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The role of rural education programs on Conservation Biology

Unravelling and possibly affect the
understanding of ecosystem services and
attitudes toward nature amongst people
living in the Serengeti-Mara ecosystem

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Master of Science in Conservation Biology and Ecology

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Photo 1. Participants in one of the villages outside the house where the educational program was conducted

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Hanne Marstrand Andersen

Abstract

Today, human-induced impacts like climate change, human population growth and land use change are negatively affecting the biodiversity and ecosystems, which are important for human well-being. Africa is amongst the places hit hardest. In addition, many of the worlds' poorest live on this continent, making many of the people here extra vulnerable to these impacts.

This study aimed to see if a four-day education program about biodiversity, ecosystem services and threats to nature would give the participants better understanding about and affect their attitudes towards nature. 300 adults (eighteen years or above) from ten different villages in five different districts surrounding the Serengeti-Mara ecosystem participated in the program. The exact same questionnaire were given out the first day (pre-test) and the last day (post-test) to find out what knowledge and attitudes the participants had from before, and whether these changed during the program. The results indicate that the participants got a better understanding of ecosystem services and threats and possible consequences from these to nature. The results also indicated alterations in attitudes towards nature. Analyses indicate that difference between the pre-test and the post-test was the most important explanatory factor. In addition, education level and districts also affected much of the responses. However, the pre-test revealed that the participants possessed both knowledge about and positive attitudes towards nature before the education attending the program.

I conclude that the participants gained more understanding about ecosystem services and threats to nature during the education program. However, compared to similar studies on school children, the results in this study was not as clear, indicating that the adult participants gained less knowledge from this education program than thechildren. Still, as the challenges mentioned initially happens now, I mean that it is important to include the adults when it comes to knowledge about conservation biology and restoring the natural resources and ecosystem services, but possibly by education programs focusing more on what actions can be taken, rather than a theoretic focus. possibly through similar education programs. However, the programs should possibly be more action-based than theory-based, as was the case for this study.

Keywords: Ecosystem services, biodiversity, education programs, knowledge, attitudes.

Summary in Norwegian

I dag er jorda stor grad påvirket av klimaforandringer, menneskelig populasjonsvekst og bygging av infrastruktur sammen med andre former for endring av naturlig habitat. Dette har en negativ effekt på biodiversitet og økosystemer, og dermed på økosystemtjenester, som igjen påvirker menneskelig velferd. Økosystemtjenester er de godene menneskene får fra naturen. Afrika er blant de stedene som rammes hardest av klimaforandringene. Mange av dem som bor i Afrika er fattige og ikke minst direkte avhengig naturresurser i sin hverdag, og dermed blir de sterkt påvirket av naturtruslene nevnt innledningsvis. ¨

Målet med dette studiet var å finne ut av om et utdanningsprogram over fire dager ville gi deltakerne mer kunnskap om og ikke minst påvirke holdningene deres til natur. 300 voksne (atten år eller mer) ifra ti forskjellige landsbyer i fem forskjellige distrikter rundt Serengeti-Mara-økosystemet, deltok i prosjektet. Presis den samme spørreundersøkelsen ble gitt ut den første dagen (før-test) og på den siste dagen (etter-test) for å finne ut av hvilken kunnskap og hvilke holdninger deltakerne hadde fra før, og om disse endret seg etter utdanningsprogrammet. Resultatene indikerer at deltakerne fikk en bedre forståelse for økosystemtjenester og potensielle trusler, samt endringer i holdninger. Ifølge analysene var forskjellen mellom før-testen og etter-test var den mest representerte forklarende faktoren til disse endringene. I tillegg var også hvilket distrikt og utdanningsnivå faktorer som påvirket responsen. Videre viste også før-test at deltakerne hadde både kunnskap om og positive holdninger til naturen fra før.

Jeg konkluderer med at deltakerne fikk mer forståelse om økosystemtjenester og trusler til naturen under utdanningsprogrammet. Samtidig, hvis man sammenlikner med liknende studier gjort med skolebarn var ikke resultatene i denne studien like tydelige som i de studiene. Dette indikerer at de voksne deltakerne fikk mindre ut av utdanningsprogrammet enn barna. Likevel, ettersom naturen er under stadig trussel allerede i dag, og lenge har vært det, mener jeg at det uansett er viktig å inkludere de voksne når det kommer til kunnskap rundt konserveringsbiologi. Men det er mulig at programmene bør være mer rettet på hva som faktisk kan gjøres i hverdagen, framfor det mer teoretiske aspektet som dominerte i denne studien.

Nøkkelord: Økosystemtjenester, biodiversitet, utdanningsprogram, kunnskap, holdninger

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Introduction
Background

Humans affect the planet in numerous ways. In 1997, human interference influenced almost half of the land on the planet, altering every ecosystem on earth to different degrees (Vitousek et al. 1997). Today, human-induced climate change, population growth, overexploitation of resources and habitat loss are considered to be amongst the main environmental challenges the world is facing (Balmford and Bond 2005, IPCC 2014, Røskaft et al. 2014). The rapid climate change require fast adaptions and have critical impacts on natural systems. In a worst case scenario this can lead to mass extinctions and extreme loss of biodiversity (Bellard et al. 2012, IPCC 2014). Human population growth and development are important drivers when it comes to land use change and habitat loss. This again is also a major cause of decreasing biodiversity and ecosystem degradation (Meyer and Turner 1992, Vitousek et al. 1997, Quétier and Lavorel 2011).

Biodiversity and functional ecosystems are closely linked together. Biodiversity concerns the number, abundances, functional variety, spatial distribution and interaction of genotypes, populations, species, communities and ecosystems. The processes taking place within a healthy ecosystem, are important to the well-being of many societies (Balvanera et al. 2016). These processes are the fundament of what we call "Ecosystem services", which are the benefits that people obtain from ecosystems. Examples of ecosystem services are water regulation, food, medicines, pollination and nutrient cycling (Costanza et al. 1997, Røskaft et al. 2014). Røskaft et al. (2014) presents four categories that consider different kinds of ecosystem services:

1) Provisioning services (includes amongst others crops, livestock, water, timber, biomass, medicines).

2) Regulating services (includes amongst others water storage, flood protection, improvement of water quality, regulation of water flow and carbon sequestration).

3) Cultural services (includes amongst others recreation, tourism, education, heritage).

4) Supporting services (includes amongst others nutrient cycling and pollination, which makes other services possible).

Permanent damage of such functions would be of critical harm to human societies (Primack 2012). Conservation biology addresses this topic, by concerning the persistence of biodiversity. Primack (2012) define conservation biology as "an integrated, multidisciplinary scientific field that has developed in response to the challenge of preserving species and ecosystems" (p. 5). The goal is to preserve biodiversity. However, due to the factors introduced initially, this field experiences many challenges. Poverty, human population growth, increasing resource extraction, economic opportunities and global forces are all examples of components that challenges the field of conservation biology (Lambin et al. 2001, McShane et al. 2011, Røskaft et al. 2014).

Knowledge about and Attitudes towards Conservation Biology

As presented, human actions threaten the nature and its' functions, and the way most humans live today is not sustainable (Stapp 1969). Therefore programs addressing functions of nature, and how the human behavior affects the environment, have been both encouraged (Stapp 1969) and conducted (Larson et al. 2009, Larson et al. 2010, Erdogan 2011, Zsóka et al. 2013). Such programs have been known as Environmental Education-programs (EE-programs), and aim to affect the awareness, attitudes, skills, sensitivity and participation when it comes to the environment (Stapp 1969, Hungerford and Volk 1990).

Ajzen and Fishbein (1977) claim that a "persons attitude represents his evaluation of the entity in question". Knowledge is defined as "Facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject" (Anonymous 2018).

It is debated to what degree your knowledge and attitude towards an issue will affect your behavior. Considering EE-programs, Hungerford and Volk (1990) address how knowledge earlier often was mistaken as a factor that directly lead to change in behavior. Knowledge is rather one of several factors changing the behavior. Behavior is inconsistent, but studies show that your knowledge and your attitudes will affect behavior to different degrees (Ajzen and Fishbein 1977, Chaffee and Roser 1986, Bradley et al. 1999, Ajzen 2001, Brossard et al. 2005). Regarding conservation knowledge; studies on attitudes on carnivores in Norway, indicated that people with education had the most positive attitudes towards carnivores, and also increasing age led to a more negative attitude (Røskaft et al. 2007). Another study about

recognizing bird species around Serengeti National Park showed that men, people in the age group of 40-42 years and people belonging to the Maasai tribe, recognized bird species the best (Clamsen Mmassy and Røskaft 2013). Another study conducted in the same area, showed that education led to people having a more positive attitude towards conservation areas (Kideghesho et al. 2007).

Adopting new knowledge and attitudes are often connected to the earlier years in life, and Kideghesho et al. (2007) argue that education concerning the environment should be a part of the curriculum in school. Still, from late adulthood, the susceptibility to change in attitude possibly seems to increase again. This is also affected by education, gender and ethnicity (Ajzen 2001). How you adopt knowledge also depends on your culture. Studies show that people with different cultural backgrounds also seem to learn best from different learning approaches. Your culture can imply your world view, beliefs, cognition, know-how and attitudes (Cobern and Aikenhead 1997, Masgoret and Ward 2006).

Tanzania and Kenya

The consequences from humans described initially, applies critically to Africa. Africa is one of the places where the impacts from climate change are expected to be the strongest, and impacts are already observed on ecosystems on this continent (IPCC 2014, Niang et al. 2014). In 2013, about the half of the worlds' poor lived in Sub-Saharan Africa (UN 2017), and hence the effects from climate change affect people in already vulnerable positions to a greater degree than others. In many countries in Sub-Saharan Africa, amongst them both Kenya and Tanzania, people depend on ecosystem services in their daily life. Hence, their livelihood is more sensitive to changes in nature (Røskaft et al. 2014).

Tanzania is known as one of the four mega-biodiversity nations in the world. In Tanzania and Kenya, respectively 30% and 8% of the land cover is within protected land areas to protect the unique biodiversity these countries are housing (Kideghesho et al. 2007, Røskaft et al. 2014). Protection of certain areas started already during the colonial era in Africa. For the local people, this led to a great change of their everyday life. In most cases, they were not allowed to hunt as they used to do in the past, the pasture for cows were limited and areas of importance for their culture could become unavailable for them. This naturally led to a negative view on the national parks amongst the locals (Kideghesho 2010). Today, even if the

protected areas protect important water sources, wildlife and provide currency through tourism, many of the people living in the areas surrounding the park are critical to the limitations the national park requires. The costs local people have to pay from the restraints the national parks put on them, are much higher than the benefits they gain (Igoe 2006). Increase in population growth in such areas is also adding on to the problem, as this again increases the need for natural resources, leading to over exploitation. In addition, these resources are already suffering from change in climate that lead to extreme weather events and unpredictable rain seasons (Røskaft et al. 2014).

Aim of Study

The aim of this study is to have a closer look on the attitudes towards nature to the people living in the Serengeti-Mara ecosystem in Tanzania and Kenya, and investigate whether an environmental educational program affect the knowledge and understanding of ecosystem services and possibly the attitudes towards nature.

Similar programs have been conducted in this area with younger participants in secondary- and primary school (Børresen 2016, Lyamuya et al. 2016). In this study, the participants are grown-ups (eighteen and above). In the studies mentioned above, the results indicated that the participants gained more knowledge from the education program. In light of those results, I predict that the participants in this study will show more knowledge of ecosystem services and the main threats to nature. I also predict that there will be a change in attitudes towards nature. However, considering school education and age, the background to the participants in this study is more heterogenic compared to the participants in the studies mentioned above, which are factors I predict possibly can affect the response.

Methodology

Study Area

The study was conducted in ten villages surrounding Serengeti National Park (SNP) in Tanzania and Maasai Mara National Reserve (MMNR) in Kenya. The villages were the following: Nyiberekela, Machochwe, Makao, Nyanza, Mwantimbwa, Masewa, Oloipiri, Mageri, Sekenani and Orboma (Figures 1, 2). The study took place from the middle of September to the middle of November 2017.

SNP, MMNR and the villages are part of the Serengeti-Mara ecosystem, which covers an area of about 25,000 km^2, stretching across the border between Tanzania and Kenya (Serneels and Lambin 2001). Eight of the study villages were along the sides of SNP (Figure 1), while two of the villages were next to MMNR (Figure 2). SNP covers an area of 14 763 km^2 in northern Tanzania. It is surrounded by Ngorongoro Conservation Area, Maswa Game Reserve, Loliondo Game Controlled Area and MMNR (Nyahongo 2010). The altitude range from 910-1820 m asl (Shin et al. 2017). MMNR covers an area of 1530 km^2, and is located in South-Western Kenya, elevation varying from about 1497-1620 m (Ogutu and Dublin 2002). The inhabitants residing in the areas around SNP and MMNR are predominantly agropastoralists or pastoralists, mainly belonging to the tribes Sukuma, Maasai or Kuria (Lamprey and Reid 2004, Nyahongo 2010)
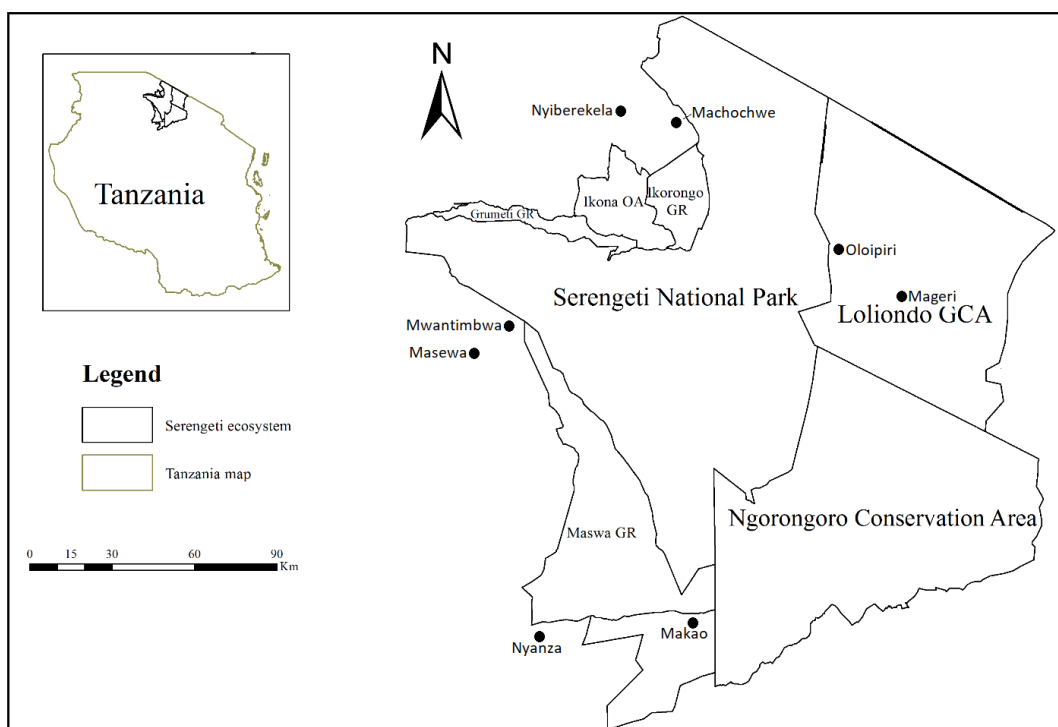
Figure 2. The Kenyan side of the Serengeti-Mara ecosystem. The two villages in Kenya, Sekenani and Orboma, where the project was conducted are indicated with black dots;.

Planning and Implementation of the Study

To plan and implement the study, I was dependent on cooperation with the five Community Facilitators (CFs) the AfricanBioServices project has employed through TAWIRI (Tanzania Wildlife Research Institute) in Tanzania and ILRI (International Livestock Research Institute) in Kenya. The role of the CFs is to be the link between the communities in their respective district and the AfricanBioServices project. Before travelling to Tanzania, the outline for the program and the plan regarding the data collection were communicated to the CFs through mail. Also, two meetings were planned for further discussion regarding the study. During these meetings we went through the project I had planned out and made the needed modifications and planning regarding the implementation of the project in the villages.

The CFs chose two villages in their own district, , and made the needed arrangements. This mainly included coordination of timing, participants and locating a place for the project to be conducted. In Tanzania (Serengeti, Meatu, Bariadi and Loliondo), these arrangements were done through communicating with the Executive Officer in the given villages. He or she

would again communicate with the sub village-leaders, who would pick out possible participants In Kenya (Narok), the CF knew the people living in the villages well enough to make the arrangements himself.

The Project

Including the sampling and data collection, the project took about two hours per day for four consecutive days in each village. Day 1 and day 4, were used for data collection through a questionnaire (appendix 1) and day 2 and day 3 were used for the program. The program was performed using a PowerPoint presentation discussing issues regarding ecosystem services, biodiversity, nature, threats to ecosystem services (focusing on climate change, human population growth and land use change) and the role of the AfricanBioServices project (appendix 2). I talked in English, however, I was assisted by the CF who translated my presentation into Swahili or Maasai, depending on the participants' language. A projector connected to a generator was used to display the PowerPoint presentation (appendix 3). At the end of every day, the participants were paid a small amount of money for their participation in the project. In Tanzania they earned 20 000 Tanzanian shillings in total (5000 tzs per day) and in Kenya they were paid 1400 Kenyan Shillings. This difference in payment was due to difference in currency. They also received a pen to use during the data collection and a pamphlet with information about AfricanBioServices project. They also received a certificate the fourth and last day, as a confirmation on their participation in the program (appendices 4,5).

Data Collection

To gather data, the participants answered a questionnaire (Appendix). The questionnaire was given out two times; the first and the fourth (last) day of the project. The terms "pre-test" and "post-test" refer to the questionnaires answered respectively before and after the program was conducted.

As many of the participants struggled with reading, the questions were displayed on the PowerPoint and explained orally by the CF in Swahili or Maasai. The participants who could not read, were orally asked the questions by the CF or by another of the participants who read well.

The questionnaire answered day-1 was exactly the same as the one answered in day 4. To test if there were any change in views and knowledge before and after the ecosystem services program, the same persons answered both the pre-test and the post-test in every village. The ecosystem services program discussed issues in relation to the questions the participants answered in the questionnaire. Hence, analyzing the differences in the pre-test and the post-test showed if any new knowledge or views were implemented through the ecosystem services program.

