The Role of Education in Conservation Biology
Can Knowledge and Understanding alter Locals’ Views and Attitudes towards Ecosystem Services?

Solveig Trøen Børresen

Master of Science
Submission date: December 2016
Supervisor: Eivin Røskaft, IBI

Norwegian University of Science and Technology
Department of Biology
Solveig Trøen Børresen

Master of Science in Conservation Biology and Ecology

The Role of Education in Conservation Biology: Can Knowledge and Understanding alter Locals' Views and Attitudes towards Ecosystem Services?

Photo 1. Students discussing during a lecture of the education project. Samunge Secondary School, Tanzania.
Photo: Per Harald Olsen

Supervisor: Professor Eivin Røskaft
Trondheim, NTNU
December, 2016
Acknowledgements

This Master thesis was carried out at the Department of Biology, Norwegian University of Science and Technology (NTNU) in the field of Conservation Biology. My study is part of the “AfricanBioServices Project” called; “Linking biodiversity, ecosystem functions and services in the Serengeti-Mara Region, East Africa: Drivers of change, causalities and sustainable management strategies”. I got permission to conduct research in Tanzania from Commission of Science and Technology in Tanzania (COSTEC). Ngorongoro Conservation Area Authority (NCAA) and Tanzania National Parks (TANAPA) granted me permission to enter Ngorongoro Conservation Area and Serengeti National Park. Tanzania Wildlife Research Institute (TAWIRI) approved my proposal and granted me the permissions.

First, I would like to thank NTNU, Department of Biology, “AfricanBioServices Project”, Tanzania Wildlife Research Institute (TAWIRI), Commission of Science and Technology in Tanzania (COSTEC, Ngorongoro Conservation Area Authority (NCAA) and Tanzania National Parks (TANAPA)for giving me the opportunity to conduct my research in Tanzania, as well as life experiences from both the culture and the secondary education in Ngorongoro district.

I would like to thank Emmanuel Masenga and Richard Lyamuya for helping me organize the education project in Tanzania. I want to thank the Education Officer, all the six schools, the head masters, the teachers and especially the school students, for allowing me to do my research, for welcoming me and giving me the opportunity to experience being a teacher in Tanzania.

I am very appreciative for all the help and support I received during my research stay in Tanzania. Mama Dogo, Mama Mika and Juma Ismaili Mkwizu; thank you for many nice conversations and for taking care of me! Franco Mbise, thank you for helping me organize, for translating and for being a good rafiki. Per Harald Olsen, thank you for letting me use your pictures in the education project, thank you for your support, for being my bodyguard, as well as for all the beautiful pictures you have taken in Tanzania. I would also like to thank Per Henning for helping me with the AfricanBioServices-blog.

I especially want to thank my supervisor Professor Eivin Røskaft (NTNU) for guidance and support through the planning and execution of my fieldwork in Tanzania, as well as the writing process. I appreciate all the encouragement and constructive feedback I have received. I would also like to thank Gine Roll Skjærvø for giving me feedback during my writing process.
A huge thanks to my family and friends for all your encouragement and moral support. This master thesis marks the end of my time as a LUR-student at NTNU. I acquire great memories and experiences, thank you to all my fellow students (especially LUR-pikene!) for making the student life enjoyable and memorable.

Asante sana!
Tusen takk!
Thank you!

Trondheim, December 2016
Solveig Trøen Børresen
Abstract
The aim of this study was to test if human knowledge, views and attitudes toward ecosystem services and biodiversity alter after a four-day education project. Climate change, human population growth and land use change are threats toward nature and ecosystem services, which are crucial for human well-being. Altogether, 180 level-two secondary school students in Ngorongoro School District, Tanzania, were tested about knowledge, attitudes and views before (pre-test) and after (post-test) an education project. In the post-test, there was found a significant increase in the number of students who knew what ecosystem services are, in addition they identified ecosystem services better compared to the pre-test. Besides, the results indicate that the students got more insight in the consequences arising from climate change, human population growth and land use change in the post-test, but not all changes were significant. The students demonstrated an understanding of threats biodiversity and ecosystem services are facing. I conclude that the respondents gained knowledge about ecosystem services and biodiversity, as well as some of the threats presented, during the education project. Analyses indicated that among the independent variables tested for, “pre-test/post-test” had the most impact on the dependent variables (answer options and statements) and on the variation in the results. On the other hand, the results showed that the students were knowledgeable and were performing positive attitudes and views about the ecosystem and its services even during the pre-test. Given that the respondents gained knowledge from the education project, I emphasize that education about ecosystem services and biodiversity should be included in school curricula for the students to gain knowledge about surroundings and its importance.

Keywords: Ecosystem services; biodiversity; education project; secondary school; knowledge; attitudes; views; conservation education
**Summary in Norwegian**


**Nøkkelord:** Økosystemtjenester; biodiversitet; utdanningsprosjekt; ungdomsskole; kunnskap; holdninger; standpunkt; bevarings-utdanning
Table of Contents

Acknowledgements ........................................................................................................ iii
Abstract .......................................................................................................................... v
Summary in Norwegian ................................................................................................... vii
Table of Contents .......................................................................................................... ix

Introduction ..................................................................................................................... 1
  Background .................................................................................................................... 1
  Attitudes, Views and Knowledge .................................................................................. 2
  Aim of Study .................................................................................................................. 3

Methodology ................................................................................................................... 5
  Study Area ..................................................................................................................... 5
  Education Project .......................................................................................................... 6
  Sampling and Data Collection ....................................................................................... 7
  The Questionnaire ......................................................................................................... 8
  Analyses and Statistics ................................................................................................. 8
  Ethical Note .................................................................................................................. 9

Results ............................................................................................................................ 11
  Demographic Information ............................................................................................. 11
  Knowledge about Ecosystem Services and Biodiversity .............................................. 11
  Knowledge of Consequences from Climate Change .................................................... 14
  Knowledge of Consequences from Human Population Growth ................................ 15
  Knowledge of Consequences from Land Use Change .................................................. 16
  Pictures ....................................................................................................................... 17
  Knowledge of Threats to Biodiversity and Ecosystem Services .................................. 17
  Statements ................................................................................................................... 20

Discussion ....................................................................................................................... 23
  Knowledge about Ecosystem Services and Biodiversity .............................................. 24
  Knowledge of Consequences from Climate Change .................................................... 25
  Knowledge of Consequences from Human Population Growth ................................ 25
  Knowledge of Consequences from Land Use Change .................................................. 26
  Pictures ....................................................................................................................... 26
  Knowledge of Threats to Biodiversity and Ecosystem Services .................................. 26
  Statements ................................................................................................................... 28
  Factors Explaining Knowledge, Views and Attitudes ..................................................... 30

Conclusion ....................................................................................................................... 31

Perspectives ................................................................................................................... 33

References ....................................................................................................................... 35

Appendices ...................................................................................................................... 39
  Appendix 1: The Questionnaire .................................................................................... 39
  Appendix 2: Structure of the Education Project ............................................................. 42
  Appendix 3: The PowerPoint of the Education Project ................................................... 50
  Appendix 4: The Posters ............................................................................................... 64
  Appendix 5: The AfricanBioServices-Blog ..................................................................... 66
Introduction

Background

Some of the most critical challenges the world is facing today are the increasing population growth, climate change and overexploitation of natural resources (Røskaft et al. 2014, Lyamuya et al. 2016). Together, these challenges are threatening a sustainable existence of nature for future generations (Bongard and Røskaft 2010). Biodiversity is globally looked at as valuable to humans since it provides important goods and services (Gereta 2010b). Biodiversity “includes all species, genetic variation, and biological communities and their ecosystem-level interactions” ((Primack 2014) p.3). A major reason for biodiversity loss and ecosystem degradation is habitat loss due to development (Quetier and Lavorel 2011).

Conservation biology is comprehensive and the definition according to Primack (2014) is a “scientific discipline that draws on diverse fields to carry out research on biodiversity, identify threats to biodiversity, and play an active role in the preservation of biodiversity” (p. 548). The meaning of biodiversity conservation can according to (Gereta 2010b) be “the preservation of nature in an unimpaired state” (p. 24). Conservation must have foundation in ecological and social aspects of the human wildlife conflict, along with scientific knowledge and local traditional knowledge, in order for successful wildlife protection to happen (Jhamvar-Shingote and Schuett 2013). The goal of conservation biology is to disclose new knowledge and in addition apply that knowledge to protect biodiversity (Primack 2014).

Ecosystem services are contributions from natural resources to human well-being (Primack 2014). As the human population increase, we will need more resources from ecosystem services (Røskaft et al. 2014). Included in ecosystem services are both direct benefits, such as food from agriculture and fishing, and indirect benefits, like regulation of flood and diseases (Røskaft et al. 2014). Røskaft et al. (2014) presented the four categories ecosystem services generally are divided in:

1) Provisioning (such as food, livestock, water, grazing, crops and timber).
2) Regulating (such as disease controlling, protection from flood, water quality improvement and storage of water).
3) Cultural (including outdoor sports, education, religious identity and heritage).
4) Supporting (including nutrient cycle and allowing other services to be possible).

If these natural resources were permanently damaged, human societies would not persist without substitute sources. These substitute sources often lead to large expenses and can cause decline in wealth, both locally as well as globally (Primack 2014).
More extreme and unpredictable weather conditions are caused by global climate change provoked by humans, which also affect ecosystems and their services (IPCC 2014). Humans in Africa, like Tanzania, depend more directly on their surroundings than in developed countries, and are therefore more sensitive to climate change (Røskaft et al. 2014). In the Serengeti, climate change is affecting the rainfall and it is now more variable and irregular (Ritchie 2008). The wet season has become more dry, while the dry season is wetter (Røskaft et al. 2014). Movement of animals is controlled by both the water quality and quantity. Animals, like humans and plants depend on water for their existence. Due to seasonally rainfall, the water quality and quantity varies (Gereta 2010a).

During late colonial days, protected areas and national parks were founded in eastern and southern Africa with purpose to protect the biodiversity. Typically for such land was small human populations and high density of wildlife (Gereta and Røskaft 2010). The Maasai people of Serengeti in Tanzania were for instance relocated to the Ngorongoro Conservation Area from their land in Serengeti National Park (Rugumayo 2000). Traditional and customary laws determined how natural resources were managed in pre-colonial times. These conservation guidelines might have been based on traditions and believes from various tribes instead of awareness towards the environment (Kideghesho et al. 2005).

The costs and benefits from conservation areas in Africa are not evenly distributed. Governments, international communities and local tour operators receive most of the benefits, while the locals are left with most of the costs (Gereta and Røskaft 2010). The costs local people have to bear due to conservation in Africa are the following: managing protected areas expenses, damage caused by wild animals on livestock and crop, loss of grazing land productive agriculture land, and constraints on exploitation of animal and plant resources (Emerton 1999).

