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Conserving the Value of Ecosystem Services in Suburban Residential Development

Case: Trondheim, Norway

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Preface

This thesis was written at the Department of Industrial Economics and Technology Management at the Norwegian University of Science and Technology (NTNU). The thesis is the culmination of my studies for a Master of Science in Industrial Ecology.

The idea stemmed from the topic of 'Green Value Creation', which is currently being explored within the department and by the observation that private developers tend to completely clear-cut and destroy all natural habitats on a parcel before beginning construction of residential properties. I have an interest in the natural world, ecology, and urban planning. To combine my interests with those of the department, I chose to focus on utilizing ecosystem services and their values in the housing construction industry. By identifying the values, policy and regulation can be created to be a win-win-win for the developers, community, and environment.

I would like to thank my supervisor John Hermansen for his guidance on how to organize my research and providing relevant literature. I also want to thank Roar Storleer for sharing his knowledge on how to conduct a professional literature search. Hans Einar Lundli from the Environmental department of Trondheim kommune provided great insight into the environmental priorities of Trondheim and some recent projects. I greatly appreciate Mari Buaas's willingness to meet with me and give valuable insight into the preferences of homebuyers and the interests of developers.

Trondheim, June 9, 2014

Heather Kristen Lee

Abstract

This study attempts to identify the values that Trondheim homebuyers place on having natural areas of forest and freshwater near their homes. These values are then examined through the cultural ecosystem services they attain from the natural spaces. By considering this information while examining the policies related to ecosystems and residential development in Trondheim, the study is able to propose new policies or regulations for the city's future planning initiatives.

The majority of the study focuses on framework because it is necessary to integrate several concepts into the evaluation of policies since they are of concern to a variety of stakeholders. The framework goes through summarizing previous studies and initiatives that this study is based on. The most important of these is the Millennium Ecosystem Assessment (MEA), as this was used to determine and define which ecosystems and which ecosystem services would be investigated. The services addressed in the study are aesthetic, recreational, educational, and climate mitigation. Following this is a presentation of the valuation techniques commonly used for valuing non-tradable services and the results from some previous studies. The third part of the framework is a presentation of global goals and local goals, policies, and regulations.

This framework was then used to guide interviews held with representatives from different industries. The results from the interviews are presented as well as the questions that guided the interviews.

The final section combines the theoretical framework and information from interviews to assess the local goals and policies and make recommendations for how to integrate ecosystem service thinking into new policies. It is useful to know how the behavior of developers is regulated and what could give incentive to conserve natural habitats.

The policy assessment found that Trondheim has set ambitious environmental goals that reflect the Sustainable Development Goals (SDGs) that should be adopted next year. However, Trondheim's regulations could give more specific requirements for developers and costs for ecosystem degradation. The study also found that the homebuyers of Trondheim do not demand that their residences be near natural areas only that the residence has a good view and sunlight.

> *"As human populations increase over the coming decade, managing ecosystems for services will become increasingly important to prevent both shortages of water, energy and food, and increases of disease and global conflict."*
>
> *(Millennium Ecosystem Assessment 2005)*

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Glossary

Albedo: Is the percentage of radiation reflected from the surface. A black surface has 0% whereas a white surface has 100%.

Evapotranspiration: Is the movement of water into the atmosphere through plants, soil, and water bodies.

Human Well-being: Human well-being has several components: basic material needs, health, personal security, freedom and choice and good social relations (MA 2005).

Kommune: the Norwegian word for municipality

Radiative forcing: This is the difference between the energy received from the sun and the energy reflected back to space. When this number is positive, the Earth is warming and negative means the Earth is cooling.

Suburban: Is the area, typically dominated by residential zoning that surrounds an urban city center. These cities tend to have populations over 100,000.

Urban Open Space: Urban open space includes parks, forests, green spaces, undeveloped land, and agricultural land that is near the urban area. These spaces provide valuable amenities to local residents, such as recreation, aesthetic, and environmental functions (Brander and Koetse 2011).

Abbreviations

GEO: Global Environment Outlook

GFRA: Global Forest Resource Assessment

IPBES: Intergovernmental Platform for Biodiversity and Ecosystem Services

ISO: International Standards Organization

MEA: Millennium Ecosystem Assessment

MGDs: Millennium Development Goals

SDGs: Sustainable Development Goals

TEEB: The Economics of Ecosystems and Biodiversity

UN: The United Nations

UNEP: United Nations Environment Program

1. Introduction

> *"The cost of a thing is the amount of what I will call life which is required to be exchanged for it, immediately or in the long run."*
>
> *— Henry David Thoreau, Walden 1854*

As cities grow quickly around the world it is easy for housing to be laid out in a patchwork mess with little thought on how these spaces are experienced by future inhabitants and the impact being made on the ecosystems. The Earth is changing from a wild landscape with pockets of urban area to a managed and developed world with pockets of wild spaces (Brummett et al. 2013). Human actions are the cause of the destruction of ecosystem services (Niemelä et al. 2010). The health and stability of the world's ecosystems has direct effect on the well-being of people living in both rural and urban areas. Humans are a part of the system and have particular requirements (Choguill 2007). Without a restructuring of urbanization policy, vital ecosystems will continue to be destroyed at an unsustainable rate thus damaging the ability for ecosystems to provide the services necessary for human existence.

In the last decade, there has been an increased interest in sustainable and environmentally friendly housing with a focus on materials used and energy efficiency. However, with increasing knowledge, amongst the general population, of climate change and other ecosystem services there is a growing need to evaluate ecosystem services as vital parts of residential planning.

It is important that developers see monetary or environmental responsibility value in ecosystem services for them to have incentive to conserve ecosystem services as a part of their planning. Economists use contingent valuation, hedonic pricing, and benefits transfer to place economic value on non-tradable ecosystem services. With values assigned, developers will clearly see benefits of conserving natural habitats and be able to use the values to increase property values. These values will also be integrated into policymaking and utilized by decision-makers.

In many cases, the policymakers do not have good information about the impact their decisions have on ecosystems. The Ecosystem services model is widely used and accepted by policymakers, industry, funding agencies, academics, and practitioners as the guiding approach to sustainability (Wensem and Maltby 2013). Policies can be made to guide or force developers to consider ecosystem services when planning a neighborhood. As other ecosystem services gain attention and concern for conservation grows in the public, policies can be created to address these in planning.

Figure 1 shows the progression from changes in the ecosystem to changes in human well-being and how we then need to assess the trade-offs being made.

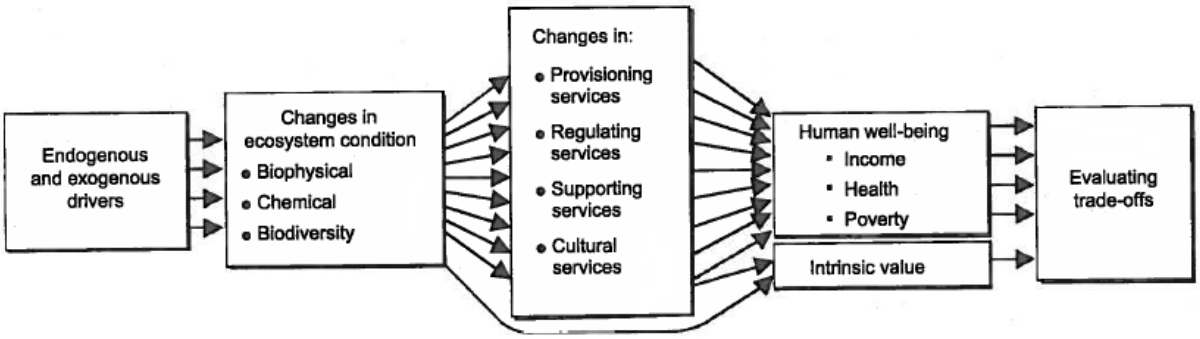

FIGURE 1 LINKING ECOSYSTEM CONDITION TO WELL-BEING (MA 2005)

Sustainable communities are necessary to significantly combat climate change and make a lasting improvement to our urban lifestyle. To create sustainable communities there needs to be stricter regulation on land-use. This is best done in cooperation with developers and community members. By utilizing the values of each actor, the regulations will be supported or at least more easily understood by all.

1.1 Research Question

The research questions are the guiding light through the entire research process. They dictate what sources are important and which research methods should be used. The questions should support the original purpose of the study.

Purpose: To identify values of ecosystem services that are important to Norwegian homebuyers and use this to assess the current regulations and make recommendations.

This study aims to answer the following questions through literature search, policy evaluation, and interviews.

- **Which valuations can motivate developers to see value in conserving natural spaces?**
- **What natural settings do homebuyers value?**
- **What policies could be implemented to support the conservation of cultural ecosystem services during suburban residential development?**

1.2 Limitations

The research presents several concepts and initiatives to give a strong foundation for which to examine policies at the local level. The research questions are examined at a project or neighborhood scale. The study aims to identify the values homebuyers in Trondheim place on having natural areas near their residence. The research is interested in cultural ecosystem services since homebuyers are more aware of these and their benefits to the neighborhood they choose to live in.

The study will not go into detail in the field of urban planning or the mathematics behind the valuation techniques. Conserving biodiversity is currently a priority issue in Trondheim, but is not considered in this study as important to homebuyers.

1.3 Case: Trondheim, Norway

Trondheim kommune is a municipality in central Norway with a population of 160,000. It has a fast growing immigrant population and two universities. Therefore, there is increasing demand for housing. The new developments can pose a threat to the ecosystem services and access to green spaces.

1.4 Questionnaire

A questionnaire was created as part of the study. It could be used to survey residents and identify their preferences for different natural environments. The information gained from this type of questionnaire is important for developers and policy makers.

1.5 Structure of Thesis

This study begins with an explanation of the research methodology and techniques used. Chapters 3 through 8 are all a part of the framework and cover other relevant studies and initiatives, the ecosystems of concern, the ecosystem services of concern, valuation techniques, values associated with nature and urban green areas, and lastly the current goals, policies, and regulations impacting development in Trondheim, kommune. The chapter describing the ecosystems is organized to discuss the topic at a global scale first and then at a local scale. The chapters following the theoretical framework summarize the interviews and explains the questionnaire created. The study closes with a presentation of the goal and policy recommendations and conclusion.

2. Methodology

This chapter begins by introducing my research model and then defining the methods used in the work. This study uses qualitative research methodology to draw connections across different disciplines. The following section will define qualitative research and specifically outline the methods used in this study: literature review, document analysis, interviews and questionnaires.

2.1 The Research Model

Figure 2 is a representation of my research process and reflects the structure of the report. The research model shows the *context*, *concepts*, *constructs*, and *application* of the thesis. The *context* defines the fields, in which the research lies. This is followed by the *concepts*, which will be used to describe the study and identify the specific interests. The *constructs* are then used to exemplify practical aspects and finally the *application* is the researcher's contribution and a culmination of the research. The research model is inspired by the *Theoretical Model* presented in the book: Business Research for Decision Making (Davis, 1996).

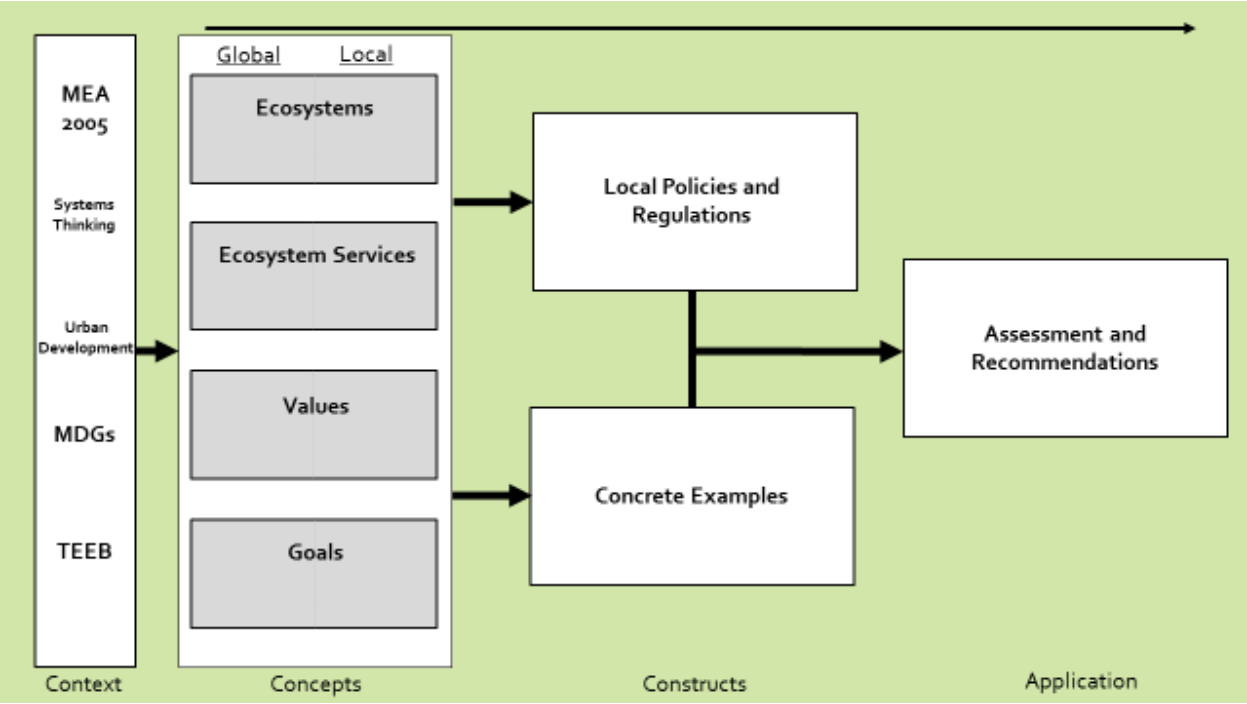

FIGURE 2 THE RESEARCH MODEL (INSPIRED BY 'THEORETICAL MODEL', DAVIS 1996)

2.2 Qualitative Research

The aim of qualitative research is to understand some aspect of society or social life by collecting descriptive data and information not numerical. The goal is to describe 'what', 'how', or 'why' something is occurring. This is an inductive research approach. It begins with observations that will create theory or insights from the research. Whereas deductive research begins with a theory and does research to test this theory.

Qualitative research is flexible and cyclical. The researcher is interpreting the data as it is collected and can formulate hypotheses during the process. This is unlike the quantitative research process that follows a linear path, where steps have a specific order.

According to figure 3 from Bryman 2008, the first and most important step in defining your research is the research question. This question will determine what methods are best suited. The second step is to choose a relevant population or location to investigate. The third step is typically a literature search and gathering of other relevant data, which gives an overview of previous studies. Step four is an interpretation of the information gathered. The fifth step is an analysis of the information and theories. This step may include the reformulation of research questions and collecting more data. The final step is writing up the findings and conclusion.

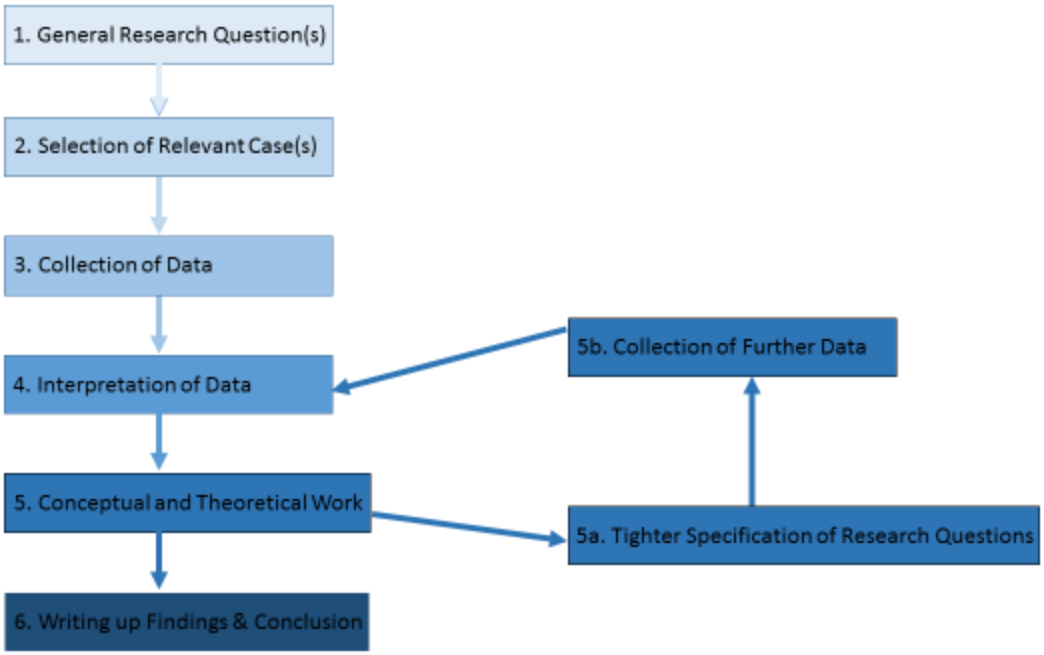

FIGURE 3 THE STEPS IN QUALITATIVE RESEARCH (BRYMAN 2008)

2.3 Quantitative Research

Quantitative research utilizes measuring techniques to derive numerical or statistical data that help to explain a phenomenon. Measurement is used to express observations as mathematical relationships. The goal is typically to gain results that can be generalized to a larger population.