Except a few modifications along the way, the project as a whole was performed in the same way in every village.

Sampling

The objective was to gather 30 participants in every village. In reality this number ranged from 28-34, and a total of 604 questionnaires were answered. Of these 309 were pre-test questionnaires, and 295 were post-test questionnaires. Of the 289 participants answered both the pre-test questionnaires and the post-test questionnaires. Yet, some participants ticked off several alternatives where they were only supposed to tick off one. These samples have been excluded from the analysis, and hence the sample size differ from task to task.

As far as possible, we ensured that the Village Executive Officer to pick participants who knew how to read, were equally gender distributed, were 18 or older and had all four days available to participate in the project, but these criteria were not always compatible. 52.8% of the participants were men, 46.0% of the participants were women, and 1.2% did not inform their gender. The average age of the participants were 36.1 years (SD = 13.2, N = 601, lowest age being 15 and the highest age being 100). 19.2 % of the participants had not attended school, 59.9 % had completed primary education, 12.6% had completed secondary education, and 8.1% had completed high school or had higher education. The participants with no education, also lacked reading skills.

By travelling to different geographical areas, different tribes were represented in the sample. Based on the pre-test, the tribes with a representative number of participants were Sukuma (35.8 %), Maasai (33.8 %), Kkuria (8.9 %), Sonjo (7.0 %) and Mwisenye (5.5 %).

The Questionnaire

The questionnaire consisted of 18 different tasks regarding ecosystem services, biodiversity, threats to nature and research (appendix 1). Sixteen of these were questions and two of the tasks implied statements where they were given the choices to agree or disagree through answering "yes" or "no". The participants were also asked to fill inn general information about themselves as gender, age, village, district and tribe (further explained in point 1 below). The questionnaire was translated into Swahili, but there were also copies available in English for those who were able to read English and preferred this (Appendix). The following ten tasks, or parts of them, were used in the analysis:

1) General information about the participant concerning age, gender (male or female), village (Nyiberekela, Machochwe, Makao, Nyanza, Mwantimbwa, Masewa, Oloipiri, Mageri, Sekenani or Orboma), district (Serengeti, Meatu, Bariadi, Loliondo or Narok), education (None, primary, secondary, high school or more) and tribe (Sukuma, Maasai, Mkuria, Sonjo, Mwisenye or other tribes).

2) Question 1: "What services do nature provide?" had 13 alternatives: food, water, roads, timber, pollution, houses, medicines, land, grazing, firewood, tourism, cars and no services. The participants could tick off all the alternatives they meant were correct.

3) Question 3: "What do you regard as a threat to nature?" had five alternatives: climate change, population growth, land use change, wildlife, tourism. The participants were supposed to tick off one of the options. Many of the participants wanted to tick off several of the alternatives, and they were then told to tick off the alternative they meant were the most threatening.

4) Question 4: "What are the consequences of climate change?" had seven alternatives: unpredictable weather, reduced human livelihoods, more tourists, improved roads, more different kinds of plants and animals, changes in temperature and no consequences. The participants could tick off all the alternatives they meant were correct.

5) Question 5 "What do you regard as consequences of human population growth?" had seven alternatives: overexploitation of resources, land use change, more space for crops, more space for each individual, less pressure on the resources from nature, more livestock and no consequences. The participants could tick off all the alternatives they meant were correct.

6) Question 6 "What do you regard as consequences of land use change?" had eight alternatives: habitat degradation, increased human-wildlife conflicts, more tourism, more grazing opportunities, increased dispersal of wildlife, easier to travel, population growth and no consequences. The participants could tick off all the alternatives they meant were correct.

7) Question 8 consisted of 12 statements about nature and humans. The statements were the following: I depend on things provided by nature, I think it is important to protect nature, all human actions that damage nature are reversible, human actions can cause irreversible damage to nature, benefits I get from nature is mostly here for human use, plants and animals are mostly here for human use, benefits from nature is not important to me, it is important to me to protect nature due to the benefits it provides me, benefits from nature is helping me make money, I think is is wise to spread information about nature and threats to nature, I want benefits from nature to be present also in the future, threats to nature will in turn affect me. The participants ticked off "yes" if they agreed, and "no" if they did not agree to the respective statement. 8) Question 9 "What are main threats to nature?" had eight alternatives: new infrastructure, pollution, unpredictable weather, human diseases, overexploitation of resources due to human population growth, harvesting of wildlife, schools and education, and protected areas. The participants ticked off "yes" if they meant the alternatives were a threat, and "no" of they did not mean the alternative were a threat to nature.

9) Question 10 "What are the three most important benefits nature provide you with?" had twelve alternatives: food, water, timber, firewood, hunting, land for settlement, crops,medicines, clean air, livestock, grazing, water storage. The participants were to tick off the three alternatives they found the most important.

Analyses and Statistics

The statistical analyses were conducted using the software Statistical Package for Social Science (SPSS) version 24. Chi-square tests were used to reveal if the differences between the pre-tests and the post-tests were statistically significant. On the questions where there were more than two possible alternatives to answer, post-hoc tests were performed on all alternatives by doing chi-square tests on the response to the respective alternative compared to the response to all the other alternatives combined.

To investigate the statistically significant differences, binary logistic regression were performed on the questions were the response had two possible alternatives, and multinomial

logistic regression were used on the questions where the response had more than two possible alternatives. The dependent variables were the alternatives or the statements to the given question. The independent variables tested were "round number" (difference in response between the pre-test and the post-test), "district" (the given district the participant resided in), "completed education level" (what level in school the participant had fulfilled), "gender" (male or female) and "age" (less than 24, 25-39, 40-54, >55 years).

Chi-square tests were performed on the response connected to the statistically significant independent variables. This test were performed on the total response and on the response in the pre-test and the post-test to investigate the effect of the independent variable in light of the education program.

Bonferroni corrections have not been conducted as the number of statistical tests performed on the same data were low. However, the lack of this can be a reason to why some of the results are unexpectedly statistically significant.

Ethical Note

NTNU and TAWIRI approved this project before it was conducted. Also, all the participants attended the project voluntarily. Before arriving to a new village, the Village Executive Officer was always contacted to be informed about the project. As the study do not look at individual performance when comparing the pre-test and the post-test, but at the performance in groups, all participants are anonymous. Also, all participants were asked whether they were comfortable with their picture taken during the program. Additionally, the pictures were shown the last day of the program for the participants to see.

Results

Response to Questions about Ecosystem Services

In Question 1 "What kind of services does nature provide", the ticking frequency differed statistically significant between the pre-test and post-test to six of the alternatives: "food", "pollution", "medicines", "tourism", "cars" and "no benefits" (Table 1). The response to the other alternatives did not differ statistically significantly (chi-square tests, NS) (appendix 6).

Table 1: The alternatives with a statistically significant change between the pre-test and the post-test in response to the question "What kind of services does nature provide?". The participants could tick off all the given alternatives they meant were correct.

Alternatives	% ticked pre-test (N = 308)	% ticked post-test (N = 289)	% change	χ^2	P ≤
Food	51.9	66.8	+14.8	13.58	0.0001
Medicines	52.3	65.7	+13.5	11.17	0.001
Tourism	65.3	56.1	-9.2	5.30	0.021
No benefits	8.8	0.7	-8.1	21.03	0.0001
Cars	14.9	8.7	-6.3	5.62	0.018
Pollution	8.8	4.5	-4.3	4.35	0.037

Binary logistic regression analyses performed on the dependent variables in table 1 showed that "round number" was statistically significantly affecting five of the variables, while "education level", "district" and "gender" affected the outcome statistically significantly to two, three or four of the dependent variables (Table 2).

Table 2. Binary logistic regression analysis performed on the statistically significant alternatives from Table 1 as dependent variables. The tested independent variables are "age", "gender", "district", "education" and "round number".

Dependent variable	Wald	R^2	P ≤	Round number (P ≤)	Other significant variables (P ≤)
Food	20.27	0.043	0.0001	0.0001	
Medicines	18.84	0.061	0.0001	0.001	Education (0.018)
Tourism	29.0	0.065	0.0001	0.014	Gender (0.001) Education (0.009)
No benefits	242.0	0.191	0.0001	0.0001	Gender (0.046) District (0.047)
Cars	248.1	0.082	0.0001	0.027	District (0.0001) Education(0.043)
Pollution	255.4	0.063	0.0001	0.063	Education (0.012)

In the case of the dependent variable "food", "round number" was the only statistically significant independent variable (table 2). The total response to the dependent variable "medicines" however, were statistically significant affected by the independent variable "education" ($\chi2 = 22.959$, df = 3, p ≤ 0.0001) in addition to "round number" (table 2). The two highest levels of education also had the highest frequency of ticking this alternative (No school 56.0%, primary 53.5%, secondary 81.6%, high school and further education 69.4%). The response were also statistically significant in the pre-test ($\chi2 = 8.928$, df = 3, p = 0.030) and in the post-test ($\chi2 = 16.450$, df = 3, p = 0.001), both showing the same trend within the education groups (no school 50.8% / 62.3%, primary 47.2% / 60.0%, , secondary 70.0% / 94.4% and high school and more 66.7%/ 72.0%).

The dependent variable "tourism" was affected statistically significantly by the independent variables "gender" and "education" in addition to "round number" (table 2). The frequency of men ticking off this alternative was statistically significantly higher than the frequency of women ($\chi2 = 13.8$, df = 1, p ≤ 0.0001; men 68.1%, women 53.1%). The differences in ticking frequency between the genders were statistically significant in both the pre-test ($\chi2 = 6.8$, df = 1, p = 0.009; men 72.5% and women 57.9%) and the post-test ($\chi2 = 7.101$, df = 1, p = 0.008; men 63.4% and women 48.1%). "Education" affected the answers statistically significantly in total ($\chi2 = 13.6$, df = 3, p = 0.003) and in the post-test ($\chi2 = 12.725$, df = 3, p = 0.005). Participants with secondary school education had the highest frequency ticking this alternative

(No school 51.7%, primary 59.8%, secondary 77.6% and high school or further education 65.3%). The same trend was present in the post-test (No school 39.6%, Primary 62.9%, Secondary 77.8% and high school and more 56.0%).

The response to the independent variable "No benefits" was affected statistically significantly by "gender" and "district" (table 2). The frequency of women ticking off "no benefits" were statistically significantly higher than the men ($\chi2 = 4.007$, df = 1, p = 0.045; women 12.1% and men 5.6%). The response to the post-test and the response in total were not statistically significant. For "district", there were no statistically significant difference between the response in total or the pre-test and post-test tested separately.

The dependent variable "pollution" was only affected statistically significantly by the independent variable "education level" ($\chi2 = 8.215$, df = 3, p = 0.042) (table 2). The frequency of participants ticking pollution as a service from nature, declined with increasing education (No school 10.3%, Primary 7.1%, Secondary 2.6%, High School or further education 0.0%). The differences within the pre-test and the post-test did not differ statistically significant (chi-square test, NS).

The response to the dependent variable "cars" were statistically significant affected by the independent variable "districts" ($\chi2 = 22.672$, df = 4, p ≤ 0.0001) in addition to round number (table 2). Participants in Serengeti had the highest frequency of participants ticking this alternative (Serengeti 24.3%, Meatu 12.0%, Bariadi 9.2%, Loliondo 6.5% and Narok 11.9%). The difference in ticking frequency were statistically significant in the pre-test ($\chi2 = 28.6$, df = 4, p = 0.0001; Serengeti 36.7%, Meatu 14.3%, Bariadi 8.3%, Loliondo 7.8% and Narok 9.1%), but not in the post-test.

For question 10 "What do you regard as the three most important benefits nature provide?" the frequency of ticking changed statistically significantly between the pre-test and the post-test to four of the alternatives; "medicines", "food", "water storage" and "crops" (table 3). The frequency of ticking the other alternatives were not statistically significant (chi-square tests, NS) (appendix 6).

Table 3. The alternatives with a statistically significant change between the pre-test and the post-test in response to the question "What do you regard as the three most important benefits nature provide?". Out of twelve alternatives, the participants had to choose the three they considered the most important.

Alternatives	% ticked pre-test (N = 286)	% ticked post-test (N = 236)	% change	Df	χ2	P ≤
Medicines	23.1	36.9	13.8%	1	11.86	0.001
Food	45.8	57.6	11.8%	1	7.23	0.007
Water storage	25.9	16.5	9.4%	1	6.66	0.01
Crops	14.0	8.1	5.9%	1	4.54	0.033

The analyses from the binary logistic regression showed that the independent variable "round number" was statistically significant to all the alternatives in table 3. To the alternatives "water storage" and "crops", "round number" was the only statistically significant independent variable (table 4).

Table 4. Binary logistic regression analyses performed on the statistically significant alternatives from the question "What do you regard as the three most important benefits nature provide?" as dependent variables. The tested independent variables are "age", "gender", "district", "education" and "round number".

Dependent variable	Wald	R²	P ≤	Round number P ≤	Other significant variables (P ≤)
Medicines	78.30	0.079	0.0001	0.0001	District (0.0001)
Food	0.071	0.077	0.790	0.003	Education (0.001) Gender (0.003) District (0.044)
Water storage	148.6	0.059	0.0001	0.002	
Crops	215.8	0.037	0.0001	0.049	

"Medicines" were statistically significant affected by "district" in addition to round number (table 4). The difference between the districts was only statistically significant in the response to the pre-test ($\chi2 = 10.206$, df = 4, p = 0.037). Both in Meatu and Bariadi, the frequency ticking off "medicines" is high (Meatu 78.0% and Bariadi 78.9%), while it is lower in the other districts (Serengeti 58.5%, Loliondo 55.6% and Narok 63.8%).

"Food" was affected statistically significantly by "education", "district" and "gender" in addition to "round number" (table 4). "Food" was ticked off statistically significantly more by women than men in the total response ($\chi2 = 10.467$, df = 1, p = 0.001; women 58.8% and men 44.4%). The difference was also statistically significant in the pre-test ($\chi2 = 9.154$, df =

1, p = 0.002; men 37.7% and women 55.9%), but not in the post-test. Also "education level" affected this result. Participants without schooling had a statistically significant higher frequency ticking this alternative ($\chi2$ = 37.734, df = 3, p ≤ 0.0001; no school 76.5%, primary 44.2%, secondary 37.5% and high school or further education 56.4%) This difference was statistically significant in both the pre-test ($\chi2$ = 25.969, df = 3, p = 0.0001; no school 73.3%, primary 38.8%, secondary 29.7% and high school and further education 47.4%) and the post-test ($\chi2$ = 13.840, df = 3, p = 0.003; no school 81.1%, primary 38.8%, secondary 45.7% and high school and further education 65.0%). "District" also affected "food" statistically significant ($\chi2$ = 46.1, df = 4, p ≤ 0.0001). The participants in all districts had a high frequency of ticking this alternative except for Bariadi (Serengeti 65.3%, Meatu 63.75, Bariadi 31.6%, Loliondo 58.3% and Narok 73.3%). This difference was statistically significant in both the pre-test ($\chi2$ = 43.447, df = 4, p = 0.0001; Serengeti 66.7%, Meatu 66.7%, Bariadi 15.8%, Loliondo 49.2%, Narok 65.5%) and the post-test ($\chi2$ = 15.475, df = 4, p = 0.004; Serengeti 63.4%, Meatu 60.5%, Bariadi 47.4%, Loliondo 71.1% and Narok 83.0%).

Response to Questions Regarding Threats to Nature

The response to question 3 "What do you regard as the main threat to nature?" differed statistically significantly between the pre-test and the post-test ($\chi2$ = 12.29, df = 4, p = 0.015). In both tests, most people ticked off "Climate Change" as the main threat, but the frequency fell with 8% between the pre-test and the post-test (table 5). When performing the post-hoc test (specified in methods) the only alternative with a statistically significant difference between the pre-test and the post-test was "population growth" ($\chi2$ = 3.611, df = 1, p = 0.011).

Table 5. The response to the question "Today we see nature is changing. What do you regard as the main threat to nature?". The participants had to tick one of the five options given in the left column in the table.

Alternatives	% ticked pre-test (N = 288)	% ticked post-test (N = 264)	% change
Climate Change	57.1	48.9	-8.2
Population Growth	29.8	40.2	+10.4
Land Use Change	3.5	6.1	+2.6
Wildlife	5.5	2.7	-2.8
Tourism	4.2	2.3	-1.9

The multinomial logistic regression analysis was performed with the alternatives to question 3 as dependent variables. All independent variables tested were affecting the result statistically significant, except for "age" (table 6).

Table 6. A multinomial logistic regression analysis performed on the response to thequestion "What do you regard as the main threat to nature?". The independent variables tested are "age", "gender", "districts", "education" and "round number". Pseudo-R^2 = 0.225.

Independent variable	$\chi 2$	Df	P $\leq$
District	33.951	16	0.006
Education	25.248	12	0.014
Gender	16.518	8	0.036
Round Number	11.924	4	0.018
Age	15.07	12	0.238

Results showed that the independent variable "district" affected the response to the above question in total response ($\chi 2$ = 43.3, df = 16, p $\leq$ 0.0001) and within the pre-test ($\chi 2$ = 31.236, df = 16, p = 0.013). In all districts, "climate change" and "population growth" were the most ticked alternatives (table 7). This also applied when only considering the pre-test (table 8). The response to the post-test did not differ statistically significant between the districts (chi-square test, NS).

Table 7. The frequencies of ticking in total to the question "Today we see nature changing. What do you regard as the main threat to nature?" considered in light of districts (left column). The possible alternatives are given in the first row.

Total	Climate change (%)	Population growth(%)	Land use change(%)	Wildlife (%)	Tourism (%)
Serengeti	60.0	20.9	5.5	13.8	3.4
Meatu	54.8	31.7	1.9	7.1	5.4
Bariadi	47.4	43.1	6.0	3.5	1.8
Loliondo	53.1	32.7	7.1	1.6	8.1
Narok	50.5	45.0	2.8	1.8	1.8

Table 8. The frequencies of ticking in the pre-test to the question "Today we see nature changing. What do you regard as the main threat to nature?" considered in light of districts (left column). The possible alternatives are given in the first row.