Attitudes, Views and Knowledge

Cognition to overall assessment about nature will vary with individual differences and attitudes (Ajzen 2001). Knowledge can be described as “facts, information, skills acquired through experience or education” (Anonamous 2016a). The definition of a view can be “a particular way of considering or regarding something” (Anonamous 2016b). von Marion (2008) defined attitudes as the way we usually react when we face situations, issues or people. Our actions are founded by our attitudes. Feelings and thoughts about particular situations are the basis of forming attitudes (von Marion 2008). Attitudes are expressed through a person’s beliefs and opinions, as emotional reaction, and action (Teigen 2012). Attitudes can be based on obtained experience or knowledge, but is often consistent with attitudes from family and friends (Teigen
2012). Nergård (2008) concluded that attitudes students have toward science are developed by experiences from school, but also affected by parents and media. We choose more or less, which attitudes we have ourselves (von Marion 2008).

Kideghesho et al. (2007) found that education is an important factor in shaping peoples’ attitudes and that there should be a focus on young people, developing awareness and changing attitudes. According to Bradley et al. (1999) are young people’s attitudes toward the environment important since they will be affected by problems regarding the environment. In addition, they also need to come up with solutions to these problems (Bradley et al. 1999).

“It is certainly true that knowledge does not per se lead to environmental action or the development of pro-environmental behavior. However, this insight can have a number of consequences, one of which is that interest is often directed toward the development of other factors, such as values, motivation, teachers as role models, etc.” ((Jensen 2002) p. 328).

African children have less knowledge about the wildlife in Africa than many western children. However such knowledge has to be shared between westerners and local people in Africa (Gereta and Røskaft 2010). In order to improve education in both primary and secondary rural village schools, knowledge about wildlife conservation programs in areas close to protected areas, should be introduced (Nyahongo 2010). Kideghesho et al. (2007) found for instance that conservation strategies do not necessarily benefit by level of education. Conservation initiatives may therefore face more opposition due to education (Kideghesho et al. 2007). Røskaft et al. (2003) therefore argued that educational programs with the aim to teach people about biology and carnivores are good management strategies.

Aim of Study
The aim of this study was to test how education can influence locals school students’ views, attitudes and knowledge towards ecosystem services.

This study emphasizes the importance of taking care of nature and why we need to use natural resources in a sustainable way. The term “education project” used in this study is similar to “environmental education (EE)”, used by Barthwal and Mathur (2012). “EE is an important tool for improving people’s understanding and for motivating local communities to cooperate and take initiatives for conservation and sustainable resource use” (Barthwal and Mathur 2012). A goal with an EE program is to help people understand the value of natural resources, and develop knowledge and understanding. People will then be more informed in decision making processes, behaving and acting responsibly (Roth 1992).
The focus of this study was to investigate the knowledge, attitudes and views students in Tanzania have about nature and ecosystem services, and if their attitudes and views alter through an educational project. The goal being that the students acquire knowledge, attitudes and views which will affect them positively in taking care of and protecting nature. It is of importance to investigate the relationship between humans and nature, and if we are aware of how we utilize natural ecosystem services. I hypothesize that an education project will change students’ knowledge, attitudes and views regarding ecosystem services. Predictions made for the education project are the following:

1) The students will answer with increased knowledge about ecosystem services after the education project.

2) The students will answer with increased knowledge about which threats ecosystem services are facing after the education project.

3) The students will acquire positive attitudes and views towards ecosystem services after the education project.
Methodology

Study Area

An area northeast of the Serengeti National Park, which is located in northern Tanzania, with an area of 14,763 km² (Nyahongo 2010), was used as the study area in order to investigate and learn more about knowledge, attitudes and views towards nature and natural ecosystem services (Figure 1). The education project was conducted in the following six villages in Ngorongoro district: Wasso (Loliondo Secondary School), Ololosokwan (Emanyata Secondary School), Soitsambu (Soitsambu Secondary School), Samunge (Samunge Secondary School), Mholo (Digodigo Secondary School) and Monic (Lake Natron Secondary School). The secondary schools are referred to as study schools. The study took place in the period August to October 2016 for six weeks.

The Serengeti ecosystem is about 30,000 km² and includes multiple protected game reserves, conservation areas and the Serengeti National Park (Zimmermann 2012). The altitude ranges from 910-1820m a.s.l. (TAWIRI 2011). A variety of different ethnic groups, either pastoralists or agropastoralists, occupy the north and west sides of Serengeti National Park. The cultural and ethnic differences in communities used to be more apparent, but due to the rapid population growth and immigration, most of the tribes in western Serengeti are now multi-ethnic (Nyahongo 2010). The name Serengeti originates from the Maasai language, and means “endless plains” (Leader-Williams 1995).
Figure 1. Tanzania and the Serengeti ecosystem. The six study schools are indicated with black dots; Loliondo, Emanyata, Soitsambu, Samunge, Digodigo and Lake Natron, located in eastern Tanzania.

Education Project

The education project was developed and planned before travelling to Tanzania. Before the education project started the purpose and schedule was explained to the district education officer for secondary schools. The district education officer contacted the headmasters at the selected secondary schools and got permission to conduct the project. The headmasters were explained the aim and schedule of the project before the educational project started. The education project took about two hours each day, for four days. It consisted of the questionnaire (Appendix 1), structure of the lectures (Appendix 2), the PowerPoint used during the lectures (Appendix 3), two posters; one informed about ecosystem services and the other one about threats to ecosystem services (Appendix 4). Along with this, a generator and a projector were
used when the education project was implemented. The school students received pencils and books they could use during the lectures and the schools received pamphlets from the “AfricanBioServices Project” about ecosystem services. Four of the study schools were also allowed to keep the posters used during the education project (there were four copies of each poster). In this education project, I have emphasized on the provisioning, regulating and supporting services and valued that “tourism” is not an ecosystem service.

**Sampling and Data Collection**

The data was assembled through a questionnaire survey (Appendix 1). At all the six study schools, 30 level two students, aged 14-20 years, were questionnaire interviewed. The study schools were all boarding schools, where the students belonged to different tribes. All the study schools, except the second study school, Emanyata Secondary School, which is private, were public schools. At the first study school (Loliondo Secondary School) the students were random picked. The teachers picked the students who participated in the education project at the other five study schools. The first time the students answered the questionnaire the questions were translated from English to Swahili by a translator.

To show the change in knowledge, views and attitudes before and after the education project, the terms “pre-test” and “post-test” have been used. The first day of the education project the 30 students answered the questionnaire (Appendix 1) with the intention to test their knowledge, attitudes and views before the lectures. The second and third day I thought the students about ecosystem services and biodiversity. I emphasized the importance of ecosystem services, how they affect humans. In addition, I went through different threats to ecosystem services and following consequences from these threats. The fourth day of the education project the same 30 students were questionnaire interviewed to test if more knowledge would alter the students’ views and attitudes with the exact same questionnaire as the first day. This gave me the opportunity to analyze the views, attitudes and knowledge the students had pre- and post-test. The education project was performed in the same matter in all the study schools included in the education project, with the same questionnaires and the same lectures. However, the lectures would differ a little according to which questions the students asked at each study school.
The Questionnaire

The complete questionnaire survey consisted of 11 questions, 12 statement questions, and seven statements about threats to ecosystem services (Appendix 1). The questionnaire was divided into seven main categories, but only the following five are used in the analyses:

a) General information about the respondent (date, secondary school (Loliondo Secondary School, Emanyata Secondary School, Soitsambu Secondary School, Samunge Secondary School, Digodigo Secondary School or Lake Natron Secondary School), gender (male or female) and tribe (Maasai, Sonjo, Chaga, Iraq or Other tribes).

b) Knowledge about ecosystem services and biodiversity.

c) Consequences from threats to ecosystems. In addition, there were pictures illustrating climate change, land use change and human population growth.

d) Statements where the students ticked “yes” if they agreed to the statement and “no” if they disagreed.

e) Threats to ecosystem services. The respondents ticked “yes” if they believed the alternative was a threat and “no” if they did not.

The students were told if the questions could have one or more correct answers, if there was only one correct answer or if they should tick “yes” or “no”. The whole questionnaire, with all the questions and statements, was in English.

Analyses and Statistics

All the statistical analyses were conducted using the software Statistical Package for Social Science (SPSS) version 23. Chi-square tests were used to determine disparity in how the respondents answered to the questions which involved categorical data. Binary logistic regression analyses were used to test the relative importance of different independent variables explaining knowledge, attitudes and views. The dependent variables being the answer options to the questions, as well as the statements represented in the questionnaire (Appendix 1). The various tested independent variables were; “pre-test/post-test” (change in views, attitudes and knowledge before and after the education project), “secondary school” (the school the respondents attend), “tribe” (based on sharing the same first language) and “gender” (male or female). Additionally, Chi-square tests were used to determine if the difference between the study schools, tribes and sexes were statistically significant. Two-sided tests were always used. There is possible pseudoreplication with the small sample size (six study schools) and the respondents from each school might not be independent. Due to this, the secondary schools and following learning environments have been taken into considerations as independent variables.
I interpreted that some of the questions and statements were harder for the respondents to understand than others. Due to this, statements with difficult “language”, where it is obvious that the students did not understand the meaning, were removed from the results. Subsequently I recognize that some of the questionnaire questions/statements were poorly formulated. Because of this, and since I have included more questions than necessary in the questionnaire, some data have been removed from the analyses. Bonferroni tests have not been conducted, thus some of the results may be explained by misunderstanding or miscommunication, particularly where results show “opposite directions” than predicted.

**Ethical Note**

NTNU and TAWIRI approved the questionnaire and the fieldwork for this study before it was conducted. The headmasters and teachers voluntarily took part in the education project. All the questionnaire interviews were anonymous. Additionally, this made it impossible to compare the pre- and post-test on individual level. The first day of my education project the headmasters, teachers and students were asked if they thought it was alright to be taken pictures of. In addition, the students where shown pictures of themselves from the first and second day of the education project after the second lecture.
Results

Demographic Information

In total, 355 questionnaires were answered during the school project. 180 students answered the pre-test questionnaire, while 175 students answered the post-test questionnaire. Gender distribution was even (7% males and 48.3% females). Average age was 15.9 years (SD = 1.3, N = 346). The most represented tribes were: 1) Maasai (24.0%), 2) Sonjo (23.4%), 3) Chaga (9.9%) and 4) Iraq (9.3%). The 27 other tribes were merged and are referred to as “Other tribes” (33.3%). For the questions/statements answered, N = 180 post-test and N = 175 pre-test, with a few exceptions.

Knowledge about Ecosystem Services and Biodiversity

Significantly more students answered correctly to the statement that “ecosystem services are human made services from nature that will always exist” post-test than pre-test (Table 1). A similar pattern was found for both the alternatives “ecosystem services are benefits nature provides humans with for free” and “ecosystem services are human-initiated services” (Table 1).

Table 1. Percentage of the students who answered the question “What are ecosystem services?” correct pre-test and post-test.