This study, though mostly utilizing qualitative methods, will propose a questionnaire to gather data that would then be expressed as percentages of people preferring different natural environments, thus quantitative.

2.4 Research Question

Formulating a research question can stem from a general interest in the topic, new developments in society, social problem, research literature, or puzzling phenomena.

The research question or questions are a critical part of any study and guides the literature search and other research methods used. It keeps the researcher focused and regulates what data is important and what is not. The research question defines what the researcher is trying to find out in an explicit manner (Bryman 2008). It will not only guide the research, but also the analysis and write-up of your results.

According to Bryman research questions should:

- Not be too broad or too narrow
- Have a connection with established theory
- Be clear
- The research questions should be linked to each other
- Be researchable
- Aim to make a new contribution to the topic

(Bryman 2008)

2.5 Literature Search and Review

Literature reviews are done as the first step in any research project to build a foundation of knowledge based on previous studies done by accredited scholars and researchers. It is also important to:

- Identify which concepts and theories have been used

- What research methods have been applied

- Any controversies surrounding the topic and how it is studied

- Who the key contributors to the topic are

This study utilizes literature review to draw new connections across disciplines. For this study, the ecosystem services concept is combined with residential development and homebuyer preferences.

A professional literature search was conducted within the Scopus database using keywords and other limiting filters to locate the most relevant articles. The literature search was most useful in locating articles describing valuation studies. The two most valuable were one from Boyer & Polasky about non-market valuation studies of wetlands and one from Mansfield et al. about the value of urban forests. These were found using keywords such as 'urban', 'valuation', 'forest', and 'wetlands'. The Scopus database was also useful in finding articles about urban planning. The two most useful were from Bryant about landscape conservation at local scale and by Niemelä et al. about an ecosystem services approach to urban planning. These were found using keywords 'planning', 'urban', and 'ecosystem services'. Using these and other recent articles, allows the research to be current and the researcher to see what needs to be contributed to the field.

The literature review began with a thorough examination of the relevant sections of the Millennium Ecosystem Assessment. This examination lead to the defining of the services, which would be of highest concern. With the services chosen, the literature search was focused on valuation studies of the chosen services within the Inland water and Forest ecosystems. It was then necessary to acquire documents from Trondheim kommune that give municipal goals, policies, and guidelines

regarding the treatment of natural habitats. Several international environmental initiatives were examined as a part of the theoretical framework for the study.

2.6 Interviews and Questionnaires

Interviews and questionnaires are both useful methods of gathering data. Interviews are common in qualitative research and questionnaires can be used quantitatively or qualitatively depending on how the questions are structured. This section briefly describes both methods.

2.6.1 Interviews

Interviews are a vital part of qualitative research, as this is where empirical data is found. The interviews are loosely structured and encourage 'rambling' off topic. The goal is to attain detailed responses that express the participant's viewpoint.

There are three different types of interviews: semi-structured, in-depth, and life histories. Semi-structured is made up of open-ended questions and follows a loose guide. The in-depth interview is less structured and usually focuses on the experiences and perceptions of the respondents. Life histories is the third interview style and gives a descriptive account, a view of the wider context in which things occur, and reveals changes over time (Medecins sans Frontiers).

The respondents chosen for interviews are carefully selected with hopes that they provide the most useful data for the project. This can be determined by geographic location, vocation, or demographic variables.

All interviewees must give consent to participate without being coerced. The participants should be well-informed about the study and what their responsibilities are for participation. It is also critical in some situations that you stress the confidentiality of their identity, as some research can expose unlawful practices or put people in danger if their identity is revealed.

An interview is like a typical conversation except is has a guideline for what needs to be discussed and a certain goal for what information needs to be attained. The techniques used in interviews need to be reproducible, systematic, credible, and transparent (Medecins sans Frontiers).

Reproducible: Another researcher should be able to conduct the same interview and get similar responses

Systematic: Should be certain that we are not choosing only respondents that we are sure will support our hypothesis

Credible: The questions and the manner in which they are asked should lead to truthful responses.

Transparent: The methodology should be clearly described so that those who read the report know how the data were collected and analyzed.

2.6.2 Questionnaires

Questionnaires are a useful tool in both quantitative and qualitative research. This study will present a questionnaire to be used for quantitative evaluation.

Questionnaires are a great tool for gathering large data sets as they do not need to be conducted in person, they are cheaper and quicker to administer, and are convenient for respondents. Some of the disadvantages to the questionnaire are: the researcher cannot clarify the questions, cannot ask

an extensive amount of questions, do not know who filled out the questionnaire, cannot follow up with respondents, lower response rates, and the questions can be answered out of order.

The questionnaire developed as a part of this study is known as a self-completion questionnaire where the respondents fill out the questions independently and then submit them to the researcher. It contains closed questions since they are easier to answer and gives the researcher the ability to quantitatively describe the results. Using an easy to follow design avoids accidently missed questions. The questionnaire is brief so that the respondents do not get bored before completing it.

2.6.3 Sampling

There are three main types of sampling; theoretical, generic purposive, and snowball sampling.

1. Theoretical Sampling allows the researcher to discover categories and their properties. It is an ongoing process of collecting and analyzing data and developing theory. This process continues until *theoretical saturation* occurs. This occurs when the researcher finds no new data and all of the concepts in the theory are well-developed.

2. Generic Purposive Sampling is when the researcher selects which individuals are most relevant for the research question. The sample size is also determined by the researcher's criteria.

3. Snowball Sampling is a technique used when it is difficult to predetermine the number of participants available that fit the research question. Initially contact is made with a small number of people who then refer you to others they know who fit the criteria. The sample grows organically through networks.

2.7 Reliability and Validity

This section discusses the role of reliability and validity in qualitative research.

2.7.1 Reliability

Reliability is concerned with whether or not the study could be repeated and get similar results. It is a major concern in quantitative research because if your calculations are not consistent then your results are not valid. LeCompte and Goetz described the following two types of reliability in qualitative research: external and internal reliability. External reliability is difficult to attain in qualitative studies since the social setting is constantly changing. Internal reliability is to what extent do researchers on a team agree with each other about what they observe.

2.7.2 Validity

Validity is expressed as the integrity of the results from a research study. Bryman discusses four main types of validity as: measurement, internal, external, and ecological validity. Measurement validity is concerned with whether a measure used is appropriate for the concept it is trying to demonstrate. If the measure is unreliable then the study loses its validity. Internal validity is concerned with causality and whether results showing a causal relationship are credible or not. External validity is whether or not the results of a study can be generalized to other contexts. Ecological validity is concerned with whether findings within social science are really true to the natural social settings of people. The research should be an actual representation of the real-world situation.

3. Theoretical Framework

The theoretical framework chapter provides a context for the study. It starts by describing several international studies that have been done since 2000 as well as a Norwegian study completed in 2013. These are presented chronologically as the following; Millennium Ecosystem Assessment (MEA), The Economics of Ecosystems and Biodiversity (TEEB), Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), The Norwegian Valuation of Ecosystem Services, Global Environment Outlook (GEO), and the Climate Change Report 2014. These studies are supported by the following initiatives and concepts: the Millennium Development Goals (MDGs), ISO 14000, systems theory, industrial ecology, and urban development. After each is described, a diagram is presented showing which of these concepts will be applied to the case study.

3.1 Previous Studies

Previous studies are important to examine as they contain much of the data and information necessary for policymakers to make the best decisions for their communities. Since urban residential planning and policy is a multifaceted concept, it is necessary to build a foundation for the study that also considers the perspectives of several actors.

3.1.1 Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MEA) is an international assessment that was taken over four years, comprised of the knowledge of 1,360 social and natural scientists from around the world (MA 2005a). The study provides a report on the conditions of various ecosystems worldwide and the services they provide that promote human well-being.

The UN secretary general, Kofi Annan in 2000, ordered that the Millennium Ecosystem Assessment (MEA) was necessary. The study began in 2001 with the aim of understanding the impact that ecosystem change has on human well-being and to give supporting scientific data for conservation and sustainable management of ecosystem services (MA 2005a). The document is the combined work of 1,360 experts in the social and natural sciences from 95 countries around the world. The synthesis was based on existing information and not new empirical research. These findings revealed which had broad consensus and where there was need for more data. The study took 4 years and had a budget of 24 million US dollars funded by several foundations, organizations, and governments.

The study describes and categorizes ecosystem services, identifies valuation methods, summarizes the supply and demand of such services, and assesses the current and future state of these provisions. The four main conclusions of the MEA were: the Earth's ecosystems have been changed more rapidly during the second half of the 20th century than ever before, which has resulted in irreversible loss of diversity; the changes to ecosystems have attributed significant gains to the human well-being and economy, but at the cost of degraded ecosystem services that will not be available to future generations; the rate of degradation is a barrier to reaching the Millennium Development Goals; and in order to reverse the degradation of ecosystems, significant changes must be made in policies and practices.

Figure 4 shows the structure of the MEA going from ecosystem services to constituents of well-being.

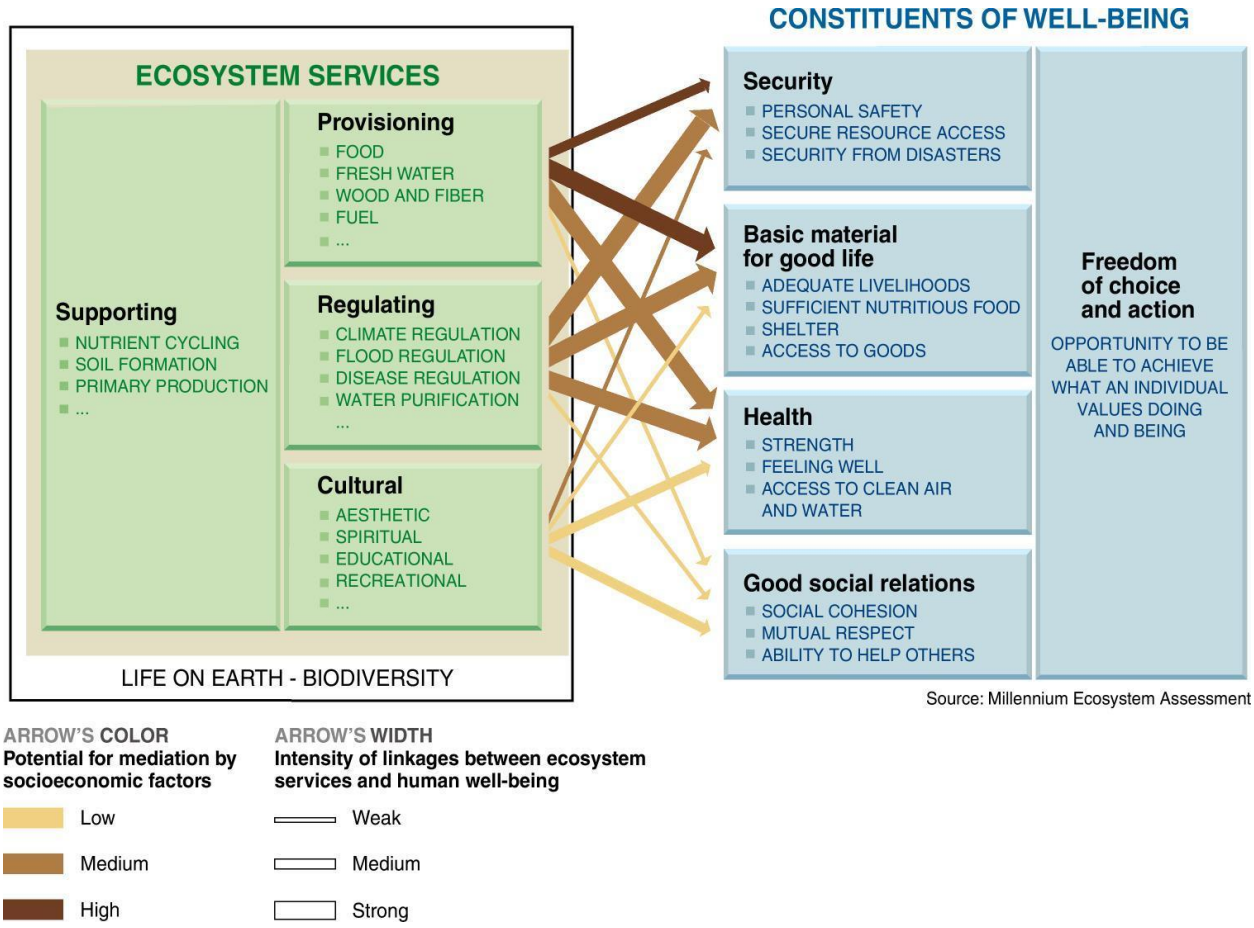

FIGURE 4 STRUCTURE OF THE MEA (MA 2005)

Following the MEA there was a need to address the economic benefits and impacts related to ecosystem services and biodiversity. This spurred the economics of ecosystems and biodiversity study.

3.1.2 The Economics of Ecosystems and Biodiversity (TEEB)

The TEEB study focused on the economic benefits of ecosystem services and the impacts that business has on ecosystem services and biodiversity (TEEB 2010). This study reclassified the supporting services as being habitat services. This stresses how important ecosystems are as habitat and how these services are independent and deliver benefits as opposed to being a part of the process that delivers services (Dunbar et al. 2013). Utilizing the TEEB allows decision makers to consider the costs and benefits of different policy options to enhance well-being and economic stability.

TEEB presents an approach to utilizing ecosystem services in decision making and planning. The questions to be answered while planning and the steps to answer them are presented below.

Questions to answer during the planning process

1. What does nature provide us at the local level?
2. How valuable is this?
3. How do we evaluate these Ecosystem Services or value them in monetary terms?
4. Who is affected by changes in services?

5. How might those affected by these changes alter their behavior?

Steps taken to answer those questions

Step 1: Specify and agree on the problem

Step 2: Identify which ecosystem services are relevant

Step 3: Define information needs and select the appropriate methods

Step 4: Assess the expected changes in the ecosystem services

Step 5: Identify and assess policy options

Step 6: Assess distributional impacts of policy options

With the economic concerns addressed, the next international initiative could focus on the policy implications so the Intergovernmental Platform on Biodiversity and Ecosystem Services was established.

3.1.3 Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)

The need for an intergovernmental organization such as this was first discussed in 2007 after a meeting for the International Mechanism of Scientific Expertise on Biodiversity (IPBES). After three subsequent meetings in 2008, 2009, and 2010 the organization was established as IPBES. After two plenary meetings, the institutional arrangements were finalized by the 94 participating nations.

The IPBES was established in 2012 to provide the necessary scientific information to policymakers and to identify tools and methods to support policy implementation (Wensem and Maltby 2013). Membership is available to all countries of the United Nations. As of March 2014 there were 118 member countries. The IPBES is supported by these countries to be the leading intergovernmental organization to assess the biodiversity and ecosystems of the planet. Both the scientific and the policy communities approve the mechanism used to evaluate the information from academia, governments, scientific organizations, and indigenous communities worldwide. The goal is that decisions are made using the most current scientific information available.