Pre-test	Climate change (%)	Population growth (%)	Land use change (%)	Wildlife (%)	Tourism (%)
Serengeti	60.3	17.2	5.2	13.8	3.4
Meatu	62.5	23.2	1.8	7.1	5.4
Bariadi	59.6	33.3	6.5	3.5	1.8
Loliondo	56.5	27.4	1.8	1.6	8.1

Narok	45.5	49.5	3.5	1.8	1.8

Completed education level also affected the answers statistically significantly ($\chi 2$ = 22.143, df = 12, p = 0.036). In all the groups the frequency of ticking climate change was highest, but the participants with no schooling had a frequency of ticking "population growth" almost as high as "climate change" (table 9). There was also some more variation in the response to the two lowest education groups. The difference between the education levels were also statistically significant in the pre-test ($\chi 2$ = 21.082, df = 12, p = 0.049), but not in the post-test (chi-square test; NS). The same tendencies as mentioned also applied to the pre-test (table 10).

Table 9 . The frequencies of ticking in the total to the question "Today we see nature changing. What do you regard as the main threat to nature?" considered in light of education level (left column). The possible alternatives are given in the first row.

Total	Climate change (%)	Population growth (%)	Land use change (%)	Wildlife (%)	Tourism (%)
No school	49.5	40.0	3.8	3.8	2.9
Primary	51.8	31.7	6.6	5.7	4.2
Secondary	63.5	36.5	0.0	0.0	0.0
High school +	55.3	42.1	0.0	0.0	2.6

Table 10. The frequencies of ticking in the pre-test to the question "Today we see nature changing. What do you regard as the main threat to nature?" considered in light of education level (left column). The possible alternativs

Pre-test	Climate change (%)	Population growth (%)	Lan use change (%)	Wildlife (%)	Tourism (%)
No school	45.6	43.9	1.8	3.5	5.3
Primary	59.6	22.8	5.3	8.2	4.7
Secondary	65.0	35.0	0.0	0.0	0.0
High school +	57.9	36.8	0.0	0.0	5.3

are given in the first row.

For the independent variable "gender", the answers in total differed statistically significantly between males and females ($\chi 2$ = 12.827, df = 4, p = 0.012). Men had a higher frequency ticking off the alternative "climate change" than women. Also, the frequency amongst women ticking the alternative "land use change" as the main threat were higher than with the men (men: climate change 57.3%, population growth 36.0%, land use change 2.4, wildlife 1.7,

tourism 2.4%. Women: climate change 48.8%, population growth 33.2%, land use change 7.3%, wildlife 1.7% and tourism 2.4%). The statistically significant difference between the genders were not present when testing within pre-test or post-test (chi-square tests, NS).

Response to Consequences to Climate Change, Human Population Growth and Land Use Change

The response to question 4 "What do you regard as consequences to climate change?" changed statistically significant between the pre-test (N = 285) and the post-test (N = 259) for the alternative "changes in temperature" ($\chi2$ = 11.78, df = 1, p = 0.003). The frequency of ticking this alternative increased by 13.3% from 54.9% in the pre-test to 68.2% in the post-test. The other six alternatives did not change statistically significant (chi-square tests, NS) (Appendix6).

The binary regression analyses showed that the independent variables "district" and "education" affected the response statistically significantly in addition to round number (table 11). Serengeti had the lowest frequency of ticking this alternative, while Bariadi and Narok had the highest frequencies ($\chi2$ = 26.440, df = 4, p $\leq$ 0.0001; Serengeti 48.7%, Meatu 54.6%, Bariadi 72.0%, Loliondo 61.8% and Narok 75.6%). The difference between the districts were also statistically significant both within the pre-test ($\chi2$ = 15.810, df = 4, p = 0.003) and the post-test ($\chi2$ = 26.440, df = 4, p = 0.002). Whilst Narok had the highest frequency in the pre-test, Bariadi ended up with the highest frequency in the post-test due to a strong increase between the pre-test and the post-test (Pre-test: Serengeti 46.7%, Meatu 42.9%, Bariadi 59.3% and Loliondo 57.8% and Narok 74.6%. Post-test: Serengeti 50.9%, Meatu 67.3%, Bariadi 84.7%, Loliondo 66.1% and Narok 76.6%). The response also differed statistically significant between the different education levels ($\chi2$ = 24.826, df = 3, p $\leq$ 0.0001), the tendency being that the two highest levels of education had the highest frequencies of ticking (No school 62.9%, primary 56.7%, secondary 80.3% and high school and further education 83.7%). The difference was also statistically significant both in the pre-test ($\chi2$ = 13.166, df = 3, p = 0.004) and the post-test ($\chi2$ = 12.498, df = 3, p = 0.006). The same tendencies were the same as in the total response (No school 55.6% / 71.7%, primary 50.6% / 62.9%, secondary 75.0% / 86.1% and high school and further education 79.0% / 88.0%).

The response to question 5 "What do you regard as consequences to population growth" also changed statistically significant between the pre-test (N = 289) and the post-test (N = 264) to

one of the alternatives, namely "land use change" (χ2 = 11.97, df = 1, p = 0.001). The frequency of ticking this alternative increased by 14.7%, from 48.6% in the pre-test to 63.35% in the post-test. The other six alternatives did not change statistically significant (chi-square tests, NS) (appendix 6).

The binary regression analyses showed that the independent variables "district" and "education" affected the response statistically significantly in addition to "round number" (table 11). The difference between the districts were statistically significant in the total response (χ2 = 27.395, df = 3, p ≤ 0.0001) and in the response to both the pre-test (χ2 = 25.573, df = 3, p ≤ 0.0001) and the post-test (χ2 = 17.452, df = 4, p = 0.002). All showed the same tendency with the two highest education levels having the highest frequency (Total response: No school 57.8%, secondary 49.9%, secondary 76.3% and high school or further education 77.6%. Pre-test: No schooling 54.0% and primary 39.3%, secondary 80.0% and high school and more 66.7%. Post-test: no schooling 62.3% and primary 60.6%, secondary 72.2% and high school and more 88.0%). The highest increase in frequency was found with primary and high school or further education. District also affected the frequency of ticking this alternative in the total response (χ2 = 23.759, df = 4, p ≤ 0.0001) and both the pre-test (χ2 = 15.330, df = 4, p = 0.004) and the post-test (χ2 = 17.452, df = 4, p = 0.002). The total response and the pre-test showed that Narok had the highest frequency. However, due to a big increase between the pre-test to the post-test, Bariadi and Loliondo had almost as high frequency as Narok in the post-test (Total response: Serengeti 50.4%, Meatu 42.6%, Bariadi 58.0%, Loliondo 58.5% and Narok 72.3%. Pre-test: Serengeti 50.0%, Meatu 37.5%, Bariadi 45.0% and Loliondo 43.8%, Narok 69.7%. Post-test: Serengeti 50.9%, Meatu 48.1%, Bariadi 71.2% and Loliondo 74.6% and Narok 75.0%).

The response to question 6 "What do you regard as consequences to land use change?" changed statistically significant between the pre-test (N = 289) and the post-test (N = 264) to two of the alternatives. The alternative "human population growth" increased with 18.0%, from 49.6% in the pre-test to 67.8% in the post-test (χ2 = 19.89, df = 1, p ≤ 0.0001). The alternative "easier to travel" increased by 7.1% from the 3.2% in pre-test to 10.4% the post-test (χ2 = 12.21, df = 1, p ≤ 0.0001). The other alternatives did not change statistically significant (chi-qsuare test, NS) (appendix 6)

According to the binary regression analyses, the independent variable "gender" was statistically significant to the alternative "population growth" in addition to round number (table 11). The differences between gender were statistically significant in the total response

($\chi 2$ = 8.664, df = 1, p = 0.003) and also within the pre-test ($\chi 2$ = 14.965, df = 3, p = 0.002) and the post-test ($\chi 2$ = 3.977, df = 1, p = 0.046). All responses showed that the frequency of ticking this alternative were higher with men than women (Total response: men 64.3% and women 52.4%. Pre-test: men 55.9% and women 42.9%. Post-test: men 73.2% and women 62.2%).

No independent variable but "round number" were statistically significant to the response to "easier to travel" (table 11).

Table 11. Binary regression analyses performed on the alternatives from question 4 "What do you regard as consequences from climate change" (Q4), question 5 "What do you regard as consequences from population growth" (Q5) and question 6 "What do you regard as consequences from land use change?"(Q6) with a significant difference in response from the pre-test to the post-test as dependent variables. The participants could tick all the alternatives they meant were correct. The independent variables tested were age, district, gender, education and round number.

Dependent variable	Wald	R^2	P $\leq$	Round number (P $\leq$)	Other significant independent variables (P $\leq$)
Change in Temperature (Q4)	40.25	0.099	0.0001	0.001	District (0.0001) Education (0.010)
Land Use Change (Q5)	11.323	0.111	0.001	0.0001	District (0.0001) Education (0.016)
Population growth (Q6)	17.09	0.084	0.0001	0.0001	Gender (0.003)
Easier to travel (Q6)	255.8	0.061	0.0001	0.001	

Attitudes towards Nature and Threats to Nature

The response to three of the twelve statements in question 8, differed statistically significantly between the pre-test and the post-test. These were the statements "I depend on things provided by nature", "Benefits I get from nature is mostly here for human use" and "Benefits from nature is helping me make money" (Table 12). All three alternatives experienced an increase in the frequency ticking "yes". The other statements did not experience a statistically significant change between the pre-test and the post-test (chi-square tests, NS) (appendix 6).

Table 12. The frequency ticking off "yes" to the statements given in the left column. The participants could answer with either "yes" or "no".

Statements	% yes pre-test (N)	% yes post-test (N)	% change	$\chi 2$	P$\leq$

I depend on things provided by nature	87.2 (290)	95.7 (279)	+8.5	12.92	0.0001
Benefits I get from nature is mostly here for human use	87.8 (287)	93.0 (273)	+5.2	4.40	0.036
Benefits from nature is helping me make money	84.5 (284)	91.4 (266)	+6.9	6.018	0.014

Binary logistic regression analysis were conducted on the statements presented in Table 12 as dependent variables. To the statement "I depend on things provided by nature" both the independent variables "round number" and "district" were statistically significant. To the statement "Benefits I get from nature is mostly here for human use", none of the independent variables tested were statistically significant. To the statement "Benefits from nature is helping me make money", the only statistically significant independent variable was "round number" (table 13).

Table 13. Binary logistic regression analyses performed on the statements in table 12 as dependent variables. Possible independent variables are "round number", "age", "education level" and "district".

Dependent variable	Wald	R^2	$P \leq$	Round number $(P \leq)$	Other significant independent variables $(P \leq)$
a) I depend on things provided by nature	245.520	0.092	0.0001	0.001	District (0.011)
e) Benefits I get from nature is mostly here for human use	239.942	0.022	0.0001	0.078	
i) Benefits from nature is helping me make money	228.95	0.032	0.0001	0.048	

The difference between the districts' response to "I depend on things provided by nature" were statistically significant in the response in total ($\chi2 = 39.050$, df = 4, $p \leq 0.0001$), and in the pre-test ($\chi2 = 37.957$, df = 4, $p \leq 0.0001$). Most participants agreed to these statements, but Bariadi had a lower frequency ticking yes to this alternative than the other districts. This tendency was present both in the total response (Serengeti 92.5%, Meatu 93.3%, Bariadi 78.4%, Loliondo 92.9% and Narok 100%) and even stronger when only considering the response to the pre-test (Serengeti 89.1%, Meatu 90.6%, Bariadi 64.8%, Loliondo 91.5%, Narok 100%).

In question 9, four of the suggested threats to nature showed a statistically significant difference in frequency of ticking between the pre-test and the post-test. These four were

"New infrastructure", "Pollution", "Human diseases" and "Overexploitation of resources due to human population growth" (table 14). All the statistically significantly differences were due to an increase in the frequency ticking "yes". The other suggested threats did not experience a statistically significant change in frequency between the pre-test and the post-test (chi-square tests, NS) (appendix 6).

Table 14. Frequency of the response to statements described in the table under**.** The participants were to consider whether they regarded the given factor as a threat to nature. The participants chose either "yes" or "no". % change indicates the change in frequency answering yes from the pre-test to the post-test.

Statements	% yes pre-test (N)	% yes post-test (N)	% change	$\chi 2$	P≤
New infrastructure	41.7 (278)	68.4 (269)	+26.7	39.280	0.0001
Pollution	85.5 (297)	92.0 (264)	+6.5	5.885	0.015
Human diseases	39.4 (269)	50.6 (257)	+11.2	6.639	0.010
Overexploitation of resources due to human population growth	83.8 (284)	93.3 (269)	+9.5	12.198	0.0001

Binary logistic regression analyses were conducted with the suggested threats presented in table 14 as dependent variables. To all the statements, "round number" was statistically significant. "District", "gender" and "completed education level" were also statistically significant to one or two of the dependent variables (table 15).

Table 15. Binary logistic regression analyses performed on alternatives from Table 7 as dependent variables. In addition to round number, age, gender, district, education are the tested independent variables.

Dependent variable	Wald	R^2	P ≤	Round number (P ≤)	Other significant independent variables (P ≤)
New infrastructure	6.228	0.118	0.013	0.0001	District(0.004)
Pollution	231.9	0.105	0.0001	0.011	Gender (0.0001) Education (0.016)
Human diseases	5.015	0.067	0.025	0.014	District (0.0001)
Overexploitation due to human population growth	228.731	0.130	0.0001	0.001	District (0.0001)

For the statement "New infrastructure", the difference between the districts were statistically significant in the total response ($\chi 2$ = 17.073, df = 4, p = 0.002), and also in both the pre-test ($\chi 2$ = 13.428, df = 4, p = 0.009) and the post-test ($\chi 2$ = 18.460, df = 4, p = 0.001). Loliondo

stood out with the highest frequency of ticking "yes" compared to the other districts, Serengeti having the lowest frequency (Serengeti 43.1, Meatu 52.9%, Bariadi 52.3%, Loliondo 70.8%, Narok 56.8%). However, in the pre-test Meatu and Bariadi had the lowest frequencies (Serengeti 41.5%, Meatu 28.6%, Bariadi 30.8%, Loliondo 59.9%, Narok 46.2%). Due to a heavy increase in frequency of ticking "yes" between the pre-test and the post-test to all districts except Serengeti, Serengeti had the lowest frequency in the post-test (Serengeti 44.9%, Meatu 76.5%, Bariadi 70.2%, Loliondo 82.4%, Narok 67.2%).

To the alternative "pollution", "gender" and "education" were affecting statistically significantly in addition to "round number". Women and men responded statistically significantly different in the total response ($\chi2 = 15.904$, df = 1, $p \leq 0.0001$) and both in the pre-test ($\chi2 = 12.697$, df = 1, $p \leq 0.0001$) and the post-test ($\chi2 = 3.907$, df = 1, p = 0.049). Men had a higher frequency of ticking "yes" than women, but the frequency increased more for women between the pre-test and the post-test (Total response: Male 93.4% and women 82.5%. Pre-test: men 91.9% and women 76.9%. Post-test: men 95.0% and women 88.5%). The difference between the education levels were statistically significant in the total response ($\chi2 = 8.385$, df = 3, p = 0.039) and in the pre-test ($\chi2 = 10.880$, df = 3, p = 0.012), but not in the post-test. Both showed the same tendencies in the response, with participants with no school having the lowest frequency ticking this alternative. However, these participants had the highest increase in frequency to between the pre-test and the post-test (+23%) (total response: no school 83.3%, primary 87.6%, secondary 87.6%, high school and further education 94.7%. Pre-test: no school 72.9%, primary 86.2%, secondary 94.9%, high school and more 91.7%).

The frequency answering "yes" to "human diseases", were statistically significantly different between districts in the total response ($\chi2 = 36.904$, df = 4, $p \leq 0.0001$) and in both the pre-test ($\chi2 = 36.524$, df = 4, $p \leq 0.0001$) and the post-test ($\chi2 = 17.442$, df = 4, p = 0.002). Considering the total response, Narok had the highest frequency of ticking this alternative (Serengeti 41.3%, Meatu 38.9%, Bariadi 26.9%, Loliondo 47.9%, Narok 65.6%). The same tendency applied to the pre-test; Narok district had the highest frequency of ticking "yes" to this question than the other districts (Serengeti 29.1%, Meatu 34.8%, Bariadi 23.1% and Loliondo 32.1%, Narok 72.1%). Due to a heavy increase in the frequency of ticking "yes", Loliondo had the highest frequency in the post-test (Serengeti 55.1%, Meatu 42.6%, Bariadi 29.6%, Loliondo 66.7% and Narok 59.7%).

The alternative "overexploitation due to human population growth" was affected statistically significantly by "district" in addition to "round number" (table 15). The total response was

statistically significant ($\chi2$ =31.419, df = 4, p $\leq$ 0.0001), and this also applied to the pre-test ($\chi2$ = 16.390, df = 4, p = 0.003) and the post-test ($\chi2$ = 19.178, df = 4, p = 0.001). Serengeti had the overall lowest frequency of ticking, despite a high increase in frequency of ticking "yes" between the pre-test and the post-test. Loliondo and Narok had the highest frequencies in both the pre-test and the post-test (Total response: Serengeti 72.9%, Meatu 90.7%, Bariadi 91.1%, Loliondo 94.4% and Narok 91.9.0%. Pre-test: Serengeti 66.7%, Meatu 84.0%, Bariadi 89.5%, Loliondo 93.1% and Narok 85.0%. Post-test: Serengeti 80.0%; Meatu 97.8%, Bariadi 93.0%, Loliondo 96.2% and Narok 98.4%).

Discussion

My results suggest that the education program affected adults to a lesser degree than children in primary and secondary school. Compared to Lyamuya et al. (2016) and Børresen (2016), there were not as many significant differences between the pre-test and the post-test. Furthermore, the frequency ticking the expected alternatives were lower when comparing to those studies. This indicates that the learning curve was steeper in younger school children than adults, supporting Kideghesho et al. (2007) when claiming that environmental education is important to implement in young age.

However, the results indicate that education program have contributed to more understanding of ecosystem services and their importance to the adult participants, which coincides with what was predicted. This will be further discussed below, after considering possible biases in the present study, and after a more in depth look at my results.