<table>
<thead>
<tr>
<th>What are ecosystem services?</th>
<th>Pre-test % correct</th>
<th>Post-test % correct</th>
<th>% change</th>
<th>$\chi^2$</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human made services from nature that will always exist</td>
<td>35.0</td>
<td>80.6</td>
<td>45.5</td>
<td>75.4</td>
<td>0.0001</td>
</tr>
<tr>
<td>Benefits nature provides humans with for free</td>
<td>61.7</td>
<td>90.3</td>
<td>28.6</td>
<td>39.6</td>
<td>0.0001</td>
</tr>
<tr>
<td>Human-initiated services</td>
<td>75.6</td>
<td>92.0</td>
<td>16.4</td>
<td>17.6</td>
<td>0.0001</td>
</tr>
<tr>
<td>N</td>
<td>180</td>
<td>175</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Binary logistic regression analyses, where the alternative definitions of ecosystem services described in Table 1 were used as dependent variables, and “pre-test/post-test”, “tribe (recoded)”, “gender” and “secondary school” were all independent variables, were conducted. The variable “pre-test/post-test” was statistical significant in all cases (all P < 0.001). However, in one case (“benefits nature provides human with for free”), “gender” was also significant (P

---

1 Ecosystem services are benefits nature provides humans with for free.
Males had significantly more knowledge about this pre-test (73.4 % (males) versus 49.4 % (females; \( \chi^2 = 10.9, \text{df} = 1, P = 0.001 \)), while females showed the same level of knowledge as males, post-test, thus there were no statistically significance between the sexes (90.9 % males versus 89.4 % females; \( \chi^2 = 0.11, \text{df} = 1, P = 0.741 \)).

The highest increases between pre- and post-test among the ecosystem services in Table 2 were found for the alternatives “food”, “timber” and “land for settlement” (Table 2). Furthermore, a significant increase in knowledge for all the other ecosystem services; “water”, “firewood”, “medicines” and “grazing” was also found during post-test questions (Table 2). A significant increase in knowledge also occurred for the non-ecosystem services; “air balloon”, “tourism” and “pollution” (Table 2), during pre-test questions. A high percentage of the respondents already knew that the alternatives “car ride” (from 90.6 % before to 91.4 % after; \( \chi^2 = 0.08, \text{df} = 1, P = 0.774 \)) and “telephones” (from 86.1 % before to 90.9 % after; \( \chi^2 = 1.96, \text{df} = 1, P = 0.162 \)) are not ecosystem services, thus no significant increase in knowledge was found.

---

2 Due to this the alternatives “food”, “timber”, “land for settlement” and “tourism” are tested further with binary logistic regression analyses.

3 “Tourism” had the highest increase between pre- and post-test and was tested further with binary logistic regression analyses.
Table 2. Percentage of the students who identified ecosystem services and non-ecosystem services correctly pre-test and post-test.

<table>
<thead>
<tr>
<th>Which services does nature provide?</th>
<th>Pre-test % correct</th>
<th>Post-test % correct</th>
<th>% change</th>
<th>$\chi^2$</th>
<th>P ≤</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>70.6</td>
<td>90.1*</td>
<td>19.5</td>
<td>20.9</td>
<td>0.0001</td>
</tr>
<tr>
<td>Water</td>
<td>73.9</td>
<td>86.3</td>
<td>12.4</td>
<td>8.52</td>
<td>0.004</td>
</tr>
<tr>
<td>Timber</td>
<td>69.4</td>
<td>85.1**</td>
<td>15.7</td>
<td>12.2</td>
<td>0.0001</td>
</tr>
<tr>
<td>Firewood</td>
<td>69.4</td>
<td>80.6</td>
<td>11.2</td>
<td>5.85</td>
<td>0.016</td>
</tr>
<tr>
<td>Medicines</td>
<td>73.9</td>
<td>84.6</td>
<td>10.7</td>
<td>6.14</td>
<td>0.013</td>
</tr>
<tr>
<td>Grazing</td>
<td>58.9</td>
<td>72.0</td>
<td>13.1</td>
<td>6.74</td>
<td>0.009</td>
</tr>
<tr>
<td>Land for settlement</td>
<td>62.8</td>
<td>84.6</td>
<td>21.8</td>
<td>21.6</td>
<td>0.0001</td>
</tr>
<tr>
<td>Air balloon</td>
<td>82.2</td>
<td>92.6</td>
<td>10.4</td>
<td>8.59</td>
<td>0.003</td>
</tr>
<tr>
<td>Tourism</td>
<td>24.4</td>
<td>72.0</td>
<td>47.6</td>
<td>80.4</td>
<td>0.0001</td>
</tr>
<tr>
<td>Pollution</td>
<td>85.0</td>
<td>94.9</td>
<td>9.9</td>
<td>9.46</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Binary logistic regression analyses were conducted with the alternatives of highest significance (“food”, “timber”, “land for settlement” and “tourism” as expressed in Table 2), as dependent variables. The independent variables were “pre-test/post-test”, “tribe (recoded)”, “gender” and “secondary school”. “Pre-test/post-test” was the only independent variable that was significant for all the alternatives; “food”, “land for settlement”, “tourism” (all P < 0.0001) and “timber” (P = 0.001). However, for “tourism”, “gender” (P = 0.017) and “secondary school” (P = 0.008) were also statistically significant. Females had significantly more knowledge about this pre-test compared to males (18.1 % males versus 31.8 % females; $\chi^2$ = 4.51, df = 1, P = 0.034). Both males and females had knowledge at a higher level post-test (68.2 % males versus 76.5 % females post-test values), however at this stage the difference between males and females was not significant ($\chi^2$ = 1.48, df = 1, P = 0.224).

Soitsambu Secondary School and Samunge Secondary School showed the highest knowledge pre-test, although there was no significant difference between the study schools (Soitsambu Secondary School 30.0 %, Samunge Secondary School 30.0 %, Loliondo Secondary School 20.0 %, Emanyata Secondary School 23.3 %, Digodigo Secondary School 4).

Ecosystem services: food, water, timber, firewood, medicines, grazing, land for settlement. Non-ecosystem services: car ride, air balloon, tourism, pollution and telephones.
6.7 % and Lake Natron Secondary School 26.7%; \( \chi^2 = 2.41, df = 5, P = 0.791 \). However, there was a significant difference in knowledge post-test. Loliondo Secondary School stood out and showed the lowest level of knowledge compared to the other study schools (Loliondo Secondary School 48.3 %, Soitsambu Secondary School 66.7%, Samunge Secondary School 73.3 %, Emanyata Secondary School 75.9 %, Digodigo Secondary School 83.3 % and Lake Natron Secondary School 85.2%; \( \chi^2 = 13.0, df = 5, P = 0.023 \))

A significant increase in the number of students who identified biodiversity as being important because “it provides everything we need to survive” was recorded post- in relation to pre-test (from 75.0 % before to 92.0 % after; \( \chi^2 = 18.5, df = 1, P < 0.0001 \)). Binary logistic regression analyses, where the dependent variable was “it provides everything we need to survive”, were conducted. The independent variables were “pre-test/post-test”, “tribe (recoded)”, “gender” and “secondary school”. “Pre-test/post-test” was the only variable that was statistical significant (\( P < 0.0001 \)) for the dependent variable.

**Knowledge of Consequences from Climate Change**

Significant fewer students identified “changes in temperature” as a consequence of climate change\(^5\), pre-test than post-test (from 76.7 % before to 85.1 % correct after; \( \chi^2 = 4.12, df = 1, P = 0.042 \)). There was no significant change in the number of students who identified “reduced human livelihood” (from 48.3 % before to 52.6 % correct after; \( \chi^2 = 0.64, df = 1, P = 0.425 \)) and “unpredictable weather” (from 72.8 % before to 64.0 % correct after; \( \chi^2 = 3.17, df = 1, P = 0.075 \)) as consequences of climate change from pre- to post-tests. For the alternatives that are not consequences from climate change there was no significant change post-test; “more tourists” (from 83.9 % before to 79.4 % correct after; \( \chi^2 = 1.18, df = 1, P = 0.277 \)), “more biodiversity” (from 81.1 % before to 86.9 % correct after; \( \chi^2 = 2.17, df = 1, P = 0.140 \)) and “improved roads” (from 90.0 % before to 85.1 % correct after; \( \chi^2 = 1.93, df = 1, P = 0.165 \)). Binary logistic regression analyses conducted, shows that among the independent variables “pre-test/post-test”, “tribe (recoded)”, “gender” and “secondary school”, “pre-test/post-test” was the only variable that was statistical significant (\( P = 0.038 \)) for the dependent variable “changes in temperature”.

---

\(^5\) Correct answers: “unpredictable weather”, “reduced human livelihoods” and “changes in temperature”. Wrong answers: “more tourists”, “more biodiversity” and “improved roads”.
Knowledge of Consequences from Human Population Growth

During post-test, a significance increase was found in the number of students who identified “land use change” and “more cattle” as consequences from human population growth (Table 3). A high proportion of students identified “overexploitation of resources” as a consequence form human population growth during pre-test, but there was no significant change in the post-test (from 71.7 % before to 68.0 % correct after; $\chi^2 = 0.57$, df = 1, P = 0.452). For the alternatives that are not consequences from human population growth, there was no significant change between pre- and post-test; “more space for crops” (from 67.0 % before to 66.6 % correct after; $\chi^2 = 0.10$, df = 1, P = 0.758), “more space for each individual” (from 73.9 % before to 76.6 % correct after; $\chi^2 = 0.34$, df = 1, P = 0.558) and “less pressure on biodiversity” (from 53.9 % before to 49.7 % correct after; $\chi^2 = 0.62$, df = 1, P = 0.431).

Table 3. Percentage of the students who identified consequences from human population growth correctly pre-test and post-test.

<table>
<thead>
<tr>
<th>Consequences from human population growth</th>
<th>Pre-test correct %</th>
<th>Post-test correct %</th>
<th>% change</th>
<th>$\chi^2$</th>
<th>P ≤</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use change</td>
<td>58.3</td>
<td>69.3</td>
<td>11.0</td>
<td>4.99</td>
<td>0.026</td>
</tr>
<tr>
<td>More cattle</td>
<td>32.8</td>
<td>54.3</td>
<td>21.5</td>
<td>16.7</td>
<td>0.0001</td>
</tr>
<tr>
<td>N</td>
<td>180</td>
<td>175</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Binary logistic regression analyses, where the dependent variables were the consequences in Table 3 and the independent variables were “pre-test/post-test”, “tribe (recoded)”, “gender” and “secondary school”, were conducted. “Pre-test/post-test” was significant for all cases (“land use change” (P = 0.016) and “more cattle” (P < 0.0001)). In addition, “gender” was a statistically significant contributor explaining the variation for the alternative “land use change” (P = 0.030). Males had more knowledge compared to females both pre-test (63.8 % males versus 51.8 % females; $\chi^2= 2.67$, df = 1, P = 0.102) and post-test (73.9 % males versus 65.9 % females; $\chi^2= 1.31$, df = 1, P = 0.252), however neither were statistical significant. Thus, in total (both pre- and post-test) this difference between the two sexes was close to being significant ($\chi^2= 3.70$, df = 1, P = 0.054).

---

6 Correct answers: “overexploitation of resources”, “land use change” and “more cattle”. Wrong answers: “more space for crops”, “more space for each individual” and “less pressure on biodiversity”.