3.1.4 Norwegian Valuation of Ecosystem Services

In the fall of 2013, the Norwegian ministry of Climate and Environment published the Norwegian Valuation of Ecosystem Services. Experts were contracted to do the research and report the results to the government. It was necessary to adequately identify the status of the ecosystems and how humans affect them. The valuation began with a review of the existing knowledge and statistics about Norwegian ecosystems and ecosystem services. The study discusses the ecosystems of importance in Norway (sea and coastal area, freshwater, wetland, forest, mountain, and arctic). This study found that the industries of agriculture, forestry, and hydropower have the largest impact on the freshwater and forest ecosystems and their service quality, while the greatest impact on wetlands comes from development of roads, sports facilities, and construction.

The study concluded that the ecosystems of Norway are in a relatively good state, but the biodiversity and ecosystems are subject to pressure from many sides. It is important to establish monitoring of ecosystem services that are not yet being monitored. There is a need to strengthen the knowledge and be active in research in Norway about the biodiversity, ecosystem functions, and ecosystem services. It is also vital to increase the visibility of the values of ecosystems for

better management. This is just some of main conclusions from the study, which includes many other recommendations.

3.1.5 Global Environment Outlook (GEO)

The GEO report is created by the United Nations Environment Program (UNEP) and is an assessment of the state of the environment. The GEO project started because of requirements brought about by the UN agenda 21 and a decision made by the UNEP governing council in 1995. The assessment is done by a global network of collaborating centers, which undergo a peer review process and are supported by an advisory group that provides guidance on policy and scientific issues. The goal of these reports is to give a scientifically credible assessment that is relevant to policy makers and can support environmental management (UNEP n.d.). The report also strives to facilitate regional cooperation to prioritize environmental issues.

The most recent report, GEO5, was published in 2012. This report is made up of three parts. The first is an assessment of the environment in relation to the Millennium Development Goals (MDGs). This assessment reveals the gaps that still exist and hinder the achievement of stated goals. The second part looks at each region and prioritizes the environmental issues of each region. This review identifies appropriate policy responses to guide the region towards achieving the internationally set goals. This part also uses case studies to illustrate the previous successes and issues related to implementing policies within the region. The third part identifies actions to be taken to attain sustainable development and achieve international goals (UNEP 2012).

3.1.6 Climate Change Report 2014

The Climate Change Report is published by the Intergovernmental Panel on Climate Change (IPCC). The IPCC was established by UNEP and the World Meteorological Organization (WMO) in 1988 to give the world a clear picture of the state of climate change and the potential impacts. The IPCC is an intergovernmental association that is open to membership by all the UN countries. It currently has 195 members (IPCC.ch). The IPCC does not do research of their own, they only collect and assess current scientific, socio-economic, and technical information. Thousands of scientists worldwide make voluntary contributions to the work of IPCC and the creation of the reports.

This report assesses the needs, options, and limits to adaptation to these changes. This is useful in seeing how land-use change is affecting climate change. It states that humans are having an impact on the climate system and the changes in the climate threaten the human and natural systems. Studies show that climate change more often has a negative impact on crop yields. The report describes these as well as other findings related to climate change. It also presents a series of charts and diagrams to support their conclusions.

3.2 Concepts and Initiatives

As previous studies alone are not enough to build a complete foundation for the study. It is necessary to present concepts and initiatives that further develop the background for the research.

3.2.1 Millennium Development Goals

The millennium development goals (MDGs) were established in 2000 by the UN with the focus on eradicating poverty and improving the health of people in developing nations. All of the UN members of the time agreed upon the goals. They established the following eight goals to reach by 2015.

1) Eradicate extreme poverty and hunger

2) Achieve universal primary education

3) Promote gender equality and empower women

4) Reduce child mortality

5) Improve maternal health

6) Combat HIV/AIDS, malaria and other diseases

7) Ensure environmental sustainability

8) Global partnership for development

These goals are quite broad and somewhat vague. Therefore, since goal 7 is relevant to this study it will be discussed in detail later in chapter 8.

Tremendous efforts have been made to reach these goals, but there is still much to be done. Therefore, the UN is collaborating with governments and others to make a plan for the future, post-2015 goals (UN.org). Griggs et al. suggests some new goals called the 'Sustainable Development Goals', which are presented in chapter 8. The establishment of the MDGs spurred further initiatives.

3.2.2 ISO 14000

ISO 14000 describes the standards for environmental management and provides cost-effective, flexible, and system based tools necessary for companies and organizations to identify their environmental impact and implement changes to improve environmental performance. ISO 14001 focuses on environmental management systems (EMS) whereas other standards include life cycle analysis, auditing, and communication.

Trondheim kommune is ISO 14001 certified, meaning that their EMS meets the requirements set by the ISO standards. The certification is not based on environmental performance, but on how the organization has built their management system (ISO.org). Therefore, any company or organization can acquire certification regardless of the industry or activities. The EMS is a part of the total management system of a company and includes structure, responsibilities, procedures, resources, and processes for achieving environmental policy (ISO.org).

Companies decide to become certified for several reasons some of which are: requirements for a contract or regulation, customer pressure, or to motivate staff by having set goals for the management system. Using ISO 14001 can help companies to reduce their waste management and distribution costs, save on energy and materials, as well as improve their image to customers and the public. Gaining certification is an effective way to promote a company's environmental goals.

ISO 14001 uses a perspective from systems theory, which is ideal when examining environmental management systems and environmental policy.

3.2.3 Systems Theory

Systems theory was developed as a common theory to understanding various systems by assessing their characteristics, behaviors, and relationship with their environment. The main pioneers of the theory were Ludwig von Bertalanffy, Ken Boulding, Jay Forrester, and Ervin Laszlo (Brattebø &Kjelstrup 2011). Bertalanffy, a biologist, is best known for his contribution of the theory of the

open system. Boulding made his contribution through his work with economic systems. Jay Forrester is known as the founder of system dynamics. Ervin Laszlo is a researcher in the theory of evolution and systems theorist.

A system is composed of elements working together for a common purpose. Each element must be important to the achievement of the purpose to be considered part of the system. Systems will always have behaviors that cannot be realized by a single element (Brattebø &Kjelstrup 2011). Every system has a structure and an organization. The structure is the physical location of the elements and the organization is how the elements connect to each other. The structure of a system can change without losing the organization.

In 1998 Krieger developed a set of characteristics for all systems:

- Every system has a principle of organization that fulfils three functions: selection, relationing, and control

- Every system is based upon a difference between itself and its environment, that is, the system/environment difference is constitutive for all elements

- Every system constructs its own elements

-Every system is in one way or another self-referential, that is, it refers its operations to itself.

3.2.4 Industrial Ecology

Industrial ecology is an interdisciplinary field addressing sustainability issues by using a life cycle orientation to examine consumption systems (Brattebø et. al. 2011). The life cycle orientation includes all processes from extraction to end-of-life or recycling. This includes the extraction of resources, production, manufacturing, consumption, transportation, disposal, and recycling phases of a product. The product in this study is the ecosystem services and addresses the consequences of destruction, (disposal) and how to mitigate this.

Industrial Ecology is also heavily rooted in systems thinking is utilized to understand complex relationships, causes, and effects between a system and its environment and within the system. Systems are examined as a whole; a typical analysis looks to measure inputs and outputs of the system. This allows for identification of the magnitudes of the interactions and revels not so obvious relationships within the system. This analysis is useful in identifying feedbacks and inefficiencies within the system.

An equation was developed to represent the environmental impact of society based on population, affluence, and technology. It is known as the IPAT formula.

$$I = P * A * T$$

I: Environmental Impact

P: Population

A: Affluence

T: Technology (impact per unit of GDP)

This equation is relevant to this case study because Norway is a highly affluent country and it is well known that affluent countries have a greater impact on the environment. This equation can allow people to see how important it is for wealthy countries to take aggressive steps towards

reducing their environmental impact. This study considers how urban development can be instrumental in accomplishing more sustainable cities.

3.2.5 Urban Development

Urban development is the process of regulating land use and design of urban spaces. This process utilizes the input of policymakers, planners, community members, and politicians. This cooperative process is necessary for the orderly development of cities.

Historically urban areas have developed in regions rich in natural resources, fertile soil, and favorable climate. With the population becoming increasingly urban these services and ecosystems are under threat. The services sought out by urban dwellers have changed and people are now interested in aesthetics, recreation, and education more than before. These become more important the higher the income of the household (Tobias 2013).The shift in the economic drivers has changed our concern for natural resources near urban areas. Today the knowledge based economy lives in urban centers that are primarily consumers and the producers are in rural areas.

Young adults tend to live in city centers close to transportation, jobs, and cultural and educational services. Families typically establish themselves in the suburbs where housing is less expensive, lots are larger, and neighborhoods tend to be safer. The aging population has a tendency to move back to the city to be close to public transport and medical services.

3.3 Summary

Of all the material presented in this chapter the most necessary topics will be used further to examine the goals, policies, and regulations of Trondheim kommune. These necessary topics are presented in the following diagram.

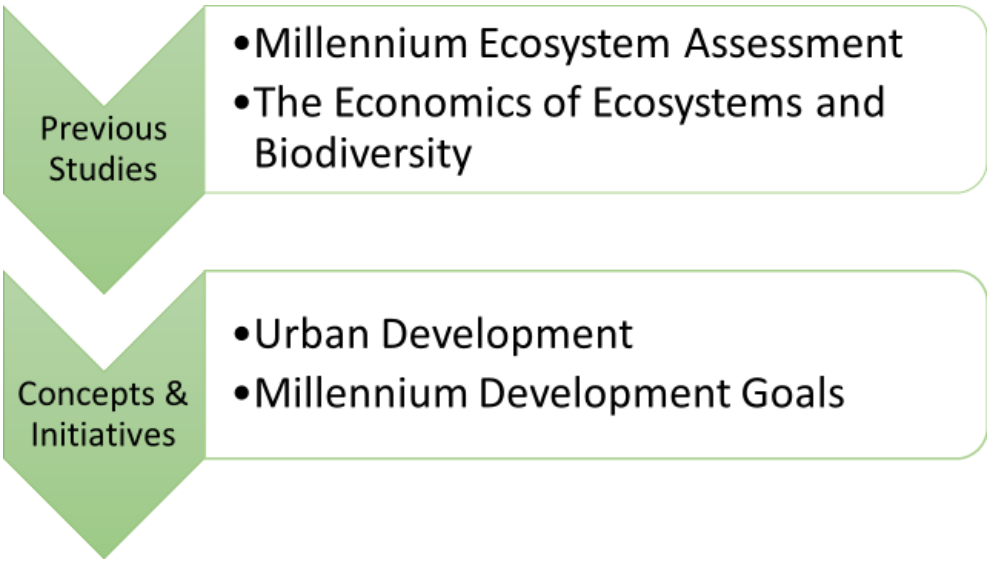

FIGURE 5 CONCEPTS USED FOR ANALYSIS

The MDGs are included as an important part of this study because they have led to the development of the new sustainable development goals (SDGs) that will be implemented in 2015 until 2030. Trondheim's goals and policies are reflective of the SDGs, these connections are discussed in chapter 11.

4. Ecosystems

> *"The Earth's ecosystems have developed and operated through millions of years slowly modifying the environment, adjusting to the change, and continuing to recycle the components of the system. These ecosystems have made this planet livable for man." (Reimold et al. 1980)*

An ecosystem is a group of organisms (plants and animals) living in the same area and interacting with their immediate environment and with each other. Solar energy is the driving force of ecosystems and sustains the many cycles taking place. Such as photosynthesis which is responsible for converting the sun's energy and the water cycle.

This chapter will discuss the forest ecosystem and the inland water ecosystems as defined by the MEA at a global scale and using other sources to define the local (Norwegian) scale. Since this study is concerned with the meeting of ecosystems with the urban area, the urban ecosystem will also be defined as determined by the MEA.

4.1 Forest

A forest is defined as having greater than 10% cover by tree canopies (FAO 2000). This includes natural forests and planted ones, but excludes trees planted for agricultural purposes. Forests are habitat to organisms and manage water flow. Forests provide several goods and services to humans as well, such as: climate change mitigation, water purification, protecting biodiversity, recreational opportunities, timber, educational, aesthetic, soil and water protection, hunting, ecotourism, non-wood forest products, and improvement of urban living conditions (MA 2005). This section describes the size of the forest at the global and local scale.

4.1.1 Global

8,000 years ago there were 6.2 billion hectares of forest covering the Earth (MA 2005). In 2000 the estimate by the Global Forest Resources Assessment (GFRA) was at 3,869 million hectares or 30% of the global land area (GFRA 2000). The 2005 ratio of hectares per capita was 0.6 and is expected to reach 0.4 hectares per capita by 2025 (Gardner-Outlaw and Engelman 1999). Table 1 shows the estimates of forest area by region in 2000.

TABLE 1 FOREST AREA BY REGION (FAO 2001)

Forest Area by Region in 2000			
Region	**Land Area**	**Natural Forests**	**Forest Coverage**
	(million hectares)		(percent)
Africa	2,978	642	22
Asia	4,362	1,105	28
Europe	983	334	37
North and Central America	2,137	532	26
Oceania	849	194	23
South America	1,755	875	51
World Total	**13,064**	**3,682**	**30**

4.1.2 Local

In Norway the forest covers 39% of the total land area (Gundersen 2005). Only 1-4% of this is considered urban forest. According to Gundersen, in Norway nearly 100% of all urban woodlands are managed forests. These forests are dominated by three tree species, the Norwegian spruce, Scots pine, and Birch.

Trondheim has two important urban forests, Bymarka (80km^2) and Estenstadmarka (30km^2). Bymarka is to the west and Estenstadmarka to the east. Estenstadmarka connects to several other forests whereas, Bymarka is more isolated as it is on a large peninsula and has been nearly completely cut off by urbanization. Both forests border residential areas and are heavily used by the city's inhabitants.

4.2 Inland Water

Inland water systems as defined by the Millennium Ecosystem Assessment, include lakes, rivers, marshes, swamps, peat lands, floodplains, ponds, small streams, and cave waters. The systems can contain fresh, saline, or brackish waters. Inland waters provide regulating, supporting, and cultural services that are important in the residential construction industry. Inland water ecosystems provide the following goods and services: erosion control, climate regulation, natural hazard mitigation, spiritual, recreational, aesthetic, educational, pollination, fish, genetic materials, pollution control, soil formation, nutrient cycling, and biodiversity.

4.2.1 Global

These waters are lost and degraded at a rate that has resulted in 50% losses of inland water ecosystems during the 20th century (MA 2005). The global estimates of global wetland areas range from 530 to 1280 million hectares; the variation is determined by the different definitions of wetlands. Table 2 displays the estimates by continent of the global inland wetland area.

TABLE 2 ESTIMATED INLAND WETLAND AREA (FINLAYSON ET AL. 1999 & LEHNER AND DÖLL 2004)

Estimates of Inland Wetland Area		
Region	1999 Global Review of Wetland Resources	2004 Global Lakes and Wetlands Database
	(million hectares)	
Africa	121-125	131
Asia	204	286
Europe	258	26
Neotropics	415	159
North America	242	287
Oceania	36	28
World Total	**1,280**	**917**

4.2.2 Local

Norway has 19,620 km^2 of freshwater surface area (NOU 2013). Trondheim kommune contains several lakes, streams and rivers. The major ones are: Jonsvatnet, Kyvatnet, Skjellbreia, Lianvatnet, Fredlybekken, Stokkbekken, Uglabekken, Ilabekken and Nidelva.

4.3 The Urban Ecosystem

The urban system is defined by a collection of human habitats and infrastructure facilitating the activities of residents. The urban system is dominated by humans, but also contains a variety of other species and ecosystems. Approximately half of the world's population lives within an urban system (MA 2005). This is a staggering number since urban areas only account for 2% of the Earth's land surface (Bryant 2006).

The urban system has a tremendous effect on human health and therefore the health of the community must be considered when planning. The following factors have been found to affect the physical health and psychological well-being of residents, density of neighborhoods, height and size of residential structures, presence and size of parks or natural areas, food store location, land-use mix, and how roads are laid out (Wells et al. 2010). The urban ecosystem can negatively affect residents in several ways, depression, headaches, eyestrain, respiratory problems, car accidents, communicable diseases, stress, anxiety, injuries, and cancer (Butterworth 2000).

> *"A feature often overlooked in everyday discussions of health and community affairs, perhaps because it forms the setting and backdrop by which we live our lives, is the impact of the physical and built environment on our senses, our emotions, our sense of community, participation in community life, and general wellbeing." (Butterworth 2000)*

The ability for urban ecosystems to provide services is dependent on green spaces (Wensem and Maltby 2013). These green spaces are constantly under threat and the EU has made a goal of no net loss of green spaces by 2050 (Wensem and Maltby 2013). This means that for each hectare of green space lost there has to the equivalent amount protected.

5. Ecosystem Services

Ecosystem services are the various ecosystem provisions that are useful to humans (Kremen 2005). Ecosystem services provide a long-term stream of benefits to people. The MEA classified them as provisioning, regulating, supporting, and cultural services. Provisioning services are material benefits such as natural resources, food, water, timber etc.. Regulating services regulate air quality, climate, biochemical cycles, soil processes, and hydrological cycles. Cultural services are non-material benefits such as health benefits, recreation and education. Some of which, enhance our lives (recreation, aesthetics, cultural) and others are critical for our existence (pollination, air purification, climate regulation, disease regulation). Cultural services cannot be replaced by technology (Weyland and Laterra 2014). Ecosystem services allow for adequate representation of the value to humans and society of all the functions performed by the natural environment (Schmidt et al. 2014). Loss of any of these services will have a substantial impact on human well-being.

This chapter will discuss the role forest and inland water ecosystems play in climate mitigation and the provision of recreational, aesthetic, and educational ecosystem services.

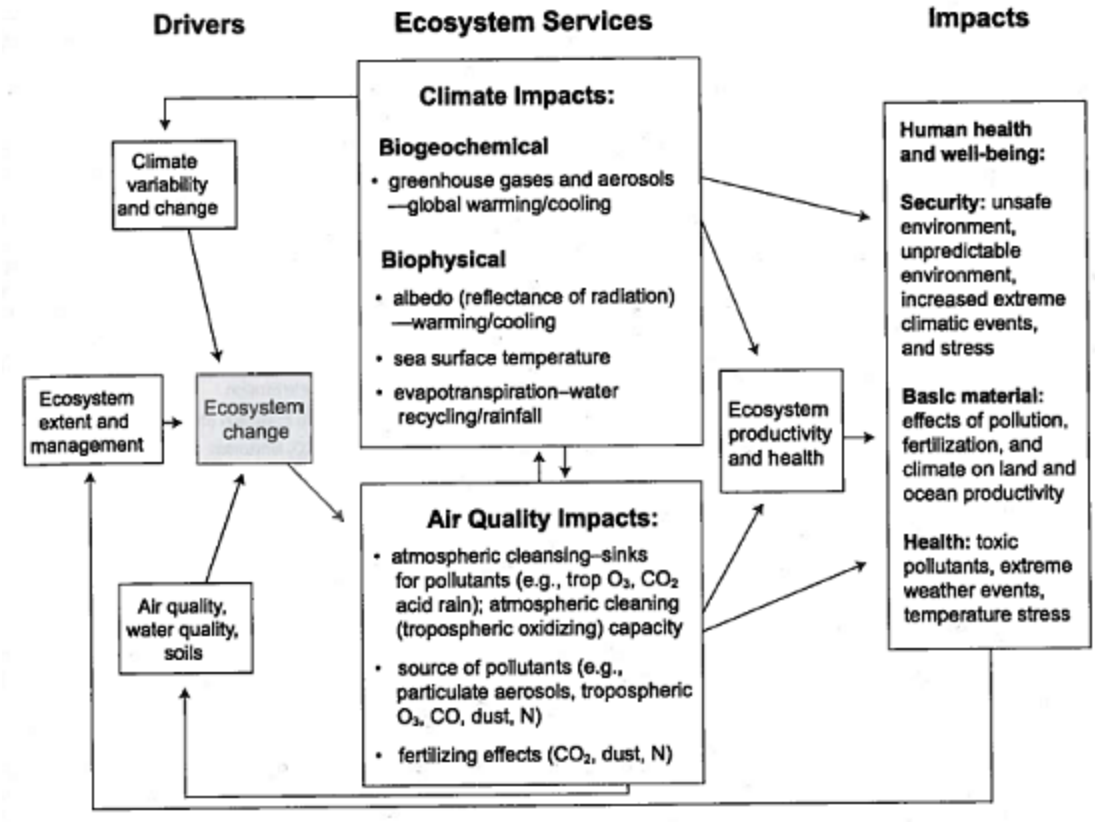

FIGURE 6 ECOSYSTEM IMPACTS ON CLIMATE AND AIR QUALITY (MA 2005)

5.1 Climate Change Mitigation

Climate change mitigation is actions that reduce climate change and slow it down over time. The Earth's ecosystems have a natural ability to mitigate climate change and by destroying nature, we are reducing the Earth's capacity to combat climate change. Figure 6 displays how ecosystem

change is connected to impacts on climate change and human well-being. This section describes how forests and inland water ecosystem contribute to climate change mitigation.

5.1.1 Forests

Forests play a major role is the regulation of the world's climates. Deforestation is a main driver of radiative forcing, therefore the fewer forests that are destroyed the lower the impact is on climate change. Forest fragmentation is the cause of increased large tree deaths, decomposition, and fire (Nascimento and Laurance 2004).Deforestation in tropical regions will have an effect on climate change through the decrease of evapotranspiration (Sellers 1996). Plants capture atmospheric CO_2 and convert it into carbohydrates, leading forests to play a major role in the accumulation and long-term sequestration of carbon (MA 2005). Forests discharge carbon into the atmosphere when they are disturbed. It is estimated that the forests contain 352-536 billion tons of carbon (Dixon et al. 1994; Houghton 1996; Brown 1998 Saugier et al. 2001). More than two-thirds of this is contained in the soil and peat (Dxion et. al. 1994). Forest canopies are able to trap radiation and reduce the albedo (MA 2005). As referenced in the MEA, the Kyoto Protocol has led to carbon sequestration being considered a vital ecosystem service for climate change mitigation. The efforts to reduce ecosystem change and loss will only show a significant affect in the short-term (Prentice et al. 2001).

5.1.2 Inland Water

Inland water systems have two ways in which they help to mitigate climate change, these are: regulating greenhouse gas emissions and physically buffering the impacts of climate change (MA 2005). They act as carbon sinks and sources of carbon dioxide. Boreal peat lands are responsible for the majority of these services and are estimated to contain 540 gigatons of carbon (Immirizy and Maltby 1992). The destruction of peat lands is detrimental to the carbon sequestration service they provide.

5.2 Recreational

Recreation is known to be a vital contributor to the health and well-being of humans. Easily accessible and high quality recreational ecosystem services are an important factor for the quality of living and public health (Niemelä et al. 2010). This section will describe the recreational services provided by forest and inland water ecosystems.

Since this study is concerned with the recreational opportunities available in neighborhoods, it is important to note that a Finnish study sited that primary school children typically only play within 300m from their home. If recreation areas are more than 1km from home, people tend to travel there by car (Neuvonen and Sievänen 2008, *(in Finnish, not read by me)*). Thus increasing the carbon contribution of those residents.

5.2.1 Forest

Forests provide opportunities for camping, hunting, photography, picking mushrooms and berries, wildlife viewing, horseback riding, biking and walking. Urban forests are used more heavily and therefore face challenges in sustainable management. Mature trees can motivate outdoor activity and give heat-reducing shade on hot summer days (Farr 2008). Forests provide a community gathering place where they can build connections and share experiences (Laband 2013). Outdoor activity and walking can reduce brain deterioration brought on by aging (McElroy 2006).

5.2.2 Inland Water

Many inland water areas are protected as National Parks, World Heritage Sites, or wetland conservations. These areas generate income from recreational and tourism uses such as fishing, boating, swimming, and paddling.

5.3 Aesthetic

Aesthetic ecosystem services are those given by merely seeing or having contact with the ecosystem. These are things just involving our senses, hearing birds chirping, the smell of the ocean, a beautiful landscape, or the feeling of grass between our toes. Forests promote an active lifestyle and can support a sense of community and enhance social connections (Wells et al. 2010). Inland waters can stimulate our senses and inspire creativity, which has been seen through the works of painters, writers, and musicians for centuries (Reimold et al. 1980).

5.4 Educational

Many wetlands and forest areas have an education center for the public and schoolchildren to be educated about the ecosystems, their habitats and biodiversity issues. Scientists and researchers use the area for studies in botany, natural history, environmental metabolism, and ornithology (the study of birds). This education is important for the citizens to have a concern for the conservation of ecosystems.

6. Valuation Methods

Ecosystem service valuation is an assessment of the contributions made to human welfare and the potential value of these for the economy (Liu et al. 2010). Non-market valuation of the natural environment is necessary for inclusion in the decision-making process. Sometimes if there is no monetary value estimated then the environment is treated as though it has zero value (Boyer and Polasky 2004). To value ecosystem goods and services they must first be identified, then quantified, and a metric must be determined to value these goods and services (Boyer and Polasky 2004).

The valuation methods most commonly used to value ecosystem services are contingent valuation and hedonic pricing. The first is based on willingness to pay and the second depends on data regarding market behavior for a related good (Hougner et al. 2006).

There are some objections to these types of valuation methods. One objection is that it is based solely on anthropogenic values and does not consider the values and needs of other species. The second objection is that valuation of the ecosystems in monetary terms reveals the moral downfall of capitalism and its focus on commoditization.

This chapter briefly describes the valuation methods: total economic value, contingent valuation, choice modelling, hedonic pricing, and benefit transfer.

6.1 Total Economic Value

Total Economic value uses two sources of value: 'use values' and 'non-use values'. Use values include consumptive (resource extraction, logging etc.) and non-consumptive (recreation, education…). Non-use values are derived without interacting with the environment. These are simply being satisfied by the existence of an ecosystem or species (eg. aesthetics, climate mitigation).

Use values are the main concern for suburban development. These are ecosystem services used directly by humans. They include food, timber, hunting of animals, medicinal plants, and cultural, recreational, other uses that don't require harvesting. The people living in the ecosystem typically are the ones utilizing these services (Pearce 1993).

6.2 Contingent Valuation

Contingent valuation is an economic technique that has been in use since the 60s' and is used to place value on non-market resources by the use of surveys. This valuation is of the stated preference model and may produce an annual willingness to pay (WTP) values based on survey responses stating preferences in hypothetical situations. Respondents are typically asked if they would be willing to pay for a specific environmental service. By varying the amount of the payment, a demand curve can be derived for the specific service and an estimate of the WTP of the respondents. It can be used to estimate use and non-use values of services and is not correlated to the location of the respondent and the resource (Brander and Koetse 2011), is greatly dependent on the socioeconomic conditions of the respondents. This is a great advantage of the method because non-use values can be significant. An issue is that since the situations are hypothetical,

respondents might say they are willing to pay more than they actually would if they had to make an actual decision (Boyer and Koetse 2011).

A typical stated preference analysis uses surveys, but instead of asking willingness to pay, they ask for preferences between different sets of attributes (Boyer and Koetse 2011). This method avoids forcing people to make the decision between money and the environment while still gaining valuable insight into the preferences of the respondents. The questionnaire developed during this study is a stated preference survey that does not include willingness-to-pay.

6.2.1 Steps in Conducting a Contingent Valuation

The following steps describe the procedure of creating a questionnaire for a contingent valuation study.

1. Creating a questionnaire

The questionnaire starts with a brief description of the purpose of the study and an assurance that the answers are confidential and anonymous. The first few questions will focus on the good or service under study. There may be questions to identify environmental problems. This builds a context by which to frame the responses for the rest of the questions.

The next section of the questionnaire will describe the environmental problem of concern. This is done by either description, photo, or map. The description is described in terms easily understood by the respondents. Following this will be a description of a proposed project that will benefit the environment or prevent further damage. The next assessment is the WTP or willingness to accept (WTA). The hypothetical payment type is described and the respondent is asked about their WTP. All household in the area of interest must be obligated to the payment. The WTA defines compensation given to the population in the area for the changes taking place in their local environment.

The last section of the questionnaire asks general questions about the respondent such as age, gender, household income, education and other potentially relevant information. It is necessary to be clear about your definition of household income.

After each questionnaire is completed, the respondent should be debriefed to determine if they understood the questions and took their answers seriously.

The questionnaires take considerable effort to design and are typically tested with a focus group before final implementation. The survey should cover 200 to 1000 respondents depending on the area of interest.

2. Choosing a survey technique

The questionnaire can be distributed via mail, face-to-face interview, internet, or telephone. Face-to-face interviews are very expensive, but have several advantages: a high response rate, control of who the respondent is, and the ability to be conducted at the site of interest. Mail surveys have a low response rate and the number of questions is limited. In addition, you will typically only get responses from those with strong feelings about their environment. Telephone surveys are the cheapest, but limit the information that can be gained.

3. Identifying the population sample

The population that is to be affected by the change in an ecosystem service is to be determined by the researchers. The population is typically determined as the users of the good or service, defined by the political boundaries, or a radius from the site of interest.

4. Analyzing the responses

Once the survey is complete, the results need to be analyzed. This starts with the mean and median WTP. When doing this it is necessary to exclude outliers and other problematic responses. There are two methods to analyzing the data, Random Utility Model and Random Expenditure Function. An explanation of these can be found in Hanemann (1999).

5. Aggregating the responses

Assuming that the respondents are all a part of your target population then you take the number of respondents and multiply it by the average WTP.

6. Evaluating the success of the valuation study

Validating the results of a CV study is done by weighing various kinds of evidence. CV are usually reliable because of their replicability. Meaning that if you give the survey again to the same or similar respondents then you should get nearly the same results.

6.3 Choice Modelling

Choice modelling is used to gain insight into the decision process of respondents within a given context. These models use the stated preference method to predict how individuals or groups will react in a particular situation. Choice modelling is a widely used and trusted method that can be used to estimate the environmental benefits and costs of non-market ecosystem services. One of the major contributors, Daniel McFadden won the Nobel Prize in Economics for his contributions.

6.4 Hedonic Pricing

Hedonic pricing estimates are one-time percentage changes in property values based on actual behavior. This method is applied to capture the value of services that are somehow dependent on a market-traded good or service (Brander and Koetse 2011). This technique is based in the revealed preference model, which can only estimate use value.

First step is to collect information on home sales in the area of interest. In this study a residential property is considered a good made up of many characteristics. Each of these characteristics contributes to the sale price of the house. One characteristic is the environmental attributes of the property and the open space provided in the neighborhood (Geoghegan 2001). Other characteristics of concern would be, quality of construction, distance to shopping and schools, neighborhood characteristics, and accessibility. The valuation uses data on the market sales prices of houses along with their corresponding features to estimate the change in property value due to the change in a feature affecting the sale price (Boyer and Polasky 2004).

Hedonic pricing studies have found correlation between home price and proximity to open spaces, recreational areas, and aesthetically pleasing natural areas. Studies have documented that homebuyers are willing to pay up 24% more for a lot facing a park or natural area (Miller 2007).

6.5 Benefit Transfer

Benefit transfer is the process of estimating the value of an ecosystem by applying the estimated values of another similar ecosystem whose values were previously determined (Zhang et al. 2013). The method has become increasingly popular because it is a timely and cost-effective method of valuing ecosystem services (Wilson and Hoehn 2006). This methodology can provide policy makers with consistency in the decision-making.

The two methods for transferring the values are: direct unit value transfer, which involves utilizing the average unit value of a similar site and the second method is the adjusted unit value transfer, which includes making simple adjustments to the unit value of a similar to account for the characteristics of the site of interest (Zhang et al. 2013).

Benefit transfers are sometimes conducted using Geographical Information Systems (GIS). This technique consists of overlaying one data layer with another. This technique allows management and other actors to visualize the change in ecosystem services of the area and issue of significance to them (Liu et al. 2010).

The following table is a summary according to the MEA of the valuation techniques previously described.

TABLE 3 SUMMARY OF VALUATION TECHNIQUES (ADAPTED FROM MA 2005:56)

Summary of Valuation Techniques				
Methodology	**Approach**	**Applications**	**Data Requirements**	**Limitations**
Revealed Preference Method				
Hedonic Pricing	extract effect of environmental factors on price of goods that include those factors	aesthetic and cultural benefits	price and characteristics of goods	requires a large amount of data, very sensitive to specification
Stated Preference Methods				
Contingent Valuation	ask respondents directly their willingness to pay for a specific service	any service	survey that presents scenario and elicits willingness to pay for a specific service	many potential sources of bias in responses, guidelines available for reliable use
Choice Modelling	ask respondents to choose their preferred option from a sest of alternatives with particular attributes	any service	survey of respondents	analysis of data is complex
Other				
Benefits Transfer	use results obtained in one context in a different context	any with suitable comparison studies	valuation exercises at another, similar site	can be inaccurate, many actors can vary even if sites seem similar

7. Value of Ecosystem Services in the Suburban Environment

Ecosystem services of cultural or spiritual significance have not received much attention in regards to economic valuation. This could be due to the subjectivity of these values and the difficulty to quantify them. In addition, these values can rarely be transferred to another location or group of stakeholders. It is rarely possible for private landowners to charge others for the benefits of ecosystem services they receive. Property owners do not have an incentive to consider how the changes they make alter the ecosystem services (MA 2005b). Private landowners and developers typically do not receive any compensation for preserving ecosystems even if they are of high value to society and therefore most choose to develop these properties for private benefit (Boyer and Polasky 2004). The economies of the world would cease to exist without ecosystem services and therefore their value is infinite (Costanza et al. 1997).

Valuation is an effective way to see the tradeoffs between conservation and development (Liu et al. 2010). Therefore, it is vital to have informed, policy-makers, developers, and residents. With this knowledge developers and policymakers can effectively increase the sustainability of cities and raise public awareness.

7.1 Monetary Value

Monetary value is at times the only value of importance to actors in the decision making process and therefore this chapter gives insight into what the global monetary value of forest and inland water ecosystems has been estimated to be.

7.1.1 Forest

An assessment of the monetary value of forest ecosystem services in 1994 revealed the potential monetary significance of the world's forests. The following table describes to results.

TABLE 4 AVERAGE GLOBAL VALUE OF FOREST ECOSYSTEMS SERVICES (COSTANZA ET AL. 1997)

Average Global Value of Forest Ecosystem Services	
	(dollars per hectare per year)
Climate Regulation	452
Disturbance regualtion	7
Water regulation	8
Water supply	11
Erosion control	341
Soil formation	30
Nutrient cycling	1,283
Waste treatment	261
Biological control	6
Food production	125
Raw materials	478
Genetic resources	57
Recreation	214
Cultural	6
Total value per ha	3,278

7.1.2 Inland Water

Table 5 shows an estimate of the values of ecosystem services derived from wetlands. According to the studies represented here, they found that cultural services hold more value than provisioning, regulating and supporting services. This could be key in establishing incentive for developers to maintain these types of services.

TABLE 5 TOTAL ECONOMIC VALUE OF WETLAND ECOSYSTEM SERVICES (MA 2005:555), DATA FROM COSTANZA ET AL. 1997 & SCHUYT AND BRANDER 2004

Total Economic Value of Ecosystem Services Provided by Wetlands	Average Value (dollars per hectare per year)
Provisioning Services	**601**
Fishing	374
Hunting	123
Water supply	45
Raw materials	45
Fulewood	14
Other	?
Cultural Services	**1,373**
Aesthetic	881
Recreation and Tourism	492
Other	?
Regulating Services	**1,086**
Flood control	464
Water treatment	288
Nursery function	201
Climate regulation	133
Other	?
Supporting Services	**214**
Habitat	214
Other	?
Total Value	3,274

7.2 Psychological Value

> *"Exposure to and enjoyment of nature in the city may indirectly result in benefiting the health of the planet….by helping to encourage the view that all species share the world in partnership, as opposed to the view that humans are the centre of the universe." (Low et al. 2005)*

Psychological health plays the most important role in human well-being. Interacting with nature can improve cognition and overall well-being (Berman et. al. 2008). As referred to by Low et al., table 5 shows the attitude classifications developed by Stephen Kellert, a psychologist at Yale.

These allow us a bit of insight into how residents might relate to or value having natural areas near their residences.

TABLE 6 ATTITUDES TOWARDS NATURE (LOW ET AL. 2005)

The Attitudes People Have Towards Nature	
Aesthetic	Physical attraction and appeal of nature
Dominionistic	Mastery and control of nature
Humanistic	Emotional bonding with nature
Moralistic	Ethical and spiritual relation to nature
Naturalistic	Exploration and discovery of nature
Negativistic	Fear of and aversion to nature
Scientific	Knowledge and understanding of nature
Symbolic	Nature as a source of language and imagination
Utilitarian	Nature as a source of material and physical reward

It is necessary for people to have a connection to nature and natural systems for their psychological health and well-being (Farr 2008). Interacting with nature can improve cognition and reduce stress (Berman et. al. 2008). These impacts are amplified in children facing stressful situations, such as being picked on, family relocation, and instability in the home (Wells et al. 2010). Being in a natural environment allows the mind to rest and people to regain focus and attention. The four characteristics in table 6 are suggested to be key in facilitating psychological restoration and are most commonly found in nature (Kaplan and Kaplan 1983).

TABLE 7 CHARACTERISTICS NECESSARY FOR MENTAL RESTORATION (KAPLAN AND KAPLAN 1983)

Characteristics Necessary for Mental Restoration	
Fascination	draw one's attention effortlessly
Being away	experience of taking a minivaction from daily concerns
Extent	becoming immersed in an experience
Compatibility	the match between the environment and one's purpose

It is these psychological benefits that are subconsciously motivated by the preferences and thereby the demand for particular ecosystems and ecosystem services. The preferences of residents of Trondheim are most pertinent to this study. The questionnaire developed through this study aims to identify these preferences.

7.3 Demand and Preference

> *"I have never found a companion that was so companionable as solitude."*
> *— Henry David Thoreau, Walden*

Demand is determined by studying purchasing or use behavior and researching the market preferences of the region. Also, the term *biophilia* comes into play as the intrinsic and biological love that humans have for the natural world and its ecosystems (Farr 2008). This creates a subconscious demand from all humans.

Demand studies focus on who participates in outdoor recreation and how often people visit forests and natural areas for recreation. Typical surveys include questions on frequency of visits over a given period of time (such as: 1 month or 1 year), the distance traveled to reach the recreation site, type of area (forest, park, recreation area, national park), time spent there, costs and money spent during visit, the outdoor activity (skiing, hiking, sports, etc.), resources available such as rentals, and socioeconomic background (Sievänen et al. 2009). These surveys use several methods: interviews in-person and by telephone, questionnaires sent through the post, and internet questionnaires. The sample size is typically hundreds or thousands depending on the study and the survey method used.

There is a tendency for Scandinavians (the surveys used included only those from Norway, Sweden, and Finland) to prefer older forests with a mixture of tree types (Gundersen 2005). Forests that are semi-open provide users with a better sense of security (Kaplan et al. 1998). Forests that provide an opportunity for a view are sought after (Savolainen and Kellomäki 1984). Studies have shown that people should be willing to pay more to live near inland water and forest ecosystems (Mansfield et al. 2005).It has also been found that trees can increase the sale price of a home by 1.9% to 7% (Dombrow et al. 2000, Payne 1973).

Cappiella et al. discuss the benefits of the urban forest to be as presented in table 7. These benefits should be further examined and the public should be educated about them in order to create a demand for forests near residential properties.

TABLE 8 BENEFITS OF THE URBAN FOREST (CAPPIELLA, SCHUELER AND WRIGHT 2005)

Benefits of the Urban Forest at the Parcel Level	
Category	**Benefit**
Economic	Decrease heating and cooling costs
	Reduce construction and maintenance costs
	Increase property values
	Positively influence consumer behavior
Environmental	Reduce urban heat island effect
	Enhance function of stormwater control measures
Community	Increase livability
	Provide shade and block UV radiation
	Buffer wind and noise
	Increase recreational opportunities
	Provide aesthetic value
	Improve health and well-being

8. Environmental Goals and Policies

This chapter describes environmental goals set at the global and local levels, the local policies and regulations supporting these goals and local projects in line with Trondheim kommune's goals. It starts with a presentation of Millennium Development Goal 7 and soon to be finalized Sustainable Development Goals (SDGs). These represent the international goals. Next, Trondheim's environmental goals are presented as well as the policies and regulations that support them. The final part describes some recent projects that support ecosystem services.

8.1 International Goals

The UN has organized the establishment of international goals for the environmental sustainability of development. These goals point to how humans can change their behaviors to support both human well-being and ecosystem functions simultaneously. This section describes Millennium Development Goal number 7 and the Sustainable Development Goals proposed by Griggs et al.

8.1.1 Millennium Development Goal 7

Goal 7 of the Millennium Development Goals titled 'Ensuring Environmental Sustainability' contains the following four sub-goals. These sub-goals are accompanied by facts regarding their status.

Millennium Development Goal 7

7A: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources

- Forests are a safety net for the poor, but they continue to disappear at an alarming rate.
- Of all developing regions, South America and Africa saw the largest net losses of forest areas between 2000 and 2010.
- World leaders approved an agreement entitled "The Future We Want," and more than $513 billion was pledged towards sustainable development initiatives.

7B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss

- More areas of the earth's surface are protected. Since 1990, protected areas have increased in number by 58 per cent.
- By 2010, protected areas covered 12.7 per cent of the world's land area but only 1.6 per cent of total ocean area.

7C: Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation

- The world has met the target five years ahead of schedule.
- Between 1990 and 2010, more than two billion people gained access to improved drinking water sources.

7D: Achieve, by 2020, a significant improvement in the lives of at least 100 million slum dwellers

- The target was met well in advance of the 2020 deadline.
- The share of urban slum residents in the developing world declined from 39 per cent in 2000 to 33 per cent in 2012.

Millennium Development Goal 7 (United Nations 2013)

The MDGs demonstrate the needs of the world and have a strong focus on the developing world and impoverished areas. However, the case of Trondheim recognizes the importance of these goals in their own community. This study is interested in pointing out the connection between the MDGs and the local goals.

They are clearly connected to 7A and 7B. 7A is to integrate sustainable development into policies and create programs to reverse the loss of environmental resources. Whereas, Trondheim has the goal to improve sustainable management of the natural environment. 7B is to reduce biodiversity loss. Preserving biodiversity and habitat is a priority goal of Trondheim. Connection between municipal policies and the MDGs are a necessity for the MDGs to be realized.

8.1.2 Sustainable Development Goals

The Millennium Development Goals (MDGs) have been quite successful at guiding policy makers and gaining public support to effectively combat global problems. With the MDGs soon reaching their deadline there is a need to reassess the status of these goals and formulate new ones. In 2013 Griggs et al. proposed some tentative goals for 2030. These goals would be renamed the Sustainable Development Goals (SDGs) and would build upon the progress made up until 2015 with the MDGs. Figure 7 shows the framework for these goals. These goals must be measurable and should apply to all countries.

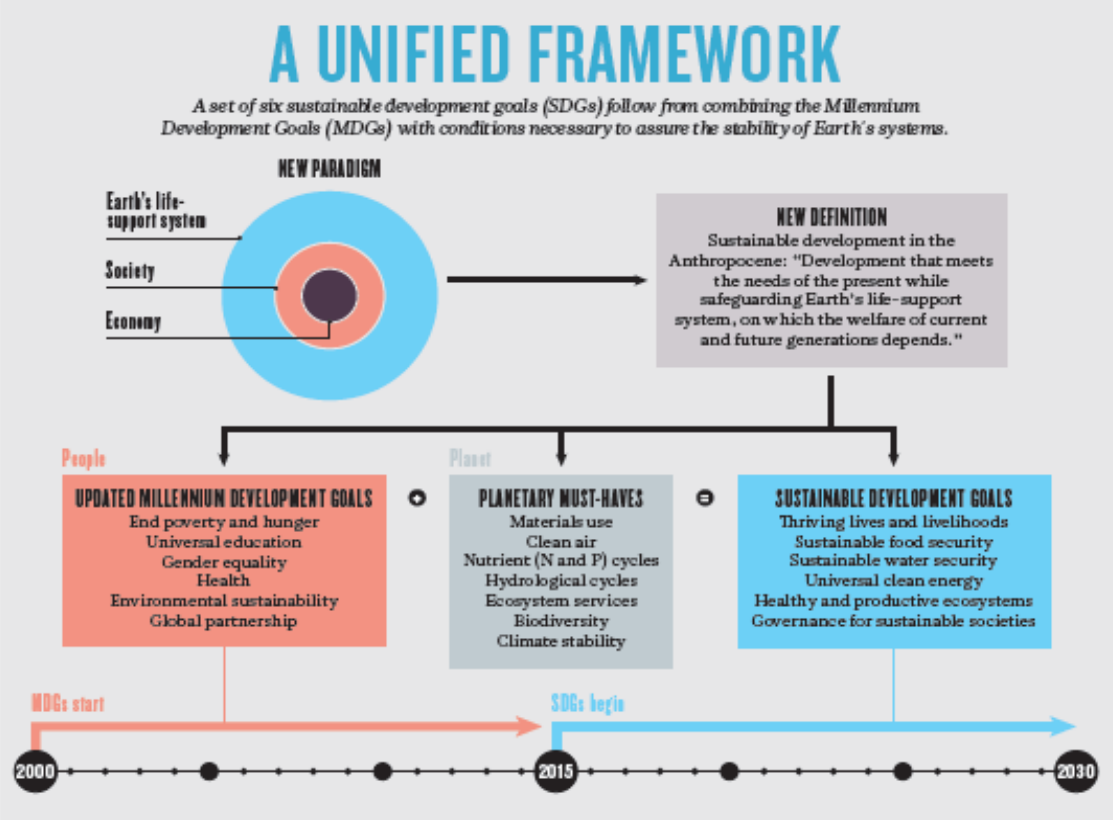

FIGURE 7 BRIDGING FROM MDGS TO SDGS (GRIGGS ET AL. 2013)

From the SDGs it is important to point out the parts valuable to this study. The focus of the SDGs is a clear shift from focusing on impoverished areas to focusing on the needs of the planet in order to secure the livelihoods of all people. This shift is demonstrated in the new definition of development presented

> *"Development that meets the needs of the present while safeguarding Earth's life-support system, on which the welfare of current and future generations depends." (Sustainable Development Goals, 2013)*

The SDGs were developed by evaluating the progress made by the MDGs and combining this with the needs of the planet. All of the planetary needs, are directly connected to the goods and services described in the MEA. 'Ecosystem Services' are actually stated as a necessity for the planet.

This is then translated into the goals of 'healthy and productive ecosystems' and 'governance for sustainable societies'. Trondheim is perhaps a forerunner in realizing these goals as much of the same sentiment of the SDGs is reflected in their environmental goals.

8.2 Local Goals

Trondheim has formulated their own goals for protecting the environment, biodiversity, and ecosystem services. This section includes a translation of the environmental goals of the city from the environmental plan and from the municipal goals for 2020. Excerpts from the original document are found in the appendix.

8.2.1 Priority Environmental Goals of Trondheim

In contrast with the MDGs, the goals of Trondheim focus on biodiversity, water & air quality, environmentally friendly public transport, and condensing the urban area. These clearly reflect the needs of the municipality and the necessity to define their own environmental goals.

Of the priority goals, the most important one for this study is goal 4, 'Secure wildlife diversity and minimize conflict between wildlife and urban communities.' This demonstrates that the kommune recognizes a need to focus on the interplay between urban and natural areas, while highlighting that there is conflict between these two realms. This study is interested in that conflict zone.

Priority Environmental Goals of Trondheim

1. Attend to endangered and vulnerable species and habitats.
2. Ensuring good water quality and ecological status of rivers, streams, lakes and coastal waters.
3. Safeguard valuable farmland.
4. Secure wildlife diversity and minimize conflict between wildlife and urban communities.
5. Combating and preventing the spread of unwanted alien species.
6. Facilitate sustainable use of the natural environment during harvesting, recreation and adventure.

Environmental Goals of Trondheim, translated from (Temaplan for Naturmiljøet 2013)

8.2.2 Trondheim 2020 Environmental Goals

Examining the 2020 goals of Trondheim gives us a slightly different view of the interests of the kommune. These show that the kommune sees a need to condense the city, provide environmentally friendly transport, encourage citizens to walk, and provide pleasant, livable spaces. They also demonstrate an interest in improving management of the natural environment through management of food production, biodiversity, public interest concerns and user interests. Water quality of rivers, lakes, coastal areas, and groundwater are also a long-term focus. The goals are presented below in figure 9.

Trondheim 2020 Environmental Goals

Trondheim kommune will:

● condense, reduce transportation needs, and locate labor intensive businesses downtown and along major roads to reduce transportation needs

● condense so that the living environment is ensured clean air, good sunlight, low noise levels, safe and pleasant urban spaces and meeting space, and easy access to parks and recreation areas

● develop an efficient and environmentally friendly transport with good public transport and excellent walking and cycling trails

Trondheim achieves sustainable management of the natural environment and land.
Trondheim will:

● ensure the long-term management of food production, biodiversity, public interest, and user interests

● ensure good environmental staus of rivers, lakes, coastal waters and groundwater

Trondheim 2020 Environmental Goals, translated from (Kommuneplanens Samfunnsdel 2010)

8.3 Local Policy and Regulation

This section presents Trondheim's policies and regulations regarding the environment. These were translated from the 'Planbeskrivelse', the 'Bestemmelser og Retningslinjer', and the 'Langsiktig Byvekst og Jordvern'. Excerpts from the original documents are located in the appendix.

8.3.1 Trondheim City Plan

The City plan reflects the environmental goals by placing importance on reducing greenhouse gas emissions through densification, not sacrificing green areas, preserving and restoring undeveloped areas, and applying environmental law to planning decision affecting ecosystems, habitats, and species.

It is important that the people of Trondheim have the same access to parks and outdoor spaces in 2030 as they did in 2011. The plan requires that all projects affecting an ecosystem, habitats, and species be evaluated by public authorities using the following criteria:

- Ecosystem approach and overall burden
- The costs of environmental degradation for the developer
- Use of environmentally sound techniques

Using these criteria, it should be very difficult for a developer to get permission to destroy any natural areas. Also if a plan is approved that degrades ecological functions, the developer must take mitigation measures, however these measures are not detailed in the City Plan.

Excerpts from Trondheim's City Plan

2.2 Public Health

Increasing the density of the city is an important way to reduce greenhouse gas emissions. This also increases residents daily activity as the need for motorized transport decreases. However densification increases the pressure on urban green spaces and exposes residents to noise and air pollution.

2.3 Nature Reserves and Green Areas

Blue-green structures are very important in a city that grows by densification and adjoining development. Densification should not come by sacrificing green areas. The goal for 2030 is that the population still has the same access to parks and outdoor spaces as were available in 2011. Green structure should be planned as an extension of the major nature and recreation areas. Emphasis should be placed on strengthening existing green areas by upgrading and preserving contiguous structures.

11.1 Biodiversity

The greatest threat to biodiversity is land use change. This includes reduction or fragmentation of green areas. These disturbances expose the wildlife along corridors, waterways, and buffer zones. All measures affecting nature should be considered by law to maintain biodiversity. Species should be protected in viable populations. When ecological functions are degraded, mitigation measures should be taken by the developer.

> Waterways are an important part of the blue-green structure in Trondheim. The pollution and human intervention affect the functioning of the river systems, their ecology, recreation and flood control. The city aims to provide good environmental status of all water bodies and groundwater.

Strengthening the blue-green structure will:

- Ensure biodiversity and maintain and develop ecological functions
- Better conditions for outdoor activities in the surrounding area
- Maintain overall stream and river landscape characteristics
- Contribute to flood prevention and protection of residential areas
- Preserve and strengthen the effect green belts have on the local climate
- Discourage subsidence on river banks and erosion from fields

11.3 Rating by Biodiversity Law & Environmental Law Principles

Public authorities should apply biodiversity and environmental law to all decisions affecting ecosystems, habitats, and species. The biodiversity law sets requirements for the documentation, evaluation, and weighting of natural interests.

The Environmental law principles:

- Knowledge base
- The precautionary principle
- Ecosystem approach and overall burden
- The costs of environmental degradation for the developer
- Environmentally sound techniques and methods of operation

The requirements depend on the specific case. Weighting the natural values against the principles above is easier at a detailed level than a municipal level.

11.7 Forest Area

Within the forest area there should be a strong consideration for nature and outdoor interests. It's important that the forest is suitable for recreation near residential areas. To suit the demand for outdoor recreation, the city needs about 105km of new daytime ski trails, 40km of night ski trails, and 140km of hiking trails for the projected 2030 population.

11.8 Allotments

An important part of the municipality's urban development strategy is to preserve undeveloped areas. Forest areas are used for recreation by the city's population and should be available to everyone.

12.2 Water in the City

When developing urban areas it has been common to reroute streams in underground pipe networks. Recently the attitudes and therefore guidelines have changed. Now there is a focus on preserving existing creeks, reopening closed creeks and reestablishing new modified streams. These actions support the desire to preserve and enhance green corridors and landscape.

(Excerpts translated from Trondheim City Plan (Planbeskrivelse 2013)

8.3.2 Regulations and Guidelines

The following is an excerpt from the regulations and guidelines of Trondheim. They are directly in-line with the city plan. They highlight the organization of the kommune by separating the regulations by the zones they refer to such as: wildlife corridor zone, forest area, and Nidelva corridor. The regulations are not very specific and come across as suggestions or ideals.

TABLE 9 EXCERPTS FROM TRONDHEIMPOILICIES & REGULATIONS (BESTEMMELSER OG RETNINGSLINJER 2013)

Regulations and Guidelines

Bluegreen Values

§ 11.1 Continuous green spaces, foot paths, and areas for play and recreation will be maintained and strengthened.

§ 11.2 All planning proposals affecting nature will be assessed according to the biodiversity law.

§ 11.3 Areas valued as A,B,C or D habitat types and natural areas will be maintained to conserve ecosystem functions.

§ 11.4 Along waterways, natural resources, landscape, cultural values and recreation are protected.

Water in the City

§ 16.1 Exisiting streams should keep their natural form as much as possible. Closing streams is not allowed.

§ 16.2 In the area plans terrain, green structure, vegetation and stormwater management should be coordinated. Surface water should be returned to the ground and the vegetation as close to the source as possible.

Green Structure

§ 33.1 Allowed to promote outdoor activity, areas for play and recreation as long as important ecological functions are maintained.

Wildlife Corridor Zone

§ 37.1 No actions allowed that degrade ecological function. All measures must be based on their overall impact and maintain or reinforce forest structure in the corridor.

Defined Forest Area

§ 40.1 Within the forest area, nature and outdoor activities should have special attention. Facilitation of outdoor activities that fit the purpose of the land are allowed as long as important ecological functions are maintained.

Defined Nidelva Corridor

§ 42.1 Within the Nidelva corridor special attention should be given to nature, landscape, cultural heritage, and recreational interests.

§ 42.2 Within the Nidelva corridor measures under the Planning & Building Law §1.20 a,d,f,j,k and l are not permitted within 100 meter of a water body.

8.3.3 Long-Term Urban Growth and Land Protection

Trondheim 2030 is a planning initiative set out to achieve certain things by 2030. It includes the investment and land area requirements for city services. The initiative describes the possibilities for combined use public spaces to achieve greater space efficiency.

Proposals for new developments are assessed based on the following criteria:

- Status of current plans
- Location and transport services
- Environmental and natural interests in the area
- Public health
- Cultural Heritage
- Existing infrastructure
- Close to schools and other public institutions

(Langsiktig Byvekst og Jordvern 2005)

The main criteria in assessing an area's compliance with urban development regulations is soil conservation.

8.4 Local Projects

Trondheim kommune has initiated some projects that are in-line with their environmental goals. The ones selected were chosen based on their intersection with residential areas and supporting ecosystem services of concern for this study.

8.4.1 Fredlybekken

Fredlybekken is a project aimed at bringing a creek that was previously put underground back to the surface. This will allow for the establishment of green structure and hiking paths. The project stretches from Nardo down to the Nidelva River. It will affect both residential properties and commercial.

The plan incorporates still and running water features as well as opportunities to access the creek. The water feature combined with the pathway give great well-being and health benefits to the residents of the area, as well as supporting the recreational, aesthetic, and educational services that the creek can give the community.

8.4.2 Iladalen Park

Iladalen Park is located in the neighborhood of Ila and Ilsvika. The park was established as part of a project to unbury Ilabekken (Ila Creek). The park was constructed between 2006 and 2008. The creek, which runs through the center and accumulates in a man-made lake and then runs down towards the fjord, is the main feature of the park. The park also features a gravel soccer field and a sand volleyball court. There are benches and grassy spaces for picnics and other activities.

The design was developed with the help of the Norwegian Institute for Nature Research (NINA) and the park has the capacity for a 1000 years flood. This is because the area has a history of flooding.

9. Case – Trondheim kommune, Norway

This chapter describes the specifics of the case, including a description of Trondheim and its ecosystems, and a summary of the information gathered through interviews.

9.1 Trondheim

Trondheim kommune is the third largest municipality in Norway with a population of 267,000. It is situated on trondhjemsfjord around 63°N, a 6.5-hour drive north from Oslo. The kommune has several institutes for higher education, a research hospital, a growing international population, and one of the largest research communities in Scandinavia. All of these contribute to the increasing demand for housing and it is inevitable that the city will need to expand its urban boundaries in the future.

Trondheim has a very active population and several recreation areas. These areas include forests, lakes, streams, a river, and coastline trails and parks. Trondheim is bordered by two forests, Estenstadmarka to the east and Bymarka to the south. Both of these forests are home to several lakes and are popular recreation areas for the residents of Trondheim. The kommune gets its water supply from Jonsvatnet, a large lake in Estenstadmarka.

9.2. Interviews

The first interview was with Hans Einar Lundli from the Environmental office for Trondheim kommune and the second was with Mari Buaas, a real estate agent for new construction with Nylander AS, a long established real estate agency in Trondheim. This section also includes the analysis of a prospectus for a new development in Trondheim. These sources were immensely valuable for the study and gave great insight into the real situation in Trondheim.

9.2.1 Interview – Trondheim Kommune, Environmental Office

An interview with Hans Einar Lundli, a representative of the environmental office of Trondheim kommune gave insight into what is important to them. Their focus is on how the environmental goals of Trondheim can be attained and what indicators and reporting is necessary to monitor their progress. The city is a part of the future cities initiative, which strives to plan cities for mitigation of climate change and adapting to climate change. Environmental changes such as sea-level rise and urban flooding need to be considered during city planning.

Fredlybekken was a project stretching from Nardo to Nidelva encompassing footpaths and water features as a part of the unburying of Fredlybekken (stream). This project was cancelled due to complaints from a few property owners whose properties border the proposed project area. Ilabekken was a similar project of a stream being unburied and a park being created with water features. It was very successful and a highlight of the neighborhood.

A recent regulation states that all developers must plan to avoid burying streams. These regulations are administered by the byplankontoret (city planning office). There is also an effort being made to avoid cutting off Bymarka from Estenstadmarka by creating wild corridors that allow animals to travel across the region.

9.2.2 Interview – Real Estate Agent, Nylander AS

An interview with Mari Buaas, a real estate agent for new construction with Nylander AS gave some insight into what homebuyers in Trondheim prefer. Three questions formed the basis for our conversation.

1. Do homebuyers ask about the environmental responsibility of the builders?

2. Do they ask about the proximity to natural areas or parks?

3. Do they prefer coastal areas or forests?

She said that people in Trondheim are mostly interested in the following:

- A good view and not losing the view
- Sunshine
- Living in an area familiar to them

Trondheim homebuyers would much rather have a view of the sea than of the forest. They never ask about the environmental responsibility of the developers and are not usually interested in paying more for something because of energy savings (i.e. Automatic lighting).

Much of the new development in Trondheim is built on agricultural land or land that was previously developed. Therefore, there is not much risk of a developer purchasing property that contains natural habitat.

For each property for sale, a catalog or prospectus is created giving photos and information about the home and the area. The following section describes the contents of one of these for a new construction project.

9.2.3 Utleirtoppen, New Development Prospectus

A prospectus is a catalog used in real estate marketing in Norway. It include photos and important information about the property for sale and the community amenities. The prospectus for Utleirtoppen is 39 pages long, 27 pages of photos, 10 pages giving the different floor plans available with a 3D graphic, 1 page with a diagram of the neighborhood, and the last 7 pages contain descriptive information. These pages describe who owns the property, who sales the property, the size of the apartment and how many apartments are in the neighborhood. It also includes the materials used to build the building, parking available, when the properties are available to move in to, different costs associated with the purchase, and which interior items can be custom selected.

The only thing related to nature that is mentioned in the prospectus is that there are some popular trails 3 kilometers away. There is no mention of energy efficiency, use of recycled materials, flood prevention, or the natural surroundings.

These types of information should definitely be included. If this information becomes a regular part of the prospectus for a new property than the customers will demand that they know about these things if the are not presented, thus increasing market demand for ecosystem service conservation and environmentally responsible developers.

9.3 Summary

Trondheim kommune is striving to develop in a way that is good for the environment, the residents' well- being, and the future. These efforts sometimes face resistance from community members or developers. The residents of Trondheim do not has as great a concern for the environment as the policy makers do and this is demonstrated by the lack of concern when purchasing a home. The same sentiment is reflected in the prospectus by the real estate agency or the developer. Therefore, it will clearly be a challenge to become a sustainable city without having the residents and developers in agreement with the kommune's goals and regualtions

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10. Discussion

Through this study the many aspects of cultural ecosystem services and the values they hold have been revealed. From the examination of several prior studies and initiatives, the study utilizes MDGs, MEA, TEEB, and urban development as the foundation which to view the values. The information gathered from these studies is vital to the analysis of the policies and regulations related to the ecosystem services.

It is necessary for the developer to convince homebuyers to purchase a lot on the housing estate. To reach homebuyers' needs you must understand what they value. The developers have control of the design and layout of the buildable lots and therefore it is vital for them to understand customers. Competitive markets deter builders and developers from allotting resources to housing sustainability (Low et al. 2005). However, the developers' lack of concern for the environment can still be controlled through municipal planning regulations that conserve the natural environment.

10.1 Framework

Though the Millennium Development Goals (MDGs) are mainly focused on the impoverished and developing regions of the world they are still important to planning and goal setting in Norway. The goal of concern for this study is goal #7, parts A and B, to integrate sustainable development into policies to reverse the loss of environmental resources and to reduce biodiversity loss. Both of these are reflected in the environmental goals and policies of Trondheim.

The ecosystems and their goods and services as defined by the MEA have been instrumental in educating and informing decision makers about the importance of our planet and the plethora of irreplaceable goods and services it provides. Services such as biodiversity, flood control, recreation, and water purification are incorporated into Trondheim's goals and policies.

The ecosystem services approach to policy development allows multiple actors to discuss and make decisions incorporating their diverse perspectives. TEEB described a process for utilizing ecosystem services in planning. These steps are to determine what goods and services are provided by the local nature, how valuable these provisions are, who will be impacted by a change in these provisions, and how would those impacted change their behaviors. The information necessary to answer these questions must be a priority for the kommune before they are adequately able to formulate a complete set of policies to reach their goals.

The need therefore is in awareness and marketing. If the customers are told about the plethora of benefits gained by living near a forest, and if developers advertise these benefits then they will increase the value of these properties and become a market demand. All it takes is one developer changing their marketing campaign.

People prefer to live in environments where they function most effectively (Wells et al. 2010). This is where the irreplaceable characteristics and stress relieving attributes of nature come into play. According to this study, these environments would contain natural areas and therefore should be a significant part of the planning of residential areas.

The presented monetary valuations show that cultural services are of high value. It would be very helpful to policy-makers and developers in Trondheim to have access to data concerning the monetary value of local ecosystem services.

As awareness grows about environmental problems, the economic prosperity of a firm will increasingly be linked to their environmental performance and stewardship. By combining environmental information and values and incorporating them into market prices, developers can effectively create a win-win-win situation (Dodds 1999). The first two wins are economic for the developer and for the conservation of the environment. The third win comes as the pleasant living environment increases the customers' satisfaction.

10.2 Case: Trondheim

Trondheim kommune is a fast growing municipality that strives to be a sustainable city. To become a sustainable city they have incorporated ecosystem services into their environmental goals, policies, and regulations. Their sustainability goals could be reached quicker if the developers had incentive to do more than the bare minimum to be approved or if the kommune set stricter regulations regarding the conservation of ecosystem services.

According to the interview with a real estate agent, there currently is not any pressure from homebuyers on developers to conserve natural habitats or improve their environmental performance. The pressure comes from the kommune as they have the final approval of the construction plans. The kommune insures that the plans fit within the regulations and goals that they have set for the city's development.

Everyman's right is a traditional concept in Norway that allows all people in Norway free access to waterways and land. People are also allowed to pick berries, mushrooms, and other natural products growing wildly regardless of who owns the land. Agricultural land can also be passed through for recreational purposes (naturfagsenteret). This law preserves and promotes environmentally friendly recreational activities.

This cultural concept is clear in the kommune's goals, policies, and regulations as they have an emphasis on maintaining natural areas and shorelines for recreation and insist that recreational activities do not negatively affect the ecological functions. The city plan states that they plan to maintain the same access to parks and outdoor spaces in 2030 as there were in 2011. This is ambitious seeing that the population is expected to continue rapidly growing.

The kommune recognizes the importance of continuous green spaces in their city plan and its value to supporting biodiversity as well as travel for people and animals across the region. Greenways allow for the conservation of ecosystem services, protection of habitat, linear recreation, and nature study (Bryant 2006).

Until now, Trondheim has been able to avoid destroying much forest area and has instead been developing old industrial sites and agricultural land. At some point in the near future there will be a need to either condense the urban area or expand into natural areas surrounding the city. These natural areas are Bymarka and Estenstadmarka, both of which are important recreational areas for the residents of Trondheim. The threat of losing these areas may be the only way to increase public concern for the environment.

10.3 Validation

During the research process there was difficulty in getting information through interviews, as most of the people of interest did not respond to inquiries or were unavailable. The interviewers provided irreplaceable information necessary when taking on a study concerning multiple actors. To further this study it would be necessary to get more respondents.

Through contact with kommune employees the research was able to examine the most recommended documents and will assume that these are a complete view into the kommune's environmental goals, policies, and regulations but, due to a lack of fluency in Norwegian, there may be documents published in Norwegian that were not addressed in this study.

The questionnaire developed as a part of this study is one method that could be used to acquire more information for policy makers. It was not implemented due to a lack of resources to distribute 1,000s of questionnaires and analyze the results within the time available.

11. Questionnaire

The proposed questionnaire will derive values base on "stated preference" where people are describing hypothetical situations rather than collected data based on behaviors. Conducting original valuation studies is costly and time-consuming. Therefore, the questionnaire was not implemented as a part of this study. The entire questionnaire can be read in the appendix.

The first few questions are to gain some demographic information that will be used to categorize the data collected and formulate statistics. It is also important to know how many children are in the home, as people tend to prefer different areas when they have children than when they do not. The next set of questions are concerned with the resident's use of the natural environment that may be available near their residence and what types of areas they prefer. This information is very valuable as a developer looking to change their marketing strategy and can be useful for policymakers to know what the residents need or prefer.

The questionnaire utilizes a variety of question types depending on what information we hope to gain. Varying the questions also prevents respondents from getting bored and forces them to think a bit on each question.

12. Recommendations

This chapter makes recommendations according to the review of Trondheim policies and regulations in chapter 8. It also includes some tools to be utilized in future planning initiatives.

Municipalities have the responsibility to provide open areas for meeting, playing, and recreation near residential areas. It is necessary to incorporate intangible values of ecosystems into decision-making to make informed decisions about the trade-offs of preservation and development. The use of local ecological data is necessary for valuations to be directly transferable to land-use management policy. To make policy proposals all consequences should be considered not just the ones that are easily measured in monetary terms.

Goals that could be added to Trondheim's agenda

- **Develop low-lying coastal area for sea level rise**
- **Maintain the integrity of ecosystem services**
- **Initiate community gardens to support sustainable access to food**

The following outlines the recommendations derived from this study.

- Place a cost on unsustainable practices. Instead of just requiring developers to take mitigation measures in another area, they should be a required to pay a fee for each cubic meter of natural vegetation destroyed during construction.

- Require that a certain percentage of the natural vegetation be kept. Developers would not be able to pay the fees to get rid of all the natural vegetation.

- Set minimum size standards for areas of natural vegetation. This allows for undisturbed areas of habitat at the center of the natural patch. These areas do not exist in long narrow greenways.

- Require developers to plant at least one tree per housing unit

- No housing units should be built less than two meters above sea-level

- The kommune could build educational centers at popular nature recreation points to educate visitors about the wildlife and the need to protect the areas. The center could be visited by school groups during forest trips. Inside the center there would be exhibits and activities to facilitate learning. As children grow up they will hopefully become good stewards of the earth and place high value on conserving ecosystem services.

12.1 Useful Planning Tools

The tools of spatial planning, urban ecosystem planning, and site assessment could be immensely useful approaches for the city to increase the sustainability of residential development. Each of these is described in this section.

12.1.1 Spatial Planning

Spatial planning can help to preserve ecosystem services in three ways (Tobias 2013):

- Setting growth boundaries for urban areas
- Compensating for habitat and ecosystem loss
- Encouraging municipalities to work together to develop comprehensive plans

Spatial planning requires that decision makers are willing to preserve ecosystem services. This requires that the regional authorities and policy makers are educated about the important services provided by the ecosystems. It is also vital that the policy makers have all the information available about the values of the ecosystem services to all of the important stakeholders. Policies work best when the stakeholders support them.

12.1.2 Urban Ecosystem Planning

According to Alberti and Marzluff 2004, the following six principles should be applied during urban ecosystem planning.

1) Maximize resilience. This is the ability to maintain both ecosystem functions and human well-being simultaneously.
2) Maintain diverse development patterns
3) Minimize resource use and diversify resource supplies
4) Create flexible policies that mimic natural processes
5) Learn by creating buffers for error and opportunities for experimentation
6) Plan by designing experiments and monitoring progress

12.1.3 Site Assessment

Site Assessment for Conserving Existing Forest (Cappiella, Schueler and Wright 2006):

1. Take a detailed inventory of the trees, including species, size, condition, and location
2. Identify the most important trees based on inventory criteria
3. Design based on tree conservation and incorporate existing trees into the open spaces
4. Use physical barriers to protect trees during construction
5. Educate the homeowners about the forest and its value to the neighborhood

It is necessary for the local government to provide a rapid assessment of a site's ecology and understand the site's importance in the regional ecosystem (Lord et al. 2003). Useful tool for rating the status of different areas would be to use a site quality gradient and give each property a score along a point scale.

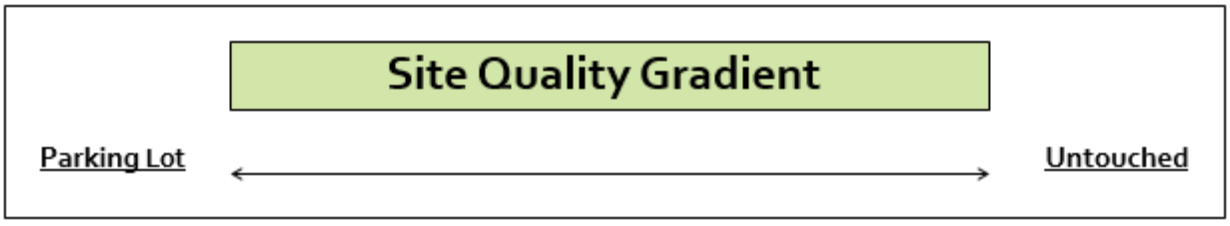

FIGURE 8 SITE QUALITY GRADIENT

There is a need for more information to be gathered from the residents of Trondheim to find out if the developers are meeting the needs of the people. Also a thorough valuation of all of the local ecosystem services should be taken of both the monetary and non-monetary values.

13. Conclusion

Trondheim and other metropolitan areas continue to rapidly grow and expand, this increases the pressure placed on the natural environment and therefore there is a need for more sustainable land-use management. Residential developers have a significant role in how our cities expand and on the livability of our communities. It is therefore necessary to educate developers about the ecological values associated with their properties and how they can utilize them. When the public/homebuyers demand that natural areas be kept during residential construction then the developers will be forced to make changes in their planning and land-use decisions.

- **Which valuations can motivate developers to see value in conserving natural spaces?**

Currently the only value of concern for developers is the monetary value. This value for them is greatly affected by what the customers demand. At this point they do not demand that natural areas be near their homes, but just that they get good sunlight and a nice view of a natural area.

- **What natural settings do homebuyers value?**

According to the interview with a real estate agent, homebuyers are most concerned with the view they get from their home and not the proximity to natural areas. They prefer to have a view of the sea instead of the forest. This question could be answered in more detail by implementing the questionnaire developed as a part of this study.

- **What policies could be implemented to support the conservation of cultural ecosystem services during suburban residential development?**

Policy recommendations were made to focus on more specific requirements for developers. It was discovered that Trondheim has incorporated preservation of outdoor recreation areas a priority goal. By preserving these areas for recreation, much of their educational and aesthetic value is also retained.

This study has revealed a need for more data on the values of ecosystem services in Trondheim kommune and the need for more public awareness of these values and the values that can be of immediate gain to the public. Trondheim is doing a great job at incorporating ecosystem services into their environmental goals, policies, and regulations. However, they are missing a few points, which came as recommendations from this report.

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Appendix I

Questionnaire for Residents

Identifying the Values Homebuyers Place on Natural Areas Close to their Residences

This study is being conducted as part of a master's thesis at NTNU. The researcher seeks to identify which environmental aspects are of value to homebuyers in Trondheim.

The information is strictly confidential and the responses will only be read by the researcher.

What is your gender?

- ○ male
- ○ female

What is your age?

- ○ under 25
- ○ 26 - 40
- ○ 41 - 65
- ○ over 65

How many people live in your home?

How many children live in the home?

What are the ages of the children?
Example: 3,7,under 1

Do you own your home?

- ○ yes
- ○ no

Did you consider access to nature when purchasing your home?

- ☐ Yes
- ☐ No

On a scale from 1 to 5 how would you rate the quality of the natural environment in your neighborhood?

	1	2	3	4	5	
low	○	○	○	○	○	high

Which natural areas would you most want near your home?
check 1 or 2 which you prefer most

- [ ] mountains
- [ ] forests
- [ ] seaside
- [ ] lakes or rivers
- [ ] no preference

How often do you use natural areas for recreation?
Activities typically include: hiking, skiing, berry picking, bird watching, etc.

- ○ rarely
- ○ once a week
- ○ 2-4 times per week
- ○ more than 4 times per week
- ○ never

How would you rate your children's access to nature for play and exploration?

- ○ no access
- ○ some access
- ○ good access
- ○ Nature at the doorstep
- ○ not applicable

Would you rather have a house with a view of the fjord or of a lake?

- ○ fjord
- ○ lake

Which would you prefer less than .5 km from your home?

- ○ manicured lawns
- ○ maintained natural vegetation
- ○ playgrounds/ sports fields
- ○ hiking trails

Appendix II

Temaplan for naturmiljøet i Trondheim – bærekraftig forvaltning mot 2020

3.2. Prioriterte forvaltningsmål

Handlingsprogrammet for naturmiljøet i Trondheim vedtatt i Bystyret i 2006 inneholdt kortsiktige og langsiktige mål og tiltak. Hovedprinsippene vil videreføres og utvikles mot 2020. Kunnskapsinnhenting og målrettede tiltak vil fortsatt være viktige strategielementer. Erfaringer fra arbeidet i perioden 2006-2012 tilsier likevel at det er behov for en mer avgrensing og prioritering av forvaltningsmål og tiltak fram mot 2020.

Temaplanen har hovedfokus på biologiske aspekter innenfor begrepet naturmangfold, og det gis følgende anbefalinger til seks prioriterte forvaltningsmål (som blir behandlet fortløpende fra kap. 3.3):

1. Ivareta truede og sårbare arter, og naturområder.
2. Sikre god vannkvalitet og økologisk tilstand i elver, bekker, vann og kystvann.
3. Ivareta verdifullt kulturlandskap.
4. Sikre viltets mangfold og samtidig minimalisere konflikt mellom vilt og bysamfunn.
5. Bekjempe og hindre spredning av uønskede fremmede arter.
6. Legge til rette for bærekraftig bruk av naturmiljøet gjennom høsting, rekreasjon og opplevelse .

Appendix III

Kommuneplanens Samfunnsdel

2.3: I 2020 skal Trondheim ha en fysisk byutforming som fremmer livskvalitet og helse

Kommunen vil

- fortette, redusere transportbehov og lokalisere arbeidsintensiv virksomhet i sentrum og langs viktige kollektivårer for å redusere transportbehov
- fortette slik at bomiljø sikres ren luft, gode solforhold, lave støynivåer, trygge og trivelige byrom og møteplasser, og lett adkomst til parker og friområder
- videreutvikle et effektivt og miljøvennlig transportsystem med god kollektivtransport og gode gang-, sykkel- og turveger
- sikre arealer til barnehager, grunnskoler, idrett, friområder og møteplasser

2.4: I 2020 skal Trondheim ha en bærekraftig forvaltning av naturmiljø og areal

Kommunen vil

- sikre langsiktig forvaltning der hensynet til matproduserende areal, biologisk mangfold, allmennhetens interesser og brukerinteresser ivaretas
- sørge for en god miljøtilstand i elver, innsjøer, kystvann og grunnvann

Appendix IV
Planbeskrivelse

2.2. Folkehelse

Fortetting er et viktig virkemiddel for å redusere klimautslipp, press på verdifullt jordbruksland og biologisk mangfold. Strategien har også et folkehelseaspekt siden den reduserer behov for motorisert transport, og gir mulighet for å øke hverdagsaktiviteten. Fortetting gir imidlertid et press på eksisterende grønne arealer/byrom. En annen utfordring er miljøforhold i fortettingsområder utsatt for støy og luftforurensning.

De sentrale problemstillingene for folkehelse i arealplanlegging er støy, luftforurensning, universell utforming, ulykkesforebygging, sosiale møteplasser, nærservice/skoler/ barnehager, tilgjengelighet til grøntarealer og blågrønn struktur, tilrettelegging for økt fysisk aktivitet, gode solforhold for boliger og uterom, elektromagnetiske felt og radonstråling. Nasjonal strategi mot sosial ulikhet i helse fremhever behovet for å prioritere helsefremmende tiltak i områder med dårlige levekår, og aktivt unngå forverring av bomiljøet i slike områder.

2.3. Naturområder og grønnstruktur

Blå-grønne strukturer er svært viktig i en by som vokser gjennom fortetting og tilsluttende utbygging. Fortettingen skal ikke gå på bekostning av de grønne lungene. Grønne områder er utsatt for et betydelig utbyggingspress og økologien må ofte vike for andre hensyn. Prosjekt 2030 (se kapittel 2.5) har beregnet behovet for større og mindre parker/uterom etter hvert som byen vokser, gitt at innbyggerne i 2030 skal ha samme tilgang til slike arealer som i 2011.
Det er viktig å ivareta både de store naturområdene med jordbrukets kulturlandskap, og leke- og

11.1. Naturmangfold

Definisjonen av naturmangfold omhandler det biologiske mangfoldet, i tillegg til geologisk og landskapsmessig variasjon. Den største trusselen mot naturmangfold i Trondheim er endringer i arealbruk. Reduksjon og/eller fragmentering av grønne områder gjennom bit-for-bit nedbygging fører til dårligere livsvilkår for planter og dyr. Spesielt viltkorridorer, vassdrag og kantsoner langs vassdrag er utsatt.

Byvekst fører i tillegg til økt forurensning, støy, ferdsel og andre forstyrrelser som kan påvirke livsvilkår for arter, for eksempel ulike fuglearter.

Spredning av fremmede arter, bl.a. gjennom dumping av hageavfall i grøntområder og massehåndtering/transport ved utbygging er en utfordring. En rekke problemarter har de siste årene spredd seg voldsomt, f.eks. slirekne-arter.

Siden forrige rullering har naturmangfoldloven trådt i kraft. Alle tiltak som berører natur skal vurderes etter loven og biologisk mangfold skal ivaretas med grunnlag i lovens prinsipper. Sentralt er forvaltningsmålene i §§ 4 og 5, som sier at naturtyper skal ivaretas, og at økosystemers funksjoner, struktur og produktivitet skal ivaretas. I følge forvaltningsmålet for arter skal de ivaretas i levedyktige bestander. For å oppnå dette må artenes økologiske funksjonsområder bevares.

Foto: Einar Kongshaug

Det skal tas hensyn til naturverdiene og gjøre det som er rimelig for å unngå skade på naturmangfoldet. I arealplansaker, der kunnskap om det biologiske mangfoldet ikke er tilfredstillende, gjelder føre-var prinsippet. Dersom kommunen krever det, skal tiltakshaver gjennomføre undersøkelser med sikte på å forbedre kunnskapsgrunnlaget Kunnskapskravet skal stå i rimelig forhold til sakens karakter og risikoen for at det planlagte tiltaket kan skade naturmangfoldet. Ved forringelse av økologiske funksjoner skal avbøtende tiltak, som bekostes av tiltakshaver, vurderes.

Utvalgte naturtyper etter naturmangfoldloven er pr i dag hule eiker og slåttemarker. Flere naturtyper kan komme til i løpet av planperioden. Disse må det tas hensyn til i arealplanlegging. Jf. egen veileder. De prioriterte artene som har fått egen forskrift etter naturmangfoldloven er foreløpig ikke aktuelle for Trondheim, men noen foreslåtte arter kan bli aktuelle i løpet av planperioden.

11.3. Vurdering etter naturmangfoldlovens miljørettslige prinsipper

Offentlig myndighet skal legge naturmangfoldlovens miljørettslige prinsipper (nml §§ 8-12) til grunn i alle beslutninger som berører økosystemer, naturtyper og arter. Alle vedtak som fattes etter plan- og bygningsloven skal vurderes etter kapittel 2 i naturmangfoldloven. Loven stiller krav til dokumentasjon, vurdering og vektlegging av naturinteressene.

De miljørettslige prinsipper er følgende:

- Kunnskapsgrunnlaget
- Føre-var prinsippet
- Økosystemtilnærming og samlet belastning
- Kostnader ved miljøforringelse bæres av tiltakshaver
- Miljøforsvarlige teknikker og driftsmetoder

Kravet til omfanget av dokumentasjon, vurdering og vektlegging er avhengig av forholdene i saken. Vekting av naturverdier etter alle ovennevnte prinsipper og avveining av ulike interesser mot hverandre vil være lettere på mer detaljerte plannivå enn på kommuneplannivå. For å sikre at dette blir gjort, er det foreslått en bestemmelse om at alle planforslag som berører natur skal vurderes etter kapittel II i naturmangfoldloven.

På dette overordnede plannivået har eksisterende kunnskap om naturverdier dannet det viktigste grunnlaget for en vurdering etter naturmangfoldloven.

Kunnskapsgrunnlaget vurderes å være godt i Trondheim. Viktige naturområder (naturtyper og vilt) er de senere årene blitt kartlagt, og dataene er samlet i en forvaltningsbase og gjort tilgjengelig gjennom kommunens kartinnsynsverktøy. I rulleringen av arealdelen er det gjort vurderinger av hvilke som er de mest sårbare naturområder og det er foreslått tiltak for å ta hensyn til disse, både gjennom bruk av hensynssone (viltkorridor) og bestemmelser/retningslinjer (knyttet til A- og B-områder for naturtyper og vilt i forvaltningsbasen, kantsoner langs vassdrag). Prinsippet om økosystemtilnærming og samlet belastning har særlig ift viltkorridorer blitt tillagt stor vekt.

Innkomne forslag til nye utbyggingsområder og områder for offentlig tjenesteyting har blitt vurdert etter et sett med kriterier, herunder "miljø- og naturinteresser i området". Vurderingen skal være dekkende og oppfylle kravene til konsekvensanalyse på kommuneplannivå. Hvilke vurderinger som er gjort med hensyn til naturmangfold fremgår av vedlagte kataloger.

11.7 Markaområdene

Markaområdene er vist som LNF-formål med bestemmelsesområde. Innenfor bestemmelsesområdet skal hensynet til natur og friluftsinteresser vektlegges. Det tillates ikke nye tiltak i strid med arealformålet, men tilrettelegging for friluftsliv kan tillates.

Det er svært viktig at det er tilrettelagt for friluftsliv i nærheten av folks bosteder, men mange søker også ut av byen for rekreasjon og friluftsliv. Grønnstrukturen og de grønne forbindelsene sikrer god tilgang til marka fra mange av byens boområder. For å dekke behovet for friluftsliv må antall km skiløyper og turstier i markaområdene økes dersom befolkningen i 2030 skal ha samme tilgang og dekningsgrad som i dag: ca 105 km nye dagløyper og 40 km lysløper for ski, og 140 nye km turstier.

11.8 Parsellhager

En viktig del av kommunens byutviklingsstrategi er å ta vare på de ubebygde arealene, både i tettstedsområdet, landbruksjord og markaområdene. Markaområdene er viktige rekreasjonsområder for byens befolkning, og bør være tilgjengelige for alle. Det er ikke ønskelig med hyttebygging i markaområdene i Trondheim.

Det har kommet et innspill om kolonihage til arealdelen, Ringvål kolonihage. En kolonihage er en parsellhage med hytte. Det foreslåtte området ligger i et viktig LNF-område innenfor markagrensa. Forslaget slik rådmannen har fått det forelagt inneholder helårshytter med tilhørende hageparseller. Forslaget skiller seg derfor ikke fra tradisjonell hyttebygging. Rådmannen vurderer det som lite gunstig med utbygging som vil bidra til privatisering av marka. Området foreslås ikke omdisponert.

Det er derimot ønskelig med parsellhager, og Ringvål kan være et aktuelt område. Området ligger langt fra eksisterende tettbebyggelse og har dårlig kollektivtilbud, noe som kan gi uønsket økt bilbruk inn i marka. Viktige naturverdier i området må ivaretas. Parsellhage er i tråd med LNF-formålet. Avklaring av områder for parsellhager vil skje i egen sak, jfr vedtak i formannskapet 02.05.2012 sak 77/12.

12.2. Vann i by

Ved utvikling av byområder og utnyttelse av arealer til blant annet landbruksformål har det gjennom tiden skjedd en betydelig gjenlegging av bekker i rør i kommunen. Holdninger, lovverk og retningslinjer har i den siste tiden endret seg, og det jobbes nå for å bevare eksisterende bekkeløp, å gjenåpne lukkede bekkeløp og å reetablere nye modifiserte bekkeløp. Dette vil i mange tilfeller sammenfalle med behovet for å ivareta naturlige flomveier i terrenget, og ønsket om å bevare og forsterke de grønne korridorene i landskapet. EUs Vanndirektiv hvor hovedmålsetningen er å tilbakeføre alle vannforekomster så nær opptil sin "naturlige tilstand" som mulig er en viktig pådriver. Det vil være viktig også i framtiden å ha fokus på vannets plass i byen for å unngå at det taper i kampen om arealbruk.

Fortetting medfører økning i tette flater og reduksjon av naturområder og grønne arealer. Dette gir store avrenningstopper for overvann, noe som i mange tilfeller medfører kapasitetsproblemer i nedenforliggende overvannssystemer (ledningsnett, bekkeløp, kulverter, bekkeinntak mm).

Utbygging og etablering av overvannshåndtering basert på rene rørsystemer medfører endringer i vannets naturlige kretsløp. De grønne arealene som gjenstår, evt etableres, opplever forverrede vekstvilkår og man går glipp av naturens evne til fordrøyning, forsinkning og rensing av overvann.

For å motvirke disse uheldige virkningene er det ønskelig å øke tilførselen av overvann til grønne arealer og til grunnen generelt, der dette er mulig. Det er også ønskelig å bevare og reetablere åpne bekker. I tillegg til effekter som forsinkning og fordrøyning av overvann vil dette gi en rekke andre gunstige effekter, som økt biologisk mangfold, bedring av lokalklima, forbedrede vekstvilkår for vegetasjon og vannkvalitetsforbedringer på overvannet. Det forventes ikke at de grønne arealene og åpne bekkene kan ivareta alle funksjonene knyttet til overvannshåndtering. Det anbefales derfor overvannsløsninger basert på en kombinasjon av ulike tiltak på overflaten og tiltak i grunnen i form av ledningsanlegg og nedgravde fordrøyningsvolumer.

Ved utbygging i de mest urbaniserte deler av kommunen bør det vurderes om overvannet kan håndteres lokalt, og utnyttes som et synlig element i byens gater og plasser før overskytende vannmengder transporteres bort. Regnvann kan samles og avledes i et åpent system av dammer, renner og kanaler. På den måten blir det en del av bymiljøet og bidrar til en positiv utvikling av vassdragene både med hensyn til vannføring og biologisk mangfold.

En samordnet arealplanlegging er viktig for å kunne utnytte synergier knyttet til grønnstruktur, vann i by og behov for overvannsreduserende tiltak. Det er derfor viktig at vannet inkluderes i en tidlig planfase.

Appendix V

Bestemmelser og Retningslinjer Kommuneplanens areadel

Landskap og grønnstruktur

11. Blå og grønne verdier

§ 11.1 Sammenhengende grøntdrag, grønne lunger, turveier og områder for lek og rekreasjon skal ivaretas og styrkes.

Minimumsbredde på turdrag bør være 30 meter. Områder tilrettelagt for lek, opphold og rekreasjon skal være universelt utformet.

Arter som er svartelistet og definert som problemart i Trondheim skal unngås i grønnstrukturen. Det bør i størst mulig grad brukes stedegen vegetasjon i grønnstrukturen.

§ 11.2 Alle planforslag som berører natur skal vurderes etter naturmangfoldloven kapittel II.

Hensynet til naturmangfoldet skal vektlegges og avveies mot andre samfunnsinteresser, jf. veileder til naturmangfoldloven kapittel.II, forskrift om utvalgte naturtyper med veileder og i kommunens forvaltningsbase for naturdata.

§ 11.3 I områder registrert med verdi A, B, C og D for naturtyper og vilt i kommunens forvaltnings-base for naturdata, samt større sammenhengende naturområder og viltkorridorer, skal økologiske funksjoner søkes opprettholdt.

Tiltak etter plan- og bygningsloven § 20-1 bør ikke tillates innenfor områder registrert med verdi A og B for naturtyper og vilt.

§ 11.4 Langs vassdrag skal naturverdier, landskap, kulturminner og friluftslivsinteresser ivaretas. Langs alle vassdrag med årssikker vannføring, inklusive elver, bekker, vann og tjern, skal det opprettholdes og om mulig utvikles et naturlig vegetasjonbelte som ivaretar viktige økologiske funksjoner, motvirker erosjon og tjener flomsikring og friluftslivet.

For vassdrag med årssikker vannføring, avmerket på temakart "vannforekomster", gjelder generelle kantsoner fra normal strandlinje på begge sider: et 10-metersbelte innenfor tettbebygde områder og et 50-metersbelte innenfor LNFR-områder. For noen utvalgte vassdrag er kantsoner arrondert for å ivareta viktige økologiske funksjoner.

Krav til minstebredden for vegetasjonsbeltet er beskrevet i Kantsoneveileder og levende skog-standarden.

16. Vann i by

§ 16.1 Eksisterende bekker skal bevares så nært opptil sin naturlige form som mulig. Bekkelukking tillates ikke. Lukkede vannveier bør åpnes og restaureres i den grad det er praktisk gjennomførbart.

§ 16.2 I arealplaner skal terreng- og overflateutforming, grønnstruktur, vegetasjon og overvann-shåndtering samordnes. Overvann skal i den grad det er mulig tilbakeføres til grunnen og til vegetasjon nærmest mulig kilden.

Vann og overvann skal søkes utnyttet som positivt element i bymiljøet. Grønne overvannsløsninger i kombinasjon med tradisjonelle overvannsløsninger bør vurderes i alle utbygginger.

For alle planforslag med bebyggelse og anlegg skal det utarbeides en overordnet vann- og avløpsplan, i henhold til Trondheim kommunes VA-norm.

Ved utbygging av mer enn 4 boenheter og alle øvrige bygninger og anlegg der overordnet VA-plan ikke foreligger, skal vann- og avløpsløsninger avklares med kommunen. Ved behov kan overordnet VA-plan kreves utarbeidet.

33. Grønnstruktur

Grønnstruktur som er offentlig eller inngår i sammenhengende grøntdrag er vist på plankartet.

§ 33.1 Tiltak for å fremme friluftslivet, turveier og områder for lek og rekreasjon kan tillates dersom viktige økologiske funksjoner blir opprettholdt. Andre tiltak tillates ikke.

37. Retningslinjer for hensynssone viltkorridor

Innenfor hensynssone viltkorridor bør det ikke tillates tiltak som forringer viltkorridorens økologiske funksjon. Alle tiltak som berører viltkorridoren må vurderes ut fra den samlede belastningen tiltakene vil ha på området. Det skal legges vekt på å opprettholde og helst forsterke/reetablere skogstruktur og vegetasjonskjermer innenfor korridoren.

40. Bestemmelsesområde marka

§ 40.1 Innenfor bestemmelsesområde marka skal det tas særskilt hensyn til natur og friluftsinteresser. Tilrettelegging for friluftsliv i samsvar med arealformålet kan tillates dersom viktige økologiske funksjoner blir opprettholdt. Andre tiltak tillates ikke.

Søknad om tilbygg/påbygg på eksisterende boligeiendommer vurderes særlig strengt.

41. Bestemmelsesområde havnivåstigning

§ 41.1 Reguleringsplaner og tiltak etter plan- og bygningsloven § 20-1 som berører bestemmelsesområde havnivåstigning skal planlegges og utformes slik at tilstrekkelig sikkerhet oppnås. Behov for risikoreduserende tiltak skal alltid vurderes.

For reguleringsplaner som berører bestemmelsesområde for havnivåstigning skal det gjennomføres ROS-analyse.

Vurderinger av havnivåstigning, stormflo og bølgepåvirkning skal utføres etter "Håndtering av havnivåstigning i kommunal planlegging" og ved bruk av hensynssone for havnivåstigning, stormflo og bølgepåvirkning vist i kommunens forvaltningsbase.

42. Bestemmelsesområde Nidelvkorridoren

§ 42.1 Innenfor bestemmelsesområde Nidelvkorridoren skal det tas særskilt hensyn til natur, landskap, kulturminner og friluftslivsinteresser.

§ 42.2 Innenfor bestemmelsesområde Nidelvkorridoren oppstrøms Stavne jernbanebru og langs Gaula og Vikelva er tiltak etter plan- og bygningsloven § 20-1 a, d, f, j, k og l ikke tillatt inntil 100 meter fra normal strandlinje jf. temakart "vannforekomster".

Appendix VI
Langsiktig Byvekst og Jordvern

Kriterier for vurderinger av områdene

Klassifiseringen av områdene er resultat av en avveining mellom vernehensyn og egnethet som framtidige utbyggingsområder.

Ved prioritering av områder har det vært lagt vekt på:

Verneinteresser:

- større sammenhengende landbruksområder
- jordbruksområder med god produksjonsevne
- sammenhengende overordnet grønnstruktur
- områder med høy kulturlandskapsverdi
- områder rikt på biologisk mangfold
- områder som er viktige for friluftsliv
- å etablere varige grenser for byveksten som følger naturlige avgrensninger og landskapsformer

Utbyggingsinteresser:

- byvekst som forsterker eksisterende bymønster og senterstruktur
- områder som bidrar til å utnytte kapasitet i offentlig og privat tjenesteyting
- områder som etablerer effektive og avsluttede bebyggelsesstrukturer
- områder som bidrar til å styrke og binde sammen bydeler
- områder med god tilgjengelighet/potensiale for kollektivtrafikk
- områder hvor fysisk infrastruktur er utbygd/ført fram
- områder med tilfredsstillende grunnforhold
- områder som er egnet for lager- og industrivirksomhet med nærhet til hovedvegnett og kollektivtilbud

Prioriteringen av framtidig byvekstområder er avhengig av hvilke kriterier og hensyn som blir vektlagt tyngst. En sentral problemstilling er i hvor stor grad jordvernhensyn skal vektlegges opp mot hensynet til langsiktige prinsipper for utvikling av bymønster og senterstruktur og en geografisk fordeling av byveksten.