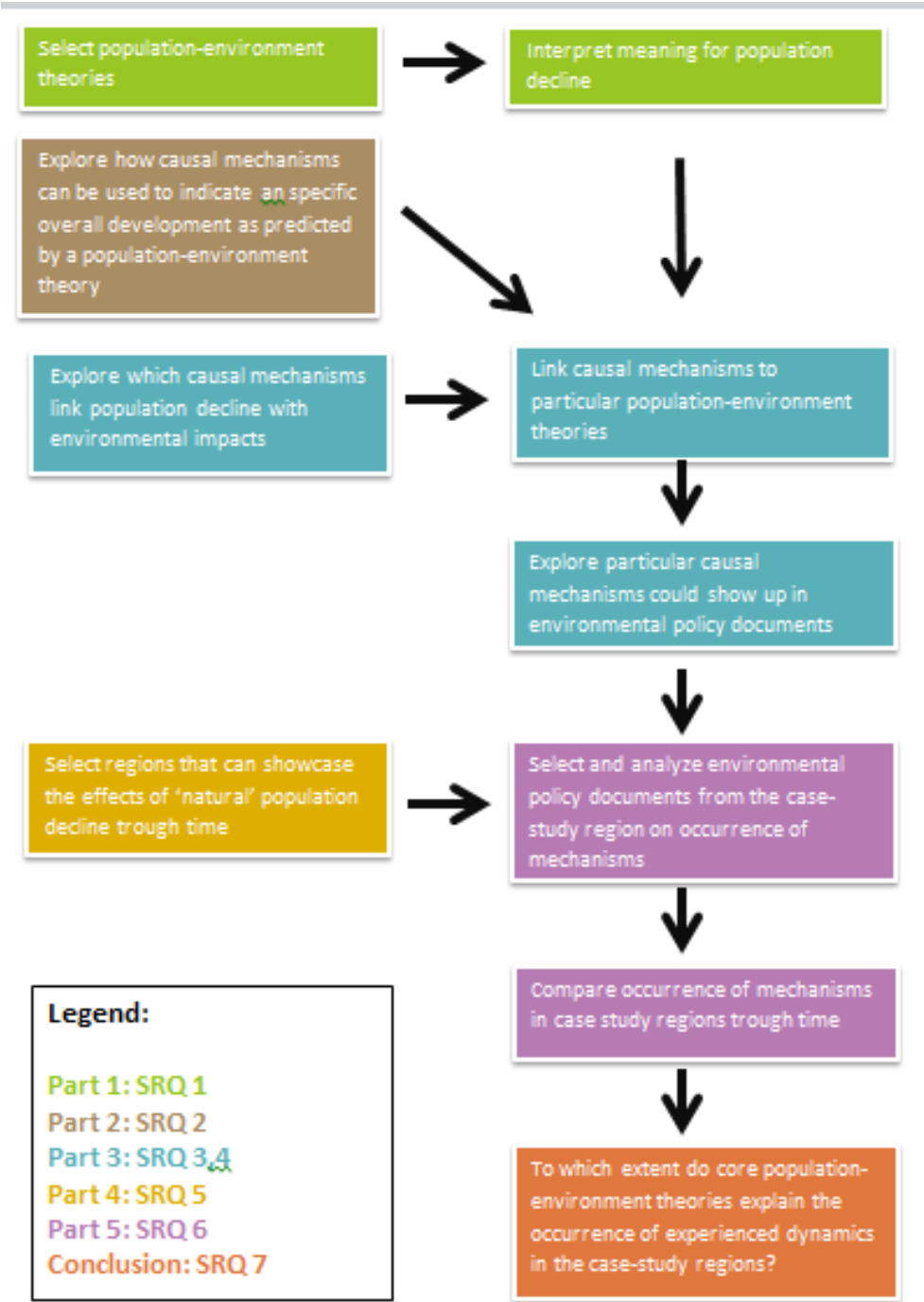


Figure 4: Schematic representation of the major steps in the research and the chapters where they can be found

# PART 1: EXPLORING MEANING OF POPULATION-ENVIRONMENT THEORIES FOR DECLINING REGIONS

## Methodology

*In this first section of the thesis, the first sub-research question of the research is being investigated: What would core population-environment theories look like if they were applied to situations of population decline? In order to answer this question, it is not only necessary to select a number of theories, but also to find a suitable form for describing the theories in a generalized ways. In the following section, it will be described how the theories were selected and a description of the IPAT equation and its origins will be given, which will be used later to characterize the different theories.*

### Selection of theories

For the selection of population-environment theories, a review of five main theories by de Sherbinin et al. (2007) was used. Although perhaps different distinctions between theories and groups of theories could be made, the theories mentioned in this review more or less match the main distinctions between theories that showed up in the other literature (e.g. Jolly, 1994). From these five theories, three were selected for further study. Although these three theories do not belong specifically to a single person and her/his opinions, I have opted to simplify the analysis by focusing a large part of the analysis around authors that can be considered influential and illustrative in each theory (Paul Ehrlich, Esther Boserup and Julian Simon). Since these names frequently reoccurred in the papers about population-environment theories, where they were marked as main influential theorists, this seems a reasonable choice. It should, however, be bore in mind during the rest of the analysis, that the views of these authors do not fully represent the true broadness of these theoretical views.

### The IPAT equation

In order to provide an understanding about the different theories, I have opted to use the 'IPAT' equation as a descriptive tool. The origins of this IPAT equation can be traced back to a debate between Barry Commoner on the one side and Paul Ehrlich and John Holdren on the other side (Chertow, 2001; York et al., 2003). This debate took place in the late 60's and the 1970's, when pollution and environmental deterioration were 'hot topics' in public and scientific debate. While both Commoner and Ehrlich/Holdren recognized that major environmental impacts were taking place, Commoner contributed this mainly to 'ecologically faulty technology', whereas Ehrlich and Holdren saw the increased (world) population as the main cause of human environmental impacts. This also meant that both sides argued for different responses to environmental problems. In his famous book 'The population bomb' (1968), Ehrlich had argued for population control measures to avert an ecological crisis. Commoner would instead argue for cleaner production technologies. Ehrlich and Holdren used a first version of the IPAT equation in 1971 to defend their stance that population is a major determinant of environmental impacts rather than the minor cause Commoner assumed it to be, by stating that environmental impacts (which could mean practically everything) equals the number of persons times their average impact, which they expressed as (Ehrlich & Holdren, 1971):

$$Impact = Population \times \frac{Impact}{Population}$$

Or in terms:

$$I = P \times F$$

Obviously, this puts population very central in determining environmental impacts. It does, however, not suggest that P and F are independent variables: Ehrlich and Holdren are quick to point out that such interdependencies may exist. Commoner later uses a modified version of this equation to further quantify the variables and introduce a technology term in order to assess if technology is more influential in shaping impacts than population. This resulted in the following reformulation:

$$Impact = Population \times \frac{economic\ good}{population} \times \frac{pollutant}{economic\ good}$$

With this reformulation, a numerical analysis of the production processes of specific goods could take place, as the terms can be expressed in real-life indicators. It also means that separate terms are introduced for affluence (the economic goods per unit of population) and technology (the amount of pollutant it costs to produce a certain commodity). Commoner used this formula for empirical research and concluded that environmental impacts can mainly be ascribed to changes in productive technology rather than in population. This formulation was later on rewritten by Ehrlich and Holdren as:

$$I (Impact) = P (population) \times A (Affluence) \times T (Technology)$$

Since the Ehrlich/Holdren vs. Commoner debate, the IPAT equation has been used in a number of variants to describe determinants of environmental pollution. As an *analytical* tool, the IPAT formulation is however of limited use for determining relative importance of the factors P, A and T, because the term T encompasses everything that affects resource-use efficiency. So, rather than using T as an input to determine I, the formula is often used to determine T when a certain impact (e.g. amount of pollution), affluence (e.g. GDP per capita) and population is known. The ambiguities in the terms of the IPAT equation have led some authors to conclude that, rather than being an analytical tool to analyze environmental impacts empirically, the IPAT formulation should be used to discuss the *conceptual* interactions between the variables determining environmental impacts (Chertow, 2001).

A possible source of bias for the use of the equation as a conceptual tool comes from the research tradition from which the equations stems. De Sherbinin et al. (2007) note that the IPAT- equation mainly stems from neo-Malthusian approaches - which is not surprising as Paul Ehrlich is one of the most prominent representatives of neo-Malthusian thinking (see next section). This association with one particular population-environment theory suggests, that using the equation without further elaboration can possibly distort the depiction of other theories by a structural bias towards neo-Malthusian explanation of population-environment dynamics. However, in practice, the research in which the formula is applied, is not always neo-Malthusian in character. According to Chertow (2001, p. 20): *“That the IPAT formulation can be interpreted in so many ways represents a weakness and a strength: on the one hand, it may simply be too broad and general to account for the interrelationships among the variables. On the other hand, it has not revealed a bias and need not be definitive to be extremely useful as a thought model.”*(...)“*There really has been no underlying disagreement that each of the terms belongs to the equation in some way and so, as a conceptual analytic approach, IPAT provides readily identifiable common ground.*” So, even though the IPAT model has been developed in the first instance to debate neo-Malthusian perspectives on population-environment relations, the model may be general enough to describe other perspectives as well when it serves as a conceptual model.



## Applying population-environment theories to shrinking populations

*In the coming section, several core-population-environment theories are explored for applicability in the research. The selection of theories took place based on a review of five main theories by de Sherbinin et al. (2007). Of these five theories, three were explored in more detail with help of the IPAT equation, which describes how human activity produces environmental impacts.*

### Political ecologists views on population and environment

According to de Sherbinin et al. (2007), political ecologists point out that population growth and environmental problems have a similar root cause, which is poverty. Environmental problems in the developing world are therefore mainly attributed to inequity. This theory will not be further explored, because the topic of the research only involves 'developed' countries, an area in which this theory is not meant to be applied.

### Intermediate variable theory

The intermediate variable theory, which is mostly rooted in demography, argues that population is mostly a scaling variable, which scales the overall magnitude of impacts of the human societal on the environment. The effects of bad policy, for example, will be increased if there are more people under influence of this policy; higher individual consumption will have a stronger impact within a larger population (Jolly, 1994). This is closely related to what is sometimes referred to as the holistic approach, which means that population (and population size) is regarded as only one of many factors influencing the environment. These factors can also interact with each other in a rather unpredictable way, so that if one factor becomes stronger, it can also change the effect of other factors. This holistic approach seems to be the most common frame of mind within population-environment research nowadays (Ruth et al., 2011). This holistic approach/intermediate variable theory is left out of the analysis because the acknowledgement that environmental impacts can depend on many different factors makes it difficult to provide predictions about the future, which means that there is no real thesis available for testing. The holistic approach may therefore be regarded as a consensus paradigm rather than a theory, which reduces its applicability, even though it may be the most realistic and most widely accepted view. This means that there are three theories left from the review by De Sherbinin et al. (2007), which are described in more detail below.

### Neo-Malthusian population-environment theory

More than two hundred years ago, Thomas Malthus wrote his famous 'Essay on the principle of population', in which he outlined the idea that food supply cannot possibly keep on supporting a 'geometrically' growing population (Brander, 2007). Generally, his 'Essay' is seen as the start of a scientific debate about population and resources (de Sherbinin et al., 2007). During the industrial revolution, which led to higher population numbers and higher living standards, Malthusian theory remained more in the background of public interest. In the 1960's and 70's, however, a new interest in human-environment relations arose. This time, also other environmental issues like (different types of) pollution, waste disposal, biodiversity and later on also climate change, ozone depletion, etc., were a source of discussion (Pebley, 1998; Brander, 2007). It may not be surprising that this interest arose in the 60's and 70's, when a public awareness about environmental problems began to grow and when population growth rates peaked at around 2.1% per year (Cohen, 2003). The new, modern adherers of such a Malthusian-style view, who believe that population has the tendency to grow over natural limits which might result in collapse, are called neo-Malthusians (de Sherbinin et al., 2007). Some well-known examples include the work of Paul and Anne Ehrlich (e.g. Ehrlich et al., 1993; Ehrlich, 1968; Ehrlich & Ehrlich, 2006) and the Club of Rome (Meadows et al., 1972). Thinking along these neo-Malthusian lines has led to expressions of fear about the consequences of (global) population increase (e.g. Ehrlich, 1968; Nentwig, 1999). Such a neo-Malthusian view on population-environment relations is often regarded as deeply pessimistic. Paul Ehrlich, one of the neo-Malthusian authors mentioned above, is for example mentioned by Harper (2000) as one of the important 'prophets of doom' of the past generation of environmental thinkers. Most notably in his 1968 book 'The population bomb', Ehrlich pointed out the disastrous consequences of continued population growth and predicted large-scale famine in the 70's due to overpopulation, leading

him to argue for more stringent population control policies. In terms of the IPAT equation, this view means that P is of great importance in defining impacts, compared to affluence and technology. Neo-Malthusians do however not deny that A and T also have an impact. After all, the IPAT formula was proposed by Ehrlich himself, which shows that he does recognize A and T as important determinants as well. Neo-Malthusian also do not discard the possibility of interrelations between the variables I,A,T and P. In the 1971 article in which Ehrlich and Holdren present the  $I = P * F$  formulation, they are quick to note that *“it is often assumed that population size and per capita impact are independent variables, when in fact they are not”* (p1212). In the spirit of their “doomster” classification, however, the examples that they name of such interactions are those when population increases impacts per person or when the impact feeds back negatively on population. If we compare such interactions between population and technology or affluence with the traditional Malthusian theory, Ehrlich may here actually be at odds with it. In the classic Malthusian theory, where population increases exponentially and agricultural output increases just linearly, a vision is suggested where P is largely *independent* from A and T (Brander, 2007). At this point, it thus becomes hard to separate the neo-Malthusian theory from sheer pessimism: does the neo-Malthusian view mean that population growth will *always* lead to deteriorating environmental impacts, even in interactions with technology and affluence, or does it stress that population, if unchecked, tends to growth towards a natural limit? It has some consequences for a neo-Malthusian view of population decline if we take this ‘pessimistic’ or ‘mechanistic’ view of neo-Malthusian theory. If we take the last, ‘mechanistic view’(which is closer to traditional Malthusian theory), it would pose the question if the current population decline is perhaps an outing of such limits to population. We may for example consider a mechanism where the costs of having children increases due to resource scarcity, leading to a choice for not having many children. Off course, in reality such a population decline could also be an external, cultural factor that is not incorporated by Malthusian theory. In either case, a declining population would mean a stabilization of environmental impacts and a population at or below carrying capacity, simply because population size determines environmental impact.

Yet, if we follow the line that feedbacks between P, A and T tend to increase impacts even more (which is closer to statements in Ehrlich & Holdrens article, the ‘pessimistic’ view), we should expect not only a decreasing total impact when population declines, but even a decreasing impact **per person**. This would be attributed to a decrease in T (which means more efficient technology) rather than a decrease in affluence, because that would suggest that there are less resources used per person. After all, in a neo-Malthusian view, the total number of available resources is fixed, which means that a declining number of persons will have to share an equal total amount of resources, which actually should increase affluence (Simon, 1996). (in my opinion, as argued above).

In order to summarize the neo-Malthusian view on population decline, I will take a definition that more or less combines the predicted consequences of population of this ‘pessimistic’ and ‘mechanistic’ view. In that case, neo-Malthusian decline should involve

- *Equal or increasing* affluence A
- *Steady or decreasing* technology factor T (indicating an *improved or equal* resource-use efficiency)
- An overall *reduction* of environmental impacts I

Obviously, both this means that interpretations of (neo-) Malthusian theory are combined in these criteria.

### Boserupian population-environment theory

Boserupian theory, named after agricultural economist Esther Boserup (1910-1999), argues that technology is not to be regarded as developing independently from population size and density. Rather, technological innovations are occurring because there is a need for the new technology due to population pressure (Boserup, 1965; 1981). This argument is derived from the history of agricultural progress, and is in that way, more or less a parallel to Malthus’ work. Both Malthus and Boserup study the question how food supply is related to population, but where Malthus regards technological progress as exogenous to population growth – which means exponential population growth eventually will outstrip the

technological progress – Boserup points out that population size – through population density – allows more labor-intensive technologies to be used, which means that technology is endogenous to population size (Marquette, 1997)

Using historic analyses from early hunter-gatherer societies to multi-cropping systems, Boserup tracks how societies have developed their agricultural system by implementing such new technologies. An example of this, is transport technology: high-quality paved roads require high investments in the first place, and after that ongoing maintenance. For low population densities, such investments may be too high to bear. In areas with higher population densities, investments in such roads becomes profitable and can facilitate a division of labour by enabling food transports over larger distances. Some reservations should be made when trying to apply such Boserupian mechanisms to the research of declining areas. Although population-driven technological improvement may be taking place in modern-day, developed societies as well, Boserup's theory mainly focusses around historical societies or developing countries (Boserup, 1981; Marquette, 1997). Additionally, Marquette (1997, p3) notes that *"is important to recognize that neither Boserup nor Malthus specifically address 'population', 'environment', and 'technology' per se but rather the topics of land use or food production. Implications on the linkages between these factors are subsequently inferred from their work."* An important realization should be that Boserup does *not* say that technology can *always* overcome population. She points out that enhanced technologies are often available *before* they become necessary. This may create geographical differences: a certain advanced technology may be at use in some part of the world, while in others it is not yet adapted because population density is not high enough to make a shift toward these new technologies profitable. Although Boserup generally places high importance on human ingenuity to overcome resource scarcity, she refrains from extrapolating her theories about the past to modern-day technological development. She also does not say that natural resources cannot put a limit on population: *"On the one hand, population density has adapted to the natural conditions for food production by migrations and difference in natural rates of growth; on the other hand, food supply systems have adapted to changes in population density (Boserup, 1981, p15)"*. In this way, Boserup can be seen as adding a new dimension to Malthusian theory rather than completely toppling Malthus (Marquette, 1997). Whether resource-scarcity leads to a Malthusian response (declining population growth rates or even population collapse) or a Boserupian response (technological progress) is largely determined by the opportunity a society has to change either technology or population (Bilsborrow, 1979, in: Marquette, 1997).

But, even with all these limitations, the main argument by Boserup remains that an increase in population will stimulate increases in resource-use efficiency by improving technology. In the IPAT formulation, this would mean that, if P increases, it will lead to a subsequent decline of the term T (which indicates an increase in resource use efficiency). This does not always have to mean that the impact declines or remains stable. This is only the case if there is enough capacity to adapt such new technologies. If we reverse the statement to situations of decline, the outcome of the formula becomes a bit more troublesome. In that case, a decrease in P should reduce technology. It is exactly at this point, that a modern-day interpretation of Boserupian theory seems to become difficult. In a globalized world, where technologies are spreading rapidly, and in modern states with centralized control and policies to redistribute wealth also to peripheral or less competitive (but still developed) regions (such as European cohesion policies), population decline does not necessarily seem to be an incentive for transcending back to less resource-efficient technology. It is also questionable if such a statement would fall within the domain Boserup assessed her theory to be valid. It is also possible that technological change would not result directly from a change in P, but rather from how population decline influences A, affluence, and how a change in affluence shapes the ability to maintain technological standards. Interestingly, Boserup has commented on the economic effects of population decline. In a commentary on an article about the economic consequences of population decline, Boserup envisions for these declining areas an elder workforce that lacks the incentives to invent or apply technological innovations. Also, less money would be available for public budgets that are necessary to maintain a high standard of living. There would also be a continued outsourcing of labor-intensive work from declining to growing areas (Boserup, 1986). Although she does not address the impact of this, it shows a view where population decline (although she mainly addresses ageing) decreases affluence, while in the process also worsening resource-use efficiency (increasing T). This creates a difficult situation to assess the impacts I on the environment: While a

decrease in A may decrease impacts, an increase in T could heighten it. To sum up, this means that decline as predicted by Boserupian theory should show the following pattern:

- Decreasing affluence A
- (Possibly) an increase in T
- Impacts I are indecisive

### Cornucopian population-environment theory

Cornucopia refers to the 'horn of plenty' from classical mythology. This can be seen as an allegory for the view of Cornucopians that the earth – or even the universe – (Simon, 1980) holds enough resources for all human beings to live a prosperous life, regardless of population developments. Cornucopian theory seems even more positive about the adaptive capacities of society to population growth than Boserupian theory. It differs from Boserupian theory by emphasizing the power of the free market to solve resource scarcity issues, and by its broad scope, which goes beyond purely agricultural development. Rather than exploring the exact pathways of technological and innovations along which larger population can be sustained, it presents natural capital as highly substitutable by other forms of capital, which implies that resources are actually plentiful (e.g. Simon, 1996). In its focus on the power of the market to adequately distribute goods and achieve more resource-efficient growth, Cornucopian theory owes much to neoclassical economic theory. Environmental problems, in this way, are regarded as market failures rather than as resulting from population pressure and overexploitation to support such a population (Miller & Spoolman, 2009). Still, Cornucopian and Boserupian thinking may share a part of their worldviews as both can be characterized by their 'technology optimism' (Brander, 2007). One of the prominent adherers of the Cornucopian view, and a fervent combatant of environmentalist positions in general and neo-Malthusian theory in particular, is Julian Simon. Pebley (1998) notes his particular role in repelling the alarmist (neo-Malthusian) notions about population growth that arose in the 60's and 70's - such as the work of Paul Ehrlich. According to Simon, population growth is actually *beneficial* for society and stimulates economic growth through continued innovation, creating higher resource efficiency. In "The ultimate resource II", Simon mentions that "*From the economic point of view an additional child is like a laying chicken, a cacao tree, a computer factory, or a new house. A baby is a durable good in which someone must invest heavily long before the grown adult begins to provide returns on the investment.*" (Simon, 1996). So, while initially requiring investment and capital input to grow up, a human being will after some time become part of the productive system and generally, over the whole course of life, produce more than it consumes during his/her lifetime – provided that the productive phase of life is long enough. This means that population growth tends to increase overall human welfare as time progresses. The environmental impacts that such population growth might have, are deemed largely irrelevant by Simon. He argues that many data about such environmental problems is flawed, estimates and predictions often lack a strong empirical basis and that environmental scientist are generally biased towards proving that something bad is going on (Simon, 1980). He does acknowledge some environmental problems occurring, but, overall sees the environment improving rather than worsening throughout modern history and points to the human living standards that have increased drastically over the past century – at least in the more developed countries. So, even if the environment in some aspects may be deteriorating, the quality of the services it provides to society are increasing and will continue to do so in the future. Although many of Simon's critiques on environmental issues may be outdated by now, it could be argued that such opposing voices are still heard today in the discussion about climate change or in (controversial) books like "The skeptical environmentalist" by Bjørn Lomborg (2001). Although the work of Simon may be controversial in its denial of many environmental issues, his view that population is only a single factor in influencing the environment, seems much closer to the 'holistic approach' which is more or less the current scientific consensus (De Sherbinin et al., 2007). The reduction of different types of pollution in western states during the past half century and the existence of downward trend in some Environmental Kuznets Curve's may be further indications that to some extent, more (population, wealth) does not necessarily mean *more pollution*.

When analyzed with help of the IPAT equation, the Cornucopian views of Simon implies that affluence (A) is seen as increasing with population growth (at least as long as such growth is not too fast-pace, (Simon, 1996)) as well an improvement of technology (which means T is declining). The impacts (I) are not of much importance, as they are perceived as a sign of resource scarcity – rather than an unwanted impact, such resource scarcity is seen as the driver of new innovations and improved living conditions (Simon, 1996). Simon has presented some views on population *decline* as well. First of all, he notes that population decline is highly uncertain as a long-term trend, as past forecast so often have been wrong (Simon, 1996, Chapter 23). Considering population decline, he mentions selective migration and falling birthrates in US rural counties to result in worsening economic opportunities for those who remain, which would be contrary to Malthusian theory, as the remainders should have more resources per person available. Further, Simon foresees a shortage of labor, creating problems to support the older population – an argument much similar to the one employed by Boserup. And in chapter 33, he once more stresses the importance of a growing population for increasing productivity by technological development. In this chapter he mentions: *“Many people in the U.S. and Europe - school administrators, university teachers, social security planners, and publishing houses, for example - have by now seen the face of zero population growth, and many have not liked what they have seen. Slower population growth and diminished demand have not brought the expected benefits, especially in education.”* At the same time he recognizes that in the developed nations, technologies are spreading rapidly, which means that technology levels would remain at about equal pace with the rest of the world, even if population would be declining. Still, the innovative capacity of such declining areas would strongly decline, which would create economic setbacks.

All in all, it seems that Simon envisions affluence to decline while technology would remain more or less stable in declining regions. Impacts remain indecisive (similarly to Boserupian theory ), or rather, irrelevant: Even with less people, impacts are a measure of scarcity and scarcity leads to future efficiency gains. What may be added, is that Simon would perhaps argue that the adaptive capacity of declining societies to such occurring scarcity would be less than in growing ones, as there is less capital and innovative capacity available to solve such issues. So *if* environmental impacts would exist in declining areas (which is itself often repudiated by Simon and other Cornucopians), these impacts would be more likely to be persistent and more difficult to solve. This means that a Cornucopian theory of decline points to:

- *Decreasing* affluence A
- Stabilizing T (or relatively with growing regions an increase in T)
- Impacts I are irrelevant. If they would be relevant, the capacity to cope with them decreases

### **Towards two main opposing theories**

To sum up, the three theories present different views on population and environment. On closer analysis, however, the theories do not seem to be of the same value and comparability. The main opposing positions seems to be between neo-Malthusian and Cornucopian views, as both have opposing answers to the question if population influences environment and to which extent that creates problems (Marquette, 1997). Boserupian theory is specifically focused at developing countries and historic situations, as well as that it focusses around agricultural development rather than environment in general. While the predicted outcomes of population decline for Boserupian and Cornucopian theory are pretty similar, Boserupian theory is not as radically contradictory to (neo-)Malthusian theory as Cornucopian theory is. However, as the predictions for population decline by Cornucopian and Boserupian theory are largely similar, I taken the step to merge them together for the analysis of declining regions. As the main controversy seems to be neo-Malthusian-Cornucopian, this will mean that I leave out the Boserupian theory in name. The problem with Cornucopian theory, however, is that it does not recognize environmental impacts as such. Because the research focusses around environmental management (and thus supposes that environmental impacts do exist), I feel that it would be more prudent to replace the Cornucopian concept of impact with the concept of environmental impacts of Boserupian theory. This means that mankind *can* have an impact on the environment, but that population density drives technological development to minimize these impacts. A synthesized view of both theories would thus

imply that human environmental impacts do occur, but that population size does not matter much. However, if problems with the environment do occur, these problems are more difficult to manage in declining regions, because less capital is available and because it is more difficult to develop innovations that counteract these impacts. This means that the conceptual understanding of the IPAT equation is modified to:

(neo)-Malthusian:

- *Equal or increasing* affluence A
- *Steady or decreasing* T (indicating an *improved or equal* resource-use efficiency)
- An overall *decrease* of environmental impacts I

Cornucopian, combined with Boserupian:

- *Decreasing* affluence A
- *Stabilizing or increasing* T (or relatively with growing regions an increase in T)
- Impacts I are *more or less stable*; the *capacity to cope* with them *decreases*

With this understanding of the main theories and how they would envision population-environment interactions in declining regions, the next step is now to find out which population-environment interactions may take place in declining regions and how they fit in with the different theories. This is done by grouping these specific population-environment interactions as symptoms of demographic change. With this, the syndrome approach enters the research, which will be discussed in the next part of the research.

# PART 2: INTRODUCING THE SYNDROME

## APPROACH

*In the previous section, Neo-Malthusian and Cornucopian theory were selected as two core-theories that present different views on how population decline can affect environment. In the next section, section 3, it will be researched which causal mechanisms are known that connect population decline with environmental impacts, and how these mechanisms fit in with the two theories. However, during the process of the research, it turned out that it would be difficult to identify such potential causal mechanisms in real life. This has led to a search for a research approach that could help to identify such causal relations in actual policy documents. Because this chosen research approach affects the contents of section 3, this second part of the thesis will be devoted to an explanation of this particular research approach: the syndrome approach by Petschel-Held et al. (1999). First, it will be explained why the research of population decline as a change process requires such a separate research approach, by mentioning the issues that such research brings with it. These are derived from the practical difficulties/issues that were encountered. Then, the syndrome approach itself is explained. As a final step, the implications of this approach for the research will be elucidated.*

### Issues

In order to extract causal mechanisms of population-environment interactions from literature and to assess its relevance for declining regions, some issues need to be resolved or addressed. These are:

- *The issue of framing 'population decline' within a demographic change context*  
Whereas the first interest of this thesis lies in researching the effects of population decline, it is virtually impossible to study cases of population decline without addressing other aspects of demographic change like ageing, household size and socio-demographic change. According to Coleman & Rowthorn (2011), population decline and population ageing can be seen as "divergent sisters", because both are the results of increasingly lower fertility rates. Because younger cohorts are not replaced by similar size or larger new young cohorts when fertility is below replacement level, there will be relatively less youth compared to elderly, leading to increasing average ages. Although this type of population ageing will come to a hold after a prolonged period of time, currently, both phenomena will mostly co-occur. And besides this low-fertility caused ageing, there is also the 'regular' ageing that takes place as life expectancy continues to increase.  
It would, therefore, not make sense to isolate the effects of ageing from the effects of decline. After all, that would imply that case-study regions would have to be found where decline does *not* co-occur with ageing. Even if this would be possible, it would not provide a picture of a *typical* declining region. By viewing the co-occurrence of ageing and decline as a typical pattern for declining regions, an analysis of such regions produces much more relevant results than the deviant case where decline and ageing do not co-occur.

Another such issue is population composition. Selective regional migration and international migration do not exist independently from fertility-induced decline. While both types of migration not necessarily have to take place to create decline (below-replacement fertility can do the job on its own), they also cannot be viewed as being totally disconnected from decline. For one thing, the regions that are *currently* facing a declining population, mostly do so because of strong and selective outmigration (e.g. Coleman & Rowthorn, 2011). While this is often more ascribed to the economic history of such regions than fertility, it does affect the demographic profile of possible case-study regions, and should thus be dealt with. Causal relations of migration with fertility-

caused population decline can also not be ruled out; an example is the case where (natural) population decline leads to a lower level of public services, which could stimulate migration to regional centers (e.g. Verwest et al., 2008). Another example is international migration. Population decline can for example be an incentive for stronger international immigration when it causes a scarcity of workers (Hugo, 2011). A final issue is that of changing household size. In the Netherlands, and most other (developed) countries, household growth rates have been higher than population growth over the last 50 years (Van Duin & Stoeldraijer, 2011, p61). This implies that average household size has been declining. Some environmental effects appear to be more closely related to a decline in the number of households than the number of persons (Jiang & Hardee, 2011). Mackellar (1995) shows for example, how one third of the increase in energy consumption from 1970-1990 can be explained by population increase, while household increase explains 76% of the rise in energy consumption. When studying the effects of population decline, it should therefore be kept in mind that a shrinking population does not necessarily mean a shrinking number of households – although the stronger the decline, the more likely it becomes that the number of households is declining as well. To which extent this would influence environmental impacts should be a matter of consideration: some environmental variables may be more strongly influenced by the number of households, while others are more directly influenced by the number of persons.

Also other research concludes that the effects of population changes should be researched in coherence with other demographic phenomena. Müller et al. (2007), in their research of the effects of demographic change on environmental policy in Germany, research population decline, ageing and socio-demographic change in cohesion, rather than separately. For this research, there remains a challenge to make the research on one hand representative for fertility-induced decline, but at the same time to account for how population decline interacts with other forms of demographic change.

- *The issue of interaction between societal/economic impacts of demographic change and the environment*

If it would be possible to separate population decline from other forms of demographic change in such a way that only its direct impacts on the environment would be measured – ignoring the concerns expressed in the above paragraph – still not all issues would be resolved. In that case, the research could show the correlation between population size (or growth rate) and some selected environmental indicators. Still, without an understanding of how such correlations can be explained, this would not tell much. After all, the general view held is that population size, in the developed world, is only a single determinant of environmental impact and that lifestyle and economic factors play a relatively bigger role (see Part 1). This means that there can also be interactions between population decline and environmental impacts via the impact that decline has on society. If population decline leads to empty housing, what will this mean for the environment? How will the economy be affected by shrinkage? Does population decline lead to social or psychological changes that make people think differently about growth, decline and environment? Such questions show that where decline affects society and economy, this will also shape the environment impacts of this society. This suggests that it makes sense to *also* analyze how demographic change interacts with *society*, and how this, in turn, affects the environment (Van Dam et al., 2006). It means that population decline does not only lead to a reduction in the number of ‘polluters/disturbers’, but also a change in *how* people pollute/disturb. It thus seems necessary to find an approach that allows the incorporation of complex society-environment interactions if we are to study environmental effects of population decline.

- *The issue of scales*

Although the thesis addresses *regional* population decline, these regions cannot be analyzed in isolation from other regions or local or supra-regional processes. Conclusions about the impact of decline on the regional environment cannot directly be translated to general environmental impacts of decline without realizing how regional decline interacts with global economy, society



and environment. Therefore, some questions need to be asked if findings from literature are to be projected onto a regional scale: To which spatial levels are the do particular causal relations apply? Which micro-processes create macro-dynamics, and how do macro-dynamics translate to local manifestation? An example can be the relation between regional product demand and regional production. If population decline leads to decreased regional demand for a certain product, it is by no means sure that this leads to less regional production. Modern-day agricultural production is for example little depending on regional food demand (Beetz et al., 2008); as such there is no need to assume that regional population decline will lead to less intensive land use. Such examples illustrate that spatial interactions have to be taken into account as well.