15
Knowledge of Consequences from Land Use Change

A high percentage of students identified “habitat degradation” as a consequence from land use change pre-test, and there was no significant change post-test (from 71.7 % before to 69.1 % correct after; $\chi^2 = 0.27$, df = 1, P = 0.602). There was no significant difference in the number of students identified “increased human-wildlife conflict” (from 67.2 % before to 74.1 % correct after; $\chi^2 = 2.04$, df = 1, P = 0.153) and “more tourism” (from 23.9 % before to 30.3 % correct after; $\chi^2 = 1.84$, df = 1, P = 0.175) as consequences between pre- and post-test. Post-test, a significant increase was found in the number of students who identified “increased dispersal of wildlife” and “easier to travel” as consequences (Table 4). There was no significant change between pre- and post-test for the alternative (“more grazing opportunities”) that is not a consequence from land use change (from 80.6 % before to 74.9 % correct after; $\chi^2 = 1.67$, df = 1, P = 0.197).

Table 4. Percentage of the students who identified consequences from human population growth correctly pre-test and post-test.

<table>
<thead>
<tr>
<th>Consequences from land use change and infrastructure development</th>
<th>Pre-test correct %</th>
<th>Post-test correct %</th>
<th>% change</th>
<th>$\chi^2$</th>
<th>P ≤</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased dispersal of wildlife</td>
<td>55.0</td>
<td>66.3</td>
<td>11.3</td>
<td>4.73</td>
<td>0.030</td>
</tr>
<tr>
<td>Easier to travel</td>
<td>17.8</td>
<td>35.4</td>
<td>17.6</td>
<td>14.2</td>
<td>0.0001</td>
</tr>
<tr>
<td>N</td>
<td>180</td>
<td>175</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A binary logistic regression analyses, with dependent variables represented in Table 4, were conducted. The independent variables were “pre-test/post-test”, “tribe (recoded)”, “gender” and “secondary school”. “Pre-test/post-test” was statistical significant for both “increased dispersal of wildlife” (P = 0.048) and “easier to travel” (P < 0.0001). However, “tribe (recoded)” was only significant for “increased dispersal of wildlife” (P = 0.042). The tribes Maasai, Iraq and Chaga showed the highest level of knowledge pre-test, thus the difference in knowledge level between the tribes was not significant (Maasai 69.0 %, Iraq 68.8 %, Chaga 64.7 %, Sonjo 46.5 % and Other tribes 45.9 %; $\chi^2 = 8.51$, df = 4, P = 0.074). Besides, the difference between the tribes was not statistically significant post-test neither, thus Iraq showed the lowest level of

---

7 Correct answers: “habitat degradation”, “increased human-wildlife conflict”, “more tourism”, “increased dispersal of wildlife” and “easier to travel”. Wrong answer: “more grazing opportunities”.

16
knowledge (Maasai 74.4 %, Iraq 47.1 %, Chaga 66.7 %, Sonjo 70.0 % and Other tribes 66.3 %; \( \chi^2 = 4.58, \text{df} = 5, P = 0.333 \)).

**Pictures**

A high percentage of students identified the changes in the pictures (Appendix 1), “land use change” (from 79.9 % before to 83.8 % correct after; \( \chi^2 = 0.91, \text{df} = 1, P = 0.340 \), “human population growth” (from 85.3 % before to 91.9 % correct after; \( \chi^2 = 3.76, \text{df} = 1, P = 0.052 \)) and “climate change” (from 77.7 % before to 84.0 % correct after; \( \chi^2 = 2.30, \text{df} = 1, P = 0.130 \)). Therefore, there were found no significant increase between the two tests.

**Knowledge of Threats to Biodiversity and Ecosystem Services**

Significant fewer students answered “yes” to “climate change, drought” being a threat to biodiversity and ecosystem services, post-test compared to pre-test (Table 5). Contrary, there was found a significant increase in the number of students who answered “yes” to “human population growth, infrastructure development” being a threat to biodiversity and ecosystem services post-test (Table 5). No difference between the two tests was found regarding “tourism” as a threat to biodiversity and ecosystem services (from 19.4 % before to 21.7 % correct after; \( \chi^2 = 0.28, \text{df} = 1, P = 0.597 \)). A significant increase in the number of students answered “no” to “wildlife” and “carnivores” being a threat to biodiversity and ecosystem services between the two tests (Table 5).

*Table 5. Percentage of respondents who answered correct to the following alternatives from the question; “What are threats to biodiversity and ecosystem services?” correctly pre-test and post-test*.

<table>
<thead>
<tr>
<th>Answer</th>
<th>Pre-test correct %</th>
<th>Post-test correct %</th>
<th>% change</th>
<th>( \chi^2 )</th>
<th>P ≤</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change, drought</td>
<td>87.2</td>
<td>77.7</td>
<td>-9.5</td>
<td>5.57</td>
<td>0.018</td>
</tr>
<tr>
<td>Human population growth, infrastructure development</td>
<td>53.9</td>
<td>82.9</td>
<td>29</td>
<td>34.3</td>
<td>0.0001</td>
</tr>
<tr>
<td>Wildlife</td>
<td>75.0</td>
<td>87.4</td>
<td>12.4</td>
<td>8.95</td>
<td>0.003</td>
</tr>
<tr>
<td>Carnivores</td>
<td>68.9</td>
<td>92.0</td>
<td>23.1</td>
<td>29.9</td>
<td>0.0001</td>
</tr>
<tr>
<td>N</td>
<td>180</td>
<td>175</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8 Threats: “climate change, drought”, “human population growth, infrastructure development” and “tourism”. Not threats: “wildlife” and “carnivores”.
Binary logistic regression analyses, where the alternatives in Table 5 were the dependent variables and “pre-test/post-test”, “tribe (recoded)”, “gender” and “secondary school” were the independent variables, were conducted. The independent variable “pre-test/post-test” was statistical significant in all the cases (“climate change, drought” (P = 0.027), “human population growth, infrastructure development” (P < 0.0001), “wildlife” (P = 0.003) and “carnivores” (P < 0.0001)). However, in one case (“human population growth, infrastructure development”), “secondary school” was also a statistically significant contributor in explaining the variation (P = 0.021). Loliondo Secondary School showed the lowest level of knowledge compared to the other study schools, pre-test, thus the difference between the study schools were not statistical significant (Loliondo Secondary School 33.3 %, Emanyata Secondary School 56.7 %, Soitsambu 60.0 %, Samunge Secondary School 46.7 %, Digodigo Secondary School 66.7 % and Lake Natron Secondary School 60.0 %; $\chi^2 = 8.70$, df = 5, P = 0.122). There was a significant difference in knowledge post-test and all the study schools showed higher level of knowledge. Thus, Soitsambu Secondary School and Digodigo Secondary School stood out with highest level of knowledge (Loliondo Secondary School 69.0 %, Emanyata Secondary School 75.9 %, Soitsambu Secondary School 96.7 %, Samunge Secondary School 83.8 %, Digodigo Secondary School 96.7 % and Lake Natron Secondary School 74.1 %; $\chi^2 = 14.5$, df = 5, P = 0.013).

A high percentage of students knew that “new infrastructure and pollution” (from 79.9 % before to 75.4 % correct after; $\chi^2 = 1.02$, df = 1, P = 0.314) and “harvesting of wildlife” (from 71.7 % before to 70.7 % correct after; $\chi^2 = 0.04$, df = 1, P = 0.839) are threats to ecosystem services pre-test, and there was no significant change in knowledge. There was a significant decrease in number of students who identified “unpredictable weather” as a threat between the two tests (Table 6). Contrary, a significant increase was found in the number students who identified “overexploitation of resources due to human population growth” between the two tests (Table 6). A significant increase was found in the number of students who identified that “human diseases” are not threats to ecosystem services, post-test compared to pre-test (Table 6). For the alternatives “schools and education” and “protected areas” the results showed a significant increase in the number of students who answered that these were threats post-test compared to pre-test (Table 6).
Table 6. Percentage of respondents who answered correct to the alternatives from the question; “What are threats to ecosystem services?” pre-test and post-test.

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre-test correct %</th>
<th>Post-test correct %</th>
<th>% change</th>
<th>χ²</th>
<th>P ≤</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unpredictable weather</td>
<td>91.1</td>
<td>80.5</td>
<td>-10.6</td>
<td>8.28</td>
<td>0.004</td>
</tr>
<tr>
<td>Overexploitation of resources due to human population growth</td>
<td>83.7*</td>
<td>93.1*</td>
<td>9.4</td>
<td>7.65</td>
<td>0.006</td>
</tr>
<tr>
<td>Human diseases</td>
<td>38.8*</td>
<td>51.7</td>
<td>12.9</td>
<td>5.97</td>
<td>0.015</td>
</tr>
<tr>
<td>Schools and education</td>
<td>92.8</td>
<td>79.4*</td>
<td>-13.4</td>
<td>13.3</td>
<td>0.0001</td>
</tr>
<tr>
<td>Protected areas</td>
<td>88.3**</td>
<td>69.0</td>
<td>-19.3</td>
<td>19.6</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Binary logistic regression analyses were conducted, where the dependent variables were the cases in Table 6 and the independent variables were “pre-test/post-test”, “tribe (recoded)”, “gender” and “secondary school”. “Pre-test/post-test” was the only variable that was statistically significant in all cases (“unpredictable weather” (P = 0.005), “overexploitation of resources due to human population growth” (P = 0.010), “human diseases” (P = 0.022), “schools and education” (P = 0.001) and “protected areas” (P < 0.0001)). However, “secondary school” was significant for both “human diseases” (P = 0.013) as well as “schools and education” (P = 0.007).

For “human diseases”, Lake Natron Secondary School had lower knowledge level pre-test compared to the other study schools, and the difference between the study schools was statistically significant (Loliondo Secondary School 56.7 %, Emanyata Secondary School 41.4 %, Soitsambu Secondary School 50.0 %, Samunge Secondary School 31.0 %, Digodigo Secondary School 36.7 % and Lake Natron Secondary School 16.7 %; χ² = 12.7, df = 5, P = 0.027). There was found a higher level of knowledge for all the study schools, except for Loliondo Secondary School, post-test. Post-test, the difference between the study schools was also statistically significant (Loliondo Secondary School 34.5 %, Emanyata Secondary School 55.2 %, Soitsambu Secondary School 66.7 %, Samunge Secondary School 62.1 %, Digodigo

---

9 Threats: “new infrastructure and pollution”, “unpredictable weather”, “overexploitation of resources due to human population growth” and “harvesting of wildlife”. Not threats: “human diseases”, “schools and education” and “protected areas”.
Secondary School 60.0 % and Lake Natron Secondary School 29.6 %; $\chi^2 = 13.6$, df = 5, P = 0.018). For “schools and education”, all the study schools showed high level of knowledge pre-test, and there was no significant difference between the schools (Loliondo Secondary School 90.0 %, Emanyata Secondary School 83.3 %, Soitsambu Secondary School 96.7 %, Samunge Secondary School 93.3 %, Digodigo Secondary School 93.3 % and Lake Natron Secondary School 100.0 %; $\chi^2 = 7.38$, df = 5, P = 0.194). However, post-test, the difference between the study schools was statistically significant, and Loliondo Secondary School and Samunge Secondary School showed lower knowledge level than the other study schools (Loliondo Secondary School 65.5 %, Emanyata Secondary School 75.9 %, Soitsambu Secondary School 90.0 %, Samunge Secondary School 66.7 %, Digodigo Secondary School 93.3 % and Lake Natron Secondary School 85.2 %; $\chi^2 = 12.8$, df = 5, P = 0.025).

In one case (“protected areas”), “tribe (recoded)” was also a statistically significant contributor in explaining this variation (P = 0.001). The difference between the tribes was significant pre-test, thus the Maasai and Sonjo tribes showed lower knowledge level than the others (Maasai 80.5 %, Sonjo 79.1 %, Chaga 94.1 %, Iraq 100.0 % and Other tribes 95.1 %; $\chi^2 = 11.3$, df = 4, P = 0.024). All the tribes showed lower knowledge level post-test, thus the difference among the tribes was not significant (Maasai 60.5 %, Sonjo 62.5 %, Chaga 77.8 %, Iraq 58.8 % and Other tribes 80.4 %; $\chi^2 = 7.10$, df = 4, P = 0.131).

Statements

Almost all the respondents answered “yes” to “I depend on ecosystem services” (from 97.8 % before to 97.1 % yes after; $\chi^2 = 0.15$, df = 1, P = 0.697) and “I think it is important to protect ecosystem services” (from 100.0 % before to 99.4 % yes after; $\chi^2 = 1.03$, df = 1, P = 0.310) pre-test, thus there was no significant change in knowledge post-test. There were no significant changes in the students answer to the statements “I want ecosystem services to be present in the future” (from 98.3 % before to 98.3 % yes after; $\chi^2 = 0.001$, df = 1, P = 0.972) and “threats to the ecosystem affect me” (from 76.7 % before to 70.9 % yes after; $\chi^2 = 1.50$, df = 1, P = 0.221) post-test compared to pre-test, however a high percentage answered “yes” to both of these statements. There was no significant change in the students answer to the statements “plants and animals are mostly here for human use” (from 82.1 % before to 83.9 % yes after; $\chi^2 = 0.20$, df = 1, P = 0.655). Contrary, there was a significant increase in the number of students who answered “yes” to “ecosystem services are mostly here for human use” post-test (Table 7). Few students agreed to the statement “ecosystem services are not important to me” and there was no significant change post-test (from 2.2 % before to 6.3 % yes after; $\chi^2 = 3.62$, df = 1, P = 0.057).
Few students also agreed to the statement “it is not important for me to protect ecosystem services”, but there was a significant increase in the number of students who agreed to this post-test (Table 7). Significant fewer students answered “yes” to “I think it is important to share knowledge about ecosystem services” post-test than pre-test (Table 7).

Table 7. Percentage of respondents who answered “yes” to statements about nature and ecosystem services pre-test and post-test.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Pre-test yes %</th>
<th>Post-test yes %</th>
<th>% change</th>
<th>$\chi^2$</th>
<th>P ≤</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystem services are mostly here for human use</td>
<td>78.3</td>
<td>88.0</td>
<td>9.7</td>
<td>5.90</td>
<td>0.015</td>
</tr>
<tr>
<td>It is not important for me to protect ecosystem services</td>
<td>3.4*</td>
<td>8.6</td>
<td>5.2</td>
<td>4.32</td>
<td>0.038</td>
</tr>
<tr>
<td>I think it is important to share knowledge about ecosystem services</td>
<td>100.0</td>
<td>97.1</td>
<td>-2.9</td>
<td>5.22</td>
<td>0.022</td>
</tr>
<tr>
<td>N</td>
<td>180 *179</td>
<td>175</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Binary logistic regression analyses were conducted, where the statements in Table 7 were the dependent variables. The independent variables were “pre-test/post-test”, “tribe (recoded)”, “gender” and “secondary school”. “Pre-test/post-test” only gave a statistical significance for the following statements; “ecosystem services are mostly here for human use” ($P = 0.016$) and “it is not important for me to protect ecosystem services” ($P = 0.049$). For the statement “it is not important for me to protect ecosystem services”, “tribe (recoded)” was also a statistically significant contributor in explaining the variation ($P = 0.006$). The difference between the tribes was not significant pre-test (Maasai 9.5 %, Sonjo 0.0 %, Chaga 0.0 %, Iraq 0.0 % and Other tribes 3.3 %; $\chi^2 = 7.50$, df = 4, $P = 0.112$), but the difference between the tribes was statistically significant post-test. Post-test, the Maasai, Iraq and Chaga showed less positive attitudes compared to the others (Maasai 18.6 %, Sonjo 5.0 %, Chaga 11.1 %, Iraq 17.6 % and Other tribes 0.0 %; $\chi^2 = 13.5$, df = 4, $P = 0.009$).
Discussion

The findings suggest that education contribute to knowledge gain about ecosystem services and biodiversity. However, since there is possible pseudoreplication with the small sample size, the optimal would have been to conduct the education project at 180 different study schools and questionnaire interviewed one respondent form each school. Additionally, there are multiple possible biases that should be considered. Among these are the people present during the education project, the design of the study, the language, the questionnaire, as well as the PowerPoint and projector. The respondents may have been affected by me, the translator, the photographer, teachers or other students, when answering the questionnaire and also when participating in the class.

The length of the education project can be another bias. It is a possibility that the education project would have had more effect if it was longer and the students received more lessons and had more discussions. Bogner (2002) emphasized that attending a field course that last for several days is not enough to acquire an education for ecological and environmental competence. Furthermore, Lindemann-Matthies (2002), claimed that the influence of an educational program on children’s everyday perception of species showed that the educational program had increased positive effect with the number of lessons spent. I spoke English to the students, who speak Swahili as their second language and their tribal language as their first language. There was occasionally an issue with communication. The students, teachers and I sometimes had trouble understanding each other due to different English pronunciation. The questions might have been difficult to understand, especially if English in general was challenging for students. There is also the possibility that the questions were not explained well enough by me, both with and without translations. Misunderstanding questions can be an error by survey respondents (Fowler 2013). In some cases, all questions were ticked with the wrong answers, and not the correct answers, which support the difficulty with communication. Thus, this might have had an effect on the significance of the results.

The questionnaire might have been too long, resulting in that the students experienced difficulty paying attention and showing interest. Bosnjak and Tuten (2001) explained that respondents can have different motivation to respond and that some individuals lose interest during surveys, resulting in not looking at all the questions. Johnson et al. (2011) informed that researchers can face the problem that respondents can be disinterested in the study and/or become bored. Besides, there is a bias if the questions asked/formulated affected the respondents to answer a certain way. Furthermore, my study lack control groups. Lindemann-
Matthies (2002) argued the importance of a meaningful control groups in educational studies. In addition, at the last three schools, the projector did not work as it should, and the PowerPoint appeared pink. Due to this, it was difficult to see the pictures on the PowerPoint slides and the text was unclear.

**Knowledge about Ecosystem Services and Biodiversity**

As predicted (prediction 1), there was a statistically significant increase in the number of students who knew what ecosystem services are post-test compared to pre-test. This agrees with Bitanyi et al. (2012), who argued that adding wildlife conservation programs into primary and secondary school curriculum can result in an increase in conservation knowledge. Furthermore Kollmuss and Agyeman (2002), informed that people will have more comprehensive knowledge about environmental issues after more education. Contrary, a study by Erdogan (2011), where elementary school students were part of an ecology-based nature education program, found that a such nature education program did not have any significant effect on environmental knowledge. A reason for this could be that the students already had good environmental knowledge.

There was also a significant increase post-test, in recognition of ecosystem services and non-ecosystem services, except for the two non-ecosystem services “car ride” and “telephones”. This might indicate that the few lecture hours have contributed to an increase in knowledge. Lyamuya et al. (2016) supported this finding. In addition, the study by Larson et al. (2009) support that students’ knowledge increases after an educational program.

The results also showed a significantly increase in the number of students who thought that biodiversity is important because “it provides everything we need to survive”. This indicates that knowledge increases with education. Previous studies have found that environmental education programs improved the students’ knowledge (Kollmuss and Agyeman 2002, Larson et al. 2009, Lyamuya et al. 2016). Thus, Gadgil et al. (1993) implied that indigenous people were aware that biological diversity is necessary for the natural resources and ecological services they depend on. This might indicate that many of the students additionally had a broad knowledge base pre-test, even though there was a significantly increase post-test.
Knowledge of Consequences from Climate Change

A significant increase in the number of students who identified “changes in temperature” as a consequence from climate change was found post-test. Education has in this case led to an increase in knowledge, which is supported by previous studies (Kollmuss and Agyeman 2002, Larson et al. 2009, Lyamuya et al. 2016). However, there were no significant changes in the students answers for “reduced human livelihood”, “unpredictable weather” or the alternatives that are not consequences. This may indicate that the respondents are not directly affected by the climate change in their daily live routines or that the students have not noticed any change in the climate. A study by Jones et al. (2014) argued that the reason for why some Americans do not believe in climate change turned out to mostly be based on personal experience. Skepticism was among others based on that “weather has not changed/still cold” and that there is naturally variation in temperature (Jones et al. 2014). This might support why there were no significant change in the students answer for “unpredictable weather” and “reduced human livelihood”. Results by Ojala (2012) showed that in order to cope with climate change, young people use a variety of strategies, ranging from contributing to solve the problem with daily life activities, to placing less emphasis on how serious climate change is. Based on this one could argue that some of the respondent students use a strategy where they act down the effects of climate change. Besides, the results could be supported by Erdogan (2011) or that indigenous people have a broad knowledge base which has been transferred between generations (Gadgil et al. 1993).

Knowledge of Consequences from Human Population Growth

More respondents answered that “land use change” and “more cattle” are consequences from human population growth, post-test. Education has led to an increase in knowledge as reported by Kollmuss and Agyeman (2002), Larson et al. (2009) and Lyamuya et al. (2016). The results for “overexploitation of resources”, along with the alternatives that are not consequences, were not significant. The results can therefore indicate that the students had valuable and broad knowledge previous to the lectures (Gadgil et al. 1993). Contrary, the results can suggest that the educational project did not have any significant effect on knowledge (Erdogan 2011).
Knowledge of Consequences from Land Use Change

A significant increase in the number of students who identified “increased dispersal of wildlife” and “easier to travel” as consequences from land use change, were found post-test compared to previously, which is supported by previous studies (Kollmuss and Agyeman 2002, Larson et al. 2009, Lyamuya et al. 2016). Contrary, there were no significant increase in the number of students who identified “habitat degradation”, “increased human-wildlife conflict” and “tourism” as consequences, or the alternative that is not a consequence (“more grazing opportunities”), post-test compared to pre-test. This can be supported by Erdogan (2011) or Gadgil et al. (1993).

Pictures

The results indicate that there was no significant increase post-test in noticing the “change” happening in the pictures of “climate change”, “human population growth” and “land use change”, but there was an increase in recognition. The respondents might acquire a broad knowledge base about ecological systems independent of the education project, as supported by Gadgil et al. (1993).

Knowledge of Threats to Biodiversity and Ecosystem Services

Significant more students identified “climate change, drought” as a threat to biodiversity and ecosystem services pre-test. There were also significant fewer respondents who answered “yes” to if “unpredictable weather” was a threat to ecosystem services post-test. Even so, the percentage was still high for both the alternatives. The reduction in the respondents’ answers could be explained by the respondents using a coping strategy which put less emphasis on how serious climate change is (Ojala 2012).

Significant more students answered that “human population growth, infrastructure development” and “overexploitation of resources due to human population growth” were threats to ecosystem services, post-test (Kollmuss and Agyeman 2002, Larson et al. 2009, Lyamuya et al. 2016). Kollmuss and Agyeman (2002) also argued that people will have more comprehensive knowledge about environmental issues after more education, but education might not contribute to increased pro-environmental behavior. This could indicate that the students’ behavior might not become more positive towards the environment, even though there was a significant increase in knowledge. However, there was found no significant change in knowledge for the threat “new infrastructure and pollution”, thus a high percentage of the students knew this, which can indicate that the students had knowledge about this previously
(Gadgil et al. 1993). Furthermore, no significant change was found between pre- and post-test for “tourism” being a threat, and it should be taken into consideration that the percentage of students that answered that “tourism” was a threat was low. An explanation could be that education did not have significant effect on knowledge, as supported by Erdogan (2011). On the other hand, it is a possibility that it was confusing for the students that tourism is a threat when tourism in Tanzania contributes significant to the economy (Kweka et al. 2003).

A significant increase in the number of respondents who recognized that both “wildlife” and “carnivores” are not threats to biodiversity and ecosystem services was found post-test. The results agree with Røskaft et al. (2007), who found that education might improve the attitudes local people have towards carnivores. In addition, Mmassy and Røskaft (2013) found that there is a need for public education about species that are threatened or in danger of becoming extinct, in addition to a species’ conservation status. However, there was no significant alteration in the number of students who recognized “harvesting of wildlife” as a threat post-test. Bitanyi et al. (2012) stated that to ensure long term wildlife survival, continual education programs which improve locals’ knowledge are important. This can indicate that the students previously have experienced an education project about wildlife harvesting, or that this is something that should be included in school curriculum to enhance knowledge. The students showed better understanding for some of the threats ecosystem services are facing post-test, but not all threats, as predicted (prediction 2). However, for the threats that showed a decline in percentage between pre-test and post-test, the percentage was still high.

The respondents had significant more knowledge about that “human diseases” are not threats to ecosystem services, post-test compared to pre-test (Kollmuss and Agyeman 2002, Larson et al. 2009, Lyamuya et al. 2016). On the other hand, fewer student answered that “schools and education” and “protected areas” are not threats to ecosystem services post-test. Kideghesho (2006) found that socio-demographic factors like education and wealth, in addition to the cost wildlife apply to locals, affect conservation attitudes. Those who were less likely to support protected areas were educated people and those who experienced little cost from wildlife conservation (Kideghesho 2006). This could indicate that the students experienced little cost from wildlife conservation, in addition that they are educated. However, the percentage of the students who knew that the alternatives are not threats is still high post-test. These finding could be explained by misunderstanding and language confusion.
**Statements**

Most of the respondents have positive attitudes and views towards ecosystem services (prediction 3), but it is hard to determine exactly whether knowledge has affected the students’ attitudes and views, due to the results pre-test. Furthermore, most of the respondents depend on ecosystem services, believe it is important to protect ecosystem services and think ecosystem services are important. However, many of the statements tested, did not significantly change between pre- and post-test. This result indicates that many of the students already had positive attitudes towards ecosystem services pre-test. Furthermore, most of the respondents want ecosystem services to be present in the future, and believe that threats to ecosystem services affects themselves.

There was no significant change post-test in the students answer to the statement “plant and animals are mostly here for human use”. Røskaft et al. (2007), who studied attitudes towards carnivores in Norway, concluded that fear towards large carnivores and negative attitudes are not equivalent. Fear can be reduced by knowledge, but this may not influence other conditions of negative attitudes (Røskaft et al. 2003, Røskaft et al. 2007). This can indicate that the students do not have a more positive view regarding plant and animals, even though they gained more knowledge about wildlife. Domestic animals can also be harmed by diseases and parasite transmissions from wildlife and because of this, local people can retain negative attitudes towards wildlife, even though communities can benefit from the wild (Gereta and Røskaft 2010). This might contribute in explaining why the students did not have more positive attitudes towards plants and animals. More students think that ecosystem services are mostly here for human use, post- compared to pre-test. The finding can indicate that the education project was too short, which can be supported by (Bogner 2002). This also indicates that the students would have benefited from a longer education project and more lessons (Lindemann-Matthies 2002). Although, Kidengeche et al. (2007) argued that education might not be positive for conservation initiatives, Røskaft et al. (2003) found that educational programs are good management strategies.

The two statements “I think it is important to protect ecosystem services” and “it is not important for me to protect ecosystem services” gave contrary results. This might be since it is harder to understand negative statements (“it is not important for me to protect ecosystem services”) than positive ones. This is supported by Patten (2016) who informed that it is easy to get confused when responding to negative worded statements, besides negatives are easily overlooked. Thus, Johnson et al. (2011) findings suggest that “it is untrue that negatively worded questions do not adversely affect the pattern of responses to a survey question”. The
statements have the same meaning, but the wording used can affect how people understand the statements. However, Nieuwland and Kuperberg (2008) argued that as long as negation is used to communicate a useful sound message, it is not necessary more difficult to understand negative than affirmative sentences. Nevertheless, the results indicate that most of the respondents believed that it is important for themselves to protect ecosystem services, both pre- and post-test. Besides, many of the students answered that they think it is important to protect ecosystem services pre-test, and no significant change was found post-test. Few students agreed to the statement “ecosystem services are not important to me”, even though there was found no significant change post-test. This might indicate that that the students think it is important to protect ecosystem services, and that ecosystem services are important to themselves, which they also thought pre-test. Christensen et al. (2007) found that respondents who participated in an education program often believed that nature is important and require protection. In addition, these respondents were more aware of consequences from their own action on environment (Christensen et al. 2007). Besides, Erdogan (2011) found that “ecology-based nature education program contributed significantly to children’s responsible environmental behavior”. According to this, there is a possibility that the students behave more responsible in nature post-test, even though there was found no significant change between pre- and post-test for the following statements; “I think it is important to protect ecosystem services” and “ecosystem services are not important to me”.

Most of the students believed “it is important to share knowledge about ecosystem services”. However, there were significant fewer students who answered this post-test, even though the percentages were still high. These results can indicate that the respondents had positive attitudes towards the importance of sharing knowledge previously to the environmental education lectures. Contrary Røskaft et al. (2007) conveyed that attitudes locals have towards carnivores might be improved by education. The positive attitudes toward ecosystem services in both pre- and post-test could be explained by knowledge being communicated from one generation to the next (Gadgil et al. 1993) and that these attitudes often are influenced by family and friends (Nergård 2008, Teigen 2012).
Factors Explaining Knowledge, Views and Attitudes

The analyses showed that “pre-test/post-test” was the variable that had the most impact on the results. Previous studies support that education programs can contribute to more knowledge (Kollmuss and Agyeman 2002, Larson et al. 2009, Bitanyi et al. 2012, Lyamuya et al. 2016). Besides, Holmern et al. (2007) concluded that in villages outside the Serengeti National Park, wildlife conservation education programs, along with development of better primary and secondary education, can contribute to less misconception and more tolerance about depredation. In some cases, “gender”, “tribe” and “secondary school” were also significant contributors in explaining some of the variation. Males and females had in a few cases unequal knowledge about different topics. Mmassy and Røskaft (2013) found that in recognizing bird species, gender was an important criterion. Males had more knowledge about such species than women (Mmassy and Røskaft 2013) and this can explain why “gender” at times was significant. However, Kideghesho et al. (2007) found that gender did not have any effect on attitudes towards protected areas, which support most of the findings in this study. There is also the possibility that different teaching environments, as well as the different tribes, acquire dissimilar knowledge about ecosystems. Mmassy and Røskaft (2013) also indicated that experiencing wild environments is an important factor for being able to recognize selected bird species. Among the tribes they tested, the Maasai tribe was the one who best recognized bird species (Mmassy and Røskaft 2013). Wiborg et al. (2011) emphasis that positive learning environment have a positive impact on performance development in secondary school. According to this, dissimilar teaching environment might have had different effect on the students. Furthermore, both home- and school-environment can influence students attitudes toward science (Nergård 2008, Teigen 2012). This could be explanations for why “tribe” and “secondary school” in some cases were statistically significant. However, the results for Loliondo Secondary School might also be explained by the random sampling method, different from the other study schools.
Conclusion

The focus of this master thesis has been how education, with emphasis on biodiversity, ecosystem services and the following threats, affect secondary school students’ knowledge, attitudes and views. The results indicated that the short education project led to an increase in knowledge about ecosystem services and biodiversity. In addition, knowledge about consequences following climate change, human population growth and land use change and some threats ecosystem services and biodiversity are facing. Furthermore, the results showed that the students have positive views and attitudes toward nature and natural resources. It is difficult to make conclusions regarding why the students in some cases had more positive attitudes and views about awareness statements pre-test compared to post-test. However, the percentage was still high post-test. I conclude that the students were aware of the importance of nature and the adjacent ecosystem services. Possible correlations between the dependent variables (the answer options to the questions and the statements from the questionnaire (Appendix 1)) with different independent variables (“pre-test/post-test”, “tribe (recoded)”, “gender” and “secondary school”), showed that “pre-test/post-test” was the variable that contributed the most to statistically significant change in knowledge, attitudes and views.
Perspectives

The results from this education project supports that there should be included environmental education projects in schools and at places where it is important that individuals are aware of the natural resources nature provide. Although the students’ knowledge increased with education and the students showed positive attitudes, there is no guarantee that the knowledge and attitudes will persist over time. For now, one can only hypothesize that this education project could contribute to knowledge, attitudes and views that are more stable and that will persist. It would be important to test the effect of a similar education project that last for a longer teaching period and/or have more lectures. I will recommend similar education projects to other schools and countries. The reason for this is that “conservation education is a continuing learning process” (Lyamuya et al. 2016), and also that knowledge about wildlife conservation programs should be included in rural primary and secondary school to improve education (Nyahongo 2010). Besides, the ecosystem is constant changing and affected by human activities. The method and design of this study have biases. The small decline found from pre-to post-test for some of the statements might be partial explained by the translator not being a part of the second time of the questionnaire. Future studies could include a translator both the first and second time the students answered the questionnaire (Appendix 1). There could also be a translator present during the education project. A similar questionnaire (Appendix 1) could also be improved by getting help from a psychologist, to ensure that there is as little bias to the questions and statements as possible.
References

Christensen, A., S. Rowe, and M. D. Needham. 2007. Value orientations, awareness of consequences, and participation in a whale watching education program in Oregon.


Appendices
Appendix 1: The Questionnaire

AfricanBioServices

TANZANIA WILDLIFE RESEARCH INSTITUTE PROJECT
P.O.BOX 661 ARUSHA
SERENGETI WILDLIFE RESEARCH CENTRE

QUESTIONNAIRE IN NGORONGORO & LOLIONDO DISTRICTS

1: RESPONDENT GENERAL INFORMATION

a. Date___________________________
b. Age___________________________ Gender___________________________
c. District_________________________ Village___________________________
d. Tribe__________________________________________________________________________

2: WHAT DO YOU KNOW ABOUT ECOSYSTEM SERVICES AND BIODIVERSITY

a. What are ecosystem services?
   - Human made services from nature that will always exists
   - Benefits nature provides humans with for free
   - Human-initiated services

b. Which of the following services does nature provide?
   Food
   Water
   Car ride
   Timber
   Air balloon
   Firewood
   Tourism
   Pollution
   Telephones
   Medicines
   Grazing
   Land for settlement

b. Biodiversity is important because
   - It provides ornaments to make necklaces
   - It provides timber to build houses
   - It provides everything we need to survive

d. What are threats to biodiversity and ecosystem services?
   - Climate change, drought
   - Human population growth, infrastructure development
   - Wildlife
   - Carnivores
   - Tourism

3: CONSEQUENCES

a. Consequences of climate change:
   Unpredictable weather
   Reduced human livelihoods
   More tourists
   More biodiversity
   Changes in temperature
   Improved roads

b. Consequences of human population growth:
   Overexploitation of resources
   Land use change
   More space for crops
   More space for each individual
   More cattle
   Less pressure on biodiversity
c. Consequences of land use change and infrastructure development:
   - Habitat degradation
   - Increased human-wildlife conflict
   - More tourism
   - Increased dispersal of wildlife
   - Easier to travel
   - More grazing opportunities

d. What does the change between pictures A and B illustrate?

4: STATEMENTS
   a. I depend on ecosystem services
      - Yes
      - No
   b. I think it is important to protect ecosystem services
      - Yes
      - No
   c. All human actions that damage nature are reversible
      - Yes
      - No
   d. Human actions can cause irreversible damage to nature
      - Yes
      - No
   e. Ecosystem services are mostly here for human use
      - Yes
      - No
   f. Plants and animals are mostly here for human use
      - Yes
      - No
   g. Ecosystem services are not important to me
      - Yes
      - No
   h. It is not important for me to protect ecosystem services
      - Yes
      - No
   i. Ecosystem services are important for me to make money
      - Yes
      - No
   j. I think it is important to share knowledge about ecosystem services
      - Yes
      - No
   k. I want ecosystem services to be present in the future
      - Yes
      - No
   l. Threats to the ecosystem affect me
      - Yes
      - No

5. MAIN THREATS TO ECOSYSTEM SERVICES
   a. New infrastructure and pollution
      - Yes
      - No
   b. Unpredictable weather
      - Yes
      - No
   c. Human diseases
      - Yes
      - No
   d. Overexploitation of resources due to human population growth
      - Yes
      - No
   e. Harvesting of wildlife
      - Yes
      - No
   f. Schools and education
      - Yes
      - No
   g. Protected areas
      - Yes
      - No

6. WHAT ARE THE 3 MOST IMPORTANT ECOSYSTEM SERVICES FOR YOU?
   - Food
   - Water
   - Timber
   - Firewood
   - Hunting
   - Crops
   - Medicines
   - Land for settlement
   - Livestock
   - Water storage
   - Grazing
7. SCHOOL
   a. Why do you go to school?
      Because my family say I should go □      Because I want to go □      Other reasons □

"Thank you for your cooperation and good answers"
Appendix 2: Structure of the Education Project

Questionnaire – day 1 (2 hours)

I will read and explain the questions carefully in English, and explain that the students will check the box to the answer(s) they think is correct. A translator will translate the questions to Swahili after I read them out loud in English. I will inform that the students should raise their hands if they have questions.

Teaching – day 2 (2 hours)

<table>
<thead>
<tr>
<th>What</th>
<th>How</th>
<th>Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction – 10 min</td>
<td>Introduce myself and where I come from.</td>
<td>I think it will make the students more eager to learn and comfortable about the teaching situation if they know who I am and where I come from.</td>
</tr>
<tr>
<td>Jambo! Me, Norway</td>
<td>Show where Norway and Tanzania is on the map, the distance between Norway and Tanzania.</td>
<td>I want the students to ask questions when there is something they do not understand. I will tell them that all questions are good questions. I hope this will make it less scary to ask questions.</td>
</tr>
<tr>
<td></td>
<td>I will tell the class why I am here, what I am going to teach about, and that this education project is sponsored by the “AfricanBioServices Project”.</td>
<td></td>
</tr>
<tr>
<td>Introduction – 15 min</td>
<td>Nature. ask the students: “What is nature?”, “What is living nature?”. Talk about biotic and abiotic nature. Let the students discuss in small groups. Ask: “Is all nature the same?” and talk about variation in nature.</td>
<td>I want the student to think about the nature around them and make them curious about what (living) nature really is. Through questions I will get insight in the students’ thoughts and as well as an impression about their knowledge level.</td>
</tr>
<tr>
<td>Time</td>
<td>Session</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>15 min</td>
<td>Ecosystem</td>
<td>Talk about ecosystems. Controlled by internal and external factors. Living and non-living components. Species connected to each other and depend on each other. Show example with picture of food web. “Everything is connected to everything else”. I will show a picture of an ecosystem with different components included. The students will be given the task to draw/map their own ecosystem and include what they think is important.</td>
</tr>
<tr>
<td>15 min</td>
<td>Biodiversity</td>
<td>Biodiversity – the variety of life. Ask and explain why biodiversity is important. The students will discuss in small groups before we talk together. Also, ask and talk about why biodiversity is important to humans and what biodiversity provides to humans.</td>
</tr>
<tr>
<td></td>
<td>Short break</td>
<td></td>
</tr>
<tr>
<td>20 min</td>
<td>Ecosystem services</td>
<td>Ecosystem services are benefits that nature provides us for free. The students are going to think and write down what they think of the following questions; “What are the benefits that nature provides humans with?” and “How much are this benefits worth to us humans?” The students will discuss in groups. We will then go through what the students think and discuss, followed by examples of ecosystem services. Ask the student which ecosystem services they depend on and what they think is most important for themselves. The students</td>
</tr>
<tr>
<td>Title</td>
<td>Description</td>
<td>Time</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Humans and what will happen when nature changes</td>
<td>Humans regulate populations through harvesting and overharvesting. I will ask what will happen when nature changes. The students should discuss in groups before we discuss together. Change can be difficult to reverse and can be irreversible. Nature is constant changing; species go extinct naturally and humans can cause these processes to occur faster.</td>
<td>15 min</td>
</tr>
<tr>
<td>Show pictures</td>
<td>When the lecture about ecosystem services is finished, I would like to show some pictures of animal species that exist in Norway and pictures from when Anne Cathrine Strande Straube was teaching in some of the same villages 3 years ago.</td>
<td>15 min</td>
</tr>
<tr>
<td>Questions</td>
<td>The students can ask questions</td>
<td></td>
</tr>
</tbody>
</table>

- If the students have any questions about the topics, Norway or me, I think it is very important to answer and talk together. I also think the students will be more comfortable if they feel like they get the chance to get to know me better.
<table>
<thead>
<tr>
<th>What</th>
<th>How</th>
<th>Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 min</td>
<td>Repeat what we talked about yesterday</td>
<td>Repetition - to make sure that the students are “online” and to see what we might have to “pick up” from yesterday/ if something was unclear.</td>
</tr>
<tr>
<td>5 min</td>
<td>Tanzania</td>
<td>It is interesting to learn about the situation where you live. I think this will contribute to an understanding of why we have protected areas.</td>
</tr>
<tr>
<td>10 min</td>
<td>Threats to biodiversity and ecosystem services</td>
<td>It is interesting to see if the students have thought about these aspects, what knowledge they have about it and if they learn from each other.</td>
</tr>
<tr>
<td>10 min</td>
<td>Threats to biodiversity</td>
<td>I want the students to get a taste of the threats to nature. As mentioned, I think the students learn a lot from talking to each other (and that it is important to variate “communication” during the lectures.</td>
</tr>
<tr>
<td>15 min</td>
<td>Climate change</td>
<td>To inform the students about the climate and the consequences from climate change, that they might not have thought of or never have thought of.</td>
</tr>
</tbody>
</table>

### Notes:
- **Repeat what we talked about yesterday**: About me and what we talked about yesterday; nature, living nature, ecosystem, biodiversity, ecosystem services, humans and how we affect nature and ecosystems to change. I will ask for volunteers to tell the class what we talked about.
- **Tanzania**: Rich biodiversity, about 30% of land cover is protected areas. Talk about; how protected areas contribute, what pressure on nature and ecosystems leads to. Emphasize that we need knowledge and understanding to solve environmental problems.
- **Threats to biodiversity and ecosystem services**: Ask the students what they think are threats to biodiversity and ecosystem services. The students will write down what they think and let them talk to each other in groups. We will discuss in class.
- **Threats to biodiversity**: Climate change, human population growth and land use change. I want the student to talk to each other and discuss what they think about these threats, and how they affect the biodiversity and human well-being.
- **Climate change**: The weather changes (rain, temperature, different seasons). Explain what climate is, that the climate is changing and that climate change affect human living conditions. Talk about consequences and effects of climate change. I will show pictures made by
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>“AfricanBioServices” where we see that nature is changing due to climate</td>
<td>I want them to think about how climate change can affect themselves and their livelihoods.</td>
</tr>
<tr>
<td></td>
<td>change.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ask the students why it is important to understand the effects of climate change.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I want to hear what the students think.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ask the students why it is important to understand the effects of climate change.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I want to hear what the students think.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>Human population growth</td>
<td>Explain that humans derive a large number of benefits from natural ecosystems and their associated biodiversity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>To inform the students about the increasing human population and the consequences population growth have on nature,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>that they might not have thought of or never have thought of. By using a graph of how the population in Tanzania</td>
</tr>
<tr>
<td></td>
<td></td>
<td>have increased I hope the students will be curious and relate even more to the topic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I will use visual pictures to illustrate what is happening to ecosystems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>By talking together and discussing the consequences I hope that the students will relate more to the threats we</td>
</tr>
<tr>
<td></td>
<td></td>
<td>are facing. I think it is important to let them express what they believe and the insight they have. Maybe the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>students will have different perspectives according to where they come from. I think the students can learn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>from gaining insight about their classmates’ lives.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 min</td>
<td>Land use change and infrastructure</td>
<td>Ask what infrastructure is. Explain and give examples so that the students understand the meaning of the word.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>To inform the students about infrastructure and land use change, and how the following consequences affect nature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and us humans. These consequences might</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I will show pictures made by “AfricanBioServices” where we see that nature is changing due to land use change and infrastructure.

Explain that change in land use and more infrastructure results in increased pressure on natural areas. Mention that valuable ecosystem services are sources of human-wildlife conflict. Example that migrant wildlife and livestock share grazing areas. Talk about some consequences from land use change and infrastructure on nature. Talk about “positive” consequences for humans. Mention that these might not be positive for nature.

10 min
Nature – vulnerable

Ask the following questions “How does the ongoing climate change, human population growth and land use change affect biodiversity?” “How does the ongoing climate change, human population growth and land use change affect human well-being?” The students will think to themselves and then discuss in groups.

10 min
Repeat questions about consequences for biodiversity and human well-being.

Nature is vulnerable! Why?
Repeat

Repetition to make sure that the students are “online” and understand the basics from what we have been talking about.

I want the students to think and reflect about what we have been talking about in order to challenge own knowledge. Repeat and have the students talk about the issues using their own words. This I think can help give more insight and I will see what the students might think is more important for themselves.

I will use visual pictures to illustrate what is happening to ecosystems.

I want the students to understand that the land use change happening is affecting nature and interrupting natural patterns in nature. Even though the change can seem positive for us humans, it can have serious consequences for the biodiversity and all functional ecosystems.

also be topics that the students might not have thought of or never have thought of.
<table>
<thead>
<tr>
<th>5 min</th>
<th>Repeat: Human activity</th>
<th>Weaken and destroying ecosystem services. Natural habitats destroyed. What is causing this? Let the students think for themselves.</th>
<th>Repeat from the lecture the previous day.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 min</td>
<td>What is the problem?</td>
<td>The problem: services undervalued by society, humans disrupt ecosystems (difficult to reverse or irreversible), lack of awareness alter ecosystems present.</td>
<td>When we think about future generations I think people understand how serious the subject is and that we have to cooperate to take care of and protect nature.</td>
</tr>
<tr>
<td></td>
<td>The future</td>
<td>I want to ask the students what they think will happen in the future and make them think of what they wish for future generations.</td>
<td></td>
</tr>
<tr>
<td>5 min</td>
<td>Summary</td>
<td>Summarize what we have been talking about during the education project. Ecosystems are worth a lot, we depend on ecosystem services for our well-being (physical, economic, spiritual), we need education and policies to protect the services provided to us, and repeat; natural ecosystems provide ecosystem services for free.</td>
<td>Students might remember more if they talk about topics many times and often get the opportunity to use their own words to explain and wonder.</td>
</tr>
<tr>
<td></td>
<td>Thank you, asante sana!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Questions</td>
<td>The students can ask questions.</td>
<td></td>
</tr>
<tr>
<td>5 min</td>
<td>Show pictures</td>
<td>When the lecture about ecosystem services is finished, I would like to show some pictures form when the students took the first questionnaire and the first lecture. The pictures are taken by Per Harald Olsen.</td>
<td>I think it will be fun for the students to see pictures of themselves and the few days we have been spending together. the education project from when Anne Cathrine Strande Straube was teaching. Maybe some students will see pictures of themselves or someone they know.</td>
</tr>
</tbody>
</table>
Questionnaire 2 – day 4 (2 hours)
I will read and explain the questions carefully in English, and explain that the students will check the box to the answer(s) they think is correct. This time there will be no translator. I will inform that if the students should raise their hands if they have questions.
Appendix 3: The PowerPoint of the Education Project

**ECOSYSTEM SERVICES**

SOLVEIG TRØEN BØRRESEN

---

**HELLO! JAMBO!**

- My name is Solveig
- From Norway

---

From Norway to Tanzania
WHAT IS NATURE?

NATURE

Natura (Latin natura) – birth

WHAT IS NATURE?

NATURE

• Untamed world around us
• Everything that was not made by man

NATURE – THE PHYSICAL WORLD

• Plants
• Animals
• Landscape
• Stones
• Water
• Wind
• Rain
• Products of the earth

WHAT IS LIVING NATURE?

• Living - biotic
  • Plants
  • Animals
  • Mushrooms
  • Bacteria
  • Humans

• Non-living - abiotic
  • Non living objects on earth
  • Stones, water, air
  • Outer space

Trondheim, Norway

51
IS ALL NATURE THE SAME?

Variation?
- Sun
- Rain
- Soil

ECOSYSTEM

- A community of living organisms that coexist with the environment that surrounds them

ECOSYSTEM

- Similar environments located different parts of the world
- Different characteristics due to different species present

ECOSYSTEM

- Living and non-living parts
- Structure – determined by environmental factors
IMPORTANT COMPONENTS

Living
• Living organisms
• Animals

Non-living
• Soil
• Atmosphere
• Energy
• radiation from the sun
• Water

ECOSYSTEM

• Species connected

• Species depend on each other – food chain

DRAW YOUR OWN ECOSYSTEM

INCLUDE WHAT YOU THINK IS IMPORTANT

• SUN
• RAIN
• ANIMALS – DIFFERENT SPECIES
• VEGETATION
• TREES
Everything is connected to everything else

**Biodiversity - The Variety of Life**
- The variety of living organisms locally up to globally

**Why is Biodiversity Important?**
- Intrinsic value - all species are valuable
- Creates all the functional ecosystems we know
- Diversity → human wellbeing

**Why is biodiversity important to humans?**
What does biodiversity provide to humans?

**Biodiversity Important**
- Provides everything we need for survival
  - Food
  - Pasture
  - Bush meat
  - Ornaments
  - Medicines
  - Material to build
ECOSYSTEM SERVICES

Benefits that nature provides us for FREE!

WRITE DOWN WHAT YOU THINK - DISCUSS

• What are the benefits that nature provides humans with?
• How much are these benefits worth to us?

EXAMPLES ECOSYSTEM SERVICES

• Water
• Food
• Crops
• Livestock
• Grazing
• Firewood
• Timber
• Medicines
• Land for settlement
• Seed dispersal
• Water Storage
• Flood protection

WRITE DOWN

Which ecosystem services do YOU depend on?

HUMANS

Regulate populations
• Harvesting
• Overharvesting

WHAT HAPPENS WHEN NATURE CHANGES?

Change can be
• Difficult to reverse
• Irreversible
NATURE IS CHANGING

• Humans affect
• Today – species go extinct faster than naturally

Day 2
Threats to ecosystem services and biodiversity

Yesterday – what do you remember?

• Ecosystem
  • Living and non-living parts
  • Variation
  • Biodiversity
  • Ecosystem services
• Humans affect nature and ecosystems

TANZANIA

• Rich biodiversity
• About 30% of land cover → protected areas

Pressure on ecosystems and nature

Lead to
• Species extinction
• Changes in ecosystems

Can not predict the outcome of development

We need knowledge and understanding to solve environmental problems
What is threatening biodiversity and ecosystem services?

CLIMATE CHANGE

- Human livelihoods
- Long-term changes in
  - Temperature
  - Water balance
  - Carbon budgets
- Extreme weather events
  - Droughts
  - Floods
  - Storms
  - Bushfires
EFFECTS OF CLIMATE CHANGE

• Rainfall
• Variability
• Irregularity
• Drier wet season
• Wetter dry season

Why is it important to understand the effects of climate change?

Consequences for
• Biodiversity
  • Disruption of annual migration pattern of wildebeest and zebra
• Human welfare
  • Adverse effects on crop production

HUMAN POPULATION GROWTH

More pressure and demand for natural resources
HUMAN POPULATION GROWTH

Increased demand for
• Food (agriculture, fishing)
• Space for settlements
• Grazing land
• Medicinal plants
• Timber
• Firewood
• Water
• Bush meat

What do you think will happen?

CONSEQUENCES

→ Not enough natural resources
→ Less space in nature
→ More cattle

LAND USE CHANGE AND INFRASTRUCTURE

INFRASTRUCTURE

• Roads
• Streets
• Airports
• Houses
• Hotels
• Buildings
Change in land use + infrastructure = increased pressure on natural areas

LANDS USE CHANGE
Valuable ecosystem services → sources of human-wildlife conflict
E.g. Livestock and migrant wildlife shared grazing opportunities
CONSEQUENCES FOR NATURE

- Land degradation
- Habitat fragmentation
- Deforestation
- Intense use of biological resources
- Wildlife dispersal

POSTIVE CONSEQUENCES FOR HUMANS?

- Development
- More tourism
- Economic growth
- Easier to travel
- Globalization

NATURE IS VULNERABLE!

WRITE DOWN

- How does climate change, human population growth and land use change affect biodiversity?
- Human well-being?

HUMANS ACTIVITY

Weaken/destroying ecosystem services

- Harvesting
- Overharvesting

Threats

- Rapid population growth
- Infrastructure and land use change
- Climate change

Short term/individual benefits vs. long term/societal well-being
THE PROBLEM

1. Services – undervalued by society
2. Human-initiated disruptions of ecosystems
   • Difficult to reverse or irreversible
3. Lack of awareness – alter natural ecosystems present

WHAT WILL HAPPEN IN THE FUTURE?

SUMMARY

• Ecosystems are worth A LOT
• We depend on ecosystem services for our well being
• To help protect the services provided to us
  • Need education
  • Need policies

Natural ecosystems provide them for “free”

THANK YOU!

ASANTENI!!

It's have been a pleasure 😊
Appendix 4: The Posters

Ecosystem Services

Nature → the physical world: plants, animals, landscape, wind, rain, products of the earth
Ecosystem → a community of living organisms that coexist with the environment that surrounds them
Biodiversity → the variety of living organisms locally up to globally
Ecosystem services → benefits nature provides humans with for free

The biodiversity provides all functional ecosystems. The diversity is a requirement for human wellbeing. Nature provides us with everything we need to live. Intact nature is vital for humans.

Ecosystem services:
water, food, crops, biomass fuels, fiber, minerals, medicines, grazing, timber, firewood, land for settlement, photosynthesis, nutrient cycling, pollination, disease control, seed dispersal, soil formation, water storage, flood protection

Humans regulate populations through harvesting or overharvesting. Consequence: an irreversible process or change that is difficult to reverse

Nature is constant changing. Species go extinct naturally, and humans can cause these processes to occur faster, at a rate where ecosystems and species are not developing at the demanding speed. Today species are going extinct faster than naturally.

Everything is connected to everything else
Tanzania has a rich biodiversity. About 30% of the land cover is protected areas. Such areas ensure protection of biodiversity for future generations. Pressures on ecosystems and nature lead to species extinction, changes in ecosystems and a development that we can not predict the outcome of. We need knowledge and understanding to solve environmental problems.

Threats to nature (ecosystem services) and human well-being:

1. **Climate change**
   - The weather changes from day to day. Some days are warmer and some days have rain. There are rainy seasons and dry seasons.
   - Climate is the weather over time. The climate is changing and is becoming warmer.
   - Climate change affects human living conditions.
   - Consequences from climate change:
     - Long-term changes in temperature, water balance, carbon budgets.
     - Extreme and unpredictable weather; droughts, floods, storms, bushfire.

2. **Human population growth**
   - Human population is increasing. This leads to more pressure and demand for natural resources.
   - Natural resources: food, grazing land, water, timber, firewood, space for settlement, medicine plants, bush meat.
   - Consequences: less space in nature, not enough natural resources.

3. **Land use change**
   - Infrastructure; roads, streets, airports, houses, hotels, buildings change in land use
   - Change in land use + infrastructure increases the pressure on natural areas.
   - Consequences for nature:
     - land degradation, habitat fragmentation, deforestation, intense use of biological resources, wildlife dispersal from protected areas to communal lands, introducing invasive species, more roadkill
   - Positive consequences for humans:
     - development, more tourism, economic growth, easier to travel, globalization
Appendix 5: The AfricanBioServices-Blog

“My teaching adventure in Tanzania”, video and blog:
http://africanbioservices.eu/my-teaching-adventure-in-tanzania/

“Asante Sana Tanzania!”:
http://africanbioservices.eu/asante-sana-tanzania/