There are several potential biases regarding my findings. Firstly, there are many indications that the questionnaire was too long. This seemed to make many of the participants loose interest as the time proceeded, possibly decreasing the accuracy of the response to the questionnaire.In almost all of the villages where the study was conducted, the questionnaire was pointed out by one or more of the participants to be too long. Bosnjak and Tuten (2001) pointed out how respondents can lose the interest during a survey, even if they originally were motivated to respond. Unmotivated respondents, and how this can affect the quality of the study, was also addressed by Huang et al. (2012). If participants are bored by a survey, this can lead them to repeatedly only answer one specific answer (Johnson et al. 2004). Also,

some of the topics in the questionnaire was not always as thoroughly discussed during the program as planned, as time often passed faster than planned, leading to the correspondence between the program and the questionnaire to be a possible bias.

Secondly, many of the respondents struggled with reading the questions in the questionnaire either due to poor reading skills or the small font size, or a combination of the two, possibly leading to misunderstandings and further demotivation. Moreover, some of the participants could not read at all, and had to get help from the CF of other participants to fill out the questionnaire. According to Bosnjak and Tuten (2001), participants that experience challenges during a survey can fully lose the interest in answering the survey. In addition, the fact that the same questionnaire was given out twice, some participants can have changed their answer in the post-test just to answer differently from the pre-test.

Thirdly, the translation to the participants during the program may be another bias. In Serengeti, Meatu, Bariadi and one of the two villages in Loliondo, the program were taught in Swahili, which was a second language of the participants. To me and the CFs, English is a second language. Thus, translations between different second languages can have led to poor formulations, which again can have led to misunderstandings, and then the recipients might have had a different understanding than my initial intention. Brislin (1970) found that the quality of translation seemed to be highly connected to the translators knowledge of the language that he or she was translating from and to their preparations before the translation. Even though the program was discussed between me and the CFs, there were no exact manuscript. Furthermore, it was not possible to prepare for all questions from the participants before the program, which again might have made the translation more difficult and hence more inaccurate.

Finally, the presentation itself could be a bias. In some of the places, light from outside affected the quality of the Power Point presentation. Furthermore, the participants were not always comfortably seated, as there was a lack of chairs in some of the villages. This discomfort might have affected their focus during the program.

The questions

The significant differences between the pre-test and the post-test indicates that many of the participants gained better understanding of ecosystem services and what their main threats are. Comparable studies, though many of them performed on school children, also support the findings on how environmental education increase environmental knowledge (Larson et al. 2009, Larson et al. 2010, Zsóka et al. 2013, Børresen 2016, Lyamuya et al. 2016). Also, a study on students in high school and university in Hungary showed how environmental education affected their environmental knowledge, and also their attitudes regarding the environment (Zsóka et al. 2013). Kollmuss and Agyeman (2002) argued that education was affecting the knowledge, which again was important when it comes changed attitude and behavior regarding conservation biology.

Yet, many of the alternatives and statements showed no statistically significant difference between the pre-test and the post-test. This conform to a study by Erdogan (2011), where no statistically significant change in the participants knowledge were shown after the program. This could be due to the participants having a lot of knowledge from before. Gadgil et al. (1993) point out how indigenous people live directly of nature, therefore they already know the connection between the biodiversity and conservation.Motivation is also an important factor when it comes to increase in knowledge about the environment from educational programs(Zsóka et al. 2013). Hence, if the motivation was missing, this can possibly have affected the willingness to learn.

Questions about Ecosystem Services

When it comes to understanding of ecosystem services, the participants showed a great deal of knowledge already in the pre-test. According to the results in question 1 "what do you regard as an ecosystem service?", this understanding increased during the program as the participants showed more knowledge about almost 50% of the suggested ecosystem services("Food", "Medicines", "Pollution", "Cars" and "No benefits"). This increase in knowledge coincides with the studies on similar programs conducted on students in schools and universities in America, Tanzania and Hungary (Larson et al. 2009, Larson et al. 2010, Zsóka et al. 2013, Børresen 2016, Lyamuya et al. 2016)

Furthermore, "food" and "medicines" were also amongst the ecosystem services that the participants prioritized more after the education program, according to the response to question 10 "which three ecosystem services do you find the most important?". The change can possibly be due to more knowledge obtained during the program, indicated by the results to the first question. How knowledge affects your attitudes coincides with Kollmuss and Agyeman (2002) and Kideghesho et al. (2007).

The results from question 10 (see paragraph above) also showed a significant decrease to the two alternatives "water storage" and "crops". As the participants in the study are anonymous, it was not possible to compare the pre-test and the post-test to the same question. Hence, whether the significant decrease between the pre-test and the post-test can be linked to the significant increase for choosing "food" and "medicines" is not possible to say. Food and medicines were discussed to a larger degree than water storage and crops. Also, during one of the activities where the participants listed up different benefits from nature themselves, food and medicines were mentioned by almost all groups, possibly making more participants conscious about the importance of these ecosystem services. In addition, crops leads to food, which to some degree makes ticking both unnecessary.

However, the frequency ticking the alternative "tourism" in question 1 (see paragraph above), *decreased* significant between the pre-test to the post-test. As ttourism was intended to be taught as an ecosystem service during the program, this result was not expected. However, locals in Tanzania do consider tourism as a limiting factor to natural resources (Luvanga and Shitundu 2003). Considering how direct benefits from natural resources like food and medicines probably were most emphasised during the program, tourism can have been considered to these. In the activity mentioned above, few groups mentioned tourism as a benefit from nature, but almost all mentioned food and medicines.

Furthermore, according to the results, the participants did not increase their knowledge about the alternatives "Water", "grazing", "land", "roads", "timber", "houses" and "firewood", which was unexpected. These results coincide with Erdogan (2011), who performed an ecology-based nature education program on elementary school students in Turkey. However, in that study, it is suggested that knowledge from before can be a potential explanation to the results. As the frequency of ticking the alternatives mentioned above were quite low, knowledge about these from before is less likely to be an explanation in this study.

Questions about threats to nature

The difference in response to "What do you regard as a threat to nature?" were significant between the pre-test and the post-test. This indicates that the education program affected what the participants regard as the main threat to nature, which coincides with previous studies conducted on students in schools and university in Tanzania, America and Hungary (Larson et al. 2009, Larson et al. 2010, Zsóka et al. 2013, Børresen 2016, Lyamuya et al. 2016). However, according to the results to the post-hoc tests, "population growth" was the only alternative the participants changed their mind about during the program. The non-significant change to the other alternatives coincides with Erdogan (2011). Possibly this is due to previous knowledge from school or life experiences. The impacts of climate change is something the participants have experienced from before, as was communicated in almost every village. Furthermore, as land use change often is regarded as a main threat on a global level, it is also often an advantage to the local people around, roads being a common example (Fyumagwa et al. 2013).

Consequences from climate change, population growth and land use change

When it comes knowledge about the consequences of climate change, human population growth and land use change on ecosystem services, the responses indicate that the participants increased their knowledge about this from the educational program. Based on the increase in frequency of ticking between the pre-test and the post-test, this increase in knowledge applies to "changes in temperature" as consequence to climate change, "land use change" as a consequence to human population growth and "easier to travel" as a consequence to land use change. This coincides with previous studies conducted on students in school and university in Tanzania, America and Hungary (Larson et al. 2009, Larson et al. 2010, Zsóka et al. 2013, Børresen 2016, Lyamuya et al. 2016).

Also the frequency of ticking the alternative "human population growth" as a consequence to land use change, increased statistically significant between the pre-test and the post-test. This was not an expected result. This indicates that the formulation of the question have been poor,

or possibly also that the participants connect "land use change" and "human population growth" strongly with each other. In the questionnaire, the question before this question was somehow asking the opposite (what are consequences to population growth, having "land use change" as an alternative). As already discussed, this alternative changed significantly between the pre-test and the post-test.

However, a stronger effect from education on knowledge was expected. For the question regarding possible consequences to climate change, this applies to the alternatives "change in weather" and "reduces human livelihood". These results however, agrees with the results from the same question in the study by Børresen (2016).. She emphasizes how these changes possibly is not so present in the everyday life of the participants, which was also found as an explanation to skepticism to climate change in America (Jones et al. 2014). On the other hand, Rodima-Taylor (2012) discussed how locals living close to Serengeti are acting due to the changes from climate, forming social networks to withstand different challenges these challenges could bring. Considering consequences to human population growth, an increase in frequency of ticking did not occur to the alternatives "overexploitation" and "more livestock". In Kenya, the populations of cattle have declined, but there has been a big increase in goats and sheep (Ogutu et al. 2016). The same was also for the alternatives "habitat degradation", "increased dispersal of wildlife" and "increase in human-wildlife conflicts", which was alternatives to the question "what do you regard as possible consequences to land use change". This lack of differences, indicate that the participants did not learn from the education program, which also was found with the results from the study to Erdogan (2011). However, regarding the results, this is not due to previous knowledge.

The statements about nature

The change in response to three of the statements indicate that the participants changed their attitudes to a small degree during the education program, and may be not as much as predicted. The change in response to the two statements "I depend on thing provided by nature" and "Benefits from nature is helping me make money" were expected. This coincide with comparable studies conducted in America, Tanzania and Hungary (Larson et al. 2009, Larson et al. 2010, Zsóka et al. 2013, Børresen 2016, Lyamuya et al. 2016).

The change in response to the third statement "benefits from nature is mostly here for human use" however was not expected. As almost 90% of the participants agreed to this statement in the pre-test, this indicate that this attitude is very common. Also the frequency responding that plants and animals are there for human use was very high both pre-test and post-test. Also, about 50% disagreed to the statement claiming that humans can cause irreversible change to nature. The response to these two statements did not change. One possible explanation is that I have put too much emphasize on the connection between human well-being and ecosystem services. The fact that the people in this area are dependent on resources from nature (Røskaft et al. 2014), can also enhance this opinion. In addition Pimbert and Pretty (1997) point out how conservation biology often regard humans as exclusively harmful for nature, whereas the real case is that many of the local practises often have contributed to the biodiversity in many areas, making humans an important part of nature conservation. If this is the case for many of the participants, humans would potentially be difficult to regard as any kind of threat to the nature. This can be an indication that the education project should have lasted for more days (Bogner 2002).

Furthermore, the same tendency is present in the response to this question as the others. Considering that the participants could have changed their opinion about twelve statements, change to more than three of the statements were expected. However, according to the pre-test, the participants had a positive view on ecosystem services before attending the program. This can be a possible explanation to the few changes in response to the statements, which was also pointed out as a possible explanation to the findings to Erdogan (2011). The positive attitudes regarding ecosystem services even before the education program also correlate with the study done by Børresen (2016).

Threats to nature

The response to what the participants regard as threats to nature indicate that the knowledge increased to almost 30% of the suggested threats. The increase in knowledge applies to the threat made from new infrastructure, pollution and overexploitation due to human population growth. This increase in knowledge coincides with comparable studies conducted in America, Tanzania and Hungary (Larson et al. 2009, Larson et al. 2010, Zsóka et al. 2013, Børresen 2016, Lyamuya et al. 2016)

However, the response also indicate that more participants regard human diseases as a threat to nature, which was not expected. This can possibly be due to what the participants regard as nature. The participants several times expressed how humans are part of nature. Salmón (2000) also emphasize how indigenous people consider humans as a part of the nature and a well-functioning ecosystem. Hence, a disease that harms humans can possibly also be considered a damage to the nature and ecosystem.

The response to the other four suggested threats did not change between the pre-test and the post-test, which coincides with Erdogan (2011), indicating that there were no change in opinions during the program considering these threats.

The explanatory factors

According to the binary regression analysis, "round number (i.e. before or after the course)" was the most common explanatory variable to explain the results. However, district, education level and gender were also variables explaining some of the results. Furthermore, the results indicate a trend where the variation in the responses is more common in the pre-test compared to the post-test, indicating that the education program have evened out some of the differences in knowledge amongst the participants.

Districts

Districts were the most represented explanatory factor after "round number". I suggest that this factor again is connected to three main components. Firstly, the order of what district I travelled to. When it comes to change in knowledge from the pre-test to the post-test, Serengeti is to some degree less represented, indicating that the program did not affect too much in this district. Serengeti was the first district I travelled to, and after staying here I made some adjustments to improve the program for the next villages. I also felt more secure when conducting the program as time went, which possibly have been to an advantage to the following districts.

Secondly, the participants within a district were often mainly representing one tribe. The participants in Meatu and Bariadi mainly belonged to the Sukuma tribe. The participants in Loliondo and Narok mainly belonged to the Maasai tribe. The participants in Serengeti mainly belonged to the Kurya tribe, or a sub-group within the Kurya tribe (mwisenye) (Mbise 2018)To a certain degree, the response affected by districts reflect this actuality, as districts with similar tribes in some cases show the same tendencies in the response. As shown in the study by Clamsen Mmassy and Røskaft (2013) people belonging to the Maasai tribe showed a better understanding of different bird species. Also to the statement "I depend on things provided by nature", Narok was the only district where 100% of the participants agreed.

Thirdly, different situations in the given district can affect the participants. In Narok the latest years, it has become common with heavy fencing (Løvschal et al. 2017). Narok was also the district with the highest frequency ticking that the alternative "land use change" was a consequence to human population growth, which can also be due to the situation around fencing.

Education level

In most of the responses where education was affecting the results, participants with secondary school and higher education tended to answer more of the expected alternatives than the participants with primary education or no school at all. This trend applied to both the pre-test and the post-test. This again coincides with studies on educational programs in Tanzania, America and Hungary (Larson et al. 2009, Larson et al. 2010, Zsóka et al. 2013, Børresen 2016, Lyamuya et al. 2016). However, I expected the main difference to be between the ones without schooling at all and the ones with primary education or more. This might be explained by the topic we were discussing. In the Tanzanian school system, students learn about the environment and the ecosystem in primary school, but the learning is continued in secondary school, implying more knowledge obtained if fulfilled secondary school (Education 2005)As eight of the ten villages where the study was conducted was Tanzanian, this possible factor would have affected 80% of the students.

However, considering the statements where the participants were to agree or disagree on how pollution and humans affected the nature, education did not affect how the participants

answered, which disagrees with studies implying that knowledge affect attitude (Kideghesho et al. 2007). These statements on the other hand, had already high frequencies of agreeing and disagreeing in the pre-test. Also, as mentioned in the paragraphs about biases, many of the participants needed help with filling out the questionnaire due to lack of reading skills. This especially applied to the statements, as they were often formulated in long and hence possibly difficult sentences to read. This may have led to the ones with education "filling out" for the ones with no or little education, covering possible differences between education groups. Also, the numbers of persons with high school and secondary were quite low comapared to the numbers without school or only primary (see methods part).

Gender

According to the binary regression, gender did not affect the response to a big degree. Considering a review article on how several studies show how for example climate change affect women and men differently (Goh 2012), this variable could possibly have had a bigger impact. Women are often affected more severe, for example due to longer trips needed to get water. When it comes to tourism, many studies claim how the industry helps women get work and empowerment (Scheyvens 2000, Tucker and Boonabaana 2012), which did not correlate with significantly fewer women than men claiming this as an ecosystem service.

The effect from the education program

As mentioned initially in the discussion, the response to the similar studies conducted on children in primary and secondary (Børresen 2016, Lyamuya et al. 2016) indicate that the children gained more knowledge from the education program than the adult participants in this study. However, regarding the explanatory factors, age were not an explaining factor to the response.

One feasible advantage for the children was the equality of education level leading to a more uniform group of participants. Education level was a prominent explanatory factor to the

response in this study, indicating that this factor affected many of the participants. When groups are more uniform according to knowledge level, it is easier to provide a program that will be suited to more of the participants. This can be connected to Vygotskys' Developing Zone, which emphasize how every individual have its' own zone of development. (Chaiklin 2003).Moreover, some participants said that the content of the program were way too easy, whereas other participants expressed that many of the things discussed were new to them..

Also, the program I used were highly inspired by the program used in the study with secondary students. Therefore the program was may be not pedagogically suited well enough for the adult participants, as the content was quite theoretical. A main difference between adults and school children, is that adults have often already an opinion about what is important to them, and evaluate what knowledge they can put to use in their own life. Hence, they consider to a bigger degree whether new learning will be relevant and interesting to them (Rogers 2007). A study on adults from Switzerland found that knowledge connected to actions gave better results when it came to behaviour than the theoretically based knowledge, but still emphasized that theoretically knowledge to a certain degree also was important for understanding the importance (Frick et al. 2004). To make the knowledge authentic to their everyday life is therefore more important. Possibly, the students in school were more prone about the information in the education program, which lead to more motivation to learn.

Conclusion

The aim of this study was to assess how an educational program about ecosystem services affected the adult participants. According to the results, there has been an increase in knowledge, however to a smaller degree than found in the results of the studies to Børresen (2016) and Lyamuya et al. (2016). Kideghesho et al. (2007) mean that young people are the most important target group when it comes to such education, and that educational programs like this should be implemented in school. Furthermore, in school you have a big degree of uniformity among students. In this study, there were much difference regarding both age and education.

Still, knowledge about what actions could be done considering conservation, would possibly be more interesting to the grown-up group, as argued by Frick et al. (2004). . Especially

climate change seemed to be both relatable and interesting to the participants, and learning about actions regarding this would possibly be of interest. Furthermore, as mentioned initially, the challenges the world are facing, happens today. If only the generations that are now in school are the ones to learn about these happenings, the challenges we see today will continue for many years. Therefore I argue that it is important to include the grown generations in these topics, possibly through educational programs, but with more action-based knowledge.

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Appendices
Appendix 1

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

QUESTIONNAIRE

General information

Age: _____   Gender: Man ☐   Woman ☐
District: _____   Village: _____
Tribe: _____   Level of school: _____

NATURE

1) What kind of benefits does nature provide you with?

Food ☐	Water ☐	Roads ☐	Timber ☐	Pollution ☐
Cars ☐	Houses ☐	Medicins ☐	Land ☐	Grazing ☐
Firewood ☐	Tourism ☐	No benefits ☐		

2) There are many different plants and animals in Tanzania. Why would this be of importance to humans?

a) Because it provides us with ornaments ☐
b) Because it provides us with flat areas ☐
c) Because it provides everything we need to survive ☐
d) It is of no importance to humans ☐

3) Today we see that nature is changing. What do you regard as the main threats to nature?

a) Climate change ☐
b) Human population growth ☐
c) Development of roads and buildings ☐
d) Wildlife ☐
e) Tourism ☐

The questionnaire

CONSEQUENSES

4) Which of the following do you regard as consequences to due to climate change? (you can tick several boxes)

a) Unpredictable weather ☐
b) Reduced human livelihoods ☐
c) More tourists ☐
d) Improved roads ☐

e) More different kinds of plants and animals ☐
f) Changes in temperature ☐
g) No consequences ☐

5) Which of the following do you regard as consequences to human population growth? (you can tick several boxes)

a) Overexploitation of resources ☐
b) Land use change ☐
c) More space for crops ☐
d) More space for each individual ☐

e) Less pressure on the resources from nature ☐
f) More livestock ☐
g) No consequences ☐

6) Which of the following do you regard as consequences due to land use change? (you can tick several boxes)

a) Habitat degradation ☐
b) Increased human- wildlife conflicts ☐
c) More tourism ☐
d) More grazing opportunities ☐

e) Increased dispersal of wildlife ☐
f) Easier to travel ☐
g) No consequences ☐

7) What is changing in pictures A and B?

1)	2)	3)
A B	A B	A B
a) Population growth ☐ b) Climate change ☐ c) Land use change ☐	a) Population growth ☐ b) Climate change ☐ c) Land use change ☐	a) Population growth ☐ b) Climate change ☐ c) Land use change ☐

STATEMENTS

8) Nature

a. I depend on things provided by nature	Yes ☐	No ☐
b. I think it is important to protect nature	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. Benefits I get from nature is mostly here for human use	Yes ☐	No ☐
f. Plants and animals are mostly here for human use	Yes ☐	No ☐
g. Benefits from nature is not important to me	Yes ☐	No ☐
h. It is important to me to protect nature due to the benefits it provides me	Yes ☐	No ☐
i. Benefits from nature is helping me make money	Yes ☐	No ☐
j. I think it is wise to spread information about nature and threats to nature	Yes ☐	No ☐
k. I want benefits from nature to be present also in the future	Yes ☐	No ☐
l. Threats to nature will in turn affect me	Yes ☐	No ☐

9) What are main threats to nature?

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 ☐

10) What are the three most important benefits nature provide you with?

Food ☐   Water ☐   Timber ☐   Firewood ☐   Hunting ☐   Land for settlement ☐
Crops ☐   Medicins ☐   Clean air ☐   Livestock ☐   Grazing ☐   Water storage ☐

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11) Have you ever heard about AfricanBioServices before today?

Yes ☐   No ☐

12) What is the main vision of AfricanBioServices?

a) To maintain the many kinds of plants and animals ☐
b) To expand the conservation areas ☐
c) To increase the number of roads and buildings ☐
d) To find sustainable solutions for the future through research on the Serengeti-Mara-ecosystem ☐

13) Do you think that research can maintain and improve human well-being?

Yes ☐   Sometimes ☐   No ☐

14) How do you regard the role of research

a) Unnecessary and irritating ☐
b) As a good to improve knowledge ☐
c) As something foreigners do ☐
d) As something that can potentially improve my well-being ☐
e) No opinion ☐

15) Do you think that meetings like this can provide useful information?

Yes ☐   Sometimes ☐   No ☐

16) How is your experience with researchers coming here?

Very well ☐   Well ☐   Nothing ☐   Bad ☐   Very bad ☐

17) I know who are the Community Facilitator in my area

Yes ☐   No ☐

18) Are you confident in participating in research?

Yes ☐   No opinion ☐   No ☐

Thank you for your answers!

Appendix 2
Structure of the Education Project

How accurate this structure was followed differed from village to village, but the main topics were discussed everywhere.

Time (somehow)	What?	Why?
DAY 1	**Introduction and questionnaire**	
10 min **ABS, CF, me, why**	Short introduction of African Bioservices and who is leading the organisation -African and European institutions -Main goal (sustainable development with background from research) -Lead by dr. Robert and Eivin Røskaft Introduce the FC (he/she might want to do it him/herself). Introduce myself. Tell who Per (the photographer) is. Show/explain the program and why we are doing this.	For people to get to know ABS, CF and Understand why we are there, and what wil happen the next days. Most people are more comfortable when they know what will happen!
1h	Questionnaire: The CF reads the questions to the participants in Swahili or Maasai	As very few of the participants speak English, it is better to get the questions in a language they know.
Day 2	**Ecosystem Services**	
10-15 min **Nature**	Ask: What do you think of when mentioning the word nature? Would they regard a trail as nature? Why/why not. First pictures on the presentation from nature they know, then show nature from different places in the world, using the globe and point. Ask: What would you regard as living and non-living nature? Talk about living (animals, plants) and non-living nature (stones, temperature, weather, soil → climate). Examples of these. Tell how temperature and humidity have a huge say in what nature we have around us and then also what kind of living nature we	To make a common understanding of nature, as this is the basics for the whole day and the next. To start out with something they know, and make the comparisons possible. Here also, a common understanding is important do develop, to make it easier to learn something new.

	surround us with.	
10-15 min **Ecosystem**	Tell how nature makes up different kinds of ecosystems (do not use that exact word right away), where different non-living nature makes it possible for different living nature to exist. "An ecosystem is the life of the living components interacting with and within the non-living environment, how everything is connected."	Trying to link how things are connected.
	Show the small food web (chain) with sun and rain, tell how the energy moves from the producers, consumers and so on. Move on to food chains, then move on to the food web. If one of these things is removed, what will happen? Talk about different outcomes.	Again, trying to connect things, to put things in a bigger picture. Also, discussing different outcomes can increase the understanding of the food web.
	Use a traditional household as an example? Someone fix income, someone cook, the children grow up, look for their parents and fix income and so on. In the community people have different jobs they do, and together this makes the village and the community to go around. Same with ecosystems. Everything is connected to everything else!	To use something they know. And maybe also see human living as an "ecosystem", and so get more understanding on how ecosystems are divided into smaller/bigger parts.
	Use the wildebeest/zebra migrationing together as an example, possibly comparing it with the cows, sheepsand the goats.	
	Talk about how different ecosystems are built up from different species.	
Small film	Showing the small film of predators and preys in different kinds of habitats.	Variation through the program is important. In addition, live examples of what I have been talking about can possibly increase the understanding
Pause		
20 min **Biodiversity**	Tell that due to different species in different ecosystems, we have biodiversity. This can be studied on different scales (the world, a continent, or a small pond). Tell how all the different species strengthen the ecosystem.	The meaning and reason behind biodiversity, and how it is important for a functionable ecosystem.
	Tell them how this (the Tanzanian and Kenyan) biodiversity is unique compared to the rest of the world (possibly mention the tourists, how this draws so many to Tanzania	So we together can make up what biodiversity is, what can be included. Comparison to show the uniqueness in

	and Kenya). Tanzania is one of four megabiodiversities. Compare to Norway, differences due to the abiotic factors. Ask: What does this diversity provide us? Hear what they think, bring examples (Food, medicins, bush meat, pasture and so on)	Tanzania and Kenya. For me to see what they think and mean on this topic, and also discussion often leads to new perspectives.
20 min **Ecosystem services**	Talk about how a well-functioning ecosystem often is connected to biodiversity. And how these functions are giving ecosystem services (which they just gave examples of themselves when answering the question above). Ask: What resources from the ecosystem do you rely on in your everyday life? Look at different ecosystems, look closer on soil and air. Talk about how these services are connected to human well-being, but that humans affect these services back.	Ecosystemservices are connected to biodiversity. To show the use of ecosystem services on a daily basis. How things may taken for granted is due to the ecosystem (ex. fresh air).
10-20 min **Situation today**	Tell about how the situation is today (extinction rate is increasing, we see more desert is forming, more rivers dry up more often …), and how this is threatening the ecosystems and so the ecosystem services, Ask: What role do they consider humans to have? Bring up harvesting as an example, and also tell how ABS focus on this: how is the ecosystem contributing, and how is humans affecting and how then also humans can affect the changes that is happening. Say we will continue on this tomorrow to look at main treats to the ecosystem around them.	Making it more real by looking at how things are today and make more consciousness about the human role in it all. Harvesting they probably already have good knowledge about.
Ending	Questions, pictures from the day and so on.	Hopefully make thing which is unclear, clearer and maybe see pictures is fun?
DAY 3	**Threats to Ecosystem Services**	
10 min	Repeat what we looked at yesterday, using	As we are building the

Repetition from yesterday	the Serengeti ecosystem as an example to pick up on things again. Tell what we are going to look at today. See if there is any comments and if anything was unclear.	program for today on the knowledge from yesterday, this part is important for us to get "back on track".
5 minutes	Ask: What can be potential threats to the ecosystem? Climate change, population growth and land use change. These are the main threats ABS is working on how will affect the nature and ecosystems in Serengeti.	Hopefully, during the last discussion, these things have come up in some way, and can then be built more upon.
15 min-20 min **Climate change**	Climate change Ask: What do you see in the picture [showing picture representing climate change]. Talk about temperature getting hotter → Change in normal weather conditions to more extreme, soil erotion How the climate around us change long term and how this change is now faster than it has been due to human activity (carbon budgets). Examples of change is higher temperature →more bushfires, more extreme weather (rain fall heavier, draught heavier, storm). Heavy rainfall is not incorporated in the soil. Examples: draught that is just now, Harvey and Irma in the US Ask: Possible consequenses for humans? Possible examples: Problems with crop production. Floods and temperature dries out the soil → erosion →problem for producers →affecting the ecosystem → ecosystem services. Disturbing the migration of the wildebeest and zebra → affecting the whole Serengeti area	Hopefully make a common understanding of what climate and climate change is. Make awareness. For the participants to reflect upon what the consequences can be.
Population Growth 15 min	Ask: What do you see in the picture [show picture representing climate change]. The population in Tanzania has grown (show picture of this growth and cartoon). Possibly compare to other places to show Discuss: What can be potential consequenses	To make a common understanding of population growth. To make awareness of the

	from this? -Higher demands on a decreasing area. More people → more cattle → Overgrazing -Bush meat are going scarce. -Also more need for resources like timber, places to live, fire wood, water. -More needs for houses, roads etc. Bring up harvesting again, and show the connection to ES	possible outcomes from this, both due to humans and the EC
Small film	Show small film about the wildebeest migrating	
Pause		
Land Use Change 20 min	Ask: What do you see in this picture [showing picture representing land use change]? Nowadays there is change in land use. Infrastructure: Roads, houses, airports, buildings (hotels, schools…). NP, agriculture. Ask: What are possible consequences to this? Discuss the consequenses of this? (negative and positive) -Less room for nature → more pressure on what exists of nature areas. -Conflict on areas that earlier were shared between wildlife and livestock. -Deforestation, habitat degradation and fragmentation → dispersal -Roadkill -Roads gains access, development, -Np concerves wildlife and grass, but limits their way of living, restrain access, tourists (good/bad) How does this affect the ecosystems and ecosystem services?	How humans affect the nature, and how this is gives us trade-offs. Discussion, as I want to see their meanings and their perception of the development in their area. Connection to ES important, I think this can easily fall out.
Connections and ABS 10-20 min	Ask if they see any connection between the three threats? Show picture with the three threats. Show how all three affect the ecosystem services, and how the humans again is affected and also is affecting themselves.	To possibly make the connections clearer, how one affect the other. I think they easily can be looked at as very separate.

	Long-term vs. Short term. Picture of school children (future life). How it is a problem if these factors we now have been talking about are not taken care of. What role does humans have? What part can they play? Possibly talk about family planning, how smart policies are important, but careful (areas around the outspring of Mara river, overgrazing)	How humans have the possibility to make things change, and how the future generations is included in this.
	How these issues is what ABS are doing research on to gain more information to improve better (research done on bushmeat, livestock, wildlife, grazing areas…). Repeat the main vision of ABS, how policies are made from knowing, how FCs are very important in this circle.	For the participants to reflect upon what the consequences can be. To show why ABS do what they do and why this is important. Hopefully the previous parts have made the role of ABS relevant.
5 min	Repetition, focus on the importance of ecosystem services and how there should be some act for these to survive.	To round it all up, remember the focus is on ECs.
5 min	Asante sana, possibly show pictures again	
Day 4	**Questionnaire and diploma!**	

Appendix 3
The PowerPoint presentation

The slides introducing the CFs were shown in their respective district. The slides showing population growth in two other countries beside Tanzania, were used from Bariadi and onwards.
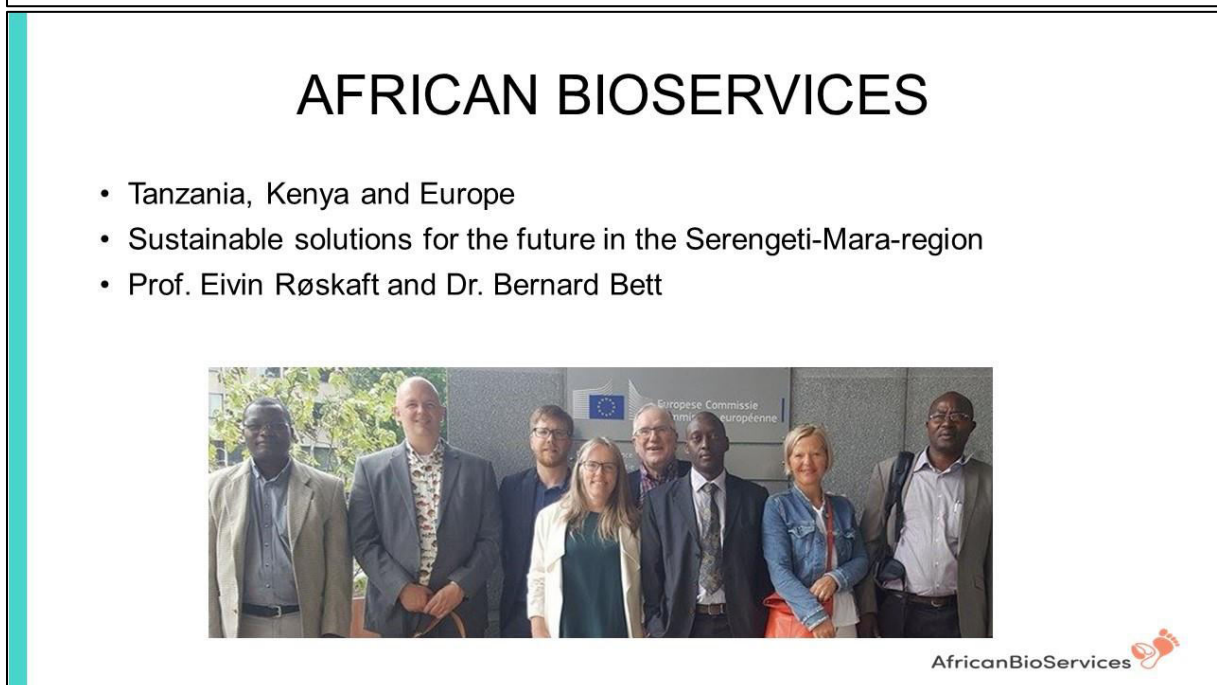
JEREMIA ZACHAYO, Serengeti district

- The CF shall disseminate information from ABS, and notice feedback from the communities
- Jeremia is working as district tourism officer since 2015, he has also been working as a teacher in secondary school for the couple of years.

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ROSE PAULO KINYAMASONGO, Meatu district

- The CF shall disseminate information from ABS, and notice feedback from the communities
- Working at Meatu District Council as Land Officer,also i working as community facilitator in the project of AfricanBioservice in Meatu District.

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DAVID GILONG SULLE, Bariadi District

- David is Working as District Wildlife Officier in Bariadi District Council, a position he has held since 2015, and as Community facilitator in AfricanBioServices Project.
- The CF shall disseminate Information from ABS, and notice feedback from the communities

AfricanBioServices

ELIBARIKI SIMON BAJUTA, Ngorongoro District

- Elibariki Bajuta is working in Ngorongoro District Council as District Tourism Officer for more than seven years now.
- He is Community Facilitor for AfricaBioservices, and who shall disseminate information from ABS, and notice feedback from the communities.
- He will be organizing community meetings and giving feedback for research findings from different Scientists.

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STEPHEN KERMUT MUNTET, Mara South

- Stephen Kermut was borned and raised in Maasai Mara. He holds a M.A in Planning, Public Policy and Management and a Master of Science in Conflict and Dispute Reolution, both fro the University of Oregon. He works as Youth Coordintor for The Maa Trust.

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HANNE MARSTRAND ANDERSEN

- Student in Biology
- Now doing my master thesis as a part of research project AfricanBioServices
- Coming from Norway

AfricanBioServices

PROGRAM

Day 1: Questionnaire

Day 2: Ecosystem Services

Day 3: Threats to Ecosystem Services

Day 4: Questionnaire
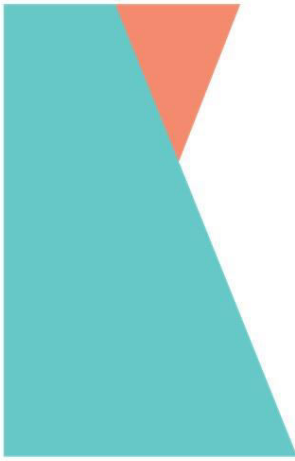
Day 2
Ecosystem Services

Nature?

Political Map of the World, January 2015
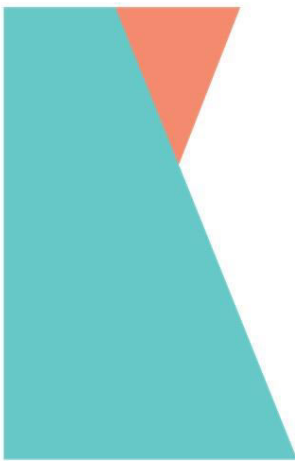
AfricanBioServices

Political Map of the World, January 2015
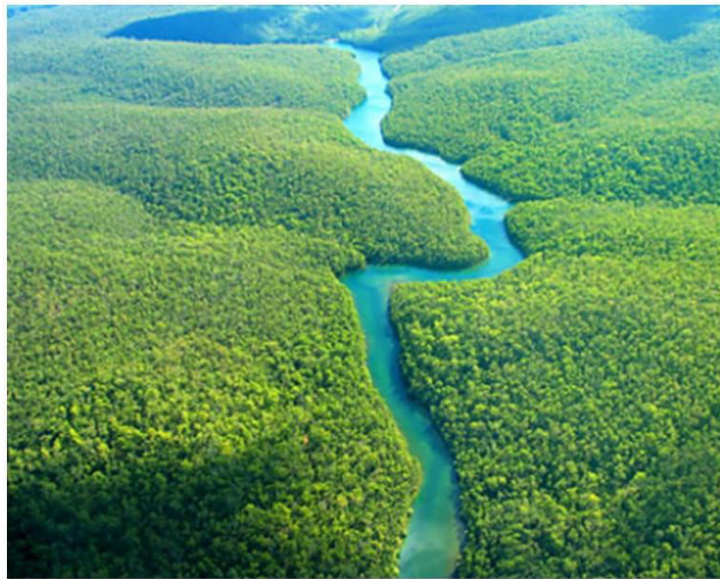
Living and non-living nature?

Living nature and non-living nature together make up ecosystems

AfricanBioServices

EAST AFRICAN FOOD WEB
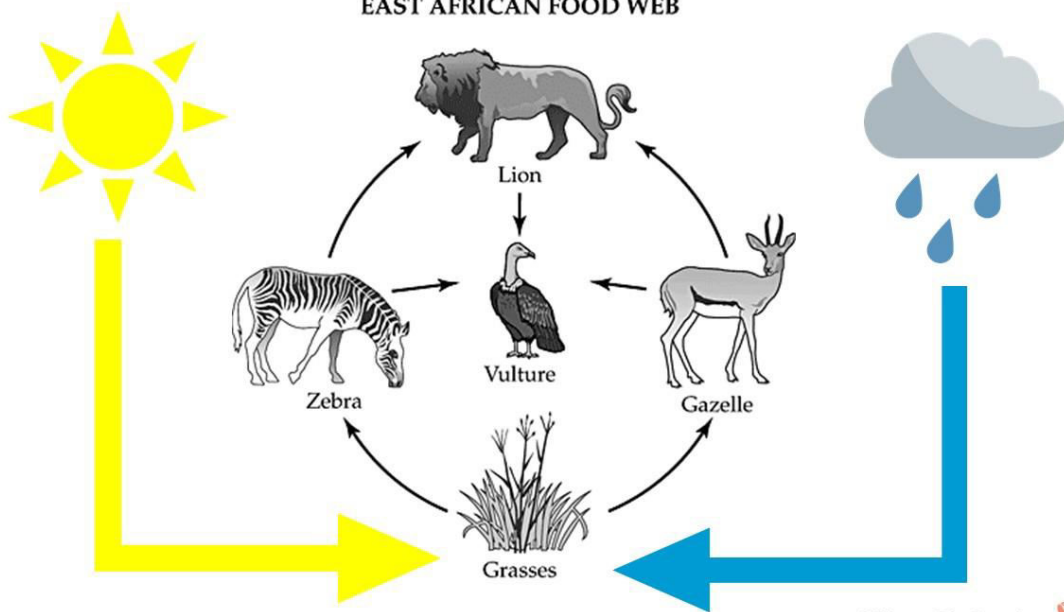
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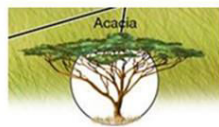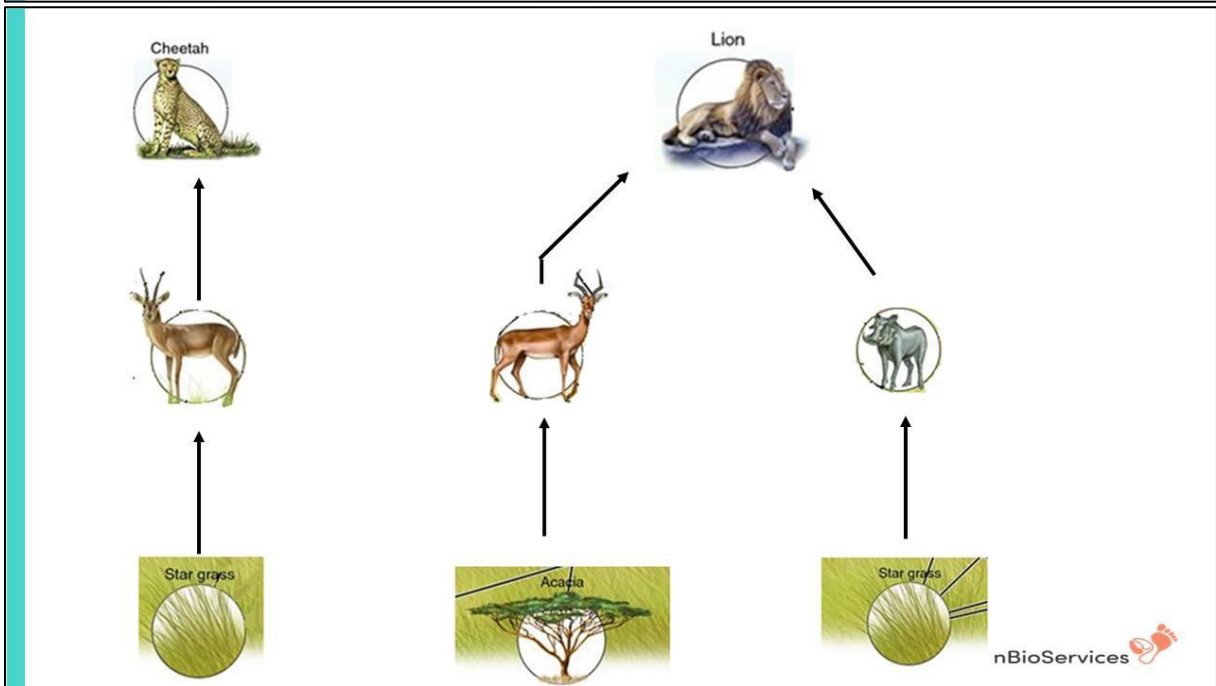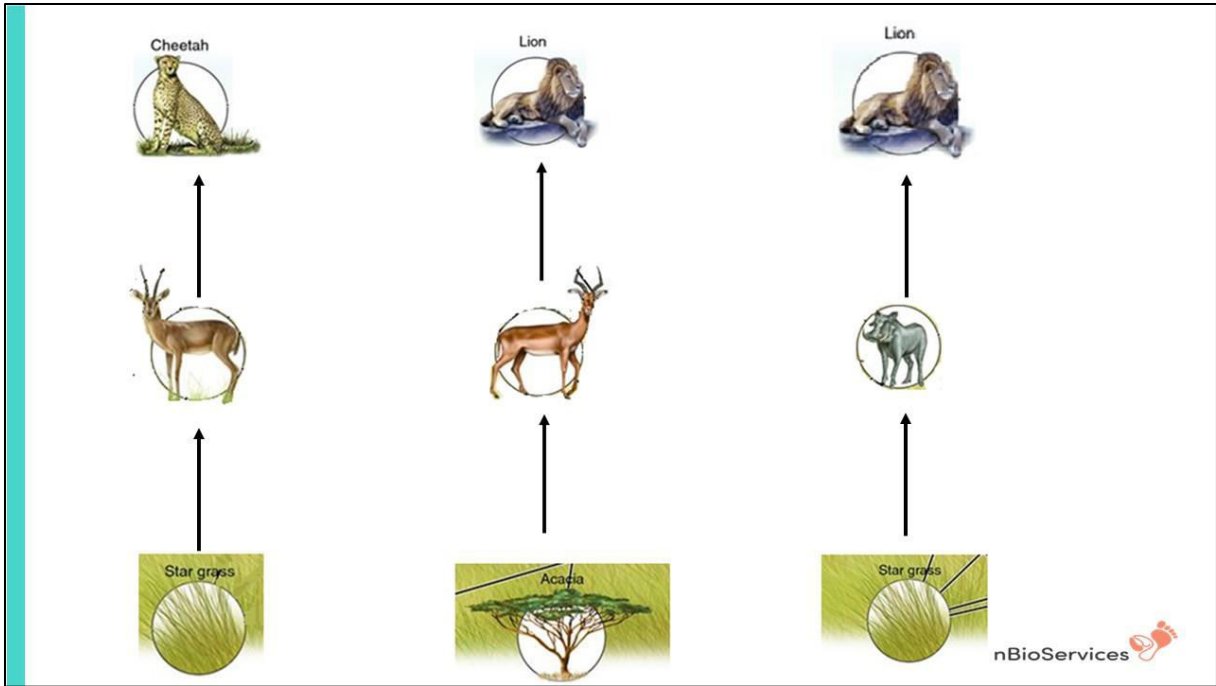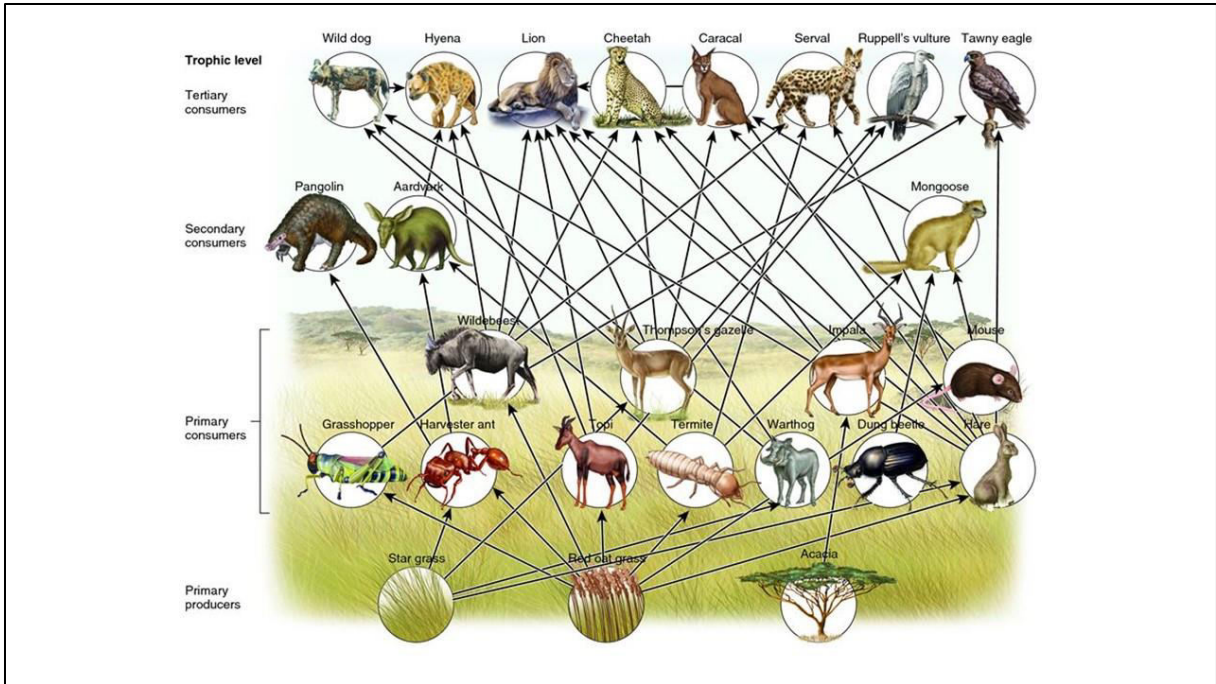
Everything is connected to everything else
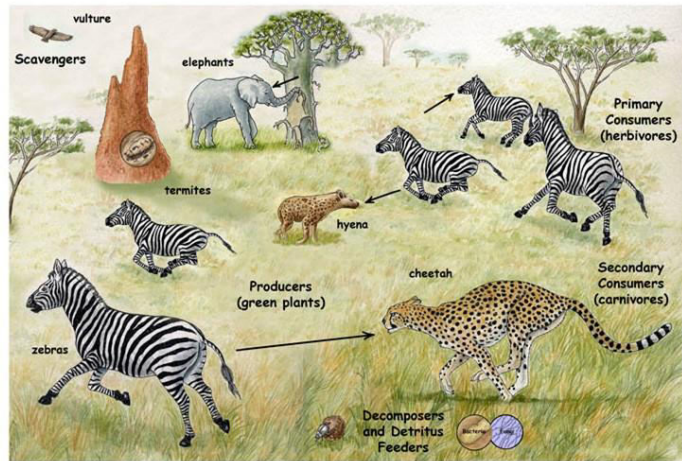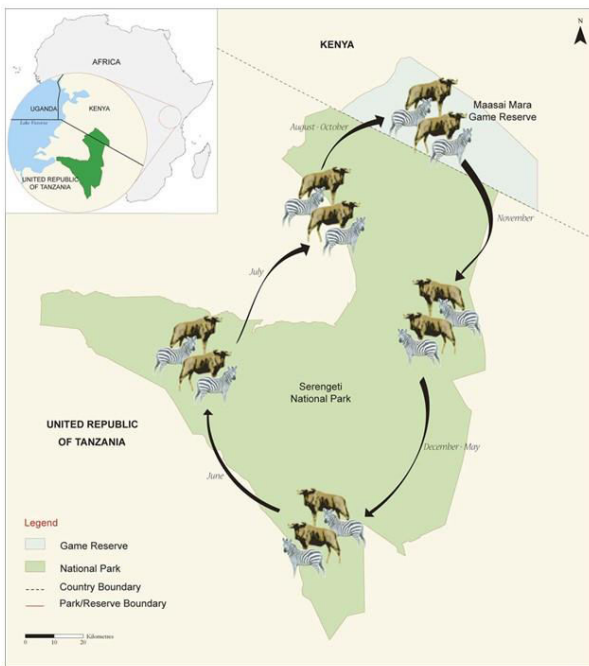
Biodiversity:
All the different kinds of organisms
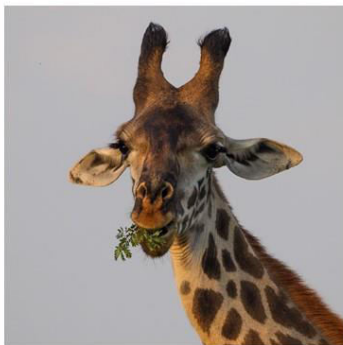
Why are biodiversity important to humans?

Water and air penetrate soil

Nutrients used to grow

Plant / animal matter breaks down into soil

Soil stores nutrients which plants absorb

Decomposers break down organic matter

Rocky subsoil breaks down providing nutrients to soil
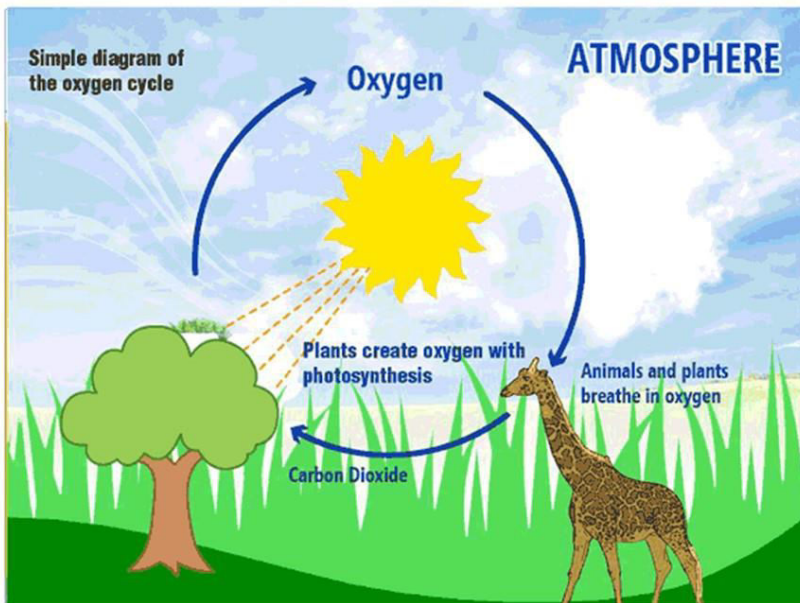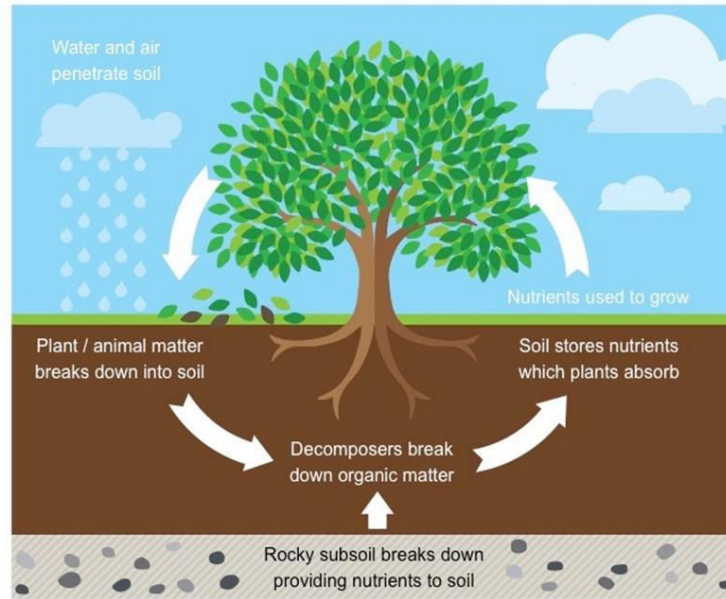
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Ecosystem Services

- Water
- Food
- Crops
- Livestock
- Pasture
- Firewood
- Mbao
- Medicines
- Land to live on

- Seed distribution
- Spiritual places
- Clan identities
- Coal
- Water storage
- Preventing soil erotion
- Tourism
- Fresh air

AfricanBioServices
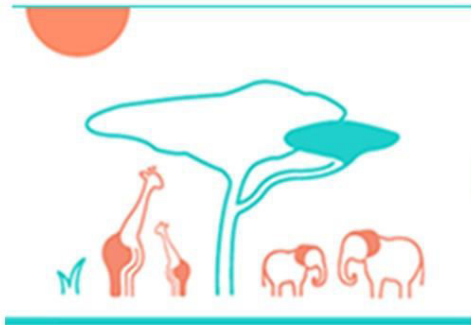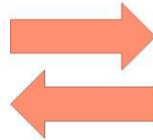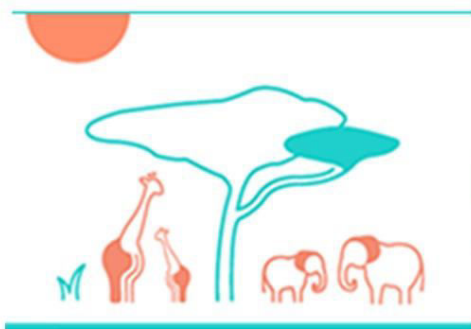
Ecosystem Services

Ecosystem Services

What is the situation now?

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Day 3

Threats to ecosystem services
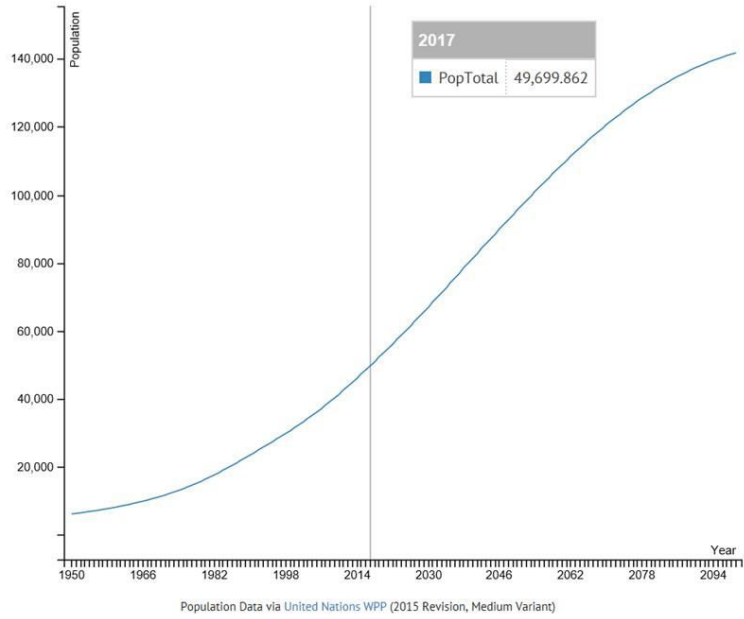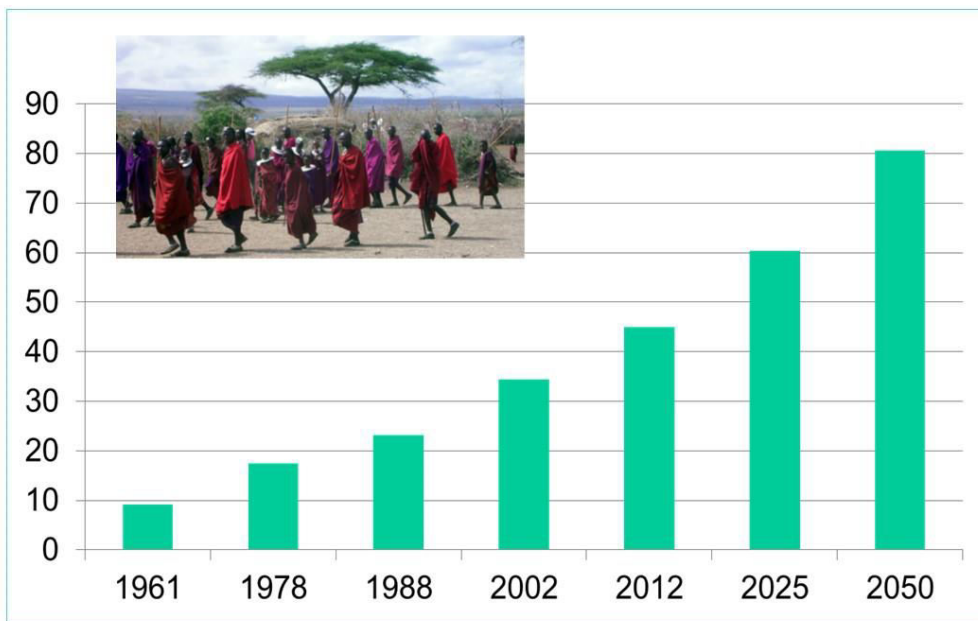
AfricanBioServices

AfricanBioServices
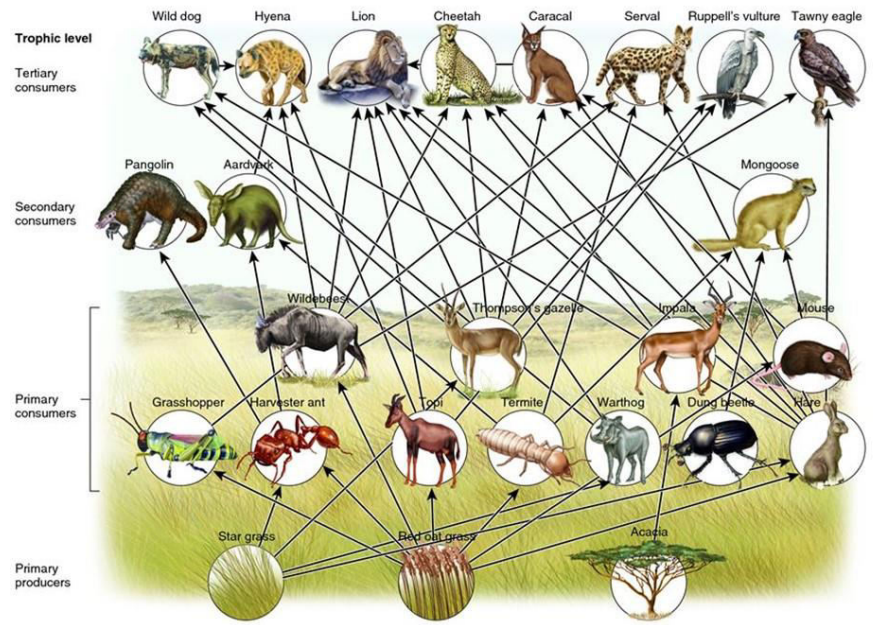
ECOSYSTEM SERVICES
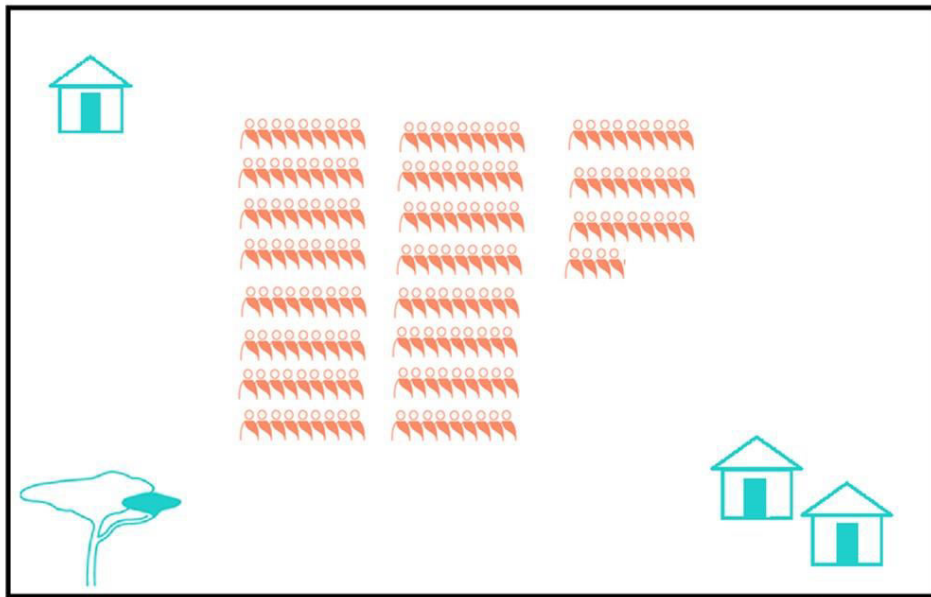
Benefits nature provides us with

AfricanBioServices

AfricanBioServices
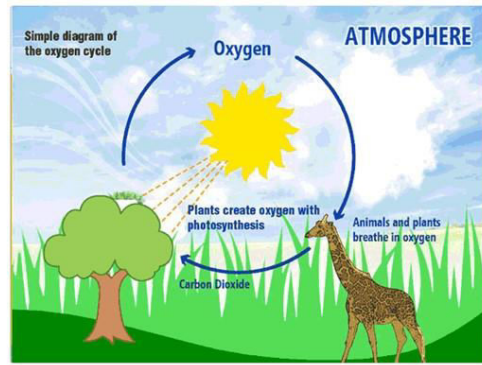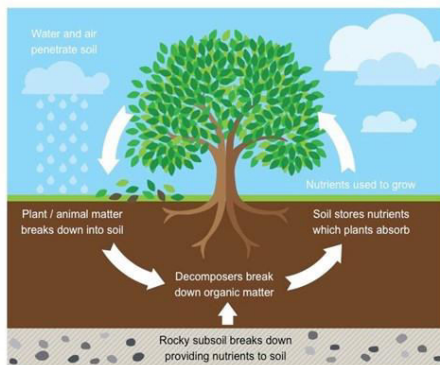
Huduma za mfumo ikolojia

AfricanBioServices

Huduma za mfumo ikolojia
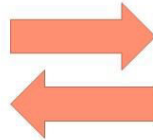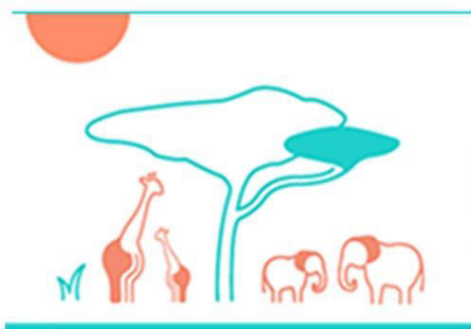
Ecosystem Services

Mabadiliko Tabia nchi
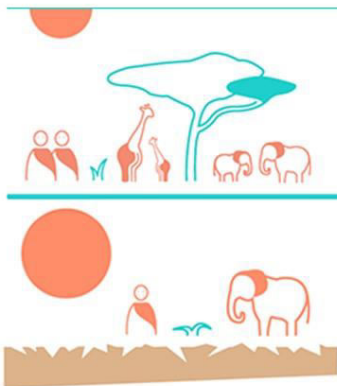
Ongezeko la idadi ya watu
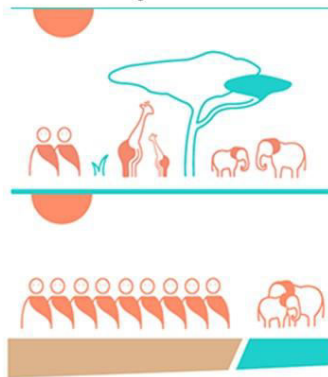
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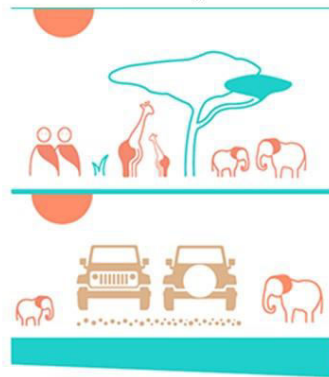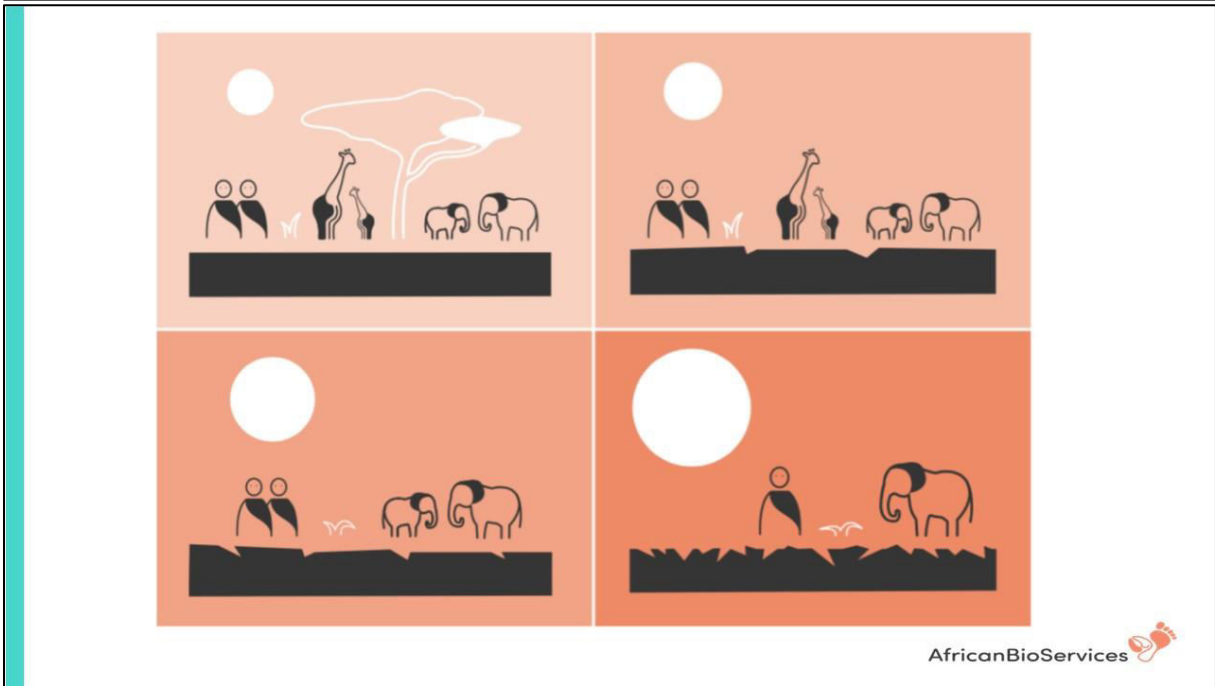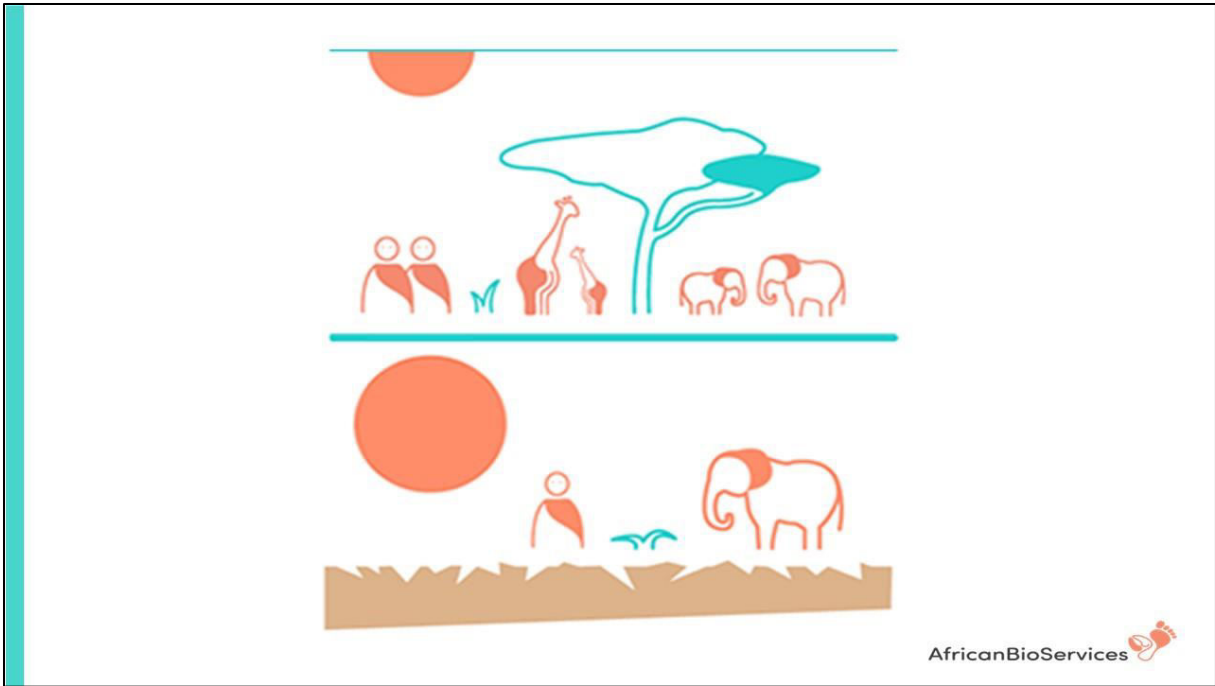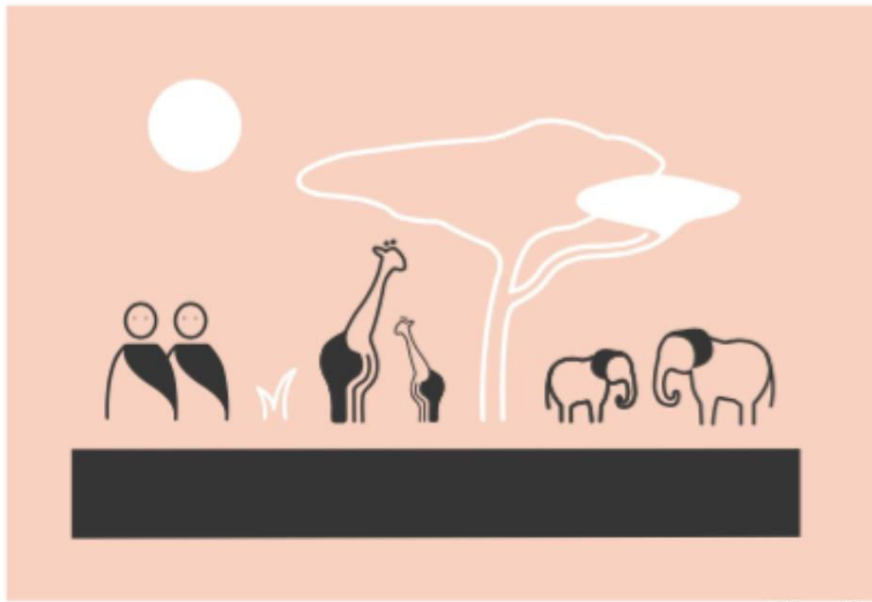
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Kenya Population (1950 - 2018)

Population Data via United Nations WPP (2015 Revision, Medium Variant)
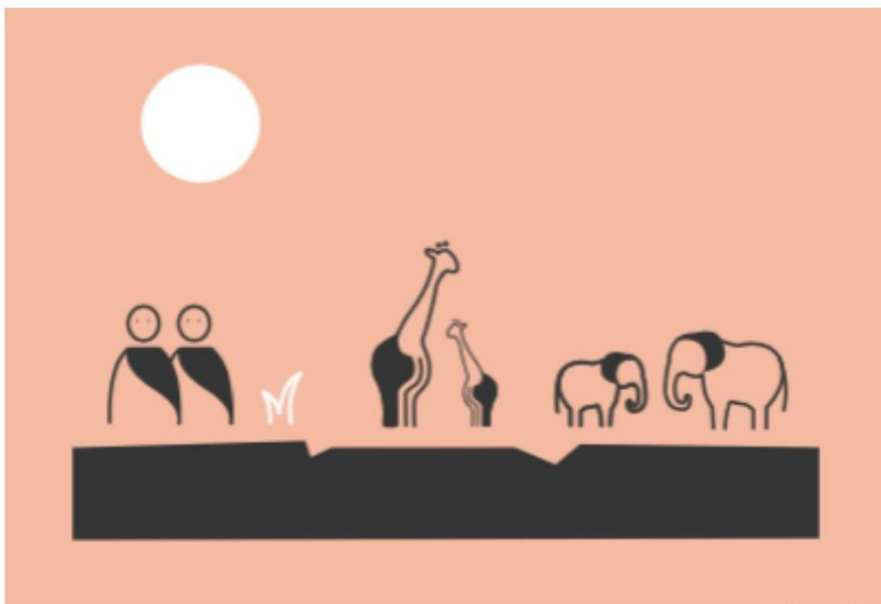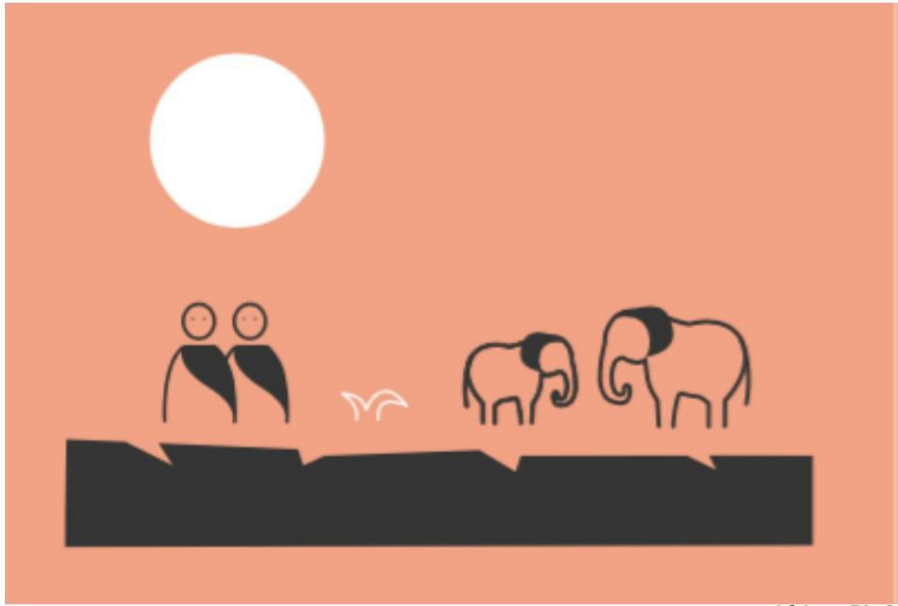
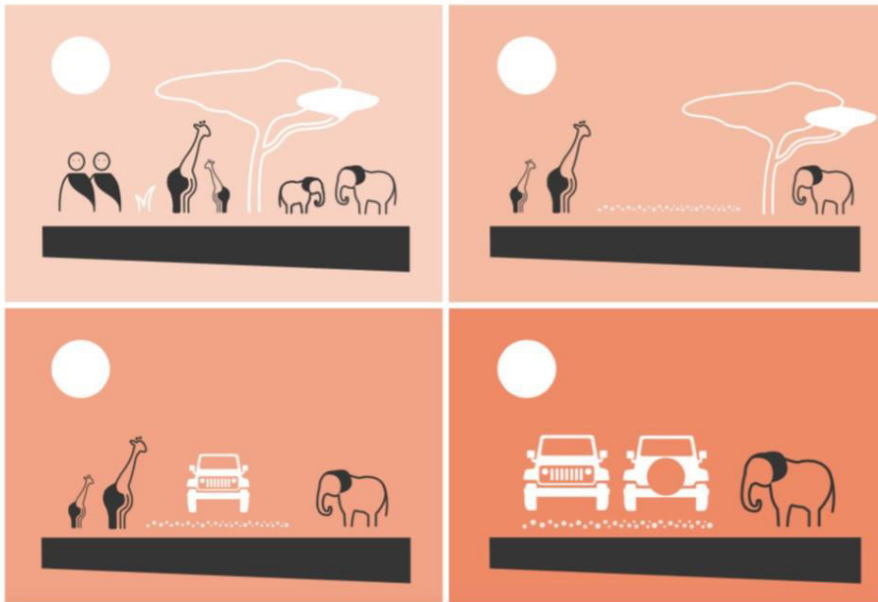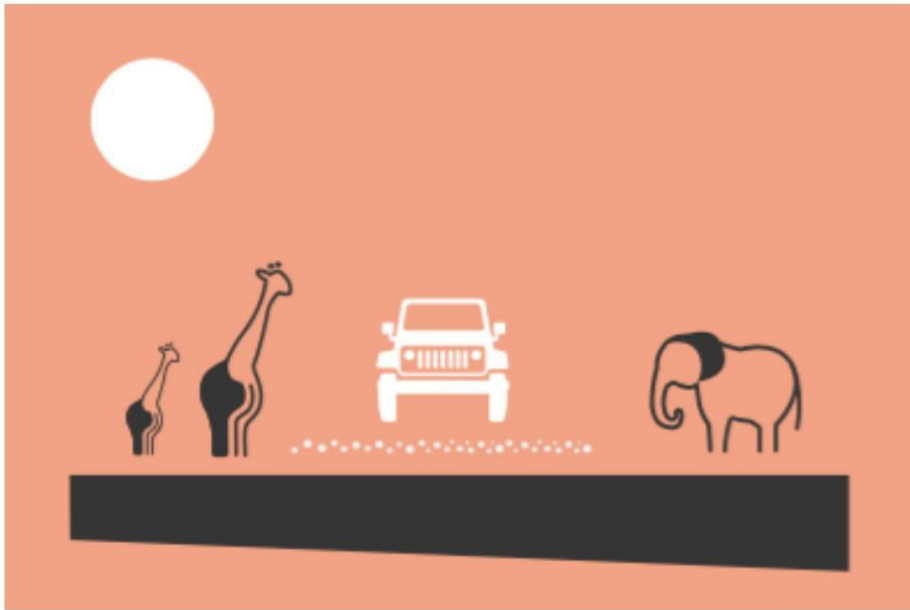AfricanBioServices
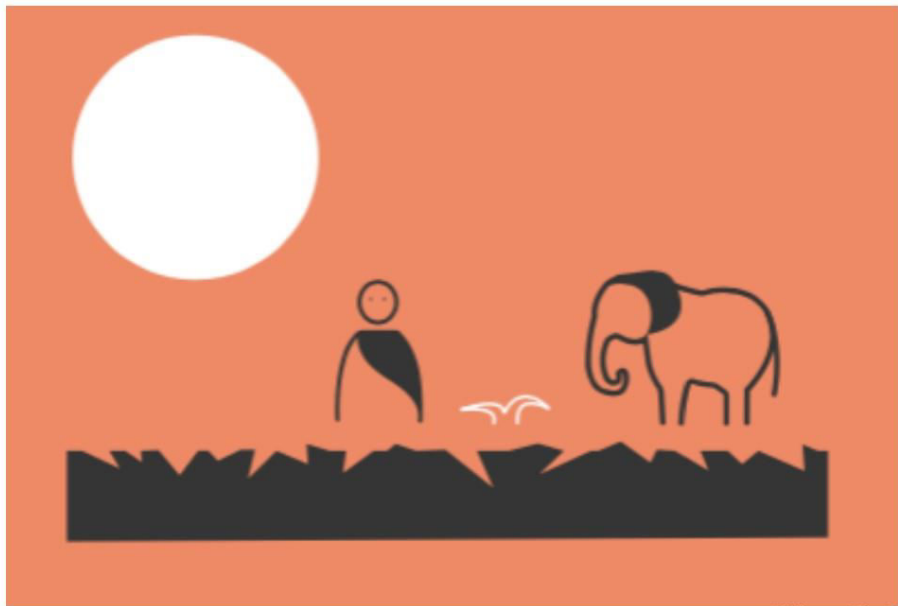
AfricanBioServices

Madhara?

AfricanBioServices

AfricanBioServices

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Biodiversity and Ecosystem Services

Biodiversity and Ecosystem Services

Biodiversity and Ecosystem Services

Biodiversity and Ecosystem Services

Asanteni sana!
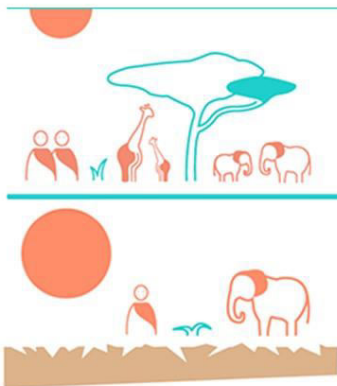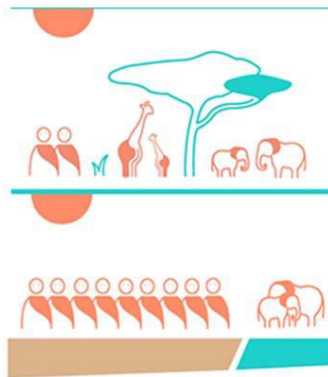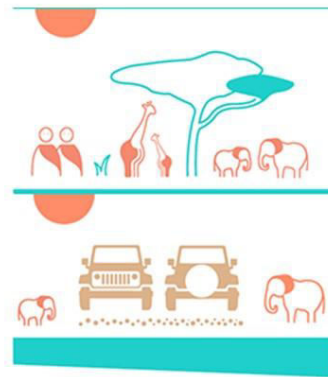
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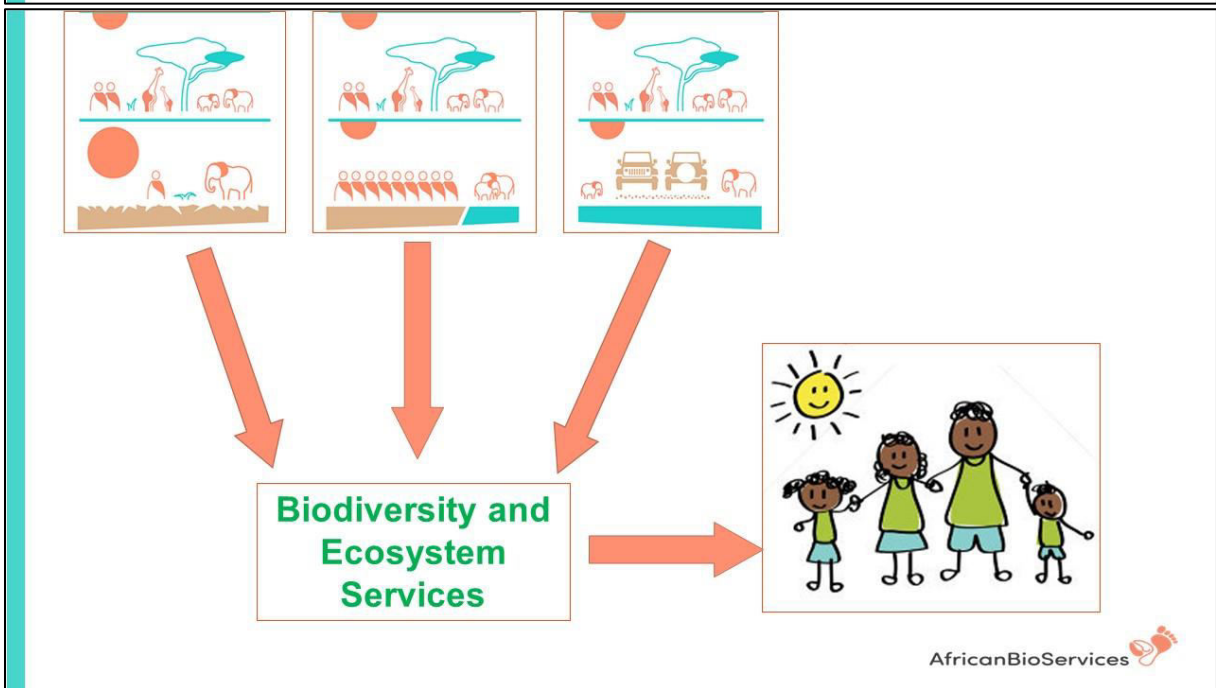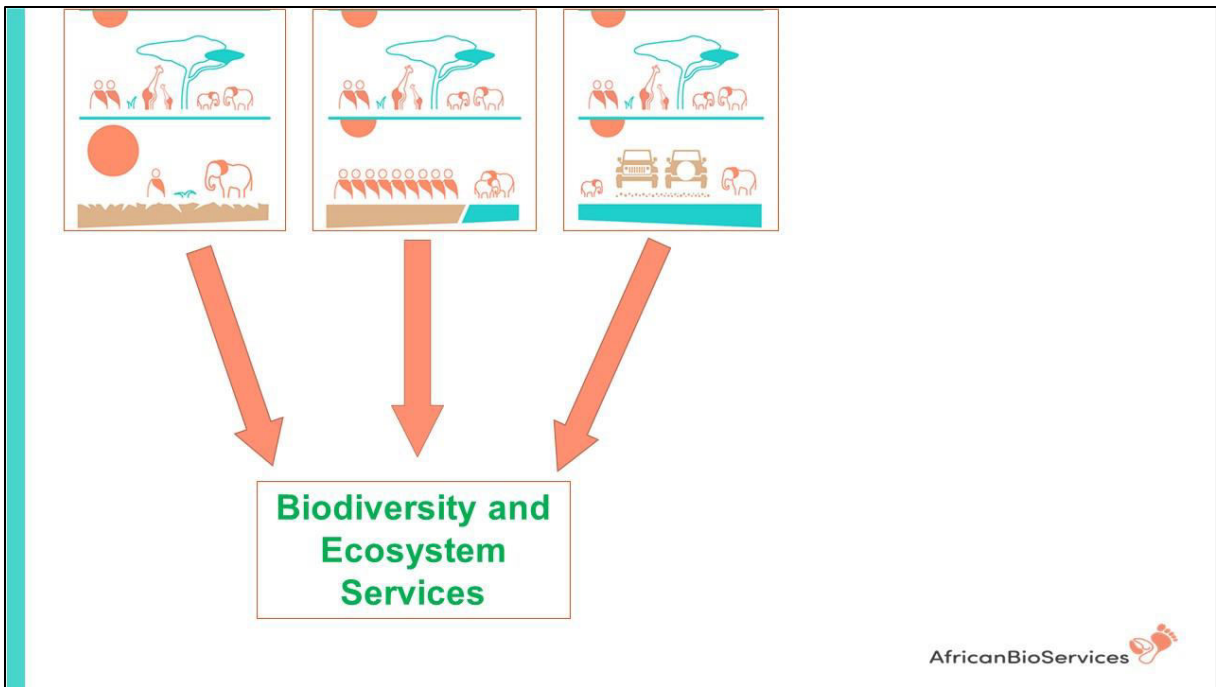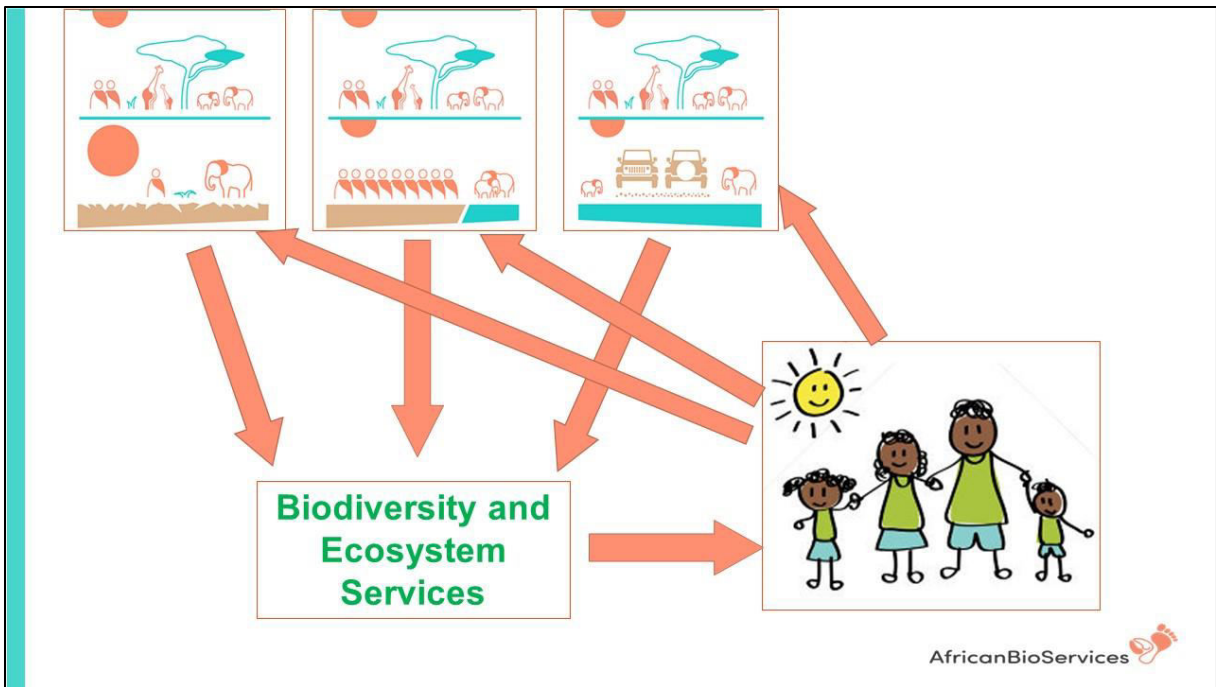