- *The issue of time: past, current and future projections*

Not only are the causal relationship that link population decline to environment differentiated in the spatial scale at which they work, they are as well differentiated across the period of time that they consider. Also the scientific studies that report such causal mechanisms can vary on a temporal scale. Which timescale and time period is taken for a certain study, can differ from the one to the other and some structural differences may exist between the different fields of science in how they deal with time. Where, for example, planning literature often considers cases of declining cities and regions of the past decades, demographic literature often includes projections for the coming 100 years, or a review of the developments in the past centuries. Some population-environment research even deals with historical cases over timescales of multiple centuries, for example the research on Easter Island (e.g. Brander & Taylor, 1998). While such long timescales may not match the timescale of the thesis (which spans about twenty years), an understanding of such long-term processes can hold valuable lessons and insights for the study of today's population decline. For example, in the analysis I mention Tainter (2011), who uses the Roman and Byzantine empires as case study, to put forward a theory about problem solving in increasingly (organizational) complex societies. This increased complexity, he argues, can undermine adaptive capacity of societies and can lead to their collapse. Although the examples are millennia old, they may inspire the thought that deinstitutionalization can be an important adaptation avoid unbearable institutional complexity in declining regions. This example demonstrates that it would be necessary to find a research approach in which can be accounted for the temporal resolution of causal mechanisms, without ruling out mechanisms that can be helpful in understanding the processes at work in declining regions.

- *The issue of uncertain occurrence of processes.*

Although it might be possible to search in literature for processes, mechanisms and cause-and-effect chains that explain how population decline might have certain environmental impacts, or impacts on environmental management, such processes will never be fully deterministic. Which of these mechanisms are at work and to what extent they are shaping population-environment dynamics is very much depending on the local context, with its own, specific history (Bernt, 2009, p757). Faus-Pujol & Higuera Arnal (2000) state it like this: *“Demographic growth, overpopulation and depopulation cannot be studied in the same way everywhere, because there are countless demographic systems, each of which is nested as a subsystem interlinked with other territorial, economic, cultural and social systems”* (p245). Müller et al. (2007), who specifically researched what demographic change might mean for German environmental policy, cite Heiland et al. (2004, p65) when expressing this difficulty: *“Die Autoren weisen darauf hin, dass es kaum möglich sei, „den demografischen Wandel als eine auslösende Variable von Umweltveränderungen so zu isolieren, dass präzise Aussagen hinsichtlich seiner Wirkung möglich wären“*

This brings up an issue of how we can compare demographic change processes over different cases of regional decline to draw conclusions about population decline and environment in general. A very relevant question following this, is if regions that are declining because of structural economic issues rather than demography can be used to make statements about population-environment theories for regions with a fertility-initiated decline. If such demographic change processes are so location-specific, can we use regional decline, which is intermingled with

economy related population decline, to say something about overall effects of fertility-induced decline? The challenge would be to isolate from these regions the general patterns of human-environment interactions that are especially caused by low fertility. Applying a *longitudinal* case study of currently declining regions, will already make this process easier because it allows to expose the processes of *change* which helps to reveal and explain the *tendencies* rather than evaluating the actual situation. This can reveal the relevant process that may also play a role in the future and that can give an overall picture of how environmental management develops under conditions of population decline. It does however also mean, that the specific geographical situation of the cases and their historic development needs to be taken into account into the research approach in order to assess the impact of local conditions.

- *The issue of lack of evidence.*

What becomes clear from Coleman & Rowthorns 2011 literature review of the optimistic and pessimistic positions scholars take about population decline, is that these positions are often poorly supported by empirical, 'hard' evidence. Coleman has stated, regarding the economic effects of population decline, that "*Enthusiasts for population growth (e.g., Simon 1981) point to the counter-inflationary effects of workforce growth and the guarantee provided by growing numbers of consumers in underwriting productive investment and promoting innovation, and they fear decline for the reverse reasons. Some of these effects, often cited and often taken to be axiomatic by economists and in business circles, chime with common sense but lack empirical evidence.*" (Coleman, 2006, p81). This statement may not come as too big of a surprise, because the fertility-induced decline that Coleman addresses, has only just begun in a few front-runner countries such as Germany. This implies that empirical evidence would not yield much 'hard' results. The complex nature of the societal and economic processes and the delay processes that may be at work (Brose, 1986) further reduce the value of empirical methods in investigating this fertility-induced decline. While empirical research on regional scales may be more likely to yield results (simply because there are more cases as well as more extreme ones), such regional empirical research is also more likely to be obstructed by confounding variables because strong regional decline is still closely tied to regional economic decline (see previous section, Coleman & Rowthorn, 2011). With no historic precedent of fertility-induced population decline, there is simply not enough input material for 'hard' empirical evidence. This means that most of the current knowledge about the effects of fertility-induced population decline on environment is still of a suggestive nature. This uncertainty and lack of evidence about how causal relations between population decline and environment work, has to be made explicit in the research. On the other hand, such suggestive mechanisms are the only source of information yet and should not be excluded lightly. While it is uncertain if such mechanisms are indeed at work, it is also uncertain if they do *not* help to explain the relation between population decline and environment.

- *The issue of different types of research methods.*

The literature on population decline and environment comes from a broad field of research. But also methods are different they include everything from literature reviews, to theoretical articles, to interviews and surveys, to expert opinions, empirical studies and GIS-and modeling studies. All of these studies hold some information on population decline and its relation with the environment, but come from different research traditions and have different strengths and weaknesses. The challenge is to combine these different types of research, to present the full speculative broadness of the effects of population decline on the environment.

### Finding an appropriate research approach: the syndrome approach

The issues that make it difficult to research 'demographic change' in a structural way are remarkably similar to the issues that come up with researching global (environmental) change. Also within global change research, issues of research methods, temporal and spatial scales, uncertainty and complex interactions make structural analysis of an overall change process challenging. Petschel-Held et al. (1999) therefore have proposed to address such global change issues as 'syndromes' of global change. The need for such an approach is mainly motivated by a need for integrating the findings of different types of

research in order to obtain an overall understanding of such global change patterns. According to them: *“the syndrome approach (...) is designed to improve (...) comprehension by incorporating cognitions and knowledge from all of these sources. This cannot be achieved without sacrificing quantitative rigour in favour of qualitative, intuitive, and typifying aspects. The basic idea is not to describe Global Change by regions or sectors, but by archetypical, dynamic, co-evolution patterns of civilization–nature interaction which we call syndromes.”* (Petschel-Held et al., 1999, p296). The similarities with medical diagnosis are evident: There may be a group of patients who may have different complaints from person to person, but they all show variations of a *general pattern* in which different symptoms co-occur in coherence. In global change, such a syndrome may for example be the Sahel Syndrome: In countries with low socio-economic development, and a poor population, living in environments that are vulnerable to human interventions, the overuse of already marginal land may become a survival strategy. This further degrades the local ecosystem which in turn worsens the socio-economic conditions, reinforcing this process. Whereas such processes are not deterministic and may have place-specific manifestations, they tend to result in a similar development patterns. Such local or regional patterns of human-environment interaction can explain changes on a global scale because the processes themselves are not bound to geographical restrictions; they only manifest themselves in different ways. Classification of such ‘patterns’ is more or less subjective: *“The baseline of the discursive processes of syndrome specification is the human ability or even propensity to group and/or classify his or her observations”*( Petschel-Held et al., 1999, p296). In scientific practice this means, that such classifications may be under constant debate, and that these classifications change every now and then as new fact and opinions lead to new insights. The value of such syndromes ultimately lies in their explanatory power: how well certain observations are explained by the syndrome and its symptoms and interactions. This brings us to a description of the three main descriptive properties of the Syndrome Approach: symptoms, interactions and syndromes. Below, these are be discussed:

1. **Symptoms** are defined as *“qualities of Global Change which appear to play a major role in the ongoing problematic developments both in the natural environment and in society”*. The last part of this definition – which stresses the *problematic* development - may however be eased, because positive trends and developments just as well can contribute to ‘global change’. The occurrence of such symptoms can be put to the test by identifying indicators for the symptoms and measuring them. If the symptom for example is “slowing down economic growth”, an indicator such as “GDP per capita” might be used to indicate this. Clearly, the symptom provides a more qualitative description of the underlying phenomenon, while the indicator is a well-defined entity, particularly suitable to measure real-world developments. These indicators can be quantitative as well as qualitative in nature. The value of the indicator(s) to identify a symptom lies in its ability to represent the processes underlying the symptom. An example would be the use of GDP to indicate economic development. ‘Economic development’ itself is a rather broad and qualitative term. However, GDP per capita is often used to indicate economic developments, even though it does not fully measure all aspects of ‘economic development’. As long such limitations are being kept in mind, such indicators can help to assess *intensity* of a symptom.
2. **Interactions** that take place between such symptoms are the second descriptive property. It is not for no good reason that symptoms form patterns of co-occurrence. The symptoms are related to each other, because they are all part of a network of causal interactions. Symptoms of a disease are also not ‘coincidental’ events, because they are the consequences of response on different fronts to, say, a bacterial infection. The same thing holds for symptoms of global change. When we go back to the example of the Sahel syndrome for example, poverty and ecosystem degradation are not random events, but co-occur because there is a causal link between the two, which makes that they reinforce each other. Such interactions are rarely simple or unidirectional: societal processes can have many different interactions, and which specific interactions are dominant depends on local context. Interactions can also be influenced by system-external factors. In the example of the Sahel syndrome, think for example about how climate change, war or local development aid could change the system behavior. Still, description of such interactions helps to understand *why* certain symptoms co-occur and helps to understand these symptoms in the light of dynamics of a system.

3. **Syndromes**, “*patterns of civilization–nature interactions*”(Petschel-Held et al., 1999, p295) can now be viewed as the total of clustered interactions between symptoms.

### Relevance of the syndrome approach for demographic change research

If this syndrome approach is compared with the research issues that were outlined earlier, it turns out that the syndrome approach may also be very applicable to research environmental effects of *population decline*. When compared to the issues that obstruct research of population decline, it turns out that the approach addresses the issues in one way or the other:

- *The issue of framing ‘population decline’ within a demographic change context:*  
The strength of the syndrome approach for resolving this issue, is its focus on *patterns of co-occurrence* rather than isolation of single causes. In declining areas, where ageing and socio-demographic change cannot be separated from population decline without losing representativeness of a ‘typical’ declining region, the room that the syndrome approach offers for intuitive classification is helpful because it allows to group all these separate developments as an overall process of ‘demographic change’. I will from here on refer to ‘demographic change’ when considering the *overall* demographic pattern shift that is taking place in declining regions. The use of this general term acknowledges that population decline is not a phenomenon that stands alone, but is part of a broader transition process, just as “global change” is.
- *The issue of interaction between societal/economic impacts of demographic change and the environment:*  
The syndrome approach recognizes the interactions between symptoms: the co-occurrence of symptoms is caused by their interactions. This means that complex interactions between the human and the environmental system may exist, and description of these interrelations is vital to understand the final environmental impact of a syndrome.
- *The issue of scales:*  
Symptoms can play across different scales and micro-scale processes are recognized to bring about macro-scale change. Description of symptoms and how they interact to create a certain syndrome also leaves space to describe on which scale such interactions work or on which scale the symptoms manifest themselves.
- *The issue of time: past, current and future projections:*  
The syndrome approach aims to integrate different types of research. This means that studies about past and current processes can be included and be combined with findings of, say, a modeling exercises that investigate future change. As long as it provides better understanding of a syndrome, any possible source could be valuable. The speculative nature of some research is no problem, because the syndrome approach is adaptive to new insights and new knowledge and allows them to be put to the test.
- *The issue of uncertain occurrence of processes:*  
The uncertain occurrence of processes is addressed by the non-deterministic nature of the approach. Local contexts are recognized to be different, which can lead to occurrence of different symptoms from one place to the other. Still, all these regions may be viewed as suffering from the same syndrome, because the overall *pattern* is similar to those of other regions. This focus on patterns rather than final outcomes is much more helpful to research processes in real life.
- *The issue of lack of evidence:*  
The lack of empirical evidence about effects of fertility-induced population decline in general and the environmental impacts of this in particular, means that there are many theories and mechanisms that *can* play a role in shaping environmental management in declining regions, but that these are often suggestive and sometimes opposing each other. The openness of the syndrome approach to hard *and* soft knowledge, and theories as well as empirical data, offers a

chance to include such mechanisms. After all, the actual assessment of the explanatory power of these – speculative – mechanisms will still be tested by the assessment of environmental policy documents.

- *The issue of different types of research methods:*

The syndrome approach aims to integrate the current state of knowledge from all sorts of research to create a conceptual model of global change. In researching declining regions, where relevant information might come from different research traditions as well, the ability of the syndrome approach to group and combine these findings in symptoms, interactions and syndromes, allows an integration of these different research methods.

### Implementation of the syndrome approach in the research strategy

Since the syndrome approach deals with all the issues that were outlined above, it could present a helpful research approach. In the following section, the question will be answered how exactly this approach can be used to aid the literature review and the analysis of policy documents. Questions to be resolved are how ‘global change’ relates to ‘demographic change’ and how the concepts of ‘symptoms’, ‘interactions’ and ‘syndromes’ can be operationalized.

For the further course of the research, I will regard ‘demographic change’ as a new syndrome of ‘global change’, which means adding a new syndrome to the model of Petschel-Held et al. (demographic change meaning the *overall* demographic pattern shift that is taking place in areas with fertility induced population decline). This seems appropriate, as the assumption of this research is, that population decline can have impacts on society, economy and the environment in such a way that it can also impact the *global* system. Regarding ‘Demographic change’ as a syndrome means that it becomes a “*pattern of civilization–nature interactions*” with its own interactions and symptoms. Since the syndrome itself now is known, the search is then for the symptoms and interactions that typify this syndrome. If these interactions and symptoms exist and form a characteristic pattern that corresponds with real-life developments in declining regions, this should indicate that such a syndrome actually exists. This would involve collecting current scientific knowledge about such symptoms and their interactions from different fields of research, and comparing them with the environmental management experiences in policy documents to assess if such a pattern does exist at all. Understanding of the interactions is more important for gaining understanding of the overall systems dynamics, while the symptoms allow to identify expressions of societal and environmental change within the ‘real world’ as experienced by environmental policy and management. The comparison between two theories means, that actually two different variations of the ‘demographic change’ syndrome are proposed: the one from neo-Malthusian viewpoints and the other from Cornucopian viewpoints. These two different visions about which “*pattern of civilization–nature interactions*” demographic change brings about can thus be compared to real world experiences and to each other.

The operationalization of the syndrome approach within this research is in the end slightly different than the original syndrome approach. Whereas the syndrome approach mainly aims to bring together knowledge from different sources about complex problems in order to analyze the interactions of these complex problems and model them, this research design uses the syndrome approach to bring together knowledge from different sources about complex problems in order to build a framework for in-depth analysis of the behavior of the syndrome. Within the syndrome approach, there is also attention for interactions between *syndromes*, but this is also not part of this thesis. Still, the research design remains closely tied to the ideas of the syndrome approach; the identification and understanding of a new syndrome (what this research does) could also be seen as a first step towards understanding the implications of a syndrome for the dynamics of other syndromes and, in the end, global change itself.

# PART 3: SYMPTOMS OF DEMOGRAPHIC CHANGE.

## Methodology

*In the next section, the methodology will be discussed that was used to identify the symptoms of demographic change. These symptoms and their interactions reflect the causal mechanisms that connect population decline to environmental impacts. Within the syndrome approach, the first step towards understanding syndromes is to integrate knowledge from different fields of research to formulate such “archetypical, dynamic, co-evolution patterns of civilization–nature interaction” (Petschel-Held et al., 1999, p296). The most natural way of collecting this current knowledge, is by undertaking a literature review. Insight will be given into how the literature review was undertaken and how literature was selected.*

### Literature review: an authorship approach

The selection of literature for a literature review is in many cases a choice of the author of the review, based on personal knowledge and assessment capacity to determine what is ‘relevant’ and what is not. This approach is characterized as the “authorship approach” (Dixon-Woods, 2011, p332). Although there are more formalized ways of undertaking a literature review, which involve search protocols (the “contractual approach”), I have chosen to stay more in line with the authorship approach for a number of reasons:

- Structuring processes in symptoms and their interactions, always involves qualitative, intuitive and typifying aspects of phenomena (Petschel-Held et al., 1999). This means that classification into syndromes and symptoms *always* needs an interpreter to place certain information in one group and other information into another group, while excluding yet other information. This is in line with the ‘authorship approach’, which trusts on the author of the review to select relevant papers and requires the author to convince readers that the treated literature is relevant (Dixon-Woods, 2011)
- An initial search of papers about environmental impacts of human population decline and its relation with environmental management, showed that such papers are not only very scarce, but also that the knowledge is spread out over different research disciplines. Gaining access to the information from these different research traditions probably works best when applying a more explorative, intuitive method.
- Formulation of a specific protocol in such a way that results of the review would allow to answer the research questions, would probably be very time-intensive, as such a systemic review always runs the risk of including irrelevant, or excluding relevant articles. It would thus require a lot of fine-tuning of the research protocol. By taking the authorship approach, it is possible to undertake an intuitive search in which results are directly evaluated, while at the same time reading new articles provides new ideas about what was relevant and what not.

### Weaknesses of the authorship approach

The author of a review in the “authorship approach”-style is, according to Dixon-Woods (2011, p 334), unfortunately susceptible to flaws like biases and sloppy practices. These practices are listed below. By addressing them, an insight is given into how the literature review took place and how these weaknesses are accounted for.

- *A focus on a small sub-set of studies without describing how they were selected*  
A focus on a small sub-set of studies may be either intentional or arise by accident. In this case, the only intentional selection of literature was based on the question if this literature provided mechanisms or causal relations that told something about how a declining human population may influence the environment. With that being a very broad topic, it is inescapable that the literature that was selected will have overlooked certain sub-sets of studies, while other sub-sets have been studied relatively intense. Table 1 provides some insight into the background of the used literature. This overview gives a rough idea of the background of the used literature, and shows that articles were drawn from many disciplines, but with a main focus on demography and sustainability/environmental science journals (which is not surprising considering the research topic). The articles were selected by entering general search terms at the Scopus online database. Articles that possibly had a relevant content were fully scanned for causal mechanisms linking population decline to environmental impacts, which were later grouped under the different symptoms. If such articles mentioned similar or related articles that could potentially be a source of extra information, these articles were included, too. Also, some additional articles were looked for, if causal relations remained ambiguous. The literature is however by no means complete and unflawed, but due to time limitations and the fragmented structure of information regarding this topic, such a complete overview would be an unrealistic goal anyway.

Type of journal	Number of articles
<b>Demography</b>	17
<b>Sustainability/Environmental science</b>	16
<b>Economy</b>	11
<b>Urban and Regional Planning</b>	9
<b>Policy</b>	9
<b>General (Science and Nature)</b>	6
<b>Human Geography</b>	6
<b>Political science</b>	4
<b>Conservation/Biology</b>	4
<b>Management</b>	1
<b>Sociology</b>	1
<b>Modeling</b>	1
<b>Technology</b>	1

**Table 1: Different types of journals that were consulted for the literature research of symptoms of decline.**

- *Results may be influenced by the authors own perspective and expert opinions*  
While the selection of papers was based on relevance for answering the research questions, the aim was to include *all mentioned mechanisms* that showed up in the papers, even if they were likely to be of little importance, or if the authors of other papers stated that such mechanisms were unimportant. This means that no pre-selection of mechanisms took place. Only in the study of indicators in policy documents should it become clear which mechanisms are *truly* at work.
- *A failure to address the quality of studies in their review*  
The quality of studies is not always addressed in the description of symptoms. In some cases, however, I have attempted to indicate the area in which the study holds validity, its status (empirical or theoretical) and the quality of argumentation and empirical evidence for statements. The article ‘The global baby bust’ by Longman (2004) for example, puts forward a lot of arguments that are poorly supported by empirical evidence and are repudiated to a large extent by Coleman & Rowthorn (2011). In this case, I have opted to still represent the arguments by Longman, while also mentioning the counterarguments.

- *Not adequately accounting for publication bias (more attention for positive outcomes)*  
No measures were taken to account for publication bias. The advantage of researching two competing theories is, however, that each theory may have a body of literature to support that strengthens the theory with certain 'positive' (=confirmatory) findings. A lack of negative results might be cancelled out between the two theories, or indicate that there simply is more evidence for the one theory than for the other.
- *Protecting the evidence of the preferred theory from criticism*  
Personally, I do not feel biased towards any of the theories, and my objective has been to include all mechanisms through which population decline may affect the environment. While possibly an environmental scientist may wish to show that something bad is going on – as he or she is probably someone who is concerned with the state of the environment (Simon, 1996) – funnily, it would be hard to favor either theory from this perspective. While neo-Malthusian theory predicts fairly positive impacts of population decline on the environment – and thus would be under harsher criticism of someone who is inclined to see the dark side of the development of environmental problems, the Cornucopian view is the one that is traditionally associated with perceiving environmental impacts as less problematic. It would thus be difficult to say in which way such unconscious biases would work out.

### Secondary sources

Besides the peer-reviewed papers, also secondary information sources were used in the literature review. Sometimes these documents were referred to in scientific studies as data sources. On other occasions, scientific literature did not provide sufficient information, which led to a broader search on the topic, leading to inclusion of other types of documentation. Finally, in some cases, I found that certain topics reminded me of things that I had read before and that were not scientific, but could help to paint a picture of the processes - that is, the symptoms and their interactions. In table 2, an overview can be found of all the documentation used in the literature review about symptoms:

Type of source	Number of sources
<b>Primary:</b>	
Articles in peer-reviewed journals	67
<b>Secondary:</b>	
Reports	8
“Academic” books (with references)	6
“Learning” books (books and readers used during study)	5
Websites	4
PowerPoint presentations	3
“Non-fiction, non-scientific” books	1
<b>Total:</b>	<b>94</b>

Table 2: The total number of sources that were consulted for the literature review, sorted by type of source.



## Symptoms of population decline

*The following section includes the results of a literature review which explores the possible causal mechanisms that connect population decline to environmental impacts (SRQ3). These mechanisms are represented as symptoms of population decline with their interactions. The interactions between the respective symptoms are marked in-text by referring to other symptoms by means of symbols (S1,S2,S3...etc). For each symptom, a short evaluation follows of how this symptom fits with either neo-Malthusian or Cornucopian theory and how it's the symptom might be indicated in environmental policy documents (SRQ4). This marks the difference between symptoms as descriptive properties of a societal-environmental processes, and indicators as a tool to recognize such processes in real life (see part 2). This finally creates two separate lists of indicators for the two main theories, which will be used for the policy document analysis.*

### Symptom 1: Government budget problems

Budget problems develop when received income no longer covers expenses. In the case of government budgets, much of this income comes from taxes. When the amount of tax-paying individuals declines due to population decline, this might be thought of to decrease income from taxation. However, this government would also have less troubled subjects who need help or care in some way, which would also decrease necessary expenses. It is therefore tempting to think that the effects of population decline on public budgets balanced out against each other. On a closer look, however, it turns out that there are many factors that are complicating this simple equation.

The structure of the tax system and national wealth distribution policies determines to a large extent how demographic change leads to changes in government income within regions. The income of Dutch municipalities, for example, largely comes from a national fund, that is distributed amongst these municipalities based on a set of criteria. Population size is in this case only a single determinant, which means that a reduction in population does not translate 1:1 into a reduction of finances. It is expected that declining municipalities will thus not be affected by a declining national funds (Van Dam et al., 2006). Revenues from local taxes can however be expected to decline, as commercial activities slow down (S2) and as the tax paying population declines. Such local taxes only make out a small portion of the total municipal balance sheet in the Netherlands, but in countries where such taxes are of more importance such as the USA, decline can lead to budgetary problems due to reduced local taxes. Where local taxes are based on housing prices, declining areas are disadvantaged even more (S12), because vacant housing tends to drive down prices. When population decline leads to selective migration, the composition of the population is changed and so are its tax-paying properties. Hollander (2011) for example notes that urban decline may lead to concentration of an undereducated, unemployed and elderly population in the areas that are most hardly hit by population decline. The better educated and more entrepreneurial part of the local population have left these areas in search for a more opportunity-rich environment, mostly in regions that still show growth. This would leave declining regions without their supply of wealthier, creative and undertaking people. This selection of tax-paying subjects is also not exactly ideal for governments to receive high tax income, which means that this elective migration cuts on two sides: not only does direct tax income decline, but regional development is also endangered.

Another source of income for (Dutch) municipalities comes from land transactions (Van Dam et al., 2006). A considerable amount of money can be made, if municipalities sell land assets for new construction. In declining regions, however, this can lead to unnecessary land consumption: Budget problems may stimulate local governments to promote new building projects in areas where demand for buildings is already low (S10). In declining regions this can lead to a prisoner's dilemma: not facilitating new building projects means a weakened financial position, while those still building receive more income, even though such building is not financially sustainable. Yet another threat is that of financial losses due to land-speculation. When growing regions turn into declining ones, local authorities who own a considerable amount of land may be faced with a devaluating stock of potential building land, which means that returns on former investments can become negative.

These impacts are often highlighted in the context of local and regional decline (e.g. Beetz et al., 2008; Bernt 2009). In the light of this thesis is it also of interest to consider what the effects would be of large-

scale, fertility-induced population decline. Financial aid for declining regions from national authorities will probably become more problematic as population decline begins to make an impact on tax collection on national scales (Coleman & Rowthorn, 2011). However, selective migration as a process would be of lesser importance on these larger scales because it is an internal affair. As long as possible reduced competitiveness (S2) does not lead to international emigration, there should be no net effect of income losses due to this selective migration. Finally, the demographic change that results from lower fertility can also lead to a general decline in economic activities, because the potential workforce becomes relatively smaller (S7, e.g. Bloom et al., 2010; Feng, 2011; Reher, 2011; Ueda, 2011). In this case, it would mean that government; businesses and households, on national, regional and local scales, can all expect a deteriorating financial situation as a result of decreasing economic activity.

Population decline and demographic change can also cause a rise in certain costs. As fertility levels descend below replacement level and remain there for some time, the average age of population will increase (if life expectancy remains constant). In developed countries, which often have developed an extensive social care system, both this fertility-induced ageing effect and increased life expectancy lend to lead to higher health and pension expenditures in the process of ageing (Longman, 2004). The causes of such higher health costs are diverse. With elderly being more likely to encounter various health problems, an aged population is faced with increasing health costs. After the age of 60, health costs grow almost exponentially in developed countries (Breyer et al., 2010). However, this does not mean that a rising average age in itself is contributing much to rising healthcare expenses. Research shows that prolonged life has only limited impacts on health costs per capita, as elderly are increasingly healthy and need less intensive healthcare at a certain age than in the past (Breyer et al., 2010). What may influence healthcare expenses is that, with more elderly, the willingness to pay for medical care also increases. This potentially can increase political pressure to maintain high healthcare standards for elderly. As the average age increases, the influences of elderly in society will likely increase accordingly (S21). Lee & Mason (2011) show that this can have significant effects on intergenerational money flows. The direction of public transfers related to pension and healthcare is upwards, meaning that there is a net money transfer from younger to elderly – at least in most developed societies. As population ages, this puts increasing stress on younger individuals to pay for services for elderly. Most elderly in current-day developed countries are after their productive life still fit enough to deploy all kinds of activities and are also consuming more. How exactly this impacts (government) budgets is also depending on how these systems are organized. If pension and health expenses are paid as savings, the elder population more or less sustains itself, although tax revenues would generally decline. However, often a part of these payouts are transferred directly from the working population to the non-working population, as is for example the case in the Dutch healthcare system.

Some costs may also *decline* under circumstances of population decline. Often mentioned is the cost of education (e.g. Longman, 2004; Coleman & Rowthorne, 2011). In developed countries, where school attendance is very high and mostly compulsory, the relatively smaller young cohorts should have a direct effect on the number of school going individuals. It thus seems obvious that schooling costs decline, as Glass already noted in 1937. This direct effect might however be balanced out by the observed increase in spending on schooling costs per child as fertility goes down (Bloom et al., 2008; Mace, 2008; Bloom et al., 2010; Reher, 2012).

Where (traffic) infrastructure is overloaded, a declining population could relieve traffic pressures (S9), which could for example mean a reduction of the detrimental effects of traffic jams on the economy. There is also no longer a need to expand infrastructure, which would reduce investment costs in new infrastructure. Whereas such effects may be positive, reduced use of infrastructure may also increase maintenance costs per capita if the infrastructure is not downsized, which means that even when population is declining, some investments will always remain necessary.

Yet another separate issue is the increasing debt load of governments. As population declines, the rent load will weigh heavier on the shoulders of the remaining inhabitants. If budgets are not restructured accordingly in short term, this leads to even greater budget deficiencies and even stronger impacts in the longer term (Coleman & Rowthorne, 2011). Overall, the tendency within literature is that, even though

population decline may improve some posts on the financial balance sheets, in general it leads to increasing restraints on budgets (Muenz, 2007).

What can be responses of governments to such budget problems? If no action is undertaken, a higher level of expenses than income can be maintained for a certain period of time. While for the time being this may allow governments to resort to business as usual, in the end it will increase public debt, after which budget cuts or tax increases are necessary to cope with the increased rent load (Coleman & Rowthorne, 2011). At the same time, this strategy of spending more than what is coming in, can be a deliberate strategy if it is thought that certain expenses or tax cuts can stimulate the local economy. It is often hoped, that by attracting new economic clusters, the negative spiral of regional decline may be broken (e.g. Bontje, 2004, S10). Hospers (2011) describes how shrinking regions often turn to place marketing strategies to attract new inhabitants, tourists and companies. If successful, in the end this may indeed lead to increasing tax revenues and a recovery of the governments' financial position. It is however more likely that such competition for scarce inhabitants and businesses leads to a 'race to the bottom', in which declining regions have to invest more and more but with decreasing results.

The other strategy of adapting to declining tax benefits means reducing expenditure in time. Although increased political power of elderly (S21) may block health-and pension reforms, it seems likely that such reforms will have to take place in some way. Many European countries are already looking to update their healthcare and pension system (Muenz, 2007). An increase of the retirement age, for example, can potentially be very effective, as it both increases productivity and decreases the years between retirement and death (O'Neill et al, 2010). Budget problems could also stimulate policies to increase the participation into the production process: a high share of elderly that are financially dependent may stimulate the involvement of other groups in the production cycle (Coleman, 2006; Myrskylä et al., 2009). This may for example lead to training for unemployed and policies for female workforce participation like good childcare facilities (e.g. Muenz, 2007) (see S17)

The past section has been devoted to a description of the impact of decline for government budgets. This has helped to understand the societal dynamics that can lead to environmental impacts. Now that these societal developments have been sketched, it can now be considered what the environmental effects of such budget problems will be. Interesting for this thesis in particular, is what will happen to budgets for environmental protection and development. This is, of course, dependent on many factors, ranging from political preferences to lifestyles to population characteristics. But, in general, it seems likely that the pressure to restructure public budget will also mean that budgets for environmental protection will experience some cuts. Because environmental management mainly focusses on long-term problems with relatively little direct effects, it is not unlikely that these particular budgets are even more vulnerable to budget cuts than expenses for short-term problem solving. Budget problems may also provide an incentive for less stringent environmental standards in order to reduce costs of regulation and stimulate new regional economic activity.

#### **Meaning as indicator in environmental management:**

Cornucopian: Budget problems (reduction of affluence) will lead to less available money for environmental management, creating budget restraints and pressures for deregulation. This would make it more difficult to manage environmental impacts in declining regions, a development that matches Cornucopian theory (see page19) .

Neo-Malthusian: Not relevant

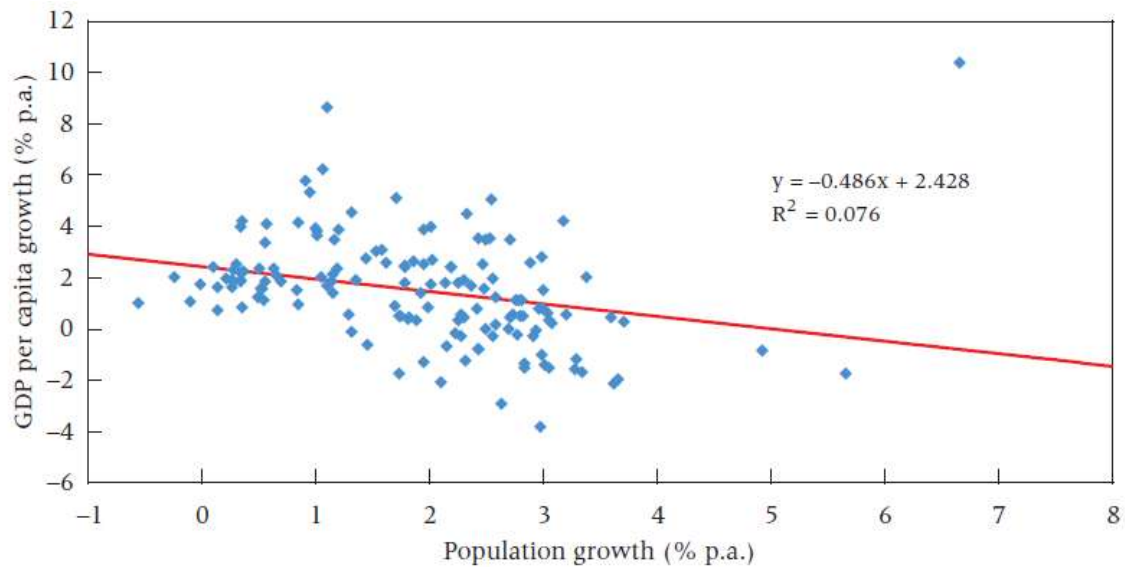
#### **Symptom 2: Reduced economic competitiveness**

The phenomena of urban and regional decline are far from new. According to Coleman and Rowthorn (2011): *"Regional and urban decline, relative or absolute, has always accompanied regional and urban growth in other parts of the same country(...)Unless accompanied by concomitant decline at the national level, the internal shifting balance is devoid of strategic or major political consequences and should generally be regarded as a natural and desirable consequence of adjustment to changed realities of*

*comparative regional advantage.*"(p218/219). The examples of these 'changed realities of comparative advantage' are the situations of population decline that we still see today: cities that have become subjected to decline because of declining industries, agricultural or mining areas that cannot be competitive on global scale or that have undergone strong mechanization and cities that suffer from relatively bad living conditions or from local agglomeration diseconomies (Knox & Marston, 2007). Often, the problems in such areas feed a negative spiral of decline and selective outmigration, resulting in declining living conditions and unemployment which may result in further abandonment and decline (Coleman, 2006; Knox & Marston, 2007; McLeman, 2011). This 'traditional' notion of the relation between population decline and competitiveness, where reduced competitiveness *causes* a cycle of population decline, may be complemented by one where reduced economic competitiveness is seen as being *caused by* population decline.

One of the arguments to fear population decline, is that it can reduce regional demand for products, which can lead to less efficient production as the benefits of an economy of scale also decline (Coleman & Rowthorn, 2011). Such decreasing demand would partly be caused by a decline of the number of consumers, but could also result from the changing (consumptive) lifestyles of the population, e.g. because of ageing (S21). Businesses that are depending on demand from shrinking areas may have to downscale their production, in the process becoming less competitive and less resource-efficient. This could also lead to higher environmental impacts per person as resource use efficiency declines. On the other hand, if regional decline creates a transition towards a more subsistence-based economy (S3), regional demand for certain products might actually increase rather than decrease. Such a economic paradigm shift could, for example, mean that food and energy-production becomes more regionalized and disconnected from the global economy. Another effect on competitiveness emerges when we consider the effects of ageing on corporate competitiveness. Where companies are mainly responsible for providing pensions and health insurance, such as in the United States, companies face additional burdens from the costs of their retired employees (Longman, 2004). While this effect is limited in European countries, government budget problems (S1) may have more profound effects in European nations, where in general taxes are higher. Where such budget problems are an incentive to raise taxes, this could become a source of reduced international competitiveness of companies.

These generally negative prospects for the economic competitiveness in declining regions may work out as a self-fulfilling prophecy, when they also lead to less trust in future economic development among businesses and investors. As trust declines (S6), so do investments and so do general economic conditions, employment and consumption. This may indicate that a declining demand can lead to increased vulnerability to slumps, although so far no empirical evidence supports this view. Rather, the evidence so far suggests an inverse relation between population growth rates and GDP growth rates (Coleman & Rowthorn, 2011, p231) and little causal strengths. Figure 5 shows these correlations between GDP growth rates per capita and population according to Coleman and Rowthorne.



**Figure 5: Growth rates of GDP per capita and population for 146 countries from 1980 to 2006. Source: Coleman & Rowthorn, 2011 p 231)**

At the same time, this type of empirical evidence means little, as the data is on national scale and only four countries show population decline over this timeframe (and these countries are actually below the regression line). The mechanisms that could lead to economic slumps in declining regions that were outlined earlier can thus still be relevant. How much the economic competitiveness would be reduced by population decline will in any way be differentiated across sectors. This would for a large part depend on the importance of transport costs in the overall product price (if relatively low, local demand is not really important) and how the industry is intertwined within regional consumptive lifestyles (Müller et al, 2007). Regional demand for building material for example, can be expected to decline quite strongly, as construction is closely related to population and household numbers. These building materials are often extracted from local/regional resources due to high relative transport costs (Müller et al, 2007). Also environmental impacts of such reduced competitiveness could be depending on the type of industries that are affected. Extraction of raw materials for fabrication of construction material can for example deeply impact the landscape, which means that the environmental effects of population decline will mean that the impact of such industries will probably be reduced. At the same time, reduced economic competitiveness would leave behind unused former production sites. This means that remediation of abandoned production sites will become an increasingly important topic. A more general effect is the decreasing tax revenues which may lead to the budgetary problems described in (S1)

**Meaning as indicator in environmental management:**

Cornucopian: Reduced competitiveness would fit in with a Cornucopian view, as it shows that growth creates more wealth than decline does. Thus, it shows that decline leads to decreasing affluence, and environmental budget problems.

Neo-Malthusian: Viewed from a Neo-Malthusian perspective, such reduced (global) competitiveness can also be positive as a more regionalized and downsized economy decreases overall environmental impacts of production.

**Symptom 3: Economic paradigm shift**

It may be easy to perceive a declining region that is suffering from economic problems (e.g. S1,S2,S7,S8) to be a 'losing' region. In neoliberal economies, growth of throughput, production and profit is highly valued (Miller & Spoolman, 2009). This leaves the economies and societies of declining regions to question if they want to play the game by these neoliberal rules and accept -or fight- the loss in the battle of competitiveness, or rather change the rules of the game and search for a new growth paradigm and

economic rationale. In (S10) it will be shown how attempts to create economic growth in declining regions will often only lead to competition over scarce inhabitants and businesses in a way that leads to a race to the bottom. The more widespread the decline, the more damaging such responses will become, which at a certain point could lead to a reconsideration of the importance placed on this growth-ideal. An example of a reconsideration of this growth-ideal is the 2009 book “Wolk 777”(Cloud 777) by Dutch innovation sociologist Gertrud Blauwhof and economist Willem Verbaan. In this book, they argue that the high value that is put to growth in current society in fact is unsustainable, as the current financial crisis has shown. They argue that a value shift is necessary: acceptance of economic- and population decline might lead to political, social, spatial and economic development that is more long-term oriented and environmentally more sustainable. This paradigm shift may partly be an automatic one, in the sense that in declining regions, possibilities for financing new projects will be limited anyway because of budgetary problems (S1) and reduced trust in future economic development(S6). Another way how economic rationales may be changing in declining areas is through the development of a more subsistence-based economy. Faced by declining welfare payments, and stagnant local economy, alternative lifestyles may be explored in declining regions, in which local social networks gain importance over global competitiveness (Beetz et al., 2008). An example for such a more social-network based economy can be found in how local business operated decades ago, such as described in the 1999 book “De eeuw van mijn vader”(My father’s century) of the Dutch writer Geert Mak. In this book it is described that at the beginning of the 20<sup>th</sup> century things like loyalty to suppliers, paying a fair price and solidarity prevented fierce competition and consolidated the local economy. It may not be unthinkable that if decline leads to regionalization and stronger social bonds, this type of economic rationale will become more common in the future in declining areas.

It is difficult to predict the effects that such economic paradigm shifts might have on society, economy and ecology. Today, global economy is highly intertwined with the economy of declining, but developed, regions. Even if a shift towards other economic ideals is being made, it seems unlikely - with for example current levels of information technology - that a total decoupling of declining regions from the global market is possible at all. Beetz et al. (2008) indeed mention that *“peripherization does not necessarily prevent the integration of peripheral regions into supra-regional and global economic cycles; however, peripheral regions usually realize only marginal welfare gains from this fact”*(p305). The question if a change in local economic rationales can lead to improved local economic conditions as measured in GDP per capita growth is therefore difficult to answer. Rather than improving the local economic conditions it is more likely that it will improve satisfaction with this economic development: if economic growth is valued less, people may be more satisfied with the same marginal economic development than when holding on to neoliberal growth values. If a shift to more localized economic systems is made (Beetz et al., 2008, p306), this can mean that demand and, following this, production of commodities at regional scale increases, because they are not imported anymore. Although this may mean that comparative advantages are not maximized, it does imply a reduction of pollution from transport (S15) worldwide and it would limit the export of external effects of consumption to other countries (e.g. Miller & Spoolman, 2009). This means that the external effects of consumption become much more localized, and thus more visible. If the impacts of consumption are more integrated into everyday life, this can also enable better management of common (environmental) goods, because the social bonding capital in such local groups will probably be much higher than in long-distance trade relations (Rydin, 2006). Another effect that can come with this, is a shift towards long-term and sustainability perspectives (as propagated in “Wolk 777”). This would express itself in more support for sustainable land uses (S11) and environmental policy. At the same time, such stronger local social bonds and a degree of disconnectedness from global events may divert attention from global environmental issues more towards local problems and their solutions.

#### **Meaning as indicator in environmental management:**

Cornucopian: If such a regionalized economy means less efficient production, it could lead to both a decreasing affluence (creating budget problems) and less resource-efficiency, implying relatively more pollution from consumption.

Neo-Malthusian: If such a paradigm shift takes place, it may lead to more valuation of the environment in general and more societal support for environmental policy. This could also mean

relatively more funding for environmental management. Additionally, a more regionalized economy would mean a more direct relation between economic activities and environmental impacts, making it easier to manage such impacts.

#### Symptom 4: Employment problems

Without action undertaken, the ageing effect of low fertility leads to lower support- and dependency ratios (resp. the ratio of 65+ and combined 14 and 65+ compared to the total population) which means that fertility-induced declining regions will also be more likely to be faced with such declining support- and dependency ratios. These declining support ratios mark the end of the demographic “Window of Opportunity” (S7, Reher, 2011). If such a development of support- and dependency ratios indeed is responsible for creating economic problems, the main problem of declining regions would be a reduced *supply* of labor. This may seem strangely at odds with the unemployment issues in many of the currently declining regions, where a combination of reduced economic activity and selective outmigration (see S1, S2) have led to high rather than low unemployment (e.g. McLeman, 2011). This is an issue –which we may call the “employment paradox”- that I have not found to be dealt with specifically in literature. One explanation for this paradox may be found in the economic structure of declining regions. Currently, population decline is mainly taking place in regions where the primary sector (agricultural-, rural- and mining areas) and the secondary sector (industrial towns) are dominant. Within these sectors, labor has generally been low-schooled and can be substituted by mechanization and automation in a cost-efficient way. Fertility-induced decline may, however, also take place in regions dominated by tertiary and quaternary sectors. As opposing to the first two sectors, who mainly produce material goods, these sectors produce services, which generally demands more schooling and of which the production is depending less on natural resources. If workforce declines, automation can do not that much to maintain productivity in the tertiary and quaternary sector (for example in health care and education). This may indicate, that in the future indeed a shortage of labor will be the *source* of economic problems in declining regions, while at the same time it shows that regions currently experiencing population decline may differ from those in the future because the root cause of decline is different.

At first sight the “employment paradox” of declining and ageing regions may be seen as an opportunity for future population decline: the supply of unemployed workers in currently declining regions may become a viable resource once a broader form of population decline sets in and labor shortages become increasingly pressing. It is, however, questionable if this potential workforce is sufficiently qualified to fill in the job vacancies that will emerge. This may be a matter of providing adequate schooling (S17) throughout the worker’s life. But, it may also lead to less competitive companies (S2) that have to invest too much in human resources and are increasingly move (part of) their operations to other, younger regions, abroad or in the same nation. Although this symptom does not have many directly related impacts on environmental policy and management, it may have some indirect effects by its impacts on society. This could involve a changing attitude towards environmental protection (unemployed often have more negative attitudes, see S17), reduced economic competitiveness (S2) and budget problems (S1). The overall effects of such changes in employment would be strongly dependent on how the employment paradox plays out: Is there a history of unemployment which now offers a valuable asset of available workers, or will the decline lead to a shortage of sufficiently skilled workers?

#### Meaning as indicator in environmental management:

Because it remains unclear how the “employment paradox” plays out due to a gap in literature, it proves to be difficult to assign specific indicators for this symptom for either theory.

#### Symptom 5: Changed innovative capacity

Innovation may originate from highly sophisticated and focused research and development projects or can develop more or less ‘by accident’ or through a single smart idea (e.g. Harhoff, 2008). In this section, innovation is addressed as innovative *capacity*, to shift the focus from these semi-random events to how the occurrence of these events is facilitated by the specific societal context in which they develop.

Many authors have thought about how innovative capacity is shaped and how population relates to this. Some of them suggest a positive relation between population size and innovation. Of these authors, some important names and works have already been introduced in Part 1, notably Ester Boserup (e.g. 1965; 1981) and Julian Simon (e.g. 1981) (Joly, 1994; De Sherbinin et al, 2007). The views these authors hold may both be characterized as “technology optimism” (Brander, 2007). While Boserup mainly sees population density as enabling the use of *already existing* technologies to produce more efficiently, Julian Simon and other cornucopian economists are even more positive about the adaptive capacities of society and are trusting on the market to resolve resource scarcity regardless of availability of technology.

If innovative capacity is indeed stimulated by population growth, population decline would mean that declining areas would suffer from reduced innovative capacity. Although this has led some authors to see population decline as a threat to welfare (e.g. Longman, 2004; Wattenberg, 2004) and both Boserup and Simon expressing their worries about population decline, it would be too bold to state that population decline always obstructs innovation in such a way that society as a whole is worse off. What both theories in essence say, is that human ingenuity will allow people to deal with scarce resources and, through that, innovate and become more efficient. There is no indication in this argument, that where *decline* takes place, this human ingenuity suddenly will be insufficient to solve the problems associated with decline. When a moment would come that population decline is limiting development, the same ingenuity would, theoretically, still be in place to find a solution, because the source of this ingenuity – the human being – would still be available.

There are, however, circumstances under which it can be argued that population decline *does* slow innovation in such a way that society no longer benefits. This would be the case if the population *structure* is altered in such a way that innovative capacity diminishes. Selective migration could be one of these mechanisms. Selective migration might lead to an exodus of the better educated and more entrepreneurial types as they search for a more opportunity-rich environment in regions that still show growth. This would leave declining regions without their supply of creative and undertaking people. Another mechanism is through disinvestment in innovation, caused by reduced trust (S6) (Longman, 2004; Coleman & Rowthorn, 2011). Under strain of budget problems that may come with ageing and decline (S1), governments and companies may choose to invest less in innovation, which is often a long-term investment. In the rationale of a politician thinking about support for his policies until the end of his or her term, it may seem attractive to cut on expenses in innovation, rather than initiate health-and pension-system reforms (S21). A final way in which population can affect innovation, comes from changing age structures and associated risk-taking behavior. Elderly are generally more prone to risk-averting behavior and, therefore, a society with more elderly could be less inclined to spend money on innovation, because the possible benefits may be high, but also highly uncertain. (e.g. Longman, 2004; Harhoff, 2008).

However, if it is true that innovative capacity is not directly related to population size and growth, but rather a response to problems encountered in society (as was argued earlier), decline may even be thought to *stimulate* innovation and implementation of innovations in declining regions, as a response to the specific problems these regions are facing. For example, the problem of urban wastelands and abandoned industrial sites, has led to many new initiatives that aim to make cities greener (S22), in the process improving urban climate and neighborhood quality. Population decline could also offer chances for new, innovative, land uses (S11). What the effects of changing innovative capacity would be on the environment remains to be seen. This is a question closely related to the debate about if economic development positively or negatively impacts the environment. This is the heart of literature about the Environmental Kuznets Curve (EKC). It has been showed that demographic factors can influence these the EKCs. The demographic transition for example has been shown to impact this relationship directly: the economic “bonus time” resulting from this demographic transition can create additional economic growth that also leads to more innovation and cleaner techniques (e.g. Franklin & Ruth, 2012). Complicating this further, innovation is not the only demography-related factor that influences how this EKC works: for example, also age-dependent energy consumption and air quality preferences can play a role in how pollutant emissions develop with increasing welfare (Menz & Kühling, 2011). Such EKCs also do not offer general conclusions about how innovation (be it through demographic developments) shapes the intensity of pollution. If the case of air pollution is taken as example, the answer to the question if



economic development reduces environmental impacts though innovation strongly depends on the type of pollution. For pollution like SO<sub>2</sub>, reductions in emissions may be technologically and environmentally much more feasible than for CO<sub>2</sub>, meaning that CO<sub>2</sub> emissions follow a pattern closer to neo-Malthusian theory and SO<sub>2</sub> more according to Cornucopian theory. To conclude, in the literature there is no clear consensus about the question if issues of technological progress and innovation will work out positively or negatively for the environment in declining regions; both options could be possible.

**Meaning as indicator in environmental management:**

Cornucopian: A slowing of innovation might mean a stagnation of improvements in resource-use efficiency. This could be indicated by reduced investment in and application of environmentally friendly, innovative technologies or land uses, which, in the end could lead to higher pollution from production industries.

Neo-Malthusian: Innovation aimed at solving the specific problems that declining regions face can increase investments in and application of environmentally friendly, innovative technologies or land uses. This could show up as an increase in ideas and initiatives for environmentally friendly land uses or technologies (such as wind parks, solar parks, biofuel crops, ect.) (see also S11)

**Symptom 6: Reduced trust in prosperous future**

Strongly connected to a decline in innovative capacity (S5), changing economic rationales (S3) and decreasing competitiveness (S2), is the notion that population decline can change the expected economic future and trust in economic growth. Continuing decreasing demand for products (which would be a long-term effect of the decline of the number of consumers) can at a certain point undermine confidence amongst producers and investors that the future holds better perspectives (Coleman & Rowthorn, 2011). This can become a self-fulfilling prophecy: as trust declines, so do investments, leading to stalling (corporate and private) consumption and more unemployment, which in turn feeds a new cycle of declining trust. According to Coleman & Rowthorn (2011, p226) *“Confidence in growth in numbers may underpin confidence among investors and inventors that their products and services will be launched onto a growing market that will sustain demand, and that a growing labor force can match demand with the required output”*(Coleman & Rowthorn, 2011, p226). With a declining population, the reverse could be observed. Also, a growing population would increase the confidence that the pay-off of high development costs for certain innovative products will be bore by an expanding market. However, no empirical evidence to support these statements was found in the reviewed literature.

However, if trust in a prosperous future would diminish in declining regions, it could not only impact economic development, but may also cause value shifts within the regional population. Recent data suggest that current young European cohorts are slightly higher on materialistic value than elder cohorts. Inglehart (2008) ascribes this to a stagnation of real income in recent years, which has undermined the trust in a prosperous future (p136). It is now interesting to imagine what the effects of continuing recession, forced by demographic pressure (S2), would be on environmental values. Scruggs & Benegal (2012) come to the conclusion, that the current recession (exemplary of such a stagnation of real income) has indeed corroded environmental values in general and, more specifically, attitudes towards climate change. If population decline would obstruct economic development in such a way that the trust in a prosperous future is undermined, citizens may become more focused on ‘urgent’ matters which, according to Inglehart’s theory, would also deteriorate attitudes towards environment protection.

**Meaning as indicator in environmental management:**

Cornucopian: If indeed affluence is decreasing under conditions of decline and trust in the future is undermined, this could lead to a value shift away from immaterial (environmental) values. This might be experienced by environmental policy and management as decreasing political and public support for environmental policy and management, which would make it more difficult to manage environmental impacts.

Neo-Malthusian: Not relevant

### Symptom 7: Loss of productive population

The first phases within the process of demographic transition, are characterized by declining mortality rates. In these phases, early deaths occur less frequent, which also means that individuals can remain productive for a longer time. This potential economic benefit is contravened by a relatively large group of young individuals, who initially require certain investments of resources (e.g. food, education) to become productive. But as the second phase of the demographic transition sets in and fertility declines, the size of this group of youngsters also becomes relatively smaller. It is in this phase of the demographic transition, when the share of young individuals becomes increasingly smaller, that a “wave” of people in their working ages is created. This period is regarded as having much potential to boost the local economy (Reher, 2011). It depends on the *pace* of the decline of fertility how long this boost lasts and how intense it is. In Western Europe the period where the share of productive individuals in the population started to climb, started already before the twentieth century and has been continuing for a long time. This (long) period, characterized by marked improvements in living conditions, has now come to an end (figure 6). Population stagnation and decline, initiated by below replacement fertility, have begun to initiate the downward movement of this “wave”: the productive cohorts are no longer fully replaced by younger cohorts, while at the same time people live much longer which now means that a large group of elderly needs to be supported after their productive life by the rest of society.

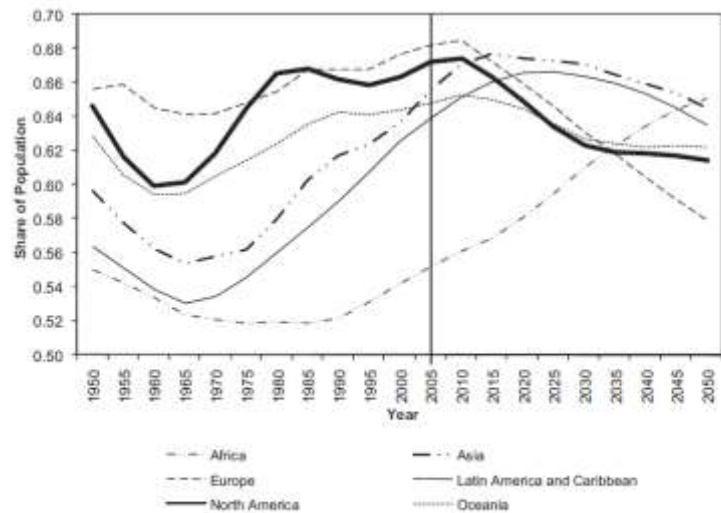


Figure 6: The observed and projected share of population in working ages of different world regions according to the United Nations. In fifty years’ time, European rates drop from the most favorable to the least favorable. Retrieved from: Hugo, 2011, S27.

The demographic phase described above, in which the share of productive individuals in a population increases for a period of time has been called the demographic “Window of Opportunity” (Reher, 2011), “Bonus time”(Ueda, 2011) or “Demographic Dividend” (Swiaczny, 2010). The strategic advantage of certain fertility rates is illustrated in figure 7. This illustration of the role of demographic transition (DT) as one of the most important *drivers* of economic growth can complement a more traditional view of the demographic transition, where economic growth is rather seen as *causing* the demographic transition. To proponents of the view that demographic transition *stimulates* economic growth (like David Reher), this demographic mechanism explains much of the current developments in world economics, such as China’s, India’s and the Asian tigers’ recent economic surge. There might even be signs that even some African countries – the last to

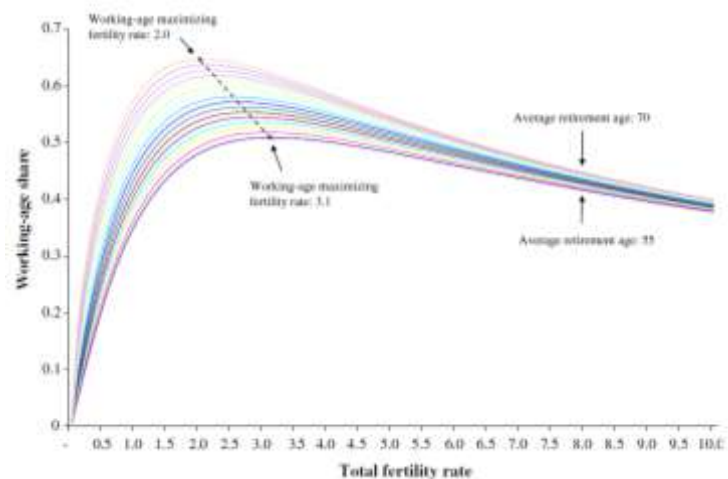


Figure 7: The calculated effects of different TFR’s and different retirement ages at working-age share. This represents the share of the population that could potentially be at work if fertility rates remained constant (taking into account a ‘typical’ European life expectancy). The optimum working-age shares depend on retirement ages, but in general, slightly growing populations have the highest working-age shares. Figure retrieved from: Bloom et al, 2008, p150.

go through the DT and thus the last to benefit from this demographic dividend – have taken their first careful steps on this transition pathway (*Opinion: Could Africa be world's next manufacturing hub?*, 2012). If indeed this demographic ‘window of opportunity’ plays a big role in shaping global economic performance, it would imply that most western economies, now at the end of the demographic transition, will experience a relative stagnation of the economy. The more a country is subject to low fertility, ageing and population decline, the more it would be vulnerable to such a stagnation. The question is now, how such an economic downfall in production will impact the environment. Economic stagnation can lead to less pollution from economic (production) activities, but would also leave behind unutilized industrial and business sites that need remediation (S13). As the “window of opportunity ends”, slowing economic growth could also allow for a better management of environmental impacts (Reher, 2011), because of a more stable economy. At the same time, if the growth paradigm remains unchanged (S3), stalling economic growth can create budget problems (S1) which can provide incentives to decrease regulatory pressure (S18), or stimulate competition over continually scarce financial and human resources, which could further aggravate social and fiscal problems (S10).

**Meaning as indicator in environmental management:**

Cornucopian: In a Cornucopian view, the negative impacts of such stalling economic growth will tend to reduce both wealth and resource-use efficiency, which would imply relatively higher impacts, e.g. of air-pollution, per capita. The reduction of productivity could lead to budget restraints and increasing deregulatory pressure as well.

Neo-Malthusian: The smaller productive production leads directly to lower pollution/emissions; because existing wealth is shared with less people no additional production is necessary to keep ‘real’ affluence at a high level. Any indicators of pollution such as air- and water- pollution thus would have to show a concomitant decline.

**Symptom 8: Increased dependency on subsidies**

Bernt (2009) describes how shrinking cities can undergo a transition in the style of governance, because the power relations of various actors are altered through the impacts that decline can have on society. He first describes the image of the modern-day “neoliberal city”, in which the traditional managerial role of government in urban development has gradually been replaced by a more entrepreneurial approach; cooperation with private parties has become increasingly common for initiating new developments. This leads to the formation of “growth coalitions”, partnerships between private parties and local authorities where both parties need each other for maintaining growth and expanding power. However, such coalitions can also rearrange the priorities of policies. Bernt notes that: *“this structural nexus privileges private business interests and thus causes a bias towards ‘pro-growth’ rather than redistributive or ecological urban politics”*(Bernt, 2009, p757). However, in a declining region, the financial position of both businesses and local authorities are weakened (S1,S2). Initiation of new developments or urban restructuring, now becomes more strongly dependent on grants from higher authorities, rather than local funds. With this, chances are opened up for a more ecological style of management, as such grants are often conditional and more aimed at improving public wellbeing than maximization private capital. Although this development can mean more support for environmentally friendly policy initiatives in declining regions in general, it should be kept in mind that these national urban development subsidies would be forms of redistributive policy. As decline becomes more widespread, continuation of such grants will be dependent more and more on the willingness of other citizens and politicians in regions with a less severe decline to remain solidary with the regions that are hardest hit by decline.

**Meaning as indicator in environmental management:**

Cornucopian: From a Cornucopian perspective, financial dependency on higher government is a negative sign, indicating an actual decrease in affluence. This dependency on government institutions to provide additional funding and subsidies would in the end not be sustainable – which could be indicated by budget problems and increasing difficulties to obtain subsidies for new or existing projects as time progresses.

Neo-Malthusian: Less corporate influence in environmental management and more dependence on subsidies could indicate that “redistributive and ecological politics” have become stronger. This could be indicated by relatively less involvement of businesses in policy and management and a stronger position of governments to enforce regulation and measures onto public parties.

### Symptom 9: Difficulties with infrastructure quality and quantity maintenance

Infrastructure may broadly be defined as “The basic facilities, services, and installations needed for the functioning of a community or society” (*Infrastructure*, n.d.). In this section, however, I confine the term to the infrastructure that facilitates the *flow of people, and materials or information*. The direct effects of population decline on utilization of this infrastructure are (partly) straightforward. As population declines, so does the density of people in an area. This leads to relatively less frequent utilization of this infrastructure, if utilization per person is held constant. Although this can be regarded as positive in some cases – for example when a reduction of traffic jams decreases the need for new roads (Coleman & Rowthorne, 2011), it can also create many new problems. For example, in rural (e.g. mountainous) areas with low population density, the maintenance of basic infrastructure, notably the road network, can deeply impact local budgets. With less people to bear the costs, the burden of maintenance becomes even higher. Because infrastructure is a rather stationary spatial phenomenon, it can be difficult to adapt infrastructure to changes in population size. Hidding (2006) mentions (for the Netherlands) a planning horizon of 10-30 years for infrastructure, and major changes in infrastructure only occurring at a timescale of about 40 to 60 years. Within this timeframe, population and population characteristics can change quite drastically, which undermines the capacity of governments to adapt to these new usage patterns. In case of growth, an upgrade towards a more intensive use of the network can be made without much long-term financial consequences, because the higher population will also provide more income than expected. A declining region, however, faces more difficult choices: should under-utilized infrastructure be closed down or modified at additional expenses, or should less be invested in maintenance? Both options come with additional expenses, while there are less people to bear such costs. Several papers and reports about decline indeed consider growing infrastructure maintenance costs per capita as one of the prominent public management issues of population decline (e.g. Müller et al., 2007; Beetz et al., 2008; Bernt, 2009; Swiaczny, 2010). This strongly suggests that Esther Boserup’s thesis (Boserup, 1981) that population growth enables more efficient resource use and stimulates economic growth also applies for today’s declining regions, but in reverse.

One of the examples of increasing problems with maintaining infrastructure quality in declining regions is public transport. As the amount of customer’s declines, service intensity is decreased, making public transport even less attractive. It is, however, not always possible to directly link declining public transport quality to a declining population. Many times, expense cuts on infrastructure and services are justified by government agencies by pointing to population decline, while they are in fact more due to rationalization than demography (Beetz et al., 2008). Another example of the effects of population decline on infrastructure quality, is the case of underutilization of drinking water and waste water networks. As population density decreases, maintenance costs per user increase as a consequence of ‘static’ infrastructural hardware (e.g. Müller et al., 2007; Nowack et al., 2010). Müller et al. (2007) note that reduced demand for water, leads to lower flow rates and longer retention time of water in pipes. Slower flowing water in drinking water networks increases sedimentation of suspended chemicals, increasing the likelihood of blockages as well as the corrosion rate of pipes. In elder pipes this could lead to increased release of (toxic) lead (Pb) into drinking water, which causes substantial health risks. Furthermore, as retention time of water in pipes becomes longer due to slower flow rates, the risk of biological pollutants such as legionella bacteria accumulating in the water increases. In extreme cases, the change in water demand has led to closure of drinking water winning facilities. While this means restoring the water table to original situation (which may be a positive aspect), the resulting rising of groundwater levels can create damage to the foundation of buildings. In waste water systems, similar problems occur, as corrosion of pipes and sedimentation in pipes increase. This requires additional flushing of the piping network, meaning not only a waste of fresh water, but also a disruption of the cleaning process. Yet another negative effect on infrastructure can be found in cities with central urban heating. In a city with vacant

housing (S12), heat losses will relatively increase, which means that the energy-efficiency of the system is reduced.

Many of the problems with (maintenance of) infrastructure might be solved by downsizing, but this requires additional investments, potentially aggravating budget problems (S1). Another way of dealing with these problems would be to change the management practices in search for more cost-efficient options. This may spur innovation and stimulate 'smart solutions' (S5). At the same time, it is not unthinkable that, rather than finding structural solutions, management standards are lowered (S18). In case of mobility infrastructure this implies a decrease in quality of the road network, but for environmental infrastructure it could also mean increased pollution and health risks.

#### **Meaning as indicator in environmental management:**

**Cornucopian:** Problems with maintenance of environmental infrastructure such as waste water plants and waste disposal systems indicate a lower technology factor. When the population is confronted with extra costs per capita to maintain the standards of such infrastructure, this means a decrease of affluence and increased difficulties to manage environmental impacts. Such issues may be directly indicated in environmental policy and management, because it means that the quality of environmental infrastructure and the environment in general is in jeopardy. Decreasing efficiency of traffic infrastructure might lead to relatively higher emissions from traffic.

**Neo-Malthusian:** If population decline relieves –mainly- traffic infrastructure from overutilization, this may be indicated by decreasing occurrence of congestion-like symptoms such as noise-and local air-pollution. Because infrastructure development is often thought to threaten biodiversity-threats, it may also show up as decreasing worries about the disturbing impacts of infrastructure on biodiversity.

#### **Symptom 10: Intraregional competition leading to continued land consumption**

Local authorities of declining regions under financial stress (S1) can apply a strategy of temporal overspending, if it is thought that additional expenses or tax cuts can stimulate the local economy in the long term. It is often hoped, that such financial stimulation attracts new economic clusters which may break the negative spiral of decline. Bontje (2004) mentions the example of Leipzig, where BMW and Porsche have opened new factories, stimulated by government subsidies. The city also tries to attract biotechnology companies and cultural tourism. Hospers (2011) describes how shrinking regions often turn to place marketing strategies to attract new inhabitants, tourists and companies. Local governments often stimulate the construction of new, high quality housing or business parks to become more attractive to new inhabitants, even though current vacancy rates of elder buildings are high (Van Dam et al., 2006). If successful, such strategies may indeed lead to increasing tax revenues and a recovery of the financial position of these administrative units. However, within a broader context of decline, such strategies will lead to competition between regions to attract the tourists, companies or inhabitants with ever more favorable offers, while at same time, the tax revenues keep declining due to natural population change processes. As a certain share of these companies or inhabitants originates from declining regions themselves, this runs the risk of eventually leading to a 'race to the bottom' in which declining regions are competing for new inhabitants and companies on price. Such a race to the bottom would probably hit the regions with the strongest decline and low comparative advantage over others regions first. These will mostly be the areas with the lowest population density that are already burdened with relatively higher costs to remain service and infrastructure levels at an appropriate level (Boserup, 1981; Van Dalen & Henkens, 2011). If interregional competition is the main strategy applied by regional politicians – which would indicate sticking to the growth paradigm (see S3) – such declining regions may also become subject to a paradoxical continuation of construction and land consumption, while at the same time having a large stock of abandoned buildings (S12, S13). This would eventually aggravate budget deficiencies both in declining regions that do and do not apply such strategies, because it implies increased spending for the one and reduced income for the other region.

### Meaning as indicator in environmental management:

Cornucopian: When intraregional competition leads to a race to the bottom, because there is a competition over a declining market, this results in a decrease of affluence. This may work out in two ways: Less money available for environmental management or pressure for deregulation to reduce costs. A more direct indicator in management and policy may come from continuing worries about high land consumption, even while there are still high vacancy rates.

Neo-Malthusian: not relevant

### Symptom 11: Increased adaptive capacity to alternative land uses

Opportunities for regional agricultural production are nowadays tightly connected to supply and demand of global markets. With global population still growing and developing countries making the transition to more consumptive lifestyle-and eating patterns (e.g. Godfray et al., 2010), it is expected that in non-marginal areas, agricultural land-use practices will continue - and probably only intensify. Thus, for many rural areas with population decline, the agricultural sector can be expected to remain strong: *“Current developments in natural resources use show that population decline and a possible cutback of infrastructure do not necessarily lead to the abandonment of land uses or the creation of new ‘wilderness’ in central Europe. Rather, economic, social and demographic decline and a vivid land use sector exist side by side in the region.”* (Beetz et al., 2008, p302). This shows that it is highly questionable if productivity of modern-day, globalized agriculture - in which even food can be transported over large distances with relatively little costs (Coleman & Rowthorn, 2011) - is directly linked to population density, as is assumed in Boserupian theory (Boserup, 1981).

However, even if land use in general remains under influence of global agricultural markets, local changes may still occur. Locally, traditional agricultural practices might be abandoned when they become too unprofitable, after which new land uses, agricultural or non-agricultural, may come to replace the traditional ones. Such changes most likely occur on marginal lands for large-scale production (Faus-Pujol & Higuera-Arnal, 2000; MacDonald et al., 2000). In such cases, declining regions may be amongst the first to experiment with new land uses such as wind farms or biofuel crops, because the need to find new economic functions of the landscape might be more pressing (Müller et al., 2007; Beetz et al., 2008; Schilling & Logan, 2008,). An example of a new idea to transform marginal agricultural areas, is a proposal to create a buffalo reserve on the Great Plains (USA). This could create new chances for conservation, as well as a new agro-touristic economic sector (Popper & Popper, 2002). Another example is the Energy Valley project in the (peripheral) north of the Netherlands, in which placement of wind turbines and tillage of energy crops for biofuel is promoted to initiate new economic developments in a demographically ‘weak’ region (*Energy Valley*, 2012). Such an seemingly increased capacity to experiment with new and innovative land uses may also be witnessed within urban areas. As existing urban land uses are abandoned, new initiatives like urban forestry or urban agriculture may develop to fill the voids that are appearing within the urban fabric (S22).

It was discussed in S5 that population decline may stimulate innovation in new economic sectors, and new land uses could be one of the notable examples of this. Such a development would take place alongside further intensification of existing intensive agriculture. It should thus be kept in mind that, even if an elevated adaptive capacity to new land uses does exist in declining regions, the environmental pressures of intensive agriculture, like pesticide, high fertilizer use and methane emissions could still persevere.

### Meaning as indicator in environmental management:

Cornucopian: Not relevant

Neo-Malthusian: If indeed the adaptive capacity to alternative land uses in declining regions is higher, more application of and plans for alternative, environmentally friendly, innovative technologies and corresponding land uses can be expected.

### Symptom 12: Abandoned housing and declining real-estate prices

Population decline will reduce overall demand for the number of housing units, as long as household size remains constant. Although this last assumption often does not hold (see p 20, 21), when the population decline is severe enough, it will still result in more vacant housing. One of the primary problems associated with this, is that this disturbs the functioning of housing markets (e.g. Van Dalen & Henkens, 2011; Verwest et al., 2008). Especially for regions where real-estate prices are inflated (as is the case in the Netherlands), reduced demand for housing can cause a housing crisis when the price-bubble deflates. In the UK, cases have been observed in old industrial towns where prices dropped to 10% of the initial price (Verwest et al., 2008, p68). Such dramatic price-drops can be perceived as a decline of welfare, because a high share of wealth of households tends to be accumulated in housing (Van Dalen & Henkens, 2011). These dropping prices results from the high number of properties for sale and imply that the rent-load for home-owners becomes higher than the actual 'real' rent should be. This can lead to a reluctance to change houses, or to enter the housing-market, as there is a good chance that one cannot retrieve the price that was paid initially when selling the house later on. There are, however, also positive effects: declining housing prices could also mean that it becomes easier for young families to find suitable housing, and mortgage rates will generally become lower (Sobotka et al., 2011; Van Dalen & Henkens, 2011).

Problems with vacant housing will not confine to the housing units that are bought, but will also affect the hiring sector. Also here, less demand for housing units would mean that a larger part of the housing stock becomes vacant. What is more, the rent of housing is usually connected to the general housing prices. Companies or association who rent houses will thus be presented both with income losses both due to lower occupation and lower rents. This could result in declining investments in maintenance of housing and renewal of the stock (Verwest et al., 2008). This, in turn, may lead to deteriorating neighborhood quality and a resulting further decline of prices, as well as selective migration. For local authorities, these lower house prices and reduced building activities will mean lower incomes from related taxes (S1).

Demographic change in declining regions does not only concern a shift in the quantity of demand for housing, but just as well in the quality of the demand for housing. Neighborhoods with higher quality housing or better facilities, services and infrastructure may still be wanted, while low-quality housing and neighborhoods are hit hard. This leaves certain (urban) areas extra vulnerable for population decline, but at the same time it ensures that in more favorable areas population density remains high and facilities can be maintained (e.g. Brose, 1986; Kabisch et al., 2006). Ageing can play a major role in type-specific housing demand as well. As elderly increasingly dominate society in numbers, the requirements for housing will change accordingly (S21). Waltersbacher (2006) lists ageing of population as an important cause for continuing land consumption (see S10) in declining areas, as it creates new demand for specific types of housing and neighborhoods, regardless of the existing housing stock (Waltersbacher, 2006 in: Kroll & Haasse, 2010).

The oversupply of vacant housing and diminished perspectives for recovery of the housing markets can lead to initiatives to demolish some of the houses and find new land uses for the resultant open spaces (e.g. Bernt, 2009; Schilling & Logan, 2008). Another option is to reinvest in neighborhood quality of such areas, for example through "greening the city" projects (S22). Although this is probably one of the more 'handsome' options, there are limits to what such projects can do for declining cities due to costs considerations. Müller et al., (2007) reason that which strategy to take in such cases depends on the scale and location of the abandoned areas and how this impacts living conditions: where greening the city projects might work at small scales to improve local conditions, this comes at high financial costs and requires cooperation of owners that is often difficult to achieve. For more isolated sites within the urban fabric, the financial benefits of ecological management (see also S 13) of such sites may outweigh a possible decrease in neighborhood quality. Besides impacts on neighborhood environmental and social quality, another aspect of such vacant housing is the problems that it brings to maintain environmental infrastructure such as centralized building heating and water services. It also would imply less efficient urban and rural transport (S15) (Müller et al., 2007).

**Meaning as indicator in environmental management:**

Cornucopian: A decline in housing prices and more difficulties to provide sufficient maintenance can be perceived as a decline of affluence. This could lead to budget restraints for environmental managements, or lead to extra spending on (urban) regeneration projects, which would indicate a decreasing capacity to deal with such impacts.

Neo-Malthusian: For positive effects of ecological management or greening the city, see S13 and S22

### Symptom 13: Abandoned industrial sites

In the currently declining regions, the stock of deserted buildings and sites consists not only of vacant housing (S12), but also of a considerable amount of old industrial sites or brownfields that were deserted when economic sectors became less competitive (Klingholz, 2009). Vacant housing and abandoned industrial land are often two sides of the same coin in such regions: the economic decline that caused problems in the housing market usually originates from the decline of certain industrial sectors (which leaves behind derelict industrial sites). Also regions influenced by fertility-induced population decline may be experiencing such abandonment of industrial/commercial sites, but in a reversed order: if demographic change leads to less competitiveness (S2), it may lead to more abandoned sites of business activity – although the vacancies might be less ‘industrial’ in character than in currently declining regions.

Such derelict industrial/commercial sites (brownfields), are often unwanted as they bring with them problems of neighborhood deterioration, pollution and sealing of the land surface (Fischer, Pers. Comm. 2011). What can be done to remediate such sites is highly dependable on the economic feasibility of such solutions. The possibilities for remediation will, however, be limited more and more, as competitiveness continues to decline and budget problems increase (S1, S2). The choice between strategies to deal with these brownfields is not only one of economic considerations, but also involves an evaluation from an environmental point of view. What is left when industrial activities cease, are the empty shells of buildings, left to slow deterioration but still occupying the land. This “sealing” of ground implies that such lands are essentially unproductive, land which may be seen as a valuable and scarce resource (e.g., Brose, 1986; Fischer, Pers. Comm., 2011). When it is realized that population decline often co-occurs with continuing land consumption (S10, S12), such sealing becomes even more worrisome. Often, “Land recycling” plans and policies are therefore developed to reintegrate such areas within the natural and economic cycle. However, brownfields often suffer from pollution, which means that some form of remediation is needed to restore such lands to their natural state or make them available for new economic use. This would require additional investments. While in current times such projects are often (partly) financed by European or national subsidies and funds, the execution of such projects is mostly still problematic (Fischer, Pers. Comm. 2011).

Another option is not to resort to remediation and let nature find its way. Even if the ground is sealed and even if some pollution and disturbance of the natural substrate is present, nature will after a while reclaim such sites. Such ‘spontaneous’ nature on sites that are heavily impacted by human activity may actually still be quite valuable. For Dutch highway roadside verges and railway terrains, it is for example known that, although they represent a small part of total land-use, they house a great deal of species diversity, amongst which many rare species. This can be attributed to their heterogeneous conditions, reduced disturbance and potential for successional progression (e.g. Koster, 1991; Kattwinkel et al., 2011). Some even argue that such brownfields and derelict sites have an ecological value that should be preserved and that too fast redevelopment of such sites is actually a bad thing (Kattwinkel et al., 2011). These last authors also conclude that recognizing the ecological value of brownfields would open up perspectives for declining cities to reconsider the value of such derelict areas. However, Popper & Popper (2002) point out that such partly overgrown areas are often not safe, healthy and beautiful and thus mostly do not contribute to perceived neighborhood quality – deeming such strategies unwanted for sites that are embedded within the urban fabric.

**Meaning as indicator in environmental management:**



Cornucopian: Remediation of brownfields poses extra costs for environmental managements. If this is recognized in environmental management as problematic, because of the extra costs it involves and the already appalling financial situation of the region, it points to a situation where human impacts on the environment have become more difficult to manage

Neo-Malthusian: If the natural value of remediated brownfields or overgrown industrial values is mostly perceived as a positive change, it signifies reduced impacts, thus fitting the neo-Malthusian view.

#### Symptom 14: Concentration of population near facility centers

As population declines, the utilization rates of public and private services also declines. This can lead to closure of basic local services like schools, shops and public transportation (S1, S9, Van Dam et al., 2006; Beetz et al., 2008; Haartsen & Van Wissen, 2012). Especially elderly, who are faced with less personal mobility, are likely to move to places where the remaining public and private services are concentrated, which means they are attracted to larger villages and small towns (Regio Eemdelta, Pers. Comm., 2009). Because an elder population favors quiet living locations and an attractive landscape (S21), such concentration does, however, not necessarily focus around central urban districts. The peripheral, rural small communities provides the kind of living environment that is more appreciated by elderly, but is clearly also less suitable because it lacks in adequate services (e.g. Boyle et al., 1998). The most appreciated living environments will be the ones that combine both, such as urban fringes or the rural facility centers.

These migration movements of the elder population may mean a few things: In peripheral areas, they would create further underutilization of infrastructure, but at the same time lead to additional pressure to maintain connected to the outside world for those that still remain. In places where population concentrates - the larger villages and towns and urban fringes – this immigration of (mainly) elderly will likely lead to reinforcement or at least consolidation of standards of public and private infrastructure, as well as some additional construction to facilitate the housing needs of elderly (S12,S21). Such concentration in larger villages and towns may also have positive effects on biodiversity when considered from the point of island theory: a more concentrated population means less disturbance of nature in the spaces in between these population centers, because it enhances connectivity and size of relatively undisturbed rural ecosystems (Pebley, 1998, p 382). In inner cities and urban districts with poor landscape qualities or low social neighborhood quality, this distributive shift can, however, lead to an additional increase in vacancy rates (S12)

#### Meaning as indicator in environmental management:

Cornucopian: For effects of increasing vacancy-rates, see S12

Neo-Malthusian: A reduction of pressure on biodiversity in rural areas can be seen as a decreasing impact of human population.

#### Symptom 15: Changing mobility patterns

In declining regions, not just the intensity (S9) but also the utilization patterns of *mobility* infrastructure networks are likely to change. As public and social services become more and more concentrated in central towns, due to service density or rationalization considerations (see S14), people outside of these centers will have to travel more to access these services (Beetz et al., 2008; Kroll & Haase, 2010; Coleman & Rowthorn, 2011). Often, this will express itself in increased mobility, especially by car. Downsizing of public transportation can further stimulate car-mobility where shrinkage has reduced the service density of public transport (Beetz et al., 2008). Kroll & Haase (2010) foresee higher environmental impacts because of these changing mobility patterns: *“A declining settlement population density has negative environmental impacts in several respects. It affects the land and energy resource-efficiency due to (...) a higher consumption of energy per capita for mobility purposes”*(p732).

However, deteriorating levels of public services in small towns and on the countryside, can also be an incentive for the remaining population to concentrate in larger villages or cities where the access to these services is better. This would imply decreasing rather than increasing mobility (S14, Coleman & Rowthorn, 2011). Müller et al. (2007) also bring up the notion that elderly travel less than working aged persons, and in that way, the increase in (car-) mobility might be limited. This seems a fairly realistic assumption, as forensic travel implies that the costs of traveling to work are directly compensated by a profitable activity, which would not be the case for retired persons. Another, process that could change mobility patterns and their environmental consequences, could be the reduction of congestion. This argument was already put forward in 1937 by D.V. Glass, but may still hold for regions that have a recent history of economic- and population growth and a strained infrastructure. As such, benefits for the economy and the environment may be more likely to be found in urbanized and industrialized regions central regions, than in rural decline areas where congestion never was a big issue.

#### **Meaning as indicator in environmental management:**

Cornucopian: More traveling would mean less resource-efficiency and relatively more pollution for the same unit of production or consumption. This can lead to relatively higher emissions from transport, such as CO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10</sub>, SO<sub>2</sub> and noise— no serious decline in these indicators is to be expected

Neo-Malthusian: If new mobility patterns lead to reduced congestion costs, and if elderly indeed travel less and live closer to important facilities, this would reduce construction of new infrastructure which could preserve natural area. It would also decrease typical traffic pollution such as CO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10</sub>, SO<sub>2</sub> and noise.

#### **Symptom 16: Increasing share of international migrants**

Ignoring the 'employment paradox' (S4), the generally held view is that fertility-induced population decline (relative or absolute) leads to a shortage of workers and a decreased capacity of the remaining workers to support the non-working population. According to Boserup (1986) there are two main pathways out of this situation: either corporal activities decline as companies go bankrupt or move their activities to more favorable places, or a new labor force should be brought in to replace and support the ageing and declining workforce. This was also illustrated in S7 by figure 6, which shows that, according to population projections, from 2010 onwards, the share of population in working ages in Europe will decrease both absolutely and relatively.

Amongst many scholars, it has been suggested that this ageing and shrinking labor force creates an incentive to attract foreign workers (Boserup 1986; Longman, 2004; Bloom et al., 2010; Hugo, 2011; Van Dalen & Henkens, 2011). This could be an attractive solution to expand the labor force in different ways. Historically, international migration has been a rather efficient way of redistributing workforce from countries with an oversupply of labor to countries with a large demand for labor (Reher, 2011; 2012). Such migration movements carry potential advantages for both sending and receiving societies: Where receiving countries can experience an economic boost as their dried up pool of labor receives a much-needed stimulus, the sending societies, which are often in earlier stages of the demographic transition, are experiencing a relief of local resources that are strained by high population growth. Because immigrant workers may send part of their loans back to their home country, or return with newly obtained skills and knowledge, international migration can also stimulate socio-economic improvement in sending countries (Reher, 2012).

Although, apparently, international immigration holds great potential benefits, and although many developed countries are today experiencing some (legal or illegal) international labor-immigration, general attitudes toward international migration are rather negative in developed nations in most cases (Longman, 2004; Van Dalen & Henkens, 2011). The acceptance of such international immigration is often obstructed by feelings of national identity, but also depends strongly on historic events and cultural factors (Van Dalen & Henkens, 2011). Coleman (2006) also notes that immigration would have to be very high to fully counterbalance the effects of population decline in developed nations. Muenz (2007) shows

that, in order to maintain the current workforce size, around 100 million immigrants would have to be added from 2005 to 2050 to sustain the current European population size of about 500 million. It is doubtful if such a huge inflow of immigrants would be able to integrate harmoniously into the existing population. Additionally, immigrant groups in Europe with a strong ethnic identity, both first- and second generation, do not seem to do well on the European labor markets and have lower chances of being employed. In the Netherlands, for example, immigrants are more than 2.5 times as likely as natives to be unemployed (Bisin et al., 2011, p62) It thus seems unlikely that immigration in the short term will be regarded as a viable solution to counteract the economic decline caused by fertility-induced population decline and ageing. But, because the impact of international migration is mentioned in literature and might become a more prominent symptom in the future (when population decline creates a shortage of workers), it is still included in this analysis.

If such international migration would occur, it would also impact the societies of receiving countries and, through that, the environment. In the Netherlands, for example, the higher fertility of first and second generation immigrants is one of the reasons for stabilizing and even an increasing TFR's (Van Duin & Garszen, 2010) – which would imply that immigration does not only change population numbers, but also lifestyle patterns. Müller et al. (2007) support this assumption when listing socio-cultural change caused by international immigration together with decline and ageing as one of the major demographic determinants of impact on the environment in Germany. So far, empirical evidence on this subject is limited, but several mechanisms through which international migrants influence the environment have been proposed (Price and Feldmayer, 2012). It is suggested that the high-density urban environments in which immigrants often live, are a source of more pollution, that the low-income-low-schooled (manufacturing) jobs which they occupy are a relatively big source of pollution and that they cause disruption of local social structures, making it more difficult to mobilize the community for environmental issues. Opposing this, are theories which say that immigration can (relatively) improve environmental conditions, because immigrants on average have lower ecological footprints than natives because they are less affluent, utilize less luxury products and use public transport more intensively. It is also argued that immigration can actually strengthen local social organization and social capital, as it can create groups with a strong identity: *“research indicates that geographically concentrated immigrant populations tend to strengthen protective social institutions (such as the family, church, and labor market) that provide beneficial community resources and support”* (Price and Feldmayer, 2012, p.124). The authors conclude from a statistical analysis that the net impact of immigrants on a number of environmental variables is very minor, but indicates positive rather than negative impacts per person.

#### **Meaning as indicator in environmental management:**

Cornucopian: Some theoretical perspectives suggest that increase of international migration leads to higher impacts of consumption and production, as well as less compliance with regulation and less public support for environmental management.

Neo-Malthusian: International immigration will not produce significant impacts, or even slightly positive ones, such as lower emissions from traffic and productive industries, as well as more public support.

#### **Symptom 17: Changing education practices to facilitate broader participation**

When the support ratio is affected by ageing (S7) in such a way that the share of productive population decreases, education practices may be changed in response. By decreasing the years of schooling for youngsters, or reducing government contributions on (certain types of) schooling (Coleman, 2006), both public money will be saved and people will spend a larger part of their lives as economically productive. However, it may also be necessary to provide continued education to the workforce, in order to keep the elder workforce up-to-date with new developments. Such investments in human capital will also become more profitable, as life expectancy and retirement ages increase (Lee & Reher, 2011; Reher, 2012). An elder workforce does not necessarily have to be less productive, as long as adequate facilities are provided. Some research has shown that an elder workforce, like in Japan, is often just as productive, or even more productive, than a younger workforce (Coleman & Rowthorn, 2011). Also scientific

productivity seems to suffer little from ageing (Edwards 2008 in: Coleman & Rowthorn, 2011). Although it may seem contradictory that on the one hand ageing can invoke a shortening of the time that is spent in school and on the other hand can stimulate continued schooling, both responses are not necessarily conflicting. Possibly, investments in the younger cohorts are reduced while expenses on schooling for elder cohorts increase at the same time. This could imply a shift from 'traditional', in-school learning, to continued education and lifelong learning, in order to keep workers up-to-date with new knowledge that directly concern the tasks that have to be taken as part of a job.

Besides elderly, also other groups that are currently not fully participating in the production process (e.g. unemployed and women) might be stimulated to do so. If female workforce participation in all of the European Union would increase to levels such as in Denmark, this would increase the European workforce by more than 30 million, which would be more than enough to compensate for the decline of workforce in the next few decades (Coleman, 2006). To which extent that would change the position of women within society and what the environmental impacts of this would be, remains to be seen. Regarding environmental management, such a change would probably be a positive thing. Women are thought to have a more positive attitude towards environmental protection – although there is not a full consensus about this (Torgler et al., 2008). Research of Torgler et al. (2008) showed that women across 33 European countries participated more in voluntary activities, perceived more pollution and had a higher willingness to pay for pollution relief than men. If decline leads to more involvement of women within the economy, this could lead to better support for environmental management, both in businesses and government institutions. Such involvement of women within the production process may, however, also change fertility patterns. Interestingly, the European countries that currently have high female-participation rates, are experiencing higher birthrates than low-participation countries (Myrskylä et al., 2009). This can probably be explained by the good childcare facilities in most of these high-participation countries, which allows women to raise their children while also spending more time working. Theoretically, this could mean that more involvement of women in production could lead to slower decline of population numbers, and therefore less pronounced environmental effects, either in Cornucopian or Neo-Malthusian direction.

Also the increased education of currently unemployed and their integration within productive life might have a positive effect. Higher education levels are associated with higher environmental awareness and willingness to act (Torgler et al., 2008). But if investments in education of workforce produce the effects that are intended (a more productive population), declining regions might still be able to be competitive with growing regions, sustaining current pollution levels from production. Also the often more consumptive lifestyle and forensic travel of working individuals can put additional strains on the environment (e.g. Swiaczny, 2010).

#### **Meaning as indicator in environmental management:**

**Cornucopian:** If the time spent in education is decreased in order to increase productive life, this can be regarded as a loss of affluence and it would mean less efficient production, as people need to work longer to achieve the same welfare benefits. This may show up as less public support for environmental policy as schooling levels get lower. This would, however, likely be a long-term effect. If the (larger) working population consumes and travels more, it would also lead to a relative increase of pollution.

**Neo-Malthusian:** If the net effect is more involvement of women and currently unemployed in the production process, these workers may have a higher level of education, which can be perceived as increased affluence. This can lead to more positive attitudes towards the environment and environmental management, although the overall effects would probably be mild and on longer timescales.

#### **Symptom 18: Decreasing regulatory pressure**

As (S1) has shown, government budget problems in declining areas will demand action to be resolved and, probably, budget cuts will be necessary. Another possible pathway out of budget problems is to

create a pleasant settling environment for new economic activities by reducing (environmental) regulatory pressure. In the last case, the financial benefits may come from two sides: less expenses necessary for monitoring and maintenance of standards, and increased tax revenues from companies that can be more profitable because they have to spend less on compliance with regulation. If one thinks of land use limitations, for example, this may be quite a natural thing to do: Whereas Dutch spatial planning has been aimed at managing growth for a long time, for example by applying spatial development concepts (Hidding, 2006), in a situation of decline, the real or perceived pressure on space tends to decrease and people may become more willing to accept land consumption. Van Dalen & Henkens (2011) show that Dutch public opinion about population decline is partly determined by how people feel about their country being 'overpopulated'. If these people would perceive their country as less overpopulated once decline sets in, could this perhaps lead to more willingness to accept land consumption activities? Another way of approaching the issue of deregulation is by placing it in a context of manageability of societal complexity. Tainter (2011) observes that societal progress is often realized by increasing complexity. This increasing complexity often creates its own, new problems, which are increasingly difficult to solve. If this view is accepted, we may perceive population- and economic decline as rapidly bringing closer a point where problem solving no longer reaps benefits for society, but only increases the burdens on society by the increased (institutional) complexity, now carried by less individuals. As an example, Tainter mentions how the Byzantine empire was able to recover from a period of decline by deinstitutionalization and by decentralization, which reduced the 'costs' of institutional capacity that had become too high to bear under a declining population and economy. If projected on currently declining regions, this would mean that deregulation and deinstitutionalization are the most effective pathways to recovery, or at least sustenance, in declining areas.

However, with deregulation, the chance of negative external effects of production may increase, as there is less capacity to evaluate the external effects of the actions of companies (Miller & Spoolman, 2009). At the same time, some of the need for regulation may decrease in declining regions for issues where population pressure strongly affects the environment. It is also possible that a more regionalized economy such as is described in (S3) – which also fits with the idea of decentralization and less top-down imposed regulation - is better suitable to manage the common goods internally (as is described by Ostrom, 1990). A more subsistence-based, regionalized economy would mean there is a more direct connection between the consumption of local resources and how this impacts the lives of local residents. Regionalization may also strengthen local social (bonding) capital as people become more dependent on each other for realizing collective action. In this case, collective action may arise to manage the local common pool resources that are left partly unguarded by decreasing regulatory pressure (e.g. Rydin, 2006). This could leave businesses more accountable to society for the negative external effects they produce. For environmental policy it would mean that practical considerations are an incentive to lower standards that were previously set. It could also have the effect that local preferences and initiatives become more important for managing the environment.

#### **Meaning as indicator in environmental management:**

**Cornucopian:** Decreasing regulatory pressure would suggest a decreasing capacity to cope with environmental impacts, as well as a decreasing affluence (because such standards can no longer be maintained). In environmental management, this could be indicated by an abandonment of certain standards, because maintaining these standards is considered to be too costly.

**Neo-Malthusian:** When deregulation is accompanied by improvement of local environmental conditions and increased public involvement in environmental management to hold polluters accountable, it would be a sign of decreasing impacts rather than decreasing affluence.

#### **Symptom 19: Decreasing political power**

From regions to states and from local coalitions to the United Nations and the EU, many political institutions are composed of individual administrative sub-units. Where these sub-units have influence in the decisions that are being made, or where they are dependent on the decisions made at an overarching institutional level, internal power distribution will determine how this decisions will work out. In many

cases, population is one of the determinants of how this power is distributed between the separate sub-units (Coleman & Rowthorn, 2011). The idea that more populous political units have more political power for example becomes clear within the EU, where from 2014 on a double majority vote will be implemented, which means that 55% of the votes of the council of ministers, representing a 65% majority of the EU's total population are necessary for main decision making (Pizzera, 2011, Pers. Comm.). The same holds for financing of local and regional authorities by national government which is often - at least partly - depending on population size. Coleman & Rowthorn (2011) relativize the meaning of population in such cases. Often, the relative (per capita) influence of less populous administrative sub-units is bigger than that of more populous ones. In the case of the EU, smaller countries represent a lower number of people per vote in the council of ministers and thus are relatively more powerful. Still, this situation carries some potential problems for managing environmental problems in declining areas. It can be argued that many environmental problems manifest themselves per surface unit rather than per unit of human population: ground or water pollution from diffuse sources can spread over a certain area, and its impacts on the biosphere are not depending on the number of people on the surface - only the human population at risk is smaller. Similarly, biodiversity conservation issues mostly concerns a certain sized territory that needs this side to provide a valuable habitat for the protected species. The threats to such territories do not only come from population density, but also from 'population-inert' factors such as intensity of neighboring agricultural areas. Thus, with declining civil political power due to declining population, fund- and awareness-raising for specific local or regional issues and projects might become more difficult, which could lead to more intense budget problems (S1).

#### **Meaning as indicator in environmental management:**

Cornucopian: A decrease of (absolute) political power could lead to an increasing difficulty to secure funding for specific environmental issues that play in declining regions. This may also lead to dissatisfaction about the cooperation of overarching institutions with regional initiatives.

Neo-Malthusian: Not relevant

#### **Symptom 20: More participative governance styles**

With public finances increasingly coming under restraints (S1) changing economic values (S3) and decreasing regulatory pressure (S18) all being possible impacts of population decline, it becomes likely that also the style of governing and participation can be affected by population decline. Bernt (2009) has coined the term "*governance in the absence of capital*" (p755) to describe how governance can change in declining areas. While such changes in governance styles may obviously be very vital for how population decline is managed, Bernt concludes that this topic has received little interest, as governance studies tend to focus most on governance in growth contexts. Because stakeholder participation may be of even higher importance in declining regions, where public and private services are under increasing restraints, a better understanding of governance processes in declining regions would, however, be vital in understanding the impacts of population decline on society and, via society, on the environment.

Most of the past experiences with such "governance in absence of capital" are in the field of urban regeneration and restructuring (Beetz et al., 2008). In the past, dealing with urban decline has often spurred top-down intervention strategies, tabula rasa planning and required a quieted public, for example to close public services or demolish/restructure (parts of) neighborhoods (Hollander & Nemeth, 2011). These approaches do not only miss the opportunity to work together with involved actors to use their knowledge, but also lack in social justice as the neighborhoods where such interventions take place are often the neighborhoods where the lower social classes reside and which already have the lowest quality of life that are impacted by decline intervention strategies. Where urban decline takes place, participative strategies should thus be part of smart decline strategies (Hollander & Nemeth, 2011). Participative governance in this case can be the normatively better option compared to traditional top-down governing, because it allows better to bring into practice principles like openness, participation and proportionality (Jordan, 2008). While such experiences with governance and decline so far have mostly come from urban contexts, also regional population decline may urge for more flexible and inclusive management (Beetz et al., 2008).

Especially when environmental impacts are considered, government may today be seen as not completely able to control the external effects of business on environment (Lemos & Agrawal, 2006, p302). The budget problems of declining regions (S1) would make this even harder. Illustrative for this, is the research by Young et al (2012), who notice that the global financial crisis (which may create budget restrictions more or less similar to the budget restrictions induced by shrinkage) has further reduced the power of governments to address ecological issues such as biodiversity management. According to them, increased participation of the public sector and civil society are needed so that these issues can be addressed within governance networks. In declining regions, however, the power of individual stakeholders to contribute financially to such governance arrangements will decline across the *whole* society rather than just for government. This is the essence of the mentioned “governance in absence of capital”, and would imply that the role of non-monetary contributions to environmental management needs to increase in declining regions. Swiaczny (2010, p200) indeed foresees an increasing role for voluntary work in shrinking societies as public and private sector both become less capable of providing goods and services. However, he also has some reservations about the extent to which volunteering can help to maintain certain services. Voluntary activities, like emergency services and sport clubs, are especially depending on young volunteers, of which recruitment becomes increasingly difficult in declining areas. As the average age of volunteer’s increases, the activities in which they engage may change accordingly. The authors conclude that mainly the social care sector and volunteering on nature and justice will remain fairly stable in the future (p205), while other activities show a slight decline. Thus, the prospects for volunteering in environmental management do look relatively positive. What may work against this increased role of volunteering, is that civic engagement often occurs when levels of public service are also high – which actually could lead to further declining levels of volunteering.

#### **Meaning as indicator in environmental management:**

Cornucopian: a more open and inclusive style of environmental management could indicate budget problems and difficulties to manage environmental impacts. It should, however, be clear that this participation was motivated by budget problems.

Neo-Malthusian: If ageing leads to relatively more volunteering and participation in environmental management, this would indicate less impact per person per unit of affluence. Increased participation on its own would be a positive sign, as long as it leads to better or similar environmental quality than could be achieved with traditional, government-steered interventions.

#### **Symptom 21: Increased societal impact of elderly**

The ageing effects of e fertility reduction cannot be separated from the effects of fertility-induced population decline (p20). To think of a typical region that is declining due to low fertility, also means to think of a society that is increasingly impacted by a high share of elderly. There is no precedent of this currently developing reality of extreme ageing, where people not only live longer because of improved living conditions, but also are faced with a decline in fertility that is not due to scarcity or conflict, but individual choice (Bloom et al., 2010). This makes assessing the impact of the current ageing of Western societies such a difficult task, and a speculative rather than a substantiated undertaking. This undertaking is made even more complicated by the non-static nature of lifestyle patterns and values. It simply does not suffice to project current lifestyle-patterns of elder cohorts onto future elderly cohorts. Not only do the next-generation elderly have a different history than current generations, they will also be living in a different society, perhaps one that will undergo severe structural change as a consequence of population decline and ageing itself. This difficult relation is reflected in literature, in which statements about the impacts of ageing on sustainability are often conflicting or even contradicting. It should also be realized that the increased societal impact of elderly works in two ways: a relative increase in impact of elderly and a relative decrease in the impact of the youth. To focus the impacts of this symptom, I will mostly consider how this changed impact of elderly can shape environment through preferences and behavior of elderly.

With regard to environmental behavior, Torgler et al. (2008), who investigated environmental preferences in 33 countries, mention how older individuals are more inclined to follow (social) rules. This also holds for norms of behavior regarding the environment, an effect that for example shows up in attitudes of elderly towards littering. But another theory is, that elderly have a shorter remaining lifetime and have often accumulated a certain wealth, making their attitudes more environmental-adverse. The same researchers indeed find that the attitudes of the elder age groups towards environmental protection (if weighed against other expenses) are more negative than that of average aged respondents. For the issue of air pollution– measured as PM10 concentrations - this seems to be different. Menz & Welsch (2010) show that elderly have a higher willingness to pay for clean air than working-aged. This is explained by the fact that this type of air pollution has larger negative health impacts in youngsters and elderly compared to working-aged.

Another potential effect of ageing is the increase of productive life in order to keep support ratios at a high level (S7). This could mean an extrapolation of the consumption patterns of working-population into higher age-categories (O'Neill et al., 2010; Coleman & Rowthorn, 2011). The other side of the coin is that the number of young parents and families will relatively decrease. At first, this decrease is relative to older age-groups, later on it also manifests itself as an absolute decline. Childbirth-events are said to be accompanied by an environmental value-shift: environmental values may be put aside if they hinder childcare. Axinn & Ghimire (2011) provide the example of the convenience of paper diapers versus reusable ones and how even environmentally concerned parents often switch to the paper variant. The impact of this priority-shift is however probably more outspoken in developing than in developed countries. Franklin & Ruth (2012), who investigated the age-related CO2 efficiency in a study of the Environmental Kuznets Curve of the United States describe the energy and resource impact of childbearing as follow: *“a country with a predominantly young population may lay claim to a larger amount of resources and impact its environment more than one with an older population, owing to the resource-intensive needs of raising children, providing housing, clothing, education and more, and owing to the rapid expansion of preferences for energy and material-intensive goods and services. Conversely, a population that is largely older may experience stabilization or even decline in its material and energy needs.”* (p31). The impact of an elder population they describe as *“(…) holding GDP per capita constant, as the share of elderly relative to the rest of the employed population increases, the lower the carbon emissions per capita will be. This suggests that the further along a country is in the demographic transition, the lower its CO2 emissions will be, holding other factors constant”*(Franklin & Ruth, 2012, p35). Thus, the authors point out that ageing of the population that occurs when population stabilizes at the end of the demographic transition, is the source of an improvement in environmental conditions, rather than the higher GDP per capita that is often found in such countries (which is regarded as the main driver of environmental improvement in developed countries in EKC literature).

There are also authors that come to opposite conclusions. Longman (2004) mentions that children in the US consume about 28% less than working-age individuals and elderly consume 27% more than working-aged. Unfortunately, no source of this statement is included in the article to support the statement. According to Longman, this higher consumption of elderly is mainly due to increasing health expenses; a type of consumption that probably does not have as many direct impacts on the environment as product consumption. Cole & Neumayer (2004) conclude in a study about demographic determinants of air pollution, that age structure has some impact on CO2 emissions, but that the overall effect is low. O'Neill et al. (2010) conclude on basis of model calculations, that population ageing in the western world may reduce CO2 emissions by 20% in 2100, but under the assumption that productivity and workforce participation declines with older age – which according to S17 is probably not a realistic assumption. In general, an elder population seems to tend to a slightly less consumptive and polluting lifestyle-pattern. However, with so many different research, indicating different outcomes due to a difference in research object or method, it is hard to go much further than to conclude that the effects of age-structure on the environment is determined by many factors, and that different age groups may impact the environment differently through different consumptive behavior, productive efficiency, attitudes towards the environment and preference setting.



As was mentioned before, the impact of a different age-composition on values and attitudes towards environment is not only a function of the number of individuals per age-group and the values that are associated with these age-groups. Values of age-groups are, after all, not static, but are developing from individual to individual in a society that is constantly changing. In 1971, Robert Inglehart put forward the idea that intergenerational value changes were taking place at that moment (Inglehart, 2008), which meant that younger individuals were growing up with a different set of values than their elders and grandparents did –values they would carry with them in the course of their lives. The dimension along which Inglehart categorized these changes, was the degree to which generations held materialist or post-materialist values. Materialistic values are, notably, economic- and physical security. Younger cohorts tend to be more inclined towards post-materialist values, like autonomy and self-expression, whereas the elder generations tend to hold on to their materialist values. Inglehart argues that such material needs are valued more than non-material ones, such as freedom and autonomy, if there is a sense of scarcity. Only when there is prosperity, people are able to aspire post-material values. However, people tend to hold on to the values with which they grow up, and are only to a certain extent capable to change these values during later life stages. In a 2008 article, Inglehart shows how different evidence suggests that such a value shift has indeed occurred over the past 35 years. This means that elderly, through time, were found to have possess more post-materialistic values. It is likely that such postmaterial values will also influence how elderly value environment and environmental management. Scruggs & Benegal (2012) suggest that post-material values for example correlates with regarding climate change as a more urgent problem and a stronger believe in scientific findings about climate change. This would suggest that, as elderly become more influential when their relative numbers compared to the rest of the increases, they take with them an adapted value pattern that is more and more open to environmental concerns when compared to today's elderly. It should also be realized that these value changes can be seen as embedded in a broader societal change: *"The shift towards post-materialist values is itself only one aspect of a still broader process of cultural change that is reshaping the political outlook, religious orientations, gender roles, and sexual mores of advanced industrial society."* (Inglehart, 2008, p138). The concept of value shift is for example strongly connected to the 'Maslowian preference' drift that Lesthaeghe sees as causing the second demographic transition (Lesthaeghe, 2010, p.214). This may lead to some complicated (long-term) feedbacks between, values, economic growth and population growth: As population grows and then stabilizes, it creates the opportunity for economic growth (see S7), which could lead to more post-materialist values, which can create a second demographic transition, which in turn can create economic problems, changing values back to materialistic ones and undoing the effects of the SDT(see S6). For now, such a feedback seems unproven as Myrskylä et al. (2009) have shown that the most developed countries (which would be high on post-materialistic values) have a relatively high fertility – the opposite of what would be expected.

#### **Meaning as indicator in environmental management:**

**Cornucopian:** If indeed elderly consume relatively more resources, this could mean a continuing high environmental impact of transport and (local and regional) production. Because elderly have structurally more materialistic values, this would lead to reduced political and public support for environmental protection and management.

**Neo-Malthusian:** If elderly consume less, this could mean a lower environmental impact of transport and (local and regional) production. Additionally, preferences for a cleaner environment may lead to higher importance placed on local environmental issues in particular such as PM10, as well imply as more political and public support for environmental protection.

#### **Symptom 22: Increase of "Greening the city" initiatives**

A study of Emmanuel (1996) for Detroit, shows from analysis of remote sensing imagery that urban areas suffering from decay (population decline and vacant housing) became literally greener through time than more prospering areas. This was explained by the amount of vacant housing (S12) and non-productive industrial sites (S13) that were gradually taken over by nature on such sites. Also such greening obviously is a natural process, which potentially can lead to locally improved biodiversity (see S13), such 'greening' of declining cities can also be a deliberate act, as a response to decreasing pressure on urban land.

Yokohari & Bolthouse (2011) describe how vacant lots in Japan's cities are sometimes used for forms of urban agriculture and forestry – an aspect of city life that has mostly disappeared from modern cities but was more commonplace in the past. They describe how retiring, but still vital city dwellers often form groups to restore and manage such sites as common property. For these persons, such activities mean a meaningful spending of their free time, while these initiatives also lead to strengthening of the local community and enhanced quality of life. Especially for elderly, such improvements of the local living environment holds advantages for health and recreation, which may provide extra support for such plans for an ageing population (see S21). Such “greening the city” projects can especially be viable in declining cities, as they help to sustain neighborhood quality and can help to create a stronger urban fabric in places where buildings have been demolished. The green spaces that are created can be used as community gardens, restored habitat, flood mitigation, storm water retention and for urban agriculture (Schilling & Logan, 2008, p455). Some of the positive effects of such urban green spaces that have come up from empirical research are increased sense of community, a reduction of ADHD in children, improvement self-discipline in inner-city girls, reduced crime and domestic violence, increased physical activity opportunities and an increase of potential consumer spending. Also, urban greening may address flooding and reduce storm water runoff, increase property values, increase access to healthy, local food and reduce the urban heat island effect, which means that, leaving costs aside, such projects are greatly beneficial both for the environment and society in declining cities.

#### **Meaning as indicator in environmental management:**

Cornucopian: Not relevant

Neo-Malthusian: If such greening of local living environments is observed or promoted in environmental management, it suggests an increase of affluence in a broad sense, as quality of life is improved. Further, it suggests a reduction of human impacts on the environment by more 'natural' land uses.

#### **Summary of indicators:**

*Following the description of symptoms in the past paragraph and the description how these symptoms can be indicated in environmental policy and management documents, the following list of indicators for environmental effects of Cornucopian and Neo-Malthusian population decline was composed:*

#### **Main indicators for Cornucopian (C) developments:**

##### **Internal organizational changes (internal management)**

- C.1.1 Increasing budget restraints and cuts
- C.1.2 Lowering of aspired or juridical standards for environmental quality
- C.1.3. More dependency on funding and subsidies from higher government (e.g. national or EU)
- C.1.4. More need for funding and subsidies for projects of local governments
- C.1.5. Additional expenses on urban regeneration projects
- C.1.6. Additional expenses on remediation of brownfields
- C.1.7. Increasing difficulties to secure funding from higher government
- C.1.8. Increasing dissatisfaction with cooperation of overarching institutions

##### **External pressure changes (internal management)**

- C.2.1. Emerging pressure from companies and civilians for deregulation
- C.2.2. Less public support for environmental management
- C.2.3. Less political support for environmental management
- C.2.4. Less willingness of the public to comply with regulation

### **Issue changes**

- C.3.1. Relatively higher emissions from transport, such as CO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10</sub> and SO<sub>2</sub>
- C.3.2. Relatively higher impacts from production industries
- C.3.3. Relatively higher impacts of consumption
- C.3.4. Reduced investment in and application of environmentally friendly, innovative technologies or land uses
- C.3.5. Problems with maintaining environmental infrastructure such as waste water plants and waste disposal systems
- C.3.6. Continuing worries about land consumption, even as population declines

### **Main indicators for neo-Malthusian (NM) developments:**

#### **Internal organizational changes (internal management)**

- NM.1.1. Relatively more funding for environmental management, less budget restraints
- NM.1.2. Stronger position of governments to enforce regulation and measures
- NM.1.3. More willingness of the public to be involved in environmental management (e.g. volunteering)

#### **External pressure changes (internal management)**

- NM.2.1. More public support for environmental management
- NM.2.2. More political support for environmental management
- NM.2.3. More willingness of the public to comply with regulation
- NM.2.4. Increasing civic pressure to act on local environmental issues (e.g. PM<sub>10</sub>, noise)

### **Issue changes**

- NM.3.1. A reduction of pressure on biodiversity (mainly in rural areas)
- NM.3.2. Relatively lower emissions from transport, such as CO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10/2.5</sub> and SO<sub>2</sub>
- NM.3.3. Less impacts from production industries (especially those producing for local markets such as for construction)
- NM.3.4. Decreasing land consumption
- NM.3.5. Possible elevated impacts are resulting from localization of production and consumption chains
- NM.3.6. Less corporate influence in environmental management and regional politics
- NM.3.7. Increased investment in and application of environmentally friendly, innovative technologies or land uses
- NM.3.8. Existence of abandoned brownfields and buildings adding to regional ecological value
- NM.3.9. Increase of “greening the city” projects finished or being developed

# PART 4: CASE SELECTION

## Methodology

*In order to present a set of cases for the analysis of demographic change – providing an answer to sub-research question 5 -, it is necessary to map out which regions are experiencing such demographic change and to which extent. This has been analyzed using population data from the European census bureau Eurostat. In this section, the methods that were used for selection of cases are explained. The cases that were selected were also described in order to provide contextual information. A short explanation about the focal points of this case description is therefore included as well.*

### Selection of eligible regions

The selection of eligible case study regions was conducted by drawing up a list of (practical) limitations, such as language and data availability. Regional data on population was analyzed in two steps; the first took place at the European NUTS-3 level, to select the country with the highest data-availability and representativeness of large-scale decline (over the past 15 years). This way, a narrowed down profile of possible case study regions was created, which led to a main focus on Germany. These NUTS-codes represent different regional spatial and administrative levels. NUTS-0 corresponds with national data, NUTS-1 regions consist of 3-7 million inhabitants, NUTS-2 of 800.000-3.000.000 inhabitants and NUTS-3 regions are ranging from 150.000 to 800.000 inhabitants. These levels of analysis correspond for a large part with national administrative units, which offered different geographical scale-levels for regional analysis of statistic data in Europe (Eurostat, 2011). Because the NUTS-1 regional scale was eventually selected as the most suitable scale for case study, the second step of the analysis took place at this NUTS-1 level, over the past 20 years, to reveal duration and intensity of the decline within possible case study regions. The population data that was necessary for the selection of declining regions was retrieved from the Eurostat website (Eurostat, 2012), the official statistics office of the EU. The result of this selection process is a list of potential case-study regions within Germany, with their associated intensity of decline.

### Case selection strategy

Within case-study research, it is important to strategically select cases, if the results of the analysis is to be extrapolated to general statements about the whole group of cases (Gehring, 2007, pp. 86-88). This research uses a 'typical case' selection to facilitate such a generalization. This means that cases were selected that could be regarded as "representative of a broader set of cases" (Gehring, 2007, p. 91). Multiple cases were chosen to represent a 'typical' relationship between population decline and environmental impacts across time. By researching multiple cases, the temporal dimension of decline could be incorporated into the research. Adding this temporal dimension to the case study research is very important for understanding the dynamics of population decline (see also Part 2). There are various reasons to research decline within a temporal dimension. According to Brose (1983, 1986), environmental effects of decline will often be delayed, which means that some time needs to pass before the effects will become fully visible. The same holds for responses to such effects from policy: it will mostly take some time to identify a problem and develop strategies to deal with them. This means that there will be some 'incubation time' before environmental changes manifests itself in policy documents. Furthermore, population change due to low fertility is a gradual process, which implies that regions that have been subject to population decline for a longer time are more likely to have experienced a higher absolute decline in population since their population peak than regions that just started shrinking. This means that, if demographic change impacts the environment in a way that is predicted population-environment theories, there would still be a transition process at work: the longer since the decline has set in, the more profound the effects and the clearer the symptoms of demographic show up. By selecting four regions with different starting years and intensity of decline, the opportunity arises to both see which theory offers the best explanation, as well as to see if population decline is a main determinant of environmental

impacts at all. This means that the typical relation for which the cases were selected, is how well they represent the different stages of the process of decline.

Still, it should be thought about how a 'typical' declining region would look like. On which dimensions can such typicality be measured? Partly, this typicality is guaranteed by the list of practical limitations that is applied within the case selection process. Similarity of the eligible regions may have been further assessed by comparing all sorts of indicators, but it should also be realized that real-life regions can never be regarded as natural experimental units. As the pool of possible cases provided to be quite small, such a search for the 'average' region can never really provide satisfying results. Much in line with the research strategy of process tracing (Gehring, 2007, chapter 7), the research will therefore rely on providing contextual information as well as reasoning about how observations from the regions compare to the general model of 'declining regions'. In order to facilitate this comparison, a geographical description of the case study regions is also included, to aid the reader to assess this context for his/herself as well.

### Case description methodology

The description of case study regions was kept short and consists of a textual description as well as some basic statistics. This description was based upon the main themes of population, economic structure and environmental issues, as well as institutional history. These topics can be of particular relevance, as they either describe the major drivers of symptoms, or the context in which changes may be observed. Information about the regions was mostly retrieved from Wikipedia (*Mecklenburg-Vorpommern*, 2012; *Nordrhein-Westfalen*, 2012; *Saarland*, 2012; *Sachsen*, 2012) and statistical offices (*Destatis*, 2012, *Genisis-Online Datenbank*, 2012), which was thought to provide a general and broad overview.

## Case selection

*In the following section, cases-study regions will be selected. The first step of this selection is to draw up a list of practical limitations for the case selections. After this, population statistics of the remaining eligible regions were analyzed to find out which regions are experiencing a declining population and to which extent. Of these regions, four were selected to provide a temporal picture of the relation between (fertility-induced) population decline and environmental impacts.*

### Practical limitations for case selection

- *The regions should be subjected to population decline for a period of time*  
In order to be studied as a case for environmental impacts of population decline, the regional decline should have affected society in such a way that impacts on society, economy and the environment have had the time to start manifesting itself, as well as for policy to respond to it (see p57). There was however no data available to indicate how long of an 'incubation time' there is, to let such changes manifest themselves enough to be recognizable for environmental management. Another concern is that finding policy document from during the time of decline is easier when the period under decline is longer. This has led to a (more or less random) selection of cases that are experiencing decline for more than five year, meaning that possible cases should have had their population peak in 2006 or before.
- *The language of data sources should be accessible*  
While regional statistics may be universally readable, the use of policy documents for indicator study is limited by the understanding of the language of these documents. Because my ability to understand written texts is limited to those written in Dutch, English, and (to a lesser degree) German, only regions from countries where these languages are spoken were included: Germany, Austria, the Netherlands, Switzerland, Luxembourg, Belgium, Liechtenstein, the United Kingdom and Ireland.

- The region under analysis should approach the context of wide-scale decline*

Declining regions situated in countries with overall population growth are likely to showcase such decline because local economic conditions are appalling rather than because of ‘natural’ population decrease (e.g. Knox & Marston 2007; Coleman & Rowthorn, 2011). If such an economic downfall is the reason for population decline, the regions are less relevant for researching population-environment theories, because any environmental effects may be attributed to local economic bust as much as to demographic change. This means that, preferably, the case-study regions should be located in countries with an overall decline as well. These countries are currently only found within Europe, with the exception of Japan (Population Reference Bureau, 2012). Especially Germany seems to be a very attractive country for selecting case study regions. German population began declining in 2003 (Swiaczny, 2010) and from 2005 to 2010 a population decline could be observed of 0,85% (Eurostat, 2012). This decline originates largely from a low fertility rate (around 1.4 children per woman, Swiaczny, 2010). This makes regions in Germany more suitable for a case-study of the impacts of population decline than other countries like the UK, Ireland, the Netherlands, Belgium and Luxembourg, where the overall population is still increasing. This is also reflected in table 3, which shows not only the high amount of declining regions at NUTS-3 in Germany, but also the consistency of this decline throughout time, especially when compared to the UK.

Additionally, in order to be representative for this wide-scale decline, regions should themselves be as ‘big’ as possible. The bigger the regions that are selected, the bigger the chance that they will be representative of large-scale decline, because local interactions will play a smaller role. This means that cases should be selected preferably from the NUTS-1 level. In Germany, these regions match with ‘Bundesländer’, which in themselves are often more populous than many European nations-states. Finally, regions that are fully urban in character were not regarded as ‘typical’ of this wide-scale decline because rural-urban dynamics are only partly included in such regions. In the case of Germany, this means that the urban regions such as Bremen, Hamburg and Berlin were left out of the analysis.

Country	Number of regions declining if period 1995-2010 is considered	Number of regions declining if 1995-2010, 2000-2010 and 2005-2010 are considered
<b>Germany</b>	196	175
<b>The Netherlands</b>	7	5
<b>Austria</b>	11	8
<b>United Kingdom</b>	27	12
<b>Belgium</b>	1	0

**Table 3: Declining NUTS-3 regions of the countries with accessible languages. Germany offers both the highest number of regions (indicating wide-spread decline) and relatively more regions with a continuous decline (indicating a structural process). Data: Eurostat (2012).**

- The institutional context of the different case study regions should be as similar as possible to increase comparability*

If regions are selected within different countries, there is a risk that different occurrence of symptoms from place to place is (partially) caused by a differing institutional context. Population decline plays a role in different European countries and regions and political responses have been different as well (e.g. Galjaard et al., 2012). By choosing regions from the same country and institutional level, it is assured that similar institutional settings and national policies were at work. For Germany, this should be however be threatened with caution, as the former division between east- and west- Germany has still left some traces behind in institutions and policies (e.g. Birke, 2003; Hörschelmann & Stenning, 2008). Although the easiest solution would be to remove East-Germany from the dataset, this would also mean a significant reduction of long-term decline cases, because these former east-German regions mostly have a long history of

population decline. To account for this specific history, this history should be incorporated within the analysis as contextual information.

- *The demographic pattern, besides from the decline, should be as much ‘typical’ as possible.* In the chapter about issues in researching population decline (Part 2, pp. 20-23), this concern was already mentioned as “the issue of framing demographic change”. By applying the syndrome approach, ageing and socio-demographic change are seen as an integral aspects of demographic change together with population decline, which means that typical case-study regions should also display this typical demographic pattern. In order not to limit the selection of cases too much, a precondition is set, that the case study regions should at least not show signs of a younger population. For socio-demographic change is proves to be more difficult to define a ‘typical’ development. Both processes of international and internal migration may play a role and work out differently according to regional contexts. Therefore the criterion was asses that there should be as little external processes (such as forced migration) which have disturbed the ‘natural’ migration flows within the case study regions.

Concluding from this, the selected cases should preferably:

- Have a experienced a population peak in or before 2006
- Be situated in Germany
- Be at NUTS-1 level
- Have a fairly ‘typical’ demographic pattern for declining regions
- Involve both urban and rural areas

### Selection of declining regions

In table 4, the regions can be found that are eligible for selection, taking into account the practical limitations mentioned above. Additional statistics are provided regarding the intensity of decline and the age patterns, as well as the average values for Germany as a whole, for comparison. Population data was retrieved from German census bureau database (*Destatis*, 2012).

NUTS-1	Type of region	Percentage decline	Year of population peak
<b>Germany</b>	National	0,951187	2003
<b>Brandenburg</b>	Land (East)	5,220411	2001
<b>Hessen</b>	Land (West)	0,504185	2005
<b>Mecklenburg-Vorpo...</b>	Land (East)	16,37459	<1990
<b>Niedersachsen</b>	Land (West)	1,032583	2005
<b>Nordrhein-Westfalen</b>	Land (West)	1,297213	2004
<b>Rheinland-Pfalz</b>	Land (West)	1,412423	2005
<b>Saarland</b>	Land (West)	6,173255	1994
<b>Sachsen</b>	Land (East)	15,32846	<1990
<b>Sachsen-Anhalt</b>	Land (East)	21,24692	<1990
<b>Thüringen</b>	Land (East)	16,72402	<1990

Table 4: regions eligible for case selection including the degree of decline and year of population peak

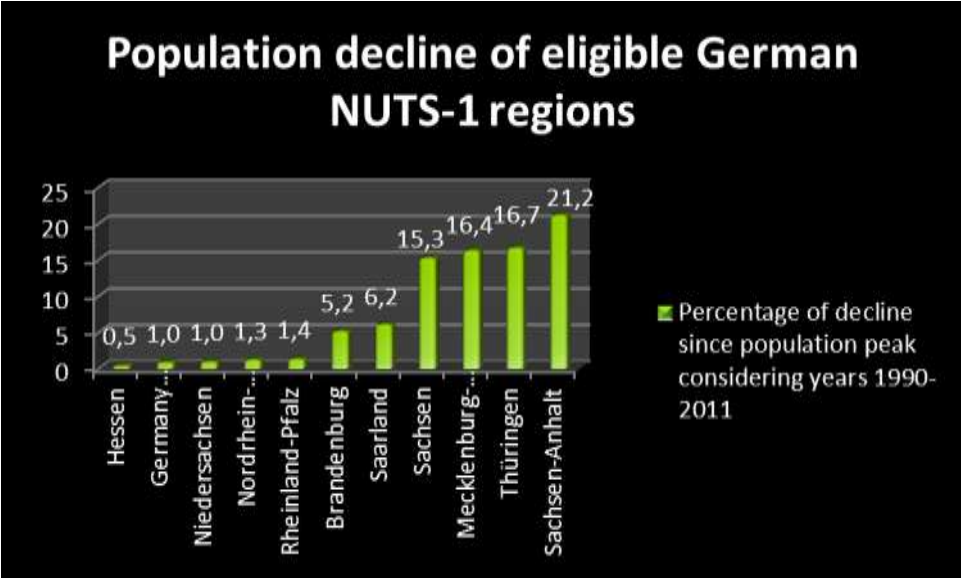


Figure 8: The percentage of population decline since the population peak for the eligible regions. Of the six regions with the sharpest decline, five are situated in former East-Germany. Only Saarland is a former West-German region.

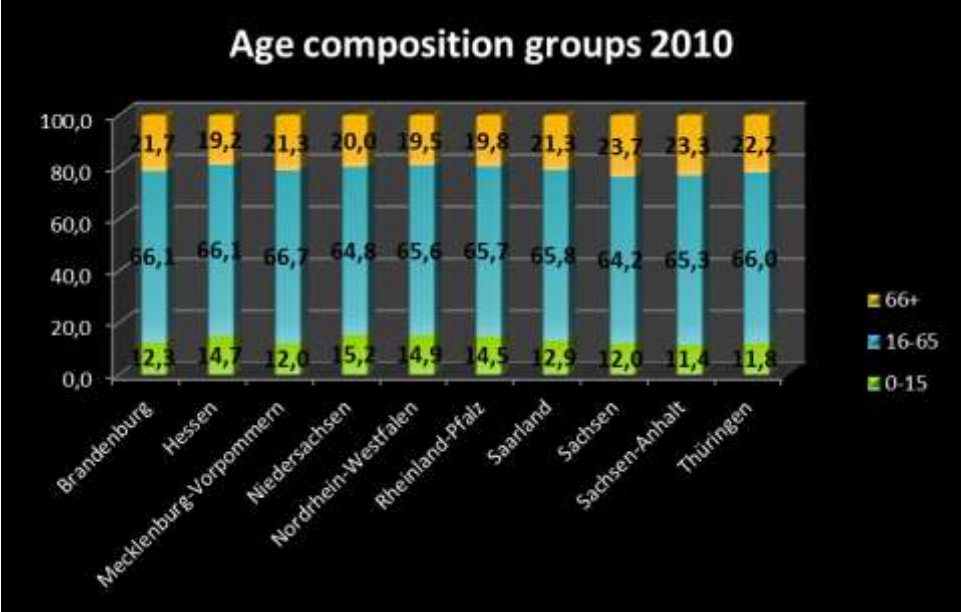


Figure 9: The age composition eligible regions in 2010. Compared with the age composition in 2000 (figure 10), all eligible regions show a higher share of 65+ and a lower share of 15- age groups in 2010, which reflects the general ageing pattern that was expected.



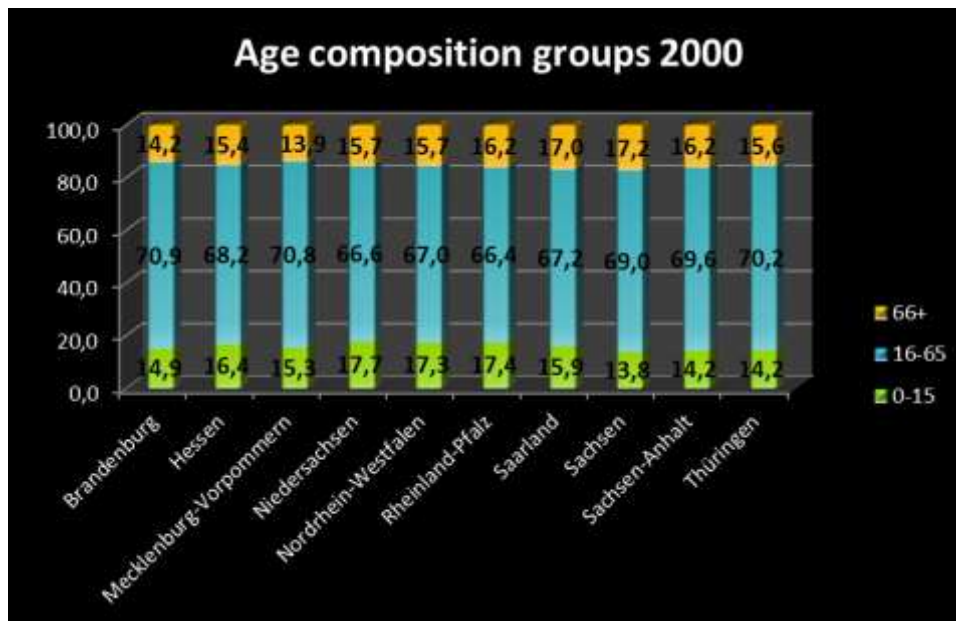


Figure 10: See figure 9 for further explanation

### Final case selection

From these ten eligible cases, four will be selected as case-study regions. These four regions should, according to the methodology of typical case selection, have the following characteristics as much as possible:

- Represent a series of cases from a shorter to a longer exposure to decline, as well as low to high intensities of decline.
- Have geographical characteristics that are 'typical' for the average fertility-induced declining region. Following the practical limitations, this typicality means that they should preferably be situated in West-Germany and have a fairly 'typical' demographic pattern for declining regions

Unfortunately, West-German regions have, however, not been subject to decline for a longer period of time. Only **Saarland** has been subject to population decline for a longer period. Hessen, Niedersachsen, Nordrhein-Westfalen and Rheinland-Pfalz all started declining along the same time and have a more or less similar degree of decline. As the region with the longest standing population decline of the four, **Nordrhein-Westfalen** (NRW) was chosen to provide the most recent case.

More severe cases of population decline can only be found in former East-Germany. Strong migration movements following the fall of the Wall have led to strong population decline rather than fertility decline alone, but the longstanding decline of these regions are particularly suitable to give insight into the long-term impacts of population decline. This does, however, mean that evaluating results within this context becomes more important. The two selected cases from former East-Germany were selected based on their different demographic profile; one case with a relatively recent and one with a relatively longer lasting decline. **Mecklenburg-Vorpommern** (MVP) used to be one of the demographically young and vital regions of East Germany before the fall of the wall, with a more or less stable and even slightly growing population at least until 1985 (Ministerium für Landwirtschaft, Umwelt und Verbraucherschutz, 2007). **Sachsen**, on the contrary, has experienced a declining population since 1950. Of the, at that time, 5 682 802 inhabitants, only 4149477 were left in 2011 (Statistisches Landesamt des Freistaates Sachsen, 2012), implying a decline of more than 25% in total. While all four regions are quite different in economic structure as well as population size and characteristics, the main concern has been to find four regions that each indicate a different severity and duration of decline. The next section includes a description of the regions to provide contextual information about the different regional characteristics. In figure 11, the locations of the

case-study regions are highlighted, as well as the other German states and their status as declining or growing regions in 2007.

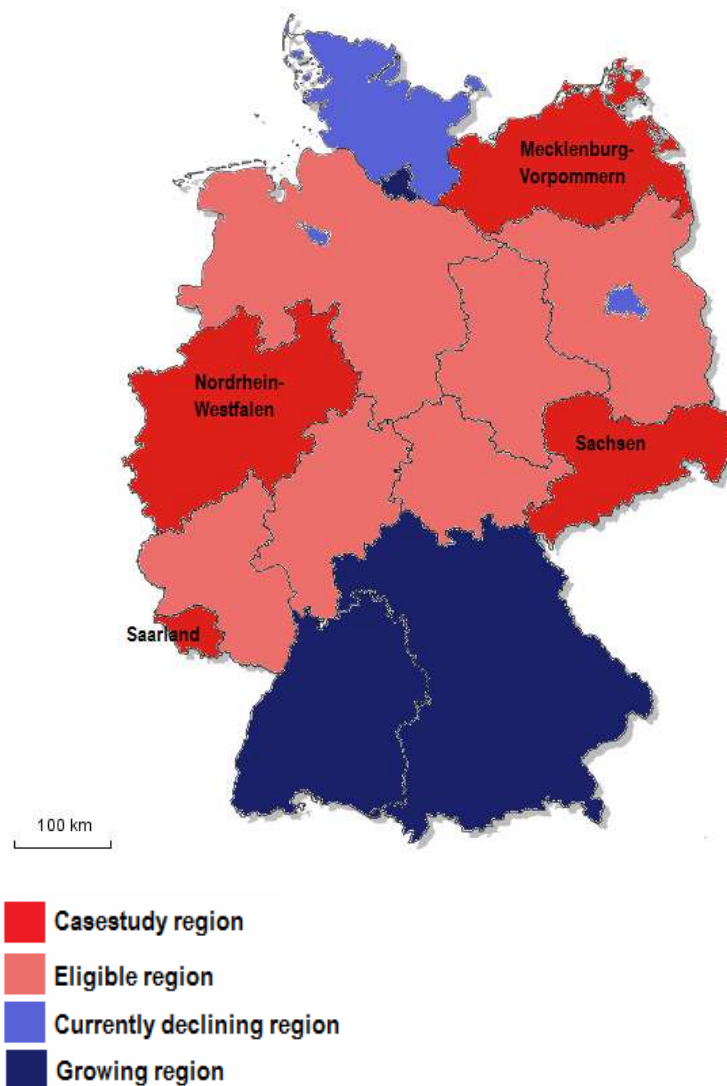


Figure 11: Location of the case-study regions as well as eligible and currently declining regions. Population data until 2010. (Eurostat, 2012)

## Case Description

*In the following section, some descriptive information about the four case-study regions is provided to provide some contextual understanding of the case study regions. The four regions are qualitatively described, starting with the one with the shortest time of decline (Nordrhein-Westfalen). Also some basic descriptive statistics were included to indicate actual economic performance and demographics in the regions.*

### Nordrhein-Westfalen

With a size of just over that of Belgium and a population of about 17,9 billion people in 2010 (Eurostat, 2012), Nordrhein-Westfalen (NRW) is one of Europe's most densely populated regions. NRW in its current form was founded in 1947 when the region 'Lippe' was merged with the former Prussian Rhine province of 'Westfalen'. Around 10 million of its inhabitants are concentrated in a conglomerate of cities along the mouth of the river Ruhr into the river Rhine, which is called the Rhine-Ruhr metropolitan area. Especially the area near the river Ruhr has a history of strong industrialization, due to its favorable position near coal- and steel reserves as well as waterways. This led to a strong expansion of many small towns and

cities independently of each other, eventually creating a major metropolitan area without a specific 'center'. After the Second World War, the industrial development of the Ruhr-area was initially still strong, but a series of economic crises and reduced demand for coal eventually led to a diversification of the economy. The industrial character of the Ruhr-area has had a substantial impact on the regional environment in the past: both (soil-, water- and air) pollution and derelict industrial- or mining areas have been important issues to deal with. However, longstanding environmental policy has, throughout the recent decades, strongly improved a number of environmental indicators (*Umweltbericht Nordrhein-Westfalen*, 2009). Demographically, the urban areas of NRW are strongly influenced by immigration, both from Germany and abroad, as people came to work in mining and industry (see also Müller et al., 2007).

Outside of the Rhine-Ruhr area, population density is much lower. While the plains to the west and north are more rural and agriculturally oriented, the southern and eastern territories are more mountainous, with the Eifel, Weser Uplands and The Süderbergland (including a.o. Sauerland) as the main mountainous areas. While the region's economy is still relatively industrial in character, a shift towards a more production- and services oriented economy has been made, creating new job opportunities. Still, unemployment is structurally above the German average (see statistics below). After a mild decline of population preceding the 90's, NRW's population started growing again, reaching a new peak around 2005. Currently, some (internal) regions are experiencing strong population decline (mainly the urban areas along the Ruhr and the eastern rural parts), while others still show some growth, such as Regierungsbezirk Köln/Cologne (*Umweltbericht Nordrhein-Westfalen* 2009; Eurostat 2012).

### Saarland

Within the former West-German states, Saarland holds a special place due to its specific history. Both after the First and Second World War, it was temporarily occupied by the French. Only in 1957 did it merge again with (West)-Germany. Today, it is the smallest of the non-urban states of Germany, but with around 1 million inhabitants it still has a relatively high population density of 390 inhabitants per square kilometer in 2011. Saarland does, however, not only consist of urban and industrial areas, but also has a substantial forest cover. Around a third of the surface is covered with forest, which is partly explained by its hilly character. This also means that relatively little land is used for agricultural purposes. Saarland borders to France to the south and west (as well as a small part of Luxembourg), but is further surrounded by the territory of Rheinland-Pfalz (Rhineland-Palatinate). There are even plans to merge the two region, under pressure of high public debts (*Stuttgarter Zeitung*, 2012), but these are, so far, not very concrete. The largest city is the capital Saarbrücken, with around 175.000 inhabitants. All of the major cities have experienced declining population over the past decade. Of the West-German states, Saarland has been the first to experience population decline and, by 2012, has already experienced eighteen consecutive years of decline. Partly this can be explained by the lowest fertility of all German (non-urban) states, but high emigration has also played a major role. Although unemployment figures are converging with German averages, they are still substantial higher than the West-German average. Just like NRW and Sachsen, Saarland has been mainly industrially oriented in recent history. Mining and the steel industry have been an important source of income. From the sixties onward, however, mining became less profitable and today all coal mines have been closed. Since then, new industries like the automobile industry have gained importance. Although these industries provide new employment opportunities and stimulate the regional economy, the high number of employees of single companies also makes the (small) region vulnerable to closure of single factories (*Stuttgarter Zeitung*, 2012). Further important sectors of importance are information technology and ceramics industry. Although the industrial past has created some economic and ecological problems, its remainders have also created opportunities, such as a dense railway network with international connections.



Figure 12: Former steelwork Völklinger Hütte, an example of the remnants of Saarland's industrial past, is now UNESCO world heritage site. Retrieved from Wikipedia: [http://de.wikipedia.org/wiki/V%C3%B6lklinger\\_H%C3%BCtte](http://de.wikipedia.org/wiki/V%C3%B6lklinger_H%C3%BCtte)

### Mecklenburg-Vorpommern

Of the four case study regions, Mecklenburg-Vorpommern (MVP) has distinctively the most rural and agricultural character. It occupies mostly flat to slightly hilly terrain in a landscape that is to large extent shaped by the ice ages. The formerly East-German state, bordering the Baltic and Poland, has the lowest population density of all German states at around 70 inhabitants per square kilometer, with a total population of around 1.6 million. Main urban centers are scarce; the only city exceeding 100.00 inhabitants is Rostock at around 200.000 inhabitants. While this city's population is slightly growing, as well as the university city of Greifswald, most other cities are declining still further. The decline is, in contrast to Sachsen, an event of the past twenty to thirty years. In 1985, population was still slightly growing, after recovering from a slight population decrease in the 50's and 60's. Before the fall of the wall, MVP was regarded as one of the most demographically vital states when compared to the rest of Eastern Germany, with a relatively young and fertile population (Ministerium für Landwirtschaft, Umwelt und Verbraucherschutz, 2007). After the fall of the wall however, massive emigration to West-Germany took place and birthrates fell as well, leading to a significant decline of the population. For a large part, this was driven by poor employment conditions. In the past few years, however, employment has increased and is converging slowly towards German averages. Economically, the agricultural sector is still of a relatively large importance. Shipbuilding is another traditional focal point, while in recent years wind-energy technology has also gained importance. MVP today is one of the front-runners of Germany's renewable energy revolution, with wind energy being able to power almost half of the states' energy supply (Ministerium für Umwelt, Saarland, 2008). Other focal points of the economy are tourism – mostly coastal and health tourism - and bio-industry. Nature areas are mostly of good quality and quantity, while in general industrial pollution has not been so much of a concern as for example in Sachsen. The low population density, however, causes troubles in providing public services to the whole population, including those in the inland, sparsely populated countryside. By concentrating limited (financial) resources on central places, it is hoped that adequate services can still be provided. Another response towards these low densities is the merging of administrative units. MVP houses, for example, the five territorially largest Landkreise of Germany following a second round of administrative reforms in 2011. Still, it remains difficult to provide the rural communities with sufficient basic services such as schools, shops, hospitals and public transportation.

### Sachsen

Of all the former East German states of Germany, Sachsen is the most populous one, with a population of around 4.1 million inhabitants. This is, however, substantially lower than the almost 5,7 million that were registered in a 1950 census (Statistisches Landesamt des Freistaates Sachsen, 2012). Of the four case-

study regions, it is the region with the most continuous and pronounced population decline. The three main urban centers of the regions are Leipzig, Dresden (both with about half a million inhabitants) and Chemnitz (about a quarter million). While these cities are famous cases for shrinkage in urban areas, with in some neighborhoods extremely high vacancy rates, Dresden and Leipzig in the past years have started growing again, both demographically as well as economically, with Dresden even becoming the fastest growing urban center in Germany. Partly, this has been aided by substantial investments in new technological sectors, such as the car industry (BMW, Porsche and VW) and microchip-, bio- and solar energy technology. Historically, Sachsen had been more oriented towards mining and heavy industry. These mining activities (amongst which substantial uranium-mining and open-pit lignite mining) have led to major environmental impacts such as soil and water pollution. While environmental standards were improved swiftly in Sachsen after the fall of the wall, industrial activities (e.g. power generation) in the Czech Republic have put additional stress on the environment for a longer time and have played an important role in forest dieback observed in the Erzgebirge. This implies that, while in general the same European standards have to be met in Sachsen and, say, NRW, the latter has had a temporal advantage in resolving these issues compared to Sachsen (and other East-German states).



Figure 13: Died-off forest in the Czech part of the Erzgebirge due to acidification. Retrieved from Wikipedia: <http://de.wikipedia.org/wiki/Waldsterben>

Outside of the three main cities and their metropolitan surroundings, the state of Sachsen is much more rural in character. Geologically, the main division is between the south (bordering the Czech republic) with the ridges of the Erzgebirge and the flatter terrain in the North. Within these rural areas, population decline is continuing and particularly pronounced. Besides a low birth rate - although it is amongst the highest in Germany -, internal rural-urban and external migration plays a big role in this continuous decline.

## Basic statistics

(Data retrieved from *Destatis*, 2012, *Genisis-Online Datenbank*, 2012)

Basic demographic statistics	Average age 2007	% change households 2003-2011	% Change foreigners 2003-2011 as share of total population (excluding naturalization)
<b>MVP</b>	44,2	3,8	2,8
<b>NRW</b>	42,6	2,8	-2,9
<b>Saarland</b>	44,4	-4,9	-2,4
<b>Sachsen</b>	45,4	3,3	-0,5

Table 5: Basic demographic statistics for the four regions. Some differences can be witnessed; Sachsen for example has the eldest population of the four, while Saarland is the only region experiencing household decline. The relative increase in share of foreigners in MVP might be explained by the initially low percentage of foreigners in east-German states.

Unemployment of population aged 15+ in %	2000	2005	2009	2010	2011
<b>MVP</b>	16,4	21,3	13,9	12,4	10,2
<b>NRW</b>	6,5	10,4	7,8	7,5	6,4
<b>Saarland</b>	7,3	10,8	8,3	7	6
<b>Sachsen</b>	16,1	18,7	12,4	11,3	9,4

Table 6: Unemployment within the four regions. Especially within the former east-German states, unemployment has been greatly reduced over the past ten years. Although all four regions have higher unemployment than the German average in 2011 (5,9%), the levels are clearly converging. This may be explained by successful regional development policies, but could also be the result of population decline (see Part 3, symptom 4, pp. 36-38)

Net disposable income in euro per household	1995	2000	2005	2009
<b>MVP</b>	11.452,30	12.832,30	14.168,80	15.226,10
<b>NRW</b>	16.241,60	17.115,80	18.745,20	19.681,90
<b>Saarland</b>	14.003,80	15.410,30	17.409,40	18.742,70
<b>Sachsen</b>	12.008,90	13.505,50	14.797,50	15.881,00

Table 7: Development of the net disposable income per household. This shows a continuous growth over the past fifteen years, particularly in the former eastern states. Although a gap in disposable income exists between west and east, MVP and Sachsen are slowly catching up, a sign of positive socio-economic developments within these regions.

GDP per capita * 1000 euro	1995	2000	2005	2009	GDP/Capita Growth % 1995-2009	GDP/Capita Growth % 2005-2009	Average annual growth % 2005-2009
<b>MVP</b>	15,6	16,7	18,7	21,2	35,9	13,4	3,3
<b>NRW</b>	24,5	25,1	26,8	28,9	18,0	7,8	2,0
<b>Saarland</b>	22,5	22,9	26,3	27,5	22,2	4,6	1,1
<b>Sachsen</b>	16	16,9	19,9	22	37,5	10,6	2,7

Table 8: Development of the GDP per capita for the four regions. Especially MVP and Sachsen are experiencing strong growth. This will also be caused by an adjustment to west-German standards

# PART 5: SYMPTOMS OF DEMOGRAPHIC CHANGE IN ENVIRONMENTAL POLICY DOCUMENTS

## Methodology

*The final step of the research, is to examine which causal mechanisms are at work in the case study regions by finding indicators for such mechanisms and assessing them (SRQ-6). A study of environmental policy documents will provide the source of information for this analysis. In the following section, the methodology of this document analysis will be further explored, and its applicability for researching environmental effects of population decline will be explained. Finally, some extra explanation will be given as to which documents were selected for analysis.*

### Methodology data analysis

For the selected case study regions, it will be analyzed to which extent the Cornucopian and neo-Malthusian symptoms of population decline actually do occur in the case-study regions. The syndrome approach leaves room for findings of many disciplines as input for analysis, but for this research, document analysis was chosen. While the research could have been made stronger by some form of triangulation with otherwise obtained data such as interviews, indicator study and modeling exercises, document analysis has been chosen mainly for practical reasons; as the accessibility of other sources, such as arranging interviews, proved to be both difficult as well as time-consuming. However, the study of environmental policy documents may have some characteristics that make it especially suitable for ex-post study of effects of population decline. Because environmental policy and management documents reflect a professional practice where population decline is a factor working in the *background*, the effects of decline will be included *implicitly* in the documents. The value of an analysis of policy documents is exactly this implicitness. Because it is not the goal of these policy documents to reflect on effects of population decline, it is in this aspect a rather 'unbiased' historic account of how environmental management has anticipated on particular population-environment interactions. This means that if the effects of population decline are minor, there will probably be little mention of the indicators in such documents, or at least not in an overall pattern that would indicate the development of a 'syndrome'. Of course, this research method also has its weakness. By all means, policy documents are not 'neutral' representations of reality and are put forward by institutions with certain stakes. Policy document analysis should thus be regarded as only one of the possible ways to study the subject, but a particularly good one for a longitudinal analysis of past and contemporary experiences.

The methodology used for the analysis of policy documents was based on the "Framework analysis", or the "analysis method framework". This is a method for qualitative data management and analysis that is mostly used for applied/policy-research. By indexing sections of texts and grouping indications into themes, it helps to explore which themes are dominant in the texts in a qualitative way (Spencer et al., 2003; Rapley, 2011). The following steps were taken, based on this analysis method as described in Spencer et al. (2003):

1. *Generate thematic framework*

In this case, the themes that should be recognized in the analysis, are the indicators that followed from the literature study (p55,56). This list of themes was divided in main themes and subthemes so that related topics are grouped. Each indicator (=theme) received its own numerical code. These steps have already been included in the list presented at the end of Part two.

2. *Indexing of policy documents*

The list of themes was compared to the content of the documents. Where statements were made regarding a certain theme, these statements were marked with the code of that theme. This involved reading through the documents and marking the places where such themes occurred, as well as noting remarkable contextual information. Additionally, any mentions of population decline or demographic change were marked to see if they were related to the occurrence of the themes. For this indexing process, the Atlas TI 7.0.77 software package was used.

3. *Sorting of data by theme*

All the indexed data of the different documents were merged and placed in a matrix that was subdivided according to the different themes/indicators. For each theme and each region, the references to the theme in the policy documents were grouped, summarized and translated to English. This step is not included in the thesis, but was a prerequisite for step 4.

4. *Developing descriptive accounts*

The next step was to structure the resulting, raw data, by classifying the information. Because the themes (which are the indicators of neo-Malthusian or Cornucopian decline) are expressed as changes or relative values, the indications of such themes were classified as either direct evidence of the theme or indirect evidence. Direct evidence shows that a change such as described by the indicator was indeed occurring for a broad representation of the theme. Indirect evidence gives only partial information about such changes. For example, a statement that "Land consumption increased between 2000 and 2010" would be direct evidence that there still is ongoing land consumption. However, the statement "More agricultural land was consumed for construction" only provides partial information; although it is likely that this statement means ongoing land consumption, we do not know for certain that total land consumption has increased. Any information that was too vague to be even considered an indirect indication was left out. Finally, each theme was classified per region. The themes/indicators were classified on a four-level scale: Strong occurrence, Weak occurrence (intentions, partial indications or not indicating temporal dynamic enough), Opposing development and No clear signs. In the case that changes throughout the years were not clear enough visible from the data, the assessment was based on the comparative performance in relation to the other case study regions. If a similar, but opposing theme (belonging to the other theory) was present (e.g. one theory indicating more pollution, the other stating less pollution), the valuation of the two similar themes was synchronized. Besides this valuation of the occurrence of these themes (in colour, see table 10), a textual value was given to describe the relation with population decline as was indicated within the policy documents. This provides additional information about if regional environmental management regards demography as having an impact on environmental management issues. The descriptive accounts that resulted from this process can be found in the Appendix. These descriptive accounts were summarized in a matrix for the sake of comprehension. This matrix is shown in the next chapter in table 11.

5. *Develop explanatory accounts*

As a last step, the data was evaluated qualitatively by describing the linkages and patterns that were arising from this analysis, in relation to the contextual information of the regions as provided in the previous section. The description of these patterns is more or less subjective, but is grounded in the descriptive accounts that can be found in the Appendix.

### Methodology document selection

The goal of the document analysis, is to gain insight into how (fertility-induced) regional population decline affects the environment. As the list of indicators from the end of section 2 shows, population decline can affect the environment not just directly (e.g. less consumption meaning less impacts), but also via environmental policy and institutional aspects (e.g. through more or less support or funding for environmental management). A selection of environmental policy documents should thus aim to include



both aspects. Especially long-term strategic evaluation and vision documents can incorporate both aspects, as they deal with the questions: which environmental issues have been going on in the past? Which issues are emerging and are becoming more important in the future? How do we organize our limited resources to achieve maximum impacts of our work? What have we received from, and what can we expect from external organizations and the public? For some regions, such strategic documents were available concerning environment as a whole (NRW and Sachsen). For the others regions, such documents were not found and information was scattered among separate and relatively unconnected documents. In the latter case, the focal points of the document analysis were determined by the list of indicators from the literature study (the list of symptoms), which provided specific topics in which population decline especially might have affected environmental policy and management. These main topics were selected to be waste water management, land consumption, air pollution and intergovernmental as well as public-private arrangements. In all cases, the regional Landesentwicklungsplan (NRW, Saarland, Sachsen) or Landesentwicklungsprogramm (MVP) was also included in the analysis, as this provided the most standardized and comparable type of documents, because all case study region have made such a plan. Although its scope is mainly spatial planning, environment and environmental considerations do play a significant role in these documents, which allows looking into the choices that are being made between ecological and economic considerations. In table 9, a final list of the analyzed documents can be found. Note that in the descriptive account of the occurrence of the indicators (in the Appendix), the shortened codes for the documents including page numbers are used instead of full citation, for sake of comprehensiveness.

Region	Document name, year of publication	Published years after population peak (MVP estimate: 1985, Sachsen: 1950)	In-text reference
<b>Nordrhein-Westfalen</b>	Landesentwicklungsplan Nordrhein-Westfalen (LEP NRW), 1995	-9	NRW-1
	Umweltbericht Nordrhein-Westfalen, 2009	5	NRW-2
<b>Saarland</b>	Naturschutz und Bauleitplanung, Ein Leitfaden, 2004	10	Saar-1
	Landesentwicklungsplan, teilabschnitt Umwelt, Vorsorge für Flachennutzung, Umweltschutz und Infrastruktur, 2004	10	Saar-2
	Umweltpakt Saar 2007-2011, 2007	13	Saar-3
	Klima schützen – die Klimafolgen bewältigen. Saarländisches Klimaschutzkonzept 2009-2013, 2008	14	Saar-4
	Landschaftsprogramm Saarland, 2009	15	Saar-5
	Beseitigung von kommunalem Abwasser im Saarland, Lagebericht 2010	16	Saar-6
	Umweltpakt Saar 2012-2016, 2012	18	Saar-7
<b>Mecklenburg-Vorpommern</b>	Landesraumentwicklungsprogramm Mecklenburg-Vorpommern, 2005	20	MVP-1
	Land hat Zukunft, Mecklenburg-Vorpommern 2020, Entwicklungstrends und Visionen für die ländlichen Räume, 2007	22	MVP-2
	Kommunale Abwasserbeseitigung in Mecklenburg-Vorpommern, heute und nach Abschluss der EU-Förderperiode 2007-2013, 2008	23	MVP-3
	Energieland 2020, Gesamtstrategie für Mecklenburg-Vorpommern, 2009	24	MVP-4
<b>Sachsen</b>	Umweltbericht 98 (Teil 1&2), 1998	48	Sach-1
	Landesentwicklungsplan, 2003	53	Sach-2
	Umweltbericht 2007 (English summary), 2007	57	Sach-3
	Landesentwicklungsbericht, 2010	60	Sach-4

Table 9: Strategic policy documents that were used for analysis, including their year of publication after population peak and reference codes for descriptive accounts

## Results

In the following section, the results of the policy document analysis are provided. The results for each region and each indicator of Cornucopian/Neo-Malthusian decline are given. Further descriptive accounts can be found in the Appendix. In order to provide the input for answering SRQ 7 in the conclusion, a qualitative evaluative description is given of the main patterns showing up from document analysis.

### List of results per indicator


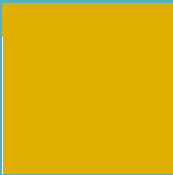


Indicator representation	Color code	Link with demographic change	Letter code
<b>Opposing development than what the indicator/theme says</b>		<b>Explicitly mentioned in-text to stimulate the occurrence of the theme/indicator</b>	D
<b>Weak occurrence of the indicator/theme (intentions, only certain aspects of the theme or not indicating temporal dynamic enough)</b>		<b>Indicator/theme logically relatable to demographic change</b>	P
<b>Strong occurrence of the indicator/theme</b>		<b>No obvious relation with demographic change</b>	N
<b>No clear signs of the indicator/theme</b>		<b>No clear signs of a theme (marked with grey), link with demography not relevant</b>	No letter code

Table 10: Legend for the list of results in table 11. How well the indicator/theme was represented within the policy documents is marked with a color code, while a letter code was assigned to evaluate to which extent the occurrence of the theme can be ascribed to demographic change processes in the region (such as population decline and its associated ageing of the population)

	NRW	Saarland	MVP	Sachsen
<b>Internal organizational changes (internal management)</b>				
C.1.1 Increasing budget restraints and cuts		P	D	D
C.1.2 Lowering of aspired or juridical standards for environmental quality		N	P	P
C.1.3. More dependency on funding and subsidies from higher government (e.g. national or EU)			P	D
C.1.4. More need for funding and subsidies for projects of local governments	P		D	
C.1.5. Additional expenses on urban regeneration projects	N		D	D
C.1.6. Additional expenses on remediation of brownfields	P	P	N	P
C.1.7. Increasing difficulties to secure funding from higher government			D	
C.1.8. Increasing dissatisfaction with cooperation of overarching institutions				
<b>External pressure changes (external, societal and political demands)</b>				
C.2.1. Emerging pressure from companies and civilians for deregulation	N	P	D	P
C.2.2. Less public support for environmental management			N	
C.2.3. Less political support for environmental management				
C.2.4. Less willingness of the public to comply with regulation				
<b>Issue changes</b>				
C.3.1. Relatively higher emissions from transport, such as CO <sub>2</sub> , NO <sub>x</sub> , PM <sub>10</sub> and SO <sub>2</sub>	N	P	P	P
C.3.2. Relatively higher impacts from production industries	N	N	N	P
C.3.3. Relatively higher impacts of consumption	N	N	D	N
C.3.4. Reduced investment in and application of environmentally friendly, innovative technologies or land uses		N	P	N
C.3.5. Problems with maintaining environmental infrastructure such as waste water plants and waste disposal systems			D	D
C.3.6. Continuing worries about land consumption, even as population declines	P	N	D	P
<b>Internal organizational changes (internal management)</b>				
NM.1.1. Relatively more funding for environmental management, less budget restraints		N	N	N
NM.1.2. Stronger position of governments to enforce regulation and measures	N		D	D
NM.1.3. More willingness of the public to be involved in environmental management (e.g. volunteering)	N	N	D	
<b>External pressure changes (external, societal and political demands)</b>				
NM.2.1. More public support for environmental management	N	N	N	N
NM.2.2. More political support for environmental management		N	P	
NM.2.3. More willingness of the public to comply with regulation				
NM.2.4. Increasing civic pressure to act on local environmental issues (e.g. PM <sub>10</sub> , noise)				
<b>Issue changes</b>				
NM.3.1. A reduction of pressure on biodiversity (mainly in rural areas)	P	P	P	N
NM.3.2. Relatively lower emissions from transport, such as CO <sub>2</sub> , NO <sub>x</sub> , PM <sub>10</sub> /2.5 and SO <sub>2</sub>	N	N	P	P
NM.3.3. Less impacts from production industries (especially those producing for local markets such as for construction)	N	N	P	P
NM.3.4. Decreasing land consumption	N	N	P	P
NM.3.5. Possible elevated impacts are resulting from localization of production and consumption chains			P	
NM.3.6. Less corporate influence in environmental management and regional politics	N			
NM.3.7. Increased investment in and application of environmentally friendly, innovative technologies or land uses	N	P	P	P
NM.3.8. Existence of abandoned brownfields and buildings adding to regional ecological value	N	N		P
NM.3.9. Increase of "greening the city" projects finished or being developed	N	N		D

**Table 11: Comprehensive results from the analysis of Cornucopian and Neo-Malthusian indicators across the four case-study regions. See table 6 for explanation of the color- and letter codes.**

## Evaluation

Cornucopian indicators:

- *Internal organizational changes (internal management)*

The more strongly declining regions are in general faced with additional expenses caused by industrial or population decline. In these regions, budget problems and additional expenses were often found to be tied to demographic conditions. These budget problems were particularly strong in MVP and Saarland. Examples of such links between budget problems and demographic factors include higher debt load per capita, increased spending on (service) infrastructure and additional costs of (urban) regeneration. In general, it seems that the more intense the decline is, the more additional expenses are needed and, in general, the higher the dependency is on subsidies. In Sachsen, budget problems seem to be relatively weaker than might be expected, due to a more positive economic development in recent years and low initial public debt. This region shows, however, to be quite still dependent on subsidies and requires additional funding for remediation of brownfields and vacant housing. Even though budget problems at the moment do not seem as pressing in Sachsen as in Saarland and MVP, decline of income is still considered as one of the main future challenges, and there is an urge for restructuring of finances. Additional expenses on remediation of brownfields is (not surprisingly) strongly indicated in the more industrial regions NRW, Saarland and Sachsen. The degree of population decline does not seem to influence the magnitude of these expenses. Rather, these challenges to remediate brownfields exist because of industrial change, which has left the regions with abandoned mining and industrial areas in its wake. Expenses on urban regeneration show another pattern; these are more directly attributed to declining population and can be found to be stronger in MVP and Sachsen than in Saarland (no occurrence) and NRW (weak occurrence). Expenses to remediate such neighborhoods are argued to be necessary in order to stabilize housing markets, improve neighborhood quality and to maintain the quality of public services. This goes, however, with considerable expenses, mostly financed from national programs (Stadtumbau Ost). In general, although the signs for this are not unidirectional, the more severely declining regions are also more dependent on subsidies and in turn have a stronger demand for financial help from municipalities. Because one of the main strategies to counter further loss of population (through migration) is to retain jobs and services, ongoing investment in spatial quality proves to be necessary. In case of the declining regions, these investments seem to be more dependent on financial input of higher government than in less severely declining regions. Some caution should however be taken in drawing this conclusion, because the arrears of the former east-German states may not have been fully undone yet, which would explain the high dependency on external financial input from a non-demographic perspective.

Also some lowering of environmental standards could be observed, although these indications are quite weak. In all regions, there is a trend to give more responsibility for environmental management to companies on voluntary basis instead of applying stricter regulation – this could however also fit within a general societal trend from government to governance.

In some cases, it was observed that the ambitions of waste water sanitation projects and land use policies were lowered, justified by the practical/financial limitations posed by population decline, which led to local exceptions to general rules.
- *External pressure changes (external, societal and political demands)*

Pressure for deregulation was commonly found, but in the more severely declining regions it was more often motivated by population decline. Especially in MVP, the government recognizes to be less capable to solve problems that arise due to population decline on its own (through regulation), leading to pleas for more self-responsibility for civilians and companies. Although this is in the end not as much an external pressure as it is an internal pressure issue (the government itself recognizes to be unable to provide sufficient services), it could also indicate that where society demands a 'strong' government, the government itself sees itself as unable to take that role. In all of the regions, public-private partnerships have been established for environmental management, often with the goal of loosening regulatory pressure and making businesses more

self-responsible for their environmental performance. Somehow surprisingly, these PPP's were established earlier in the east-German regions. Perhaps this can be explained by a more longstanding, informal, good relationship between business and government in the west-German states, while in the former east-German regions there has been a stronger tendency to formalize such relationships because of a shorter tradition of government-business cooperation. It is, however, also possible that the weaker economic conditions in MVP and Sachsen and the demographic change this brought about, has created more willingness within government institutions to cooperate with business on the terrain of environmental management. After all, if local businesses would conceive certain environmental regulation as limiting their business opportunities too much, they could choose to leave the region which could result in further economic downfall, unemployment and a new spiral of decline.

The other indicators of external pressure changes were surrounded with too much uncertainties or are mentioned too little to be considered. As the source of the study comes from internally produced, but public, policy documents, such external pressure changes are probably cared for with caution. After all, explicitly naming public pressure for certain issues runs the risk of touching on sensitive issues and could expose the areas where governmental environmental management has not responded well to the demands of the public. This does, however, make it difficult to obtain the required information from policy document analysis. Future additional research with other research methods (such as public surveys or in-depth interviews) might be necessary to obtain a better picture of these external pressure changes.

- *Issue changes*

In general, all the case-study regions show a relative increase of traffic-originated pollution over industrial-originated pollution. In MVP, these transport emissions are, however, of relatively less concern which might be attributed to the low population densities, which also implies less traffic density and in general less pollution. In the case of MVP it was however also difficult to find policy documents that referenced to specific traffic-related pollution. Anyhow, the recently strong economic growth in the two former East-German states was found to be a cause for increases in mobility, and some problems with PM10 and PM2.5 in particular. Also a modal shift from public to private transportation was observed, which will have contributed to this increased pollution. It is however difficult to evaluate which the exact impacts of population decline were on mobility, because of the interference of this economic growth with population decline. It is particularly difficult to assess to which extent this economic growth interacts with population decline. On the one hand such economic growth could have slowed population decline, on the other hand population decline may have been an incentive for economic stimulation policies, but this economic growth might just as well be a development that is not directly related to demographic factors at all. This means that while relatively high mobility-related pollution has taken place in all declining regions, indicating higher impacts and thus cornucopian symptoms, it is hard to tell if this was really brought about by Cornucopian processes.

Especially in MVP, with its low population densities, the overall pollution from production and consumption is low. However, the *growth* of production in Sachsen and MVP (particularly of agricultural production) has offset the effects of technological improvements. The relatively higher impacts thus may not be directly related to population decline but to structural economic change since the 90's. However, possibly, the declining population has been an incentive to stimulate economic activities, which could make population decline partially responsible for the relatively less improved pollution compared to Saarland and NRW.

In all four regions, no clear signs could be found that population decline relatively increases the impacts of consumption; rather the opposite is true. For Sachsen, however, it was mentioned that CO2 emissions of households sank not as much as was expected based on its population decline, but this might just as well be attributed to the mentioned economic growth of this region.

No clear signs of reduced investments in environmental friendly, innovative technology was found, rather the opposite turned out to be true (see Neo-Malthusian symptoms).

Worries about maintenance of environmental infrastructure were especially found in the more severely declining regions. Population density limits waste-water infrastructure upgrades in MVP and Sachsen and reduces the efficiency of urban heating. In both cases, population decline clearly posed a challenge for the future maintenance of such infrastructure.

In all regions, worries about land consumption continued to be high, because land consumption had not stopped yet and proved difficult to stop, even in clearly declining local areas. In the most severely declining regions, however, the pace of land consumption has become much lower, and land-recycling policies seem to be more well-developed (which is dealt with further in the Neo-Malthusian symptoms).

Neo-Malthusian indicators:

- *Internal organizational changes (internal management)*

No convincing signs were found of more funding for environmental management. For NRW, Saarland and MVP any indications of increased spending proved to be minor in comparison to the signs that point towards more budget problems as showed in the evaluation of Cornucopian indicators. Surprisingly, the current financial situation in the most severely declining region, Sachsen, seems to be the most positive. However, this is mainly attributed to recent good economic performance; worries about financial impacts of population decline were still found. There are also no clear signs that the position of government has become stronger. While in MVP there are indications that regional government has become less powerful and increasingly needs the help of the public and market parties, because population decline creates more isolated communities, in Sachsen there are some signs that especially spatial planning has gained mandate for battling ongoing land consumption and other detrimental effects of demographic change.

Involvement of the public is clearly higher than in the past in most regions, but it is unclear if this actually represents a positive development or a negative one. Although the public generally has gotten more say in procedures and more PPP initiatives and activities could be observed, the involvement of public also led to stimulation of deregulation or took place because the problem-solving capacities of government alone were not sufficient. This would imply a weakening rather than a strengthening position of government. Such a development could especially be observed in MVP, where particularly low population densities are found to limit the actions of government in rural areas due to budget restraints.

- *External pressure changes (external, societal and political demands)*

Overall, it remains largely unclear how public and political attitudes have developed. For possible explanations for this, see the external pressure change section of the Cornucopian indicators. For public support for environmental management, however, some weak indications could be found that in all regions public support has been increasing. Civilians have been keen to implement new renewable energy techniques and have shown engagement for a sound environmental quality, also by means of voluntary work. Also the existence of PPP arrangements in all regions, in which regional companies take responsibility and take initiatives to become more environmentally-friendly can be regarded as positive signs. These improvements were, however, not directly relatable to population decline and could fit in with a general trend of a shift from government to governance.

- *Issue changes*

Pressure on biodiversity seems to be stabilizing in all regions. There are, however, conflicting signals; some indicators have improved and some have declined. In general, quality of biodiversity in protected areas improved, but outside of that it decreased, which would mean that stress on (productive) land was not reduced. Especially in the former east-German regions, agricultural and infrastructural land use seems to have intensified and exerted new pressures on biodiversity. These new pressures are however not directly tied to demographic developments,

but seem to be caused by higher productivity and new infrastructure construction that is part of the transformation process after 1989.

It is however recognized that abandoned brownfields can add up to the ecological value of the industrial regions in particular. Such abandoned brownfields and mining sites have indeed become a safe haven for particular specialized and often rare pioneer species, which adds a new element of biodiversity to the industrial case study regions in particular.

Especially within the eastern regions, there are positive signs that land consumption has significantly decreased, even if this still means that each year a larger share of the soil has a 'sealed' status. Within all regions there is an awareness that population decline still involves intensive measures for preventing further land consumption. Especially within the eastern regions, priority is given to inner-city, central and previously occupied terrains when it comes to new building activity.

No sufficient evidence was found that corporal influence has declined in these regions; the relationship between business and government in environmental seems only to have been strengthened through the formation of Public Private Partnerships.

There was also not enough evidence to indicate that higher impacts of for example transport and production can be ascribed to further regionalization rather than globalization of the economy.

While impacts of production, in general, have gone down, the West-German regions comparatively perform better than the East-German regions in this aspect. In MVP and Sachsen, the impacts of agricultural production have remained high. Improvements in emissions of NO<sub>x</sub>, earth-near ozone and CO<sub>2</sub> have been lagging behind with the decline of population in Sachsen.

The stronger economic growth in the Eastern regions and societal transformations after 1989 again appear to be the main responsible factors, but this economic growth could have been stimulated by the need to create new jobs in order to counter further emigration.

The impacts of transport, over time, appear to have become higher rather than lower, although it is very difficult to say which role population decline has played in this (see Cornucopian issue changes).

A quite intense focus on new energy technology and sustainability land uses could be found in the more the strongly declining regions, while the ambitions of NRW for sustainable land uses were not as strongly indicated. In the more strongly declining regions, biofuel, wind and solar-technology are both strongly growing as well as strongly stimulated, as it is thought that this sector in particular can stimulate local (rural) development and self-sufficiency (MVP, Saarland) or attract new jobs and economic sectors (Sachsen). Although NRW in volume has the most strongly developed sustainable *technology* sector, the other regions are showing faster growth, especially in the field of sustainable land use and local self-sufficiency.

Project to make cities greener are also more prominent in more severely declining regions. This could improve local environmental quality within cities, but the documents also show that these projects were mostly highly subsidized by higher government, which pulls into question if such projects can also be financed when decline becomes even more wide-spread.

### Summary of findings

To sum up the findings in a comprehensive form, a list of Cornucopian and Neo-Malthusian indicators for the case study of the four regions will be given. The list is divided into strong and weak indicators; this gives a qualitative assessment of the evaluation above. Strong indicators can be explained to a large extent by the impacts of demographic change, while weak indicators have the risk of being more strongly influenced by external factors or do not show a clear temporal pattern. This creates the following lists:



- Strong Cornucopian indicators:
  - C.1.1 Increasing budget restraints and cuts
  - C.1.3. More dependency on funding and subsidies from higher government (e.g. national or EU)
  - C.1.5. Additional expenses on urban regeneration projects.
  - C.2.1. Emerging pressure from companies and civilians for deregulation
  - C.3.5. Problems with maintaining environmental infrastructure such as waste water plants and waste disposal systems.
  - C.3.6. Continuing worries about land consumption, even as population declines
  
- Weak Cornucopian indicators:
  - C.1.6. Additional expenses on remediation of brownfields.
  - C.3.2. Relatively higher impacts from production industries
  
- Strong Neo-Malthusian indicators:
  - NM.3.4. Decreasing land consumption
  - NM.3.7. Increased investment in and application of environmentally friendly, innovative technologies or land uses.
  - NM.3.8. Existence of abandoned brownfields and buildings adding to regional ecological value
  - NM.3.9. Increase of “greening the city” projects finished or being developed
  
- Weak Neo-Malthusian indicators:
  - NM.1.3. More willingness of the public to be involved in environmental management (e.g. volunteering)

# CONCLUSION

The final question to be resolved is sub-research question seven: Are the indications of causal mechanisms in the selected regions strong enough to indicate a development that matches with either of the associated core theories? The answer to this would also provide the answer to the main research question. Of course, it is difficult to define when the indications of causal mechanisms are strong enough to say that population-environment interactions generally follow a particular theory. But following the results of the document analysis as presented in the past section, the simple answer can be quite clear: there are no sufficient indications to say that population-environment interactions in the researched regions indicate a particular development according to a single theory. Both neo-Malthusian processes and Cornucopian processes appear to play a role; it depends much on the particular indicator that is considered in which direction the development is going. For a lot of indicators, there is even no clear temporal development, and the particular causal mechanisms (which, in this research were represented by symptoms of demographic change and their interactions) that are at work and how they work out are strongly determined by other contextual factors such as policy, economy, institutional history and physical geographical properties of the regions. This means that, when we go back to the first section of the thesis (about population-environment theories), the conclusions are actually most compatible -not with the two selected theories- but with the intermediate variable theory, or holistic approach. Population decline clearly shows to be only a single factor in determining environmental outcomes, and the context in which decline takes place as well as the specific environmental impact under consideration determines in which direction the population-environmental interactions play out. This does not mean that researching population decline from Cornucopian and neo-Malthusian perspectives has been useless. Because the selected theories were outspoken as well as contradictory, the theories allowed to distinguish and classifying the mechanisms that might lead to interactions between population decline and the environment as playing out positively (neo-Malthusian) or negatively (Cornucopian) for the environment. This polarized research design created a framework for analysis that was easy to work with and in the end was well able to capture the diversity of the possible interactions as well as their direction. What the final conclusion - namely that population-environment interactions are not easily described by a single theory- shows, is that the range of social and economic processes at work in declining areas is too variable to support the easy assumption that a declining population will benefit the environment. We cannot think about the environmental effects of population decline in a unidirectional way, from a single theoretical perspective. Understanding environmental effects of population decline rather demands in-depth-study of particular population-environment interactions, and how these are shaped by the socio-economic context of the region or country under decline. Given the lack of literature on the subject that was observed in the problem definition, this would argue for more specific research in this area. Especially the institutional changes of population decline demand more attention. This research has showed that budget problems and deregulation pressures as well as increased need for external financing were strong trends across the four regions. The role of political environmental management as a mediator of environmental impacts should therefore be investigated more closely. Although no real evidence was found that such internal organizational factors have increased environmental impacts (Neo-Malthusian indicators were mainly found amongst *environmental issues*, which reflects lower environmental pressures), these internal management issues will only become more outspoken as decline becomes more widespread and will affect higher government more and more. Potentially this could continue to a certain 'saturation point' after which subsidies and financial incentives to support declining regions no longer can be afforded- which is likely to also affect regional environmental management. Further support for the idea that population decline can have on environmental management practices can be found in the substantially higher mentioning of decline as an influential factor in shaping the performance of environmental management that was found in the more severely declining regions. Although it cannot be ruled out that population decline in these regions is used as an explanatory factor for environmental problems because it is an uncontrollable variable (and thus does not blame government for mismanagement), its increasing occurrence in strategic environmental policy signals that structural population decline can significantly affect environmental policy.

A more practical result of the research is that, for now, it is too early to do conclusive research on these *fertility-induced* decline. Although the number of declining regions is considerable, it proved difficult to find case-study regions that had been subject to decline for a longer time and for which the decline is mostly fertility-induced, rather than caused by migration. This means that still some caution should be taken with the interpretation of the results of this study; although I have tried to translate findings on regional scale to what future effects of population decline can be, the societal interactions that shape the effects of population decline are so complex that future behavior is to a large extent unpredictable. However, monitoring current population environment interactions in declining regions would, in my opinion, remain the best option for obtaining more understanding about these interactions and understanding the behavior of demographic change as a syndrome of global change. As population decline continues, Germany would continue to be a highly valuable country for researching such effects, with its declining population and well developed economy and society.

In many ways, the research has had its limits for researching the problematics that were sketched in the problem definition. This research could in that way be regarded more as an exploratory research about what the environmental effects of fertility-induced decline can be, and how research of regional population decline can help to answer this question, than as definitive research producing 'hard' conclusions. In order to fill in the gaps of this research has not filled, further research on the environmental effects of population decline would, however, be necessary. A research agenda to fill in these knowledge gaps could include:

- Additional triangulating research to further validate findings, by means of expert interviews (to obtain expert opinions and experiences about environmental management in declining regions), public surveys (for researching changing environmental attitudes of the public) and cross-case indicator analysis (for more in-depth study of environmental impacts over time in declining regions compared to growing ones)
- A comparison of regions across the globe (e.g. Italy, eastern Europe and Japan)
- Further case study of Germany's declining regions at similar or lower scale to investigate how local characteristics (e.g. dominant economic activities) of a region influences population-environment interactions
- More intensive study of government and governance in declining regions and if/how population decline leads to power shifts between government, markets and civil society

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# APPENDIX: ASSESSMENT OF INDICATORS

## Indicator assessment for Cornucopian indicators:

### Internal organizational changes (internal management)

#### C.1.1 Increasing budget restraints and cuts (Opposite of NM.1.1)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Concentration of budgets on high-quality nature (NRW-2p270)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not relatable to decline</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>Government needs to reduce debts and save money (Saar-7p2)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Cost considerations were a major incentive for starting up the PPP (Public Private Partnership) 'Umweltpakt Saar' (Saar-3p18)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Demographic change and debt reduction are main challenges for Saarland (Saar-7p2). They could be connected, if industrial and population decline have led to declining income. Declining population means more debt per capita.</li> </ul>
Assessment		P
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>Demographic change and budget restraints make infrastructure maintenance more difficult (MVP-1p6, MVP-2p7).</li> <li>Concentration of budgets on regional centers due to financial restraints and demographic change (MVP-1p17, p56, MVP-2p29)</li> <li>There is reduced financial income from other overarching political institutions (MVP-2p31).</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Urban-suburban migration creates difficulties in cities to maintain infrastructure (MVP-1p21).</li> <li>Government has decreased payouts to renewable energy projects (MVP-4p116), cuts in water sanitation initiatives (MVP-3p19)</li> <li>Budget restraints show that government cannot provide full public services without help from society (MVP-2p30)</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>Declining public budgets and demographic change urge for restructuring of finances (Sach-2p28, Sach-4p11,p15) and is considered as a main regional problems (Sach-4p25)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Local municipalities are financially weak, while structural payments are reduced (Sach-2p11, Sach-4p15,p16,p17)</li> <li>Investments in non-central places are limited because of financial and demographic considerations (Sach-2p19,p59).</li> <li>Population decline makes public infrastructure maintenance more expensive (Sach-2p56,p89).</li> <li>Abandoned neighborhoods are too costly, if not restructured (Sach-2p59)</li> <li>New policy tools are implemented to manage public budgets (Sach-1T1p16)</li> </ul>

	<p>Demography</p> <ul style="list-style-type: none"> <li>Population decline and ageing strongly impacting public budgets (MVP-2p6,p34).</li> </ul>	<p>Demography</p> <ul style="list-style-type: none"> <li>Pressure to reduce debts as they are exaggerated by decline (Sach-4p16). Population decline asks for restructuring of finances, by a focus on central places.</li> </ul>
Assessment	D	D

### C.1.2 Lowering of aspired or juridical standards for environmental quality

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Less stringent demands for permission procedures in the context of nationwide industrial air-quality regulation (NRW-2p44)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Agreement between regional government and consultation forum not to set higher targets than those set by the nation and EU (Saar-3p21, Saar-7p13)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>
Assessment		N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Centralized waste water disposal is preferred due to better water cleaning performance, but it is accepted to some degree that decentralized disposal is a reality in sparsely populated areas (MVP-3p14).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Population decline lowers population density, making centralized disposal more expensive</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Although the common policy is to let large firms only settle in regional centers (for the sake of reducing land consumption and focusing public spending on centers), creation of new jobs is considered so important that exceptions are permitted (Sach-2p55,p62)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Possibly, attracting new companies by lowering standards is permitted because jobs counter population decline and help to improve local public finances.</li> </ul>
Assessment	P	P

### C.1.3. More dependency on funding and subsidies from higher government (e.g. national or EU)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>There is some mentioning of subsidies from</li> </ul>

	Demography	national government, such as for isolation of private housing (Saar-4p38) and EU-co-financing of environmental management certification of businesses (Saar-7p7). It is, however, not certain that this replaces funding from regional government  Demography
Assessment		
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Some mentioning of increasing subsidies, e.g. for rural development (MVP-2p31) and high subsidies (around 2.5 billion euro) for urban restructuring due to empty housing (MVP-4p67).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Subsidies for restructuring of neighborhoods with high rates of vacant housing may directly be a cause of population decline</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>Internal financial capacities of Sachsen are limited by demographic change as well as relatively strongly depending on contributions from the national as well as the EU structural funds (Sach-4p15)</li> <li>Spatial measures are to a high extent (often more than 50%) financed by national government and the EU. (Sach-4p79).</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Improvements in environmental regulation and technology were co-financed by the EU (Sach-1T1p32,p73, T2p7)</li> <li>Especially the regeneration of largely abandoned urban areas requires the funding of higher institutions (Sach-4p118)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Population decline limits finances, which increases the need for structural help. Structural help is needed for urban restructuring</li> </ul>
Assessment	P	D

#### C.1.4. More demand for funding and subsidies for projects of local governments.

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Because the economic change (de-industrialization) has locally created high concentrations of polluted and industrially occupied land, the region provides (financial) help to local communities that are heavily impacted by this (NRW-2p236)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Communities that have lost a lot of industry may also have lost a lot of jobs, meaning that</li> </ul>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>



	remediation of brownfields would otherwise have to be paid by increasingly little inhabitants	
Assessment	P	
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Need for financing of local urban restructuring is expressed, especially by preserving elder, more attractive housing and restructuring more recent neighborhoods (MVP-1p37) in order to counter the consequences of demographic change and provide a better living environment, more suitable for attracting tourists and retaining inhabitants (MVP-1p38)</li> <li>• Investments in improvement of local waste water cleaning facilities was considerable (MVP-3p16), although this is probably due to adaptation to West-German/European standards.</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• To make secure living conditions and job opportunities in declining areas, additional investments are necessary</li> </ul>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>
Assessment	D	

### C.1.5. Additional expenses on urban regeneration projects.

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• New destinations for fallow land should be found to create viable inner cities and reduce land consumption. This requires subsidies and promotional measures to initiate (NRW-2p217, p241, p243, p328). When the soil has been polluted, the financial help from the region alone is mostly not enough to finance a clean-up (NRW-2p243)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• A need to reduce land consumption may arise from continuing land consumption despite decline (C.3.7)</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Saarland aims to reduce land consumption by filling in gaps in urban fabric rather than using new land (Saar-5p7)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• A need to reduce land consumption may arise from continuing land consumption despite decline (C.3.7)</li> </ul>
Assessment	N	

Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>MVP has received funds within the German program for urban adaption to population decline (Stadtumbau Ost) (MVP-1p27)</li> <li>Empty housing has to be demolished where necessary, which should make sure the housing market does not collapse (MVP-1p38) because population decline is leading to more and more vacant buildings (MVP-4p68)</li> <li>Expenses on urban regeneration have risen and are considerable (MVP-4p67,p68)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Because facilities are concentrated in a limited number of central places, reducing the housing stock will preferably takes place in non-central towns (MVP-1p27)</li> <li>Rather than expanding built-up area, new housing should be built on fallow land in inner cities (MVP-1p36,p37,p48, MVP-4p7,p65,p68)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Population decline leads to vacant housing and creates need for restructuring towns and cities.</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>Costs of uncontrolled urban decline are not bearable for society (Sach-2p58) and thus demands intervention</li> <li>Especially the regeneration of largely abandoned urban areas requires the funding of higher institutions (Sach-4p118)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Reuse of occupied land is preferred above new land consumption because decline has reduced overall demand (Sach-2p57, Sach-4,p42), which would involve additional investments</li> <li>The change of demographic perspective has radically altered thinking about urban development and has led to (financial) efforts to concentrate any expansion activities in the core cities, to strengthen their functions (Sach-2p58, Sach-4p74, p79, p117, p188, p215).</li> <li>Also in villages, vacant buildings are commonplace and preferably should be reused or else broken down and vegetated again (Sach-2p61)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Additional expenses are needed to mitigate the effects of urban and rural demographic change.</li> </ul>
Assessment	D	D

### C.1.6. Additional expenses on remediation of brownfields.

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>NRW has a long history of monitoring pollution of brownfields, and is strongly affected too due to its industrial history. Although safety and remediation is municipal responsibility, NRW supports municipalities financially as well as with knowledge(NRW-2p215)</li> <li>Because population is declining, reuse of brownfields, especially in urban inner cities, can help to slow land consumption (NRW-2p216, p241), although this presents extra costs as remediation is sometimes necessary for safe usage (NRW-2p220,p236,p240)</li> <li>There are several separate funds to facilitate brownfield regeneration (NRW-2p237,p238).</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>The government plays an active role in stimulating new construction on brownfields, by facilitating and initiating remediation of industrial areas as well as military terrain (Saar-3p21, Saar-1p26) to reduce land consumption of agricultural land (Saar-5p7, Saar-1p26,p27)</li> </ul> <p>Indirect</p> <p>Demography</p> <ul style="list-style-type: none"> <li>In the light of population decline, land consumption can be evaluated more negatively and create extra pressure to remediate brownfields (C.3.7.)</li> </ul>

	<p>Indirect</p> <p>Demography</p> <ul style="list-style-type: none"> <li>In the light of population decline, land consumption can be evaluated more negatively and create extra pressure to remediate brownfields (C.3.7.)</li> </ul>	
Assessment	P	P
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>Contaminated soils that pose a threat should be cleaned up (MVP-1p48).</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>There are substantial amounts of polluted soils (MVP-1p49). Such pollution can for example be from former oil/gas drilling sites or gas stations (MVP-2p24)</li> <li>Reuse of polluted soils is mostly viable when there is also investment in new after use(MVP-1p49, MVP-2p24)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>It is not clear whether expenses were elevated in recent years and if demographic conditions play a role in this.</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>Remediation cost for former mining areas are high (Sach-1T2p110)</li> <li>It is aimed to restore, as much as possible, the natural state of soils that are disturbed by mining (Sach-2p50) or to find new uses for such mining landscapes (Sach-4p30)</li> <li>Remediation of former mining areas is one of the main challenges for regional planning (Sach-4p30).</li> <li>Polluted soils that provide danger to the community should be sanitized and if possible, reused (Sach-2p50,p57,Sach-4p111,Sach-3p16), because land consumption is still high while many abandoned brownfields exist at the same time (Sach-2p51, Sach-1T1p30)</li> <li>For such remediation activities, special funds are available (Sach-4p43,p77,p79)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Mining activities such as mining for metals (amongst which uranium) and coal have strongly affect the environment in Sachsen (Sach-2p33, Sach-1T2p19) and left behind major areas of disturbed geological substrate.</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>In the light of population decline, land consumption can be evaluated more negatively and create extra pressure to remediate brownfields (C.3.7.)</li> </ul>
Assessment	N	P

### C.1.7. Increasing difficulties to secure funding from higher government

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <p>Demography</p>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>

Assessment		
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>Funding that was received after the fall of the wall is decreasing, while demographic changes further cause a weakening of the financial position (MVP-2p3,p6).</li> </ul> <p>Indirect</p> <p>Demography</p> <ul style="list-style-type: none"> <li>Population decline demands for extra funding, increasing existing problems</li> </ul>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>
Assessment	D	

### C.1.8. Increasing dissatisfaction with cooperation of overarching institutions

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Regarding biomass production, NRW is giving local governments more freedom to realize local potentials in cooperation with local actors, which indicates a transfer from power of higher government to lower, rather than the opposite way (NRW-2p118)</li> <li>Regional companies are dissatisfied about how the EU attempts to control even environmental regulation that only have local effects (NRW-2p340,p341)</li> </ul> <p>Demography</p>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>
Assessment		
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <p>Demography</p>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>
Assessment		

#### External pressure changes (external, societal and political demands)

### C.2.1 Emerging pressure from companies and civilians for deregulation

Region	Nordrhein-Westfalen	Saarland
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Description	<p>Direct</p> <ul style="list-style-type: none"> <li>Since 2006, NRW is involved in the “Dialog Wirtschaft und Umwelt (DWU) NRW”, where businesses and government communicate about environmental policy and its tradeoffs with economy. Companies use this platform to send strong signals if certain regulation is too bureaucratic or too limiting (NRW-2p339,p341)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>European standpoints about environmental regulation were tried to be influenced by the DWU (NRW-2p339,p340)</li> <li>Companies of the DWU put on pressure to loosen waste disposal regulation(NRW-2p341)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>There are no indications that the pressure for deregulation was tied to population decline</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>Umweltpakt Saar is a PPP between business and regional government which specifically aims for deregulation: companies become more self-responsible for their environmental management activities (Saar-3p2,p6,p18,p20), which is to improve their economic prospects (Saar-3p19)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Traditional (and more restrictive) nature protection is insufficient to fully protect nature, which has led to initiatives to search for new co-uses of natural area (Saar-5p14)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Job security is a relatively important consideration for Saarland to cooperate in Umweltpakt Saar (Saar-7p9). With demographic change and financial restraints being mentioned as big challenges for Saarland in Umweltpakt Saar (Saar-7p2), it is not unlikely that the initiative is partly fuelled by demographic causes: better cooperation with businesses could secure jobs and finances.</li> </ul>
Assessment	N	P
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>MVP also is involved in a PPP between government and businesses regarding the environment (since 2002): Umweltallianz MVP (MVP-2p7). This should shift focus from restrictive management to quality of life, involving a reduction of regulatory pressure (MVP-2p20)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>MVP aims to be less bureaucratic and more public-oriented (MVP-1p17)</li> <li>Within nature protection, policies were updated to become less bureaucratic (MVP-2p24)</li> <li>Reduction of bureaucracy is mentioned directly in connection to other structural challenges as (demographic?) change and providing employment (MVP-2p31)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Demographic change is one of the developments that leads to reconsideration of the position of government: people will have to take more individual responsibility, PPP will become more important (MVP-2p34)</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>Although the ambition is to reduce land consumption in rural areas, new land consumption is allowed if it helps to secure economic activities (Sach-2p6,p25,p63), which is to prevent further emigration(Sach-2p63).</li> <li>Umweltallianz Sachsen was, of the four regions, the first founded PPP between government and business (in 1998). It aims to reduce bureaucracy and sets associated companies free of certain reporting duties (Sach-1T1p21)</li> </ul> <p>Indirect</p> <p>Demography</p> <ul style="list-style-type: none"> <li>The early founding of the Umweltallianz may be an indication that under stress of high unemployment and relatively weak economy (in those days), pressure for cooperation and deregulation is earlier recognized by government because pressure for job security is higher to prevent further migration</li> </ul>

Assessment	D	P
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### C.2.2 Less public support for environmental management (Opposite of NM.2.1)

Region	Nordrhein-Westfalen	Saarland
Description	Direct Indirect Demography	Direct Indirect Demography
Assessment		
Region	Mecklenburg-Vorpommern	Sachsen
Description	Direct Indirect <ul style="list-style-type: none"> <li>• There is are some conflicts between nature protection and the land use sector (MVP-2p3)</li> <li>• The high quality of nature and its protection requires extra demands on communication with civilians (MVP-2p24)</li> <li>• Many measures of the energy- and climate program are particularly unpopular as they raise costs for households and companies and create extra regulatory pressure (MVP-4p61)</li> </ul> Demography <ul style="list-style-type: none"> <li>• There is no clear evidence that population decline leads to less public support</li> </ul>	Direct Indirect Demography
Assessment	N	

### C.2.3. Less political support for environmental management (Opposite of NM.2.2)

Region	Nordrhein-Westfalen	Saarland
Description	Direct Indirect Demography	Direct Indirect Demography
Assessment		
Region	Mecklenburg-Vorpommern	Sachsen
Description	Direct Indirect Demography	Direct Indirect <ul style="list-style-type: none"> <li>• The newest coalition in Sachsen specifically aims, not only to deregulate, but also to slim down spatial plans (Sach-4p219)</li> </ul>

		Demography
Assessment		

#### C.2.4. Less willingness of the public to comply with regulation (Opposite of NM.3.3)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• NRW does have a relatively high share of the nation's industrial accidents.</li> <li>• A perceived recent rise in accidents has led authorities to intensify inspections (NRW-2p137 p138).</li> </ul> <p>Demography</p>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>
Assessment		
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <p>Demography</p>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>
Assessment		

#### Issue changes

#### C.3.1. Relatively higher emissions from transport, such as CO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10</sub> and SO<sub>2</sub> (Opposite of NM.3.2)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>• In 1995, (still during the growth period), the impacts of traffic on the environment were considered high and were still growing (NRW-1p63)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>• While many industrial emissions were lowered, NO<sub>2</sub> and fine dust (PM<sub>10</sub>/PM<sub>2.5</sub>) still showed an increase (NRW-2p42)</li> <li>• There is a stagnation and even increase of NO<sub>2</sub> immission reductions measured near traffic-rich areas, while concentrations in forests were improving (NRW-2p57,p58).</li> <li>• In traffic-rich areas, an increase in Benzol-concentrations was measured in the past years, although this was kept easily below EU-</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>• The share of mobility-related pollution has increased since the 80's (Saar-5p9), amongst which a continuing increase of CO<sub>2</sub> emissions by traffic (Saar-4p25). For a large part, this is caused by higher distances of journeys and expansion of the car fleet (Saar-4p36)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Building in rural areas is not strongly ruled out and new forms of rural living that come without sprawl are encouraged and facilitated with new infrastructure (Saar-5p29), potentially increasing traffic.</li> <li>• Expansion of transport networks, notably car- and air-traffic (Saar-2p27,p31,p39) are still advocated (Saar-2p25).</li> </ul>

	<p>tolerated margins (NRW-2p66)</p> <ul style="list-style-type: none"> <li>Greenhouse gas-emissions of traffic have risen (NRW-2p111).</li> <li>Although vehicles in general have become more fuel-efficient, an overall increase of traffic has countered this (NRW-2p74)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>There is no indication that lower population densities played a role in increasing emissions.</li> </ul>	<ul style="list-style-type: none"> <li>Interregional rail traffic has been stopped (Saar-2p29), although new high-speed lines should compensate for this.</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Some signs, such as higher average transport distances and continuing allowance of sub-urban living indicates that this <i>might</i> have been shaped partially by demographic changes</li> </ul>
Assessment	N	P
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>While the general aim is to concentrate resources on central places due to declining budgets and under stress of population decline, non-central places should be able to access the facilities of central places by good infrastructural connections (MVP-1p56, MVP2p29). This should also facilitate businesses and secure jobs in rural areas (MVP-2p28)</li> <li>Although telecommunication infrastructure is of particular importance for shrinking areas, traditional infrastructure remains important (MVP-2p29)</li> <li>Air traffic infrastructure should be developed further (MVP-1p63)</li> <li>Improvement of infrastructure has been a major focus in MVP following the fall of the Wall (MVP-2p3)</li> <li>Transit of goods between west- and east-Europe will increase traffic in MVP (MVP-4p72)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Population decline is an incentive for providing good infrastructural connections to non-central places, but it is not certain if this increases traffic-related pollution.</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Within urban areas, high traffic intensities create significant air pollution (Sach-2p24), especially of PM10 and PM2.5 (Sach-4p113).</li> <li>At least in the end-90's, growing mobility greatly increased the impacts of mobility on pollution (especially NOx, noise, PM10 and CO2), even as cars became less polluting per km (Sach-1T1p4,p28,p29,T2p31,p43).</li> <li>A sharp increase of road-based mobility and its impacts was observed during the first decade after the fall of the wall (Sach-1T2p47)</li> <li>Expansion or improvement of rural road network is still considered desirable (Sach-2p61).</li> <li>PM10 and PM2.5 issues remain a problem especially in traffic-near locations</li> <li>An increase of individual transportation movements is observed, outside of traditional urban-rural traffic patterns (Sach-2p15, Sach-4p39).</li> <li>The quality and quantity of public transport has decreased, which especially affects sparsely populated areas (Sach-4p39,p156, Sach-1T1p27). Population decline puts extra pressure on public transport. (Sach-4p217)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Technological improvements may have made cars less polluting per kilometer, but increase of individual transportation may be stimulated by population decline</li> </ul>
Assessment	P	P

### C.3.2. Relatively higher impacts of production industries (Opposite of NM.3.3)

Region	Nordrhein-Westfalen	Saarland
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Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Emissions keep on endangering the state of forests (1995, NRW-1p38)</li> <li>Oak forest are still in a relatively bad condition due to, for Germans standards, high acidification (NRW-2p288,p289), which is partly also caused by industrial pollution.</li> <li>Some environmental indicators show little improvement, such as PCB air-pollution (NRW-2p42,p71,p72). This is, however, partly due to long retention times in nature of these pollutants (NRW-2p74).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Agriculture still exerts a major pressure on water quality and should preferable be made less intensive in problematic areas, although in general the situation is better than in other regions (Saar-5p11).</li> <li>Extraction of minerals tends to lower ground water levels, endangering nearby located biotopes (Saar-5p10)</li> <li>Acidification of forest soil (which partly is industry-related) presents problems to groundwater quality as it induces leaching of toxic aluminum and manganese from the soil.</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>
Assessment	N	N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>While nuclear reactors are being dismantled in the light of Germany's policy to close down all nuclear power plants, new conventional-fuel power plants are being planned or built (MVP-4p54)</li> <li>Energy demand by industry is expected to increase sharply (MVP-4p109)</li> <li>Although the economic growth was larger than growth in energy demand, improvements in energy-intensity of production industry has slowed down (MVP-4p17)</li> <li>Agricultural productivity is a main challenge for environmental protection in MVP. However, some progress has been made in recent years in combatting negative effects of this production (MVP-2p21)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Possibly, a focus on the energy sector as a new economic sector, could be stimulated by decline (NM.3.7.). Although pollution of new conventional could be elevated through this, this is too speculative to consider seriously</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Although forest dieback has been reduced, elevated concentrations of earth-near ozone and NOx, which are particularly caused by industrial emissions, pose new problems (Sach-1T1p4, T2p42, Sach-2p54).</li> <li>CO2 emissions are declining, mainly due to reduced emissions from power plants; however, until 2004 they had still been growing (Sach-4p114).</li> <li>Nitrate concentrations in groundwater had also increased by 1998 (Sach-1T1p22,p54), likely due to intensified agriculture.</li> <li>Lignite remains an important source for energy generation (Sach-2p84, Sach-4p139), although its share in energy production has been reduced (Sach-1T2p32)</li> <li>Improvements in applied combustion technology led to a sharp decrease of NOx, dust and CO emissions between 1996 and 2004 (Sach-1T1p4,p25, T2p31, Sach-3p10)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Some indicators have not improved as much as might have been expected under population decline alone. It is likely that these specific changes are strongly affected by structural economic change after the wall, such as intensification of agricultural production. Part of this economic growth in recent years can however also have been stimulated by policies to reduce demographic change by improving</li> </ul>

		regional economy
Assessment	N	P

### C.3.3. Relatively higher impacts of consumption

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Increased electricity generation has heightened CO2 emissions (NRW-2p111).</li> <li>Concentration of micro pollutants such as drug residues in surface water have decreased (NRW-2p29).</li> <li>In the waste disposal sector, CO2 emissions have decreased with 85% compared to 1990 (NRW-2p110).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>CO2 emission reductions from 1990-2002 from households were clearly substantially lower than that of industry (Saar-4p37), but the decrease was still more than the population decline over that period, implying a decrease per capita.</li> <li>Waste water treatment was greatly improved, which also improves quality of surface water (Saar-5p14)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>
Assessment	N	N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Use of electric current is expected to significantly decrease in the future due to population decline and is already doing so (MVP-4p56)</li> <li>By replacing energy-inefficient housing and concentration of buildings, reduced energy demand of households can be achieved (MVP-4p7,p67)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Population decline is recognized to decrease at least energy consumption</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>In Sachsen, CO2 emissions of households sank less than might have been expected considering the intensity of population decline (Sach-4p114)</li> <li>Waste water treatment was improved (Sach-1T1p57,p61,p71)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>
Assessment	D	N

### C.3.4. Reduced investment in and application of environmentally friendly, innovative technologies or land uses. (Opposite of NM. 3.7)

Region	Nordrhein-Westfalen	Saarland
Description	Direct	Direct

	Indirect Demography	Indirect Demography
Assessment		N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Investment of MVP in stimulation of innovative-sustainable energy technology has declined throughout recent years (MVP-4p115).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Budget problems due to decline (C.1.1) can lead to lower investment in such stimulation funds</li> </ul>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>
Assessment	P	N

### C.3.5. Problems with maintaining (environmental) infrastructure such as waste water plants and waste disposal systems.

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <p>Demography</p>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Waste-water disposal facilities have greatly been improved in the past two decades (Saa-5p12).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>
Assessment		
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>Centralized waste water disposal systems should only be applied in densely populated areas. In case of sparsely populated areas or single farms, water will have to be cleaned and disposed on site due to practical limitations (MVP-1p54) and higher maintenance costs due to population decline (MVP-2p7, MVP-3p14,p19)</li> <li>Despite these limitations, some improvements can still be made (MVP-2p7)</li> <li>Communal heating systems, which are preferred, cannot be used in sparsely populated areas due to efficiency</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>It is not possible to introduce centralized waste water disposal systems in sparsely populated areas (Sach-2p88), due to future prospects of population decline this also not aimed for because it would provide to be too costly for citizens and government (Sach-2p89, Sach-4p172)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Financial assets are particularly invested in making waste water disposal up-to-date with EU-standards in the more densely populated</li> </ul>

	<p>considerations (MVP-4p82).</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Organic pollution due to disposal of waste water has been decreasing in the past years (MVP-2p22).</li> <li>Problems with providing stable energy outputs in electricity grids due to high, but highly variable renewable energy production is exaggerated by population decline (MVP-4p56,p57)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Problems with (environmental) infrastructure in MVP are clearly present and population decline and low population density in general provide problems for maintenance and achieving the highest standards.</li> </ul>	<p>areas (Sach-2p88).</p> <ul style="list-style-type: none"> <li>Drinking water facilities were taken out of order, but with no mentioned environmental consequences (Sach-4p170, Sach-1T1p63)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>There are demographic restraints to improvement of environmental infrastructure, although the increase of maintenance costs is not directly mentioned.</li> </ul>
Assessment	D	D

### C.3.6. Continuing worries about land consumption

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>Even though population has started declining, land consumption remains “very high”, as 15 hectares per day are consumed (NRW-2p214,p217,p244), which is regarded as a major biodiversity threat (NRW-1p214), because a large part of this surface is ‘sealed’(NRW-2p219,p262). This consumption remains on a relatively ‘stable’ level (NRW-2p220)</li> <li>Efforts to reduce land consumption have been fruitless (NRW-2p326), it is an “unresolved environmental problem”(NRW-2p326)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>In the 1995 LEP (during growth), land consumption was regarded as a problem, requiring thrifty management (NRW-1p21,p22), because it endangers biodiversity (NRW-1p26).</li> <li>According to the LEP, land consumption should be reduced by concentrating the population near main infrastructure to decrease future need for expansion of the road network (NRW-1p19).</li> <li>Especially in rural areas land consumption was high in 1995 (NRW-1p22), but there was a demand for about 100.000 units a year (NRW-1p45), as well as for new industrial areas (NRW-1p82)</li> <li>Since 1995, the size of built-up area has</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Land consumption is a historical phenomenon, but has sharply increased in Saarland during industrialization, leading to loss of (valuable) soil (Saar-5p6).</li> <li>In agricultural areas, sprawl of built up area and expansion of infrastructure (Saar-1p21) is compromising both the landscape and its experience by inhabitants (Saar-5p29). Land consumption also creates pressure on local biodiversity (Saar-1p21)</li> <li>Because Saarland already is a densely populated region, increase of built up land is considered problematic (Saar-1p22), and land should be used thrifty, rather than building on free land, gaps should be filled up.</li> <li>‘Sealing’ of soil is also caused by some renewable energy forms, for example the large-scale use of PV-cells (Saar-4p53).</li> <li>In the LEP, still significant amounts of land are reserved to facilitate local developments (Saar-2p22).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Land consumption remains a prominent problem, but population does not clearly play a role</li> </ul>

	<p>increased at the cost of losing agricultural land (NRW-2p16) and the housing stock was increased with 12% (NRW-2p49).</p> <ul style="list-style-type: none"> <li>Land consumption should be reduced to 5 hectares per day in 2020 (NRW-2p241)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Despite decline, land consumption remains high, although it is not clear that population decline has stimulated land consumption</li> </ul>	
Assessment	P	N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Near the Baltic coast, settlement of new holiday residences is planned to improve touristic revenue (MVP-1p22)</li> <li>Construction of new houses and commercial areas is restricted. Only construction for the local community is allowed. Only central places are allowed to expand (MVP-1p35)</li> <li>Construction should take place within the interior of cities rather than claim new land outside of them (MVP-1p36) in order to save land as well as not hollowing out existing urban structure.</li> <li>Sealing of land through construction is considered to be a threat to agricultural development (MVP-2p24).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Population decline is an incentive for saving land because it would hollow out existing cities and villages</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>Urban areas still exert pressure on the local landscape and its ecological and recreational functions (Sach-2p24)</li> <li>Even though population declines, strict planning of green buffer zones is necessary to prevent band settlements to form (Sach-4p42)</li> <li>There has been strong consumption of land for creation of built-up area, which has reduced the number of spaces that are relatively undisturbed (Sach-2p34, Sach-1T1p29). This stands in great contrast to reduced population numbers and vacant buildings in some parts of cities (Sach-2p56).</li> <li>Recently, land consumption has continued at an even faster pace (Sach-4p70,p73, p145, Sach-3p15), mostly due to other living demands and fast economic growth (Sach-4p73).</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>In order to protect soil qualities, provide surface water infiltration capacity and nature protection (Sach-2p51, Sach-1T2p68) Sachsen aims to reduce land consumption (Sach-2p50, Sach-1T2p18,p68)</li> <li>Land use for new housing areas and commercial spaces is permitted, as long as it facilitates the needs of the local community only (Sach-2p20,p55,p62,p63).</li> <li>Any large-scale land consumption activities should preferably be concentrated in central places (Sach-2p55)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Especially economic growth has caused recent land consumption. Because this economic growth may be important to slow population declining by retaining inhabitants, it is possible that land consumption policies have become less stringent</li> </ul>

Assessment	D	P
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### Indicator assessment for Neo-Malthusian indicators:

#### Internal organizational changes (internal management)

NM.1.1. Relatively more funding for environmental management, less budget restraints (opposite of C.1.1)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Additional finances were made available to facilitate more extensive production in human-influenced, agricultural (micro)-systems (NRW-2p272).</li> <li>Extra financial effort was dedicated to nature experience areas (NRW-2p280).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Even though unsealing of soil and greening of stream valleys in urban areas may have little ecological effects, these measures are still promoted for the improvements in quality of the living environment they provide (Saar-5p30) even though these are likely costly measures.</li> <li>New projects such as planting of new forests were initiated to reduce CO2 footprint (Saar-4p45).</li> <li>Improvements of water treatment facilities were achieved without financial help from other parties (Saar-6p3)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>
Assessment		N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Over the past years, national as well as European investments have helped to realize major societal progress (MVP-2p3,p23, MVP-4p83, MVP-3p23)</li> <li>A shift in European subsidy system, means that finances for stimulation of agricultural markets are decreased, while more money is available for structural management of agricultural areas, including biodiversity conservation and landscape protection (MVP-2p4, p8, p33)</li> <li>New projects climate protection programs were established and financed (MVP-4p62).</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>Despite its declining population, economic prospects as well as regional finances still give optimism for the future environmental management (Sach-4p5)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>A new project was started that promotes energy-saving passive houses financially (Sach-3p9), in 2005 this program was expanded.</li> <li>During the 90's, expenses on nature protection increased (Sach-1T2p78).</li> <li>From 2006-2009, the size of subsidized ecologically managed area increased slightly (Sach-4p102).</li> </ul> <p>Demography</p>

	Demography <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>	<ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>
Assessment	N	N

### NM.1.2. Stronger position of governments to enforce regulation and measures.

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>In the past decades, continually stricter regulation to counter air pollution was enforced. Today, this is increasingly determined by the EU (NRW-2p74). Recently, restrictive new plans were implemented in the Ruhr area to counter the persistent air pollution above EU norms (NRW-2p88).</li> <li>Noise production is bound to strict rules which are mainly set by the federal government (NRW-2p104).</li> <li>NRW is the only German region in which landscape planning is a rule of law (NRW-2p300).</li> <li>New policies were enforced to protect avenues in the countryside (NRW-2p308)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>If conflicts between nature and new developments cannot be avoided, such new developments should be abandoned (Saar-1p33, Saar-2p12)</li> </ul> <p>Demography</p>
Assessment	N	
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Small water cleaning facilities should be technically improved to produce cleaner water (MVP-3p22)</li> <li>It is recognized that in the future, personal responsibility and creativity are necessary (MVP-2p31) rather than more influence of the government. Because of demographic change and decreasing public means, the government alone cannot provide services and PPP should become more important (MVP-2p33,p34). This rather indicates a weaker position of governmental services.</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Demographic change is mentioned as a reason for the public to take more own responsibility.</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Spatial plans will be restricted further when it comes to allowing new land consumption (Sach-4p75)</li> <li>New policies for land recycling will be put in place and more money is made available to counter land consumption (Sach-4p77)</li> <li>Regional planning authorities will get a more active role e.g. in battling effects of population decline (Sach-4p218)</li> <li>New instruments were introduced to provide better protection of valuable biotopes (Sach-1T2p81p82).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>

		Demographic change is mentioned as an incentive to strengthen the position of government in local spatial planning.
Assessment	D	D

### NM.1.3. More involvement of the public in environmental management (e.g. bigger role for volunteering)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• There are considerable positive effects of voluntary participation in contracted nature conservation (NRW-2p271)</li> <li>• Experience of nature and recreation have become stronger focal points of policy (NRW-2p280,p281)</li> <li>• Citizens have gotten more say in determining the contents of new landscape planning (NRW-2p300)</li> <li>• New PPP's were founded, a.o. to counter land consumption (NRW-2p327,p329)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• Not linkable to decline</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• There is more attention recently for the cultural and recreational potential of forests (Saar-5p25)</li> <li>• Public actors are recognized to play their own role in contributing to strategies to mitigate climate change, regional government is just a 'moderator' (Saar-4p54)</li> <li>• Concepts for protection of valuable biotopes should be developed in cooperation with local population (Saar-2p41)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• Not linkable to decline</li> </ul>
Assessment	N	N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Development of the LEP and Natura 2000 management took place in close cooperation with local population, who could actively contribute their ideas (MVP-1p3,p7, MVP-2p25)</li> <li>• More contact with civilians is recognized as necessary to make the region future-proof (MVP-1p17)</li> <li>• Self-responsibility and civic engagement are regarded as important in the light of declining financial power of the state (MVP-2p14,p29,p34)</li> <li>• Voluntary instruments for regional environmental management will become more important, of which the "Allianz Umwelt "and Landwirtschaft" and "Umweltallianz Mecklenburg-Vorpommern" are examples (MVP-2p20)</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Species conservation benefitted greatly from the work of volunteers (Sach-3p17)</li> </ul> <p>Demography</p>



	Demography <ul style="list-style-type: none"> <li>There is an urge to involve the public in environmental management</li> </ul>	
Assessment	D	

External pressure changes (external, societal and political demands)

NM.2.1. More public support for environmental management (opposite of C.2.2)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>According to “Dialog Wirtschaft und Umwelt”, more companies take their own responsibility for providing environmental management (NRW-2p339). However, this is accompanied by a pressure for deregulation, rather than increased support</li> <li>The current state of nature protection in NRW could only be realized by cooperation with other parties such as clubs and associations (NRW-2p246).</li> <li>There are high public pressures for reducing smell of agriculture (NRW-2p91).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>A consideration of the high costs of waste water disposal, and the realization that population decline poses additional challenges (and costs) for citizens, leads to a statements that citizens are willing to bear the costs if the value of these expenses for sustainable development is realized (Saar-6p3). Although speculative, this could indicate growing dissatisfaction about costs of waste water disposal.</li> <li>By means of Umweltpakt Saar, an increasing amount of companies is voluntarily implementing additional measures (Saar-4p30, Saar-3p2,p6,p13,p30, Saar-7p4)</li> <li>Saarland has is the regions with the highest number of EMAS-validated organizations per citizen (Saar-3p2)</li> <li>Citizens have installed PV-cells in high numbers (Saar-4p49)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>
Assessment	N	N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Public demand for information about how to save energy or produce renewable energy is rising (MVP-4p38)</li> <li>Improvements in environmental standards are partly attributed to engagement of citizens (MVP-2p3).</li> <li>PPP’s exist between businesses and government to improve environmental management (MVP-2p20)</li> <li>Possible, acceptance of citizens for wind technology is currently quite low, because</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>In the late 90’s, especially in the major cities, Agenda 21 principles were implemented at local level (Sach-1T1p10)</li> <li>Following the fall of the wall, both demands from consumers and more stringent regulation have forced producers to be more considerate of the environment (Sach-1T1p19).</li> </ul> <p>Demography</p>

	<p>gaining acceptance is regarded as important (MVP-4p66)</p> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>	<ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>
Assessment	N	N

## NM.2.2. More regional political support for environmental management (Opposite of C.2.3)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <p>Demography</p>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Even though climate change is a global event in which Saarlands' efforts to reduce emissions are have little impact, regional governments is determined to contribute to CO2 reduction (Saar-4p4). These contributions are, however, based on agreed international and national targets (Saar-4p24).</li> <li>Regional politics has paid special attention to securing specific sites for wind turbines, in order to provide clarity. This should both benefit the installment of turbines and secure the state of the landscape (Saar-2p20)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>
Assessment		N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Renewable energy is a political focal point in the 2020 energy strategy (MVP-4p6)</li> <li>Decentralized energy systems, such as cold-heat-exchange and biofuels, are regarded as especially important for MVP by regional government, as they can create new developments in rural areas and are easily adaptable to local demand. It is aimed to be a front leader in Germany with these technologies (MVP-4p83)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Population decline can play a role in stimulating local energy solutions, which could benefit the environment by closing resource cycles and energy efficiency.</li> </ul>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>

Assessment	P	
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### NM.2.3. More willingness of the public to comply with regulation (Opposite of C.2.4.)

Region	Nordrhein-Westfalen	Saarland
Description	Direct Indirect Demography	Direct Indirect Demography
Assessment		
Region	Mecklenburg-Vorpommern	Sachsen
Description	Direct Indirect Demography	Direct Indirect Demography
Assessment		

### NM.2.4. Increasing civic pressure to act on local environmental issues (e.g. PM10, noise)

Region	Nordrhein-Westfalen	Saarland
Description	Direct Indirect <ul style="list-style-type: none"> <li>The themes of regional environmental management have actually shifted from a local issue like air quality to climate change (NRW-2p9)</li> <li>Smell inconvenience has remained, a hot item for the public (NRW-2p91).</li> </ul> Demography	Direct Indirect <ul style="list-style-type: none"> <li>New wind farms (good in the light of global environmental issues) face strong resistance from local population due to local issues such as impact on fauna, appearance of landscape, noise and shade (Saar-4p48).</li> </ul> Demography
Assessment		
Region	Mecklenburg-Vorpommern	Sachsen
Description	Direct Indirect <ul style="list-style-type: none"> <li>Regional traffic through the centers of settlements causes emissions that obstruct building projects as well as provide inconvenience for local residents (MVP-1p61).</li> </ul> Demography	Direct Indirect Demography
Assessment		

## Issue changes

### NM.3.1. A reduction of pressure on biodiversity (mainly in rural areas)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>Land consumption was thought to threaten biodiversity, both of human-influenced and 'natural' ecosystems (NRW-2p217,p245). Especially in the (rural) plains in the north and west, land consumption remained high (NRW-2p218) and threatened species which benefit of large territories (NRW-2p302).</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>In the 1995 LEP (during growth), high-intensity spatial occupation of the land is regarded as threatening biodiversity (NRW-1p27)</li> <li>450 Hectares of agricultural land are converted into (production) forests (NRW-1p38)</li> <li>Non-productive forest cover has increased significantly since the 70's (NRW-2p250)</li> <li>Some indicator bird species have become more abundant (NRW-2p252).</li> <li>Current, as well as past pollution continues to threaten ecosystems (NRW-2p245).</li> <li>Many local streams and their valleys have been (re)vegetated since the 70's, which improved conditions for plant-and animal life significantly (NRW-2p253,p254).</li> <li>Due to intense management of some local bogs, their quality has improved significantly (NRW-2p254,p275)</li> <li>EU-stimulated bare-land policies have improved species-richness at those sites (NRW-2p257)</li> <li>Some endangered species, such as Salmon, have become more abundant or reclaimed territory, (NRW-2p262,p266)</li> <li>Outside of protected areas, the number of Black-tailed godwit has fallen sharply, as opposed to specially managed territories (NRW-2p278)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>The least optimistic prospects for biodiversity seems to come from land consumption, which in NRW, with a relatively slight decline, may have been higher for a longer time.</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Large, undisturbed areas of land of more than 15km<sup>2</sup> were registered and protected from dissection by new infrastructure (Saar-5p3)</li> <li>Many river valleys have been improved and (re)vegetated (Saar-5p12)</li> <li>Improvements in waste water disposal facilities, more natural forestry practices and nature development in abandoned surface mining sites offer good chances for improved natural development (Saar-5p14)</li> <li>High population density still exerts major pressure on biodiversity, increasing the needs to protect valuable biotopes (Saar-2p14)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Safeguarding of undissected territories and (re)vegetation of river valleys and former mining sites can indicate that combined economic/demographic change may lower pressure on land and biodiversity</li> </ul>
Assessment	P	P

Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>It is recognized that in past decades human influence has had increasingly negative effects on biodiversity (MVP-1p42) and that maintenance of this high quality requires significant effort of the government as well as cooperation with other actors (MVP-2p24).</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Nature and biodiversity is in a relatively good condition compared to the rest of Germany and Europe, and are regarded as a valuable asset, which should be preserved, to attract tourists (MVP-1p13, MVP-2p4, p24)</li> <li>A high focus of new construction effort on central places (MVP-1p27) indicates that land use pressure is especially concentrated around urban areas, while in rural areas, pressure on biodiversity of land consumption is low.</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Management of biodiversity seems to demand much from government. Possibly, low population densities and lower revenues make the management of relatively large, high quality nature difficult to bear for regional government.</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>In biosphere reserves, many protected species have stabilized or expanded in number (Sach-4p96), while in general some species show improvements while others are continuing to decline (Sach-4p100, Sach-3p17)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Although large (more than 40km<sup>2</sup>), undisturbed land areas were protected from new infrastructure construction, mesh-sizes in between major infrastructure decreased from 2004 to 2007 (Sach-4p93).</li> <li>The overall size of nature protection areas has recently increased slightly (Sach-4p94, Sach-3p16)</li> <li>New small landscape elements were erected in agricultural areas (Sach-3p17)</li> <li>The amount and surface of nature parks increased (Sach-4p97)</li> <li>It is aimed to increase forested area sharply (although for production) (Sach-1T1p24, Sach-4p149)</li> <li>New networks to connect ecologically valuable areas were developed since 1992 (Sach-2p42)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Although population was declining, there was no sign of reduced pressure outside of protected area (which means that no clear indications exist)</li> </ul>
Assessment	P	N

### NM.3.2. Relatively lower emissions from transport, such as CO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10/2.5</sub> and SO<sub>2</sub> (opposite of C.3.1)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>New developments (e.g. housing and new surface mining areas) should preferably be centered around transport axis, especially railway, to facilitate more sustainable transport (NRW-1p19, p56).</li> <li>Expansion of rail- and water transport networks is preferred over expansion of the road network. High-speed railways are a priority to reduce pollution from short-distance air traffic. (NRW-1p65, p70, p73)</li> <li>Improved engines have reduced many types of pollution from traffic in recent years,</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>New connections with European high-speed railroad and expansion of local railway connections should improve public transportation (Saar-4p36, p28)</li> <li>Active stimulation of public transport should reduce traffic-induced pollution (Saar-4p36)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Overall improvements are weak compared to C.3.1. Not linkable to decline.</li> </ul>

	<p>including CO2 (NRW-2p47,p64), although this has been offset by structurally higher mobility (NRW-2p74).</p> <p>Demography</p> <ul style="list-style-type: none"> <li>Population decline can increase mobility because service density is decreased. Because this would mostly be a rural issue and rural decline is not that outspoken in NRW, this an unlikely reason</li> </ul>	
Assessment	N	N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Pressures to improve intraregional public transport via MVP (MVP-1p16)</li> <li>The central-places concept should help to reduce traffic and its associated pollution as developments are centered in a single place (MVP-1p27,p36,p58, MVP-4p65,p67). New developments should take place in these central places or near corridors that facilitate public transportation (MVP-1p35)</li> <li>Use of public transport and rail and water good transport is promoted to reduce emissions (MVP-4p7,p65,p71), including concepts such as call-buses and private car sharing (MVP-4p71)</li> <li>Due to demographic developments, it will become more important in the future to use telecommunications to provide services (MVP-2p15,p29), possibly reducing traffic</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Population decline can be an incentive for focusing developments in central places and using telecommunications more intensively, possibly reducing regional traffic.</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Local central places, that are the most basic towns in the central places system, should maintain good-quality public transport connections with higher-level local and regional centers (Sach-2p19).</li> <li>Use of public transport and cycling/walking should be strengthened especially in (urban) areas with high pollution (Sach-2p54)</li> <li>New construction should take place near existing infrastructure (Sach-4p43)</li> <li>NOx pollution, mainly caused by transport, has been reduced in the past years (Sach-1T1p4, Sach-4p113)</li> <li>Traffic-related CO2 emissions have been declining (Sach-4p114)</li> <li>Non-methane volatile organic compounds (NMVOC) dropped by 56 % from 1996 to 2004, mainly due to cleaner engines of traffic (Sach-1T2p33, Sach-3p10)</li> <li>In recent years, noise pollution due to traffic has stalled (Sach-3p19)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>There is at least no evidence that decline, rather than technological improvements have led to the (weak) improvements in impact of traffic</li> </ul>
Assessment	P	P

### NM.3.3. Less impacts from production industries (especially those producing for local markets such as for construction) (Opposite of C.3.2)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>SO2, NO2 background concentrations, Ozone, PCDD, PAH and heavy metal concentrations in</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>Since the 80's emissions of SO2, NOx and carbohydrates/hydrocarbons due to industry</li> </ul>

	<p>PM10 have all shown a significant decline (NRW-2p56,p58,p59,p65,p67,p74). Even industrial CO2 production has declined slightly from 2004 to 2007 (NRW-2p45,p110)</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• N-deposition has regressed in past years (NRW-2p73)</li> <li>• The quality of forests now seems to stabilizing (NRW-2p288)</li> <li>• Quality of surface water has improved (NRW-1p19) through improved cleaning processes.</li> <li>• Nitrate concentrations in water have declined due to better regulation (NRW-2p28).</li> <li>• Air quality has significantly improved in past decades due to better regulation and decline of heavy industry (NRW-2p42).</li> <li>• Problems with PM10 emissions of steel mills have been reduced significantly (NRW-2p74)</li> <li>• Deposition of lead due to industrial activity has been greatly reduced (NRW-2p77)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• Improvement in the indicators is rather tied improved technology, better regulation and decline of heavy industry than population decline</li> </ul>	<p>have been greatly reduced.</p> <ul style="list-style-type: none"> <li>• The share of industry, compared to traffic, in pollution, has been declining (Saar-5p9)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Groundwater levels that were disturbed by surface mining seem to recovering (Saar-5p11)</li> <li>• Water pollution due to mining has strongly decreased (Saar-5p12)</li> <li>• Organic agriculture is relatively strongly developed in Saarland, and is stimulated by regional government (Saar-2p16), which reduces stress on the environment (Saar-4p43)</li> <li>• By changing rules for construction, wood can be used easier as construction material, reducing CO2 emissions (Saar-4p46)</li> <li>• Improvement of energy- and resource efficiency is an explicit goal of Umweltpakt Saar (Saar-3p22, Saar-7p12)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• Although the numbers are not as strong as with NRW, an overall reduction of pressure is commonplace. It is difficult to attribute this directly to population decline, similar factors as in NRW seem to be at work.</li> </ul>
Assessment	N	N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Major improvements have been made in energy production. Renewable energy, notably wind energy, made out 44% of energy generation in MVP in 2007 (MVP-4p17,p75,p111)</li> <li>• The bio-energy sector grew faster than expected (MVP-4p77)</li> <li>• Decentralized (renewable) energy projects should not only reduce CO2 emissions, but also help to close local resource cycles. Waste water treatment and resulting water quality have greatly improved since the 90's (MVP-3p17)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• All in all, certainly in CO2 emissions, steps have been made to reduce emissions in energy production. A direct link with demography is not provided, however, the high renewable energy production may have been enabled by low population densities or high investments in new technologies in the</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• SO2 emissions have been strongly reduced in the past decades to below the legal limits (Sach-1T2p31, T2p40, Sach-3p4, Sach-4p113)</li> <li>• Even though soil conditions remain poor, a slight recovery of the condition of forests could be observed, partly due to forest liming (Sach-1T1p25, Sach-2p54).</li> <li>• CO2 emissions by industry have been reduced slightly in past years, but are still clearly higher than in 1998 (Sach-4p114), possibly due to increased economic growth.</li> <li>• Production of minerals and building material from quarries shows a declining trend (Sach-1T1p26, Sach-4p138)</li> <li>• Energy use has been going up and down: while in 2000 it was clearly lower than in 1990, a slight growth until 2007 could be observed, probably due to economic growth and building of construction of new power plants (Sach-1T2p37, T2p46, Sach-3p5, Sach-4p163)</li> <li>• The share of renewable energy has been growing but is still comparatively low in comparison with for example MVP (Sach-3p8, Sach-4p163)</li> </ul>

	search of new, rewarding land uses (N.M. 3.7)	<ul style="list-style-type: none"> <li>• Use of pesticides was reduced (Sach-1T1p22)</li> <li>• , while overall, water quality improved as well (Sach-1T1p57,p59,p60). Nitrate and other pollutants in groundwater of drinking water protection areas has been reduced (Sach-1T1p61)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• Although a clear decrease in a lot of different indicators can be observed, this is mainly due to improved regulation, deindustrialization and introduction of cleaner technology. The decrease of output of raw building material and minerals does however suggest that population decline may have decreased local production at least in some sectors.</li> </ul>
Assessment	P	P

### NM.3.4. Decreasing land consumption

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• New initiatives to reduce land consumption are being deployed (NRW-1p70), such as policies to use abandoned areas first (NRW-1p78, NRW-2p217)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• Not linkable to decline</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• New initiatives to reduce land consumption are being deployed, such as policies to use abandoned areas first (Saar-5p7,p29)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• Not linkable to decline</li> </ul>
Assessment	N	N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• New initiatives to reduce land consumption were deployed, such as policies to use abandoned areas first and focus construction effort on expansion of the building stock in urban areas and central places (MVP-1p35,p36,p37,p48,p52, MVP-4p67).</li> <li>• Soil should be unsealed where possible (MVP-4p68).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• Although population decline is quite strong, reduction of land consumption is an important issue in policy. Measures not only aim to reduce land consumption, but also to</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Initiatives to reduce land consumption are deployed, such as policies to use abandoned areas first (Sach-2p55,p57,p59,p63, Sach-4p43,p215) (especially existing buildings in inner cities, Sach-2p60). Other are the protection of large areas undisturbed by infrastructure (Sach-2p24,p35) and restrictions to new land consumption based on demographic developments of communities (Sach-2p65)</li> <li>• Increasingly, new developments are realized in place of (former) built-up sites (Sach-4p42). In Chemnitz, for example, 75% of new construction was realized on such sites (Sach-4p42).</li> </ul>



	<p>concentrate population in such a way that maintenance of public services becomes easier under conditions of demographic change.</p>	<ul style="list-style-type: none"> <li>• The goal is to reduce consumption of land regionally to under 2 hectares a day (Sach-4p74).</li> <li>• If economically possible, fallow land should be made available for development again to reduce land consumption, otherwise it should be made available to nature again (Sach-2p55,p58, Sach-4p77)</li> <li>• Most new expansions of built up area are small in size and fit in with existing structures (Sach-4p42).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• Although land consumption is continuing, it shows signs of becoming less large-scaled. Population decline may play a direct role by decreasing demand for new housing or creating vacant buildings in which place new (different) demands may be realized if the land recycling policies do their work</li> </ul>
Assessment	P	P

### NM.3.5. Possible elevated impacts are resulting from localization of production and consumption chains

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <p>Demography</p>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>
Assessment		
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Regionalization trends are visible in initiatives to develop renewable energy at local scale, which would mean more or less indecency form the electric grid (MVP-4p82). This would also encompass closing of local resource cycles (MVP-4p83). Such local renewable energy initiatives would also mean localized impacts such as landscape- visual- and noise pollution and shading, but would reduce impacts of electricity generation elsewhere.</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• Because these developments are especially centered around rural, peripheral communities, that are hardest hit by population decline, there is a plausible link</li> </ul>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>

	with population decline	
Assessment	P	

### NM.3.6. Less corporate influence in environmental management and regional politics

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Securing economic activity and jobs is regarded as important in the 1995 LEP to such extent that all demand should be fulfilled without questioning the demand (NRW-1p49), which may be regarded as a very business-friendly starting point.</li> <li>• Creation of an environmental PPP on the one side might mean more sustainable companies, but can also means more corporal influence in policy (NRW-2p339)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>• There are no signs that population decline has reinforced the position of governments versus business</li> </ul>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>
Assessment	N	
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <p>Demography</p>	<p>Direct</p> <p>Indirect</p> <p>Demography</p>
Assessment		

### NM.3.7. Increased investment in and application of environmentally friendly, innovative technologies or land uses. (Opposite of C.3.4.)

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Future-oriented companies, including those involved in sustainability and those who aim to use environmentally-friendly technologies and transportation techniques, are prioritized in regional planning over regular companies (NRW-1p54).</li> <li>• Renewable energy production-suitable sites have special protection in regional planning</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>• Forested area will be expanded where agricultural lands are marginal to reduce CO2 emissions (Saar-5p25)</li> <li>• Different types of (waste) wood will be used for energy production (Saar-4p39,p47)</li> <li>• There are promotional programs for investments in future energy such as geothermal energy, as well as for future</li> </ul>

	<p>(NRW-1p79,p80)</p> <ul style="list-style-type: none"> <li>The environmental technology branch in NRW has an annual turnover of 45 billion euro (2009), offers about 250.000 jobs. NRW is the most important German region for environmental technology (NRW-2p9) and an international center for production and innovation of environment-related technologies (NRW-2p341)</li> <li>In 2008, about 2150 local wind parks or turbines were licensed in NRW (NRW-2p102)</li> <li>Although the main greenhouse gas reducing strategies are improvements in coal-powered plants, increasing the capacity of existing wind parks and use of biogas are also of importance (NRW-2p111,p115).</li> <li>New programs to develop hydrogen(cell) technologies, solar technology and energy-storage technology were initiated (NRW-2p112)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Overall, the investments in technology are high. There are however, no clues that these technologies also influence land use at large scales. The indicators are, however, not directly linkable to decline</li> </ul>	<p>energy systems, in conjunction with local companies (Saar-3p23, Saar-4p29, Saar-7p15)</p> <ul style="list-style-type: none"> <li>Programs are offered to make buildings more self-sufficient and energy efficient by means of PV-cells, heat pumps and increased use of wood as fuel, in partnership with other commercial and non-commercial institutions (Saar-4p40)</li> <li>Considerable land surface has been taken in use for the production of renewable energy, which sometimes creates conflict with other uses (Saar-4p53)</li> <li>Especially PV-cells are applied at large scale comparatively (Saar-2p20)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>While sustainable technology industry is not of such an importance as in NRW, its application is more widespread, and local strengths such as high forested areas are played out. A direct link with population decline, could however not be made, although possibly concerns of self-sufficiency and stimulating new economic developments to counter decline have played a role.</li> </ul>
Assessment	N	P
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>The region is a front-runner in wind-energy generation and exports almost 70% of its wind-generated energy (MVP-4p17, MVP-4p55,p75)</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Saying of the LEP is has been extended into the coastal zone, to prevent conflict between new demands, particularly offshore wind energy (MVP-1p18,p69) vs current users (MVP-1p7).</li> <li>Biofuel and renewable energy is mentioned as a future economic focal point. Within energy generation, the main focus is on expansion of renewables (MVP-1p12, MVP-2p27, MVP-4p19)</li> <li>The natural conditions for applying renewable energy are big: high sunshine duration and good wind potentials (MVP-2p27)</li> <li>Already 10% of primary energy demand is covered by biofuel (MVP-2p27, MVP-4p17,p60,p77)</li> <li>Goals for increase in renewable energy are ambitious. MVP should become a prime region for development and production of associated technologies (MVP-4p7), including</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Regional planning should enable new land use for renewable energy, in order to increase the share of renewable fuels in the light of climate change (Sach-2p84, Sach-4p5,p216)</li> <li>In rural areas potentials for biogas and biomass have to be seized (Sach-1T1p24, Sach-2p85)</li> <li>Biomass for energy covers about 10% of the land surface and (before 2010) was growing at a fast pace (Sach-3p8, Sach-4p147).</li> <li>Power supply remains highly dependent on lignite (Sach-2p85)</li> <li>The goal to use 5% renewable energy in 2010, amongst which 25% wind energy (Sach-2p85) was achieved already in 2007 (Sach-3p8).</li> <li>The share of wind energy should be increased (Sach2p84)</li> <li>Innovative energy-saving technology for buildings are activity (financially) stimulated in order to attract new companies and secure jobs (Sach-1T1p26, , Sach-4p19). This has provided a successful strategy in the past (Sach-1T1p19, Sach-3p2).</li> <li>Over 10.000 people had jobs in the renewable energy sector in 2010 (Sach-4p162), with</li> </ul>

	<p>hydrogen-, storage- and even nuclear fusion technology (MVP-4p8,p18,p19,p21,p83,p88).</p> <ul style="list-style-type: none"> <li>Renewable bio-resources will gain importance and can be used in manufacturing and building industry besides energy production (MVP-1p52, MVP-2p25). Especially increased production and use of wood should achieve this (MVP-1p53)</li> <li>PV-cells can be placed on abandoned, used land to provide it with new functions (MVP-1p67)</li> <li>Decentralized energy generation is increasingly combined with energy generation out of waste, to close local resource cycles and provide local services (MVP-4p8,p1,p219)</li> <li>The ecological food production of MVP is among the highest in Germany (MVP-2p32)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Although in volume, MVP environmental technology sector may not be as big in NRW, new and innovative environmental technology, particularly energy initiatives are growing fast and are having profound effects on land use. Lower population densities may allow to reach self-sufficiency goals earlier and decentralized power generation may be a way of making isolated communities that suffer from population decline more self-supportive</li> </ul>	<p>about half the jobs in PV-industry (Sach-p165). This means a sharp increase since 2007 when this number was around 6.000 (Sach-3p8).</p> <ul style="list-style-type: none"> <li>PV-technology is widely applied and new, large plants are under construction (Sach-3p8).</li> <li>Geothermal energy may be retrieved from former mining sites and has been growing in importance, although the total output is relatively small (Sach-4p166)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Overall, renewable energy shares in Sachsen seem to be slightly lower than in MVP, although especially the developments of jobs and the sharp increase in renewable energy are positive signs. Investment and stimulation of these technologies are motivated by climate change and attracting new sectors for job security, which in the last case could be motivated by attempts to reduce population decline</li> </ul>
Assessment	P	P

### NM.3.8 Existence of abandoned brownfields and buildings adding to regional ecological value

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <ul style="list-style-type: none"> <li>Abandoned industrial areas have become a substitutory refuge for species that face difficult condition in the productive landscape. This includes some rare pioneer species (NRW-2p260).</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>NRW has the highest diversity of heavy-metal adapted species (which are often rare and found near former mining sites) (NRW-2p256).</li> <li>Former industrial sites such as Landschaftspark Duisburg-Nord offer chances for developing nature experience parks (NRW-2p281)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Especially remnants from industrial past (rather than abandoned housing) have</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Mining relics such as ponds and artificial hills offer a chance for restoration and can become a new living environment for specialized animal and plant communities (Saar-5p14)</li> <li>Former building built-up land cannot be put into commercial use again when ecologically valuable developments have taken place (Saar-1p26)</li> <li>Natural successions is regarded as a possible strategy to upgrade sealed, disturbed or landfilled terrain (Saar-1p48)(it is unclear if unsealing should precede this)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>There are thus some indications that brownfields as well as abandoned buildings in practice can add to ecological value, even if</li> </ul>

	created some new, valuable ecotopes. This is, however not necessarily caused by population decline but rather by industrial decline.	there is no direct relation with population decline
Assessment	N	N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>It is recognized that resource extraction can lead to terrains that offer valuable spaces for new biotopes or touristic after use (MVP-1p55).</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>	<p>Direct</p> <ul style="list-style-type: none"> <li>The oligotrophic, poor conditions of many mines and brownfields make them refuges for species that would be outcompeted on most productive lands (Sach-1T1p26, Sach-2p43).</li> </ul> <p>Indirect</p> <ul style="list-style-type: none"> <li>Surface mining activities have left behind terrains of which the soils are disturbed, but which are little influenced by infrastructure and which can be used for providing ecological links in the future (Sach-2p35)</li> <li>Ecologically valuable areas that have developed after closure of the mines, are protected within the LEP (Sach-2p41,p42,p67)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Overall, such ecologically valuable succession of brownfield seems to be a general development. Because these are mostly industrial sites, there is no clear link with population decline</li> </ul>
Assessment		P

### NM.3.9. Increase of “greening the city” projects finished or being developed

Region	Nordrhein-Westfalen	Saarland
Description	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>In the project “Industriewald Ruhrgebiet”, industrial fallow land is deliberately left over to natural successions, in order to provide ‘wild’green spaces that are accessible for citizens for play, adventure and relaxation (NRW-2p261)</li> <li>NRW buys industrial fallow land, sanitizes this and sells it; of this, 57% ends up as green/recreational space (NRW-2p242)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>The projects mostly focus on industry, but they benefit the citizens of nearby cities (which in the Ruhr-area is an intertwined area of cities and industry), in a way ‘greening the city’. This is however, mostly facilitated by</li> </ul>	<p>Direct</p> <p>Indirect</p> <ul style="list-style-type: none"> <li>Regional green structures for recreation are expanded (Saar-5p21,p22), partly by including former mining sites and joining landscape gardens to the urban green structure (Saar-5p25)</li> </ul> <p>Demography</p> <ul style="list-style-type: none"> <li>Not linkable to decline</li> </ul>

	industrial rather than population decline	
Assessment	N	N
Region	Mecklenburg-Vorpommern	Sachsen
Description	<p>Direct</p> <p>Indirect</p> <p>Demography</p>	<p>Direct</p> <ul style="list-style-type: none"> <li>• With help of European funds, fallow lands in inner cities where restructured and where mostly given 'green' destinations (Sach-4p43,p77)</li> <li>• Demolished apartment building sites, due to population decline, are mostly 'greened' in such a way that neighborhood quality is increased (Sach-4p118).</li> </ul> <p>Indirect</p> <p>Demography</p> <ul style="list-style-type: none"> <li>• Population decline creates an urge for urban sanitation, leading to 'greener' cities</li> </ul>
Assessment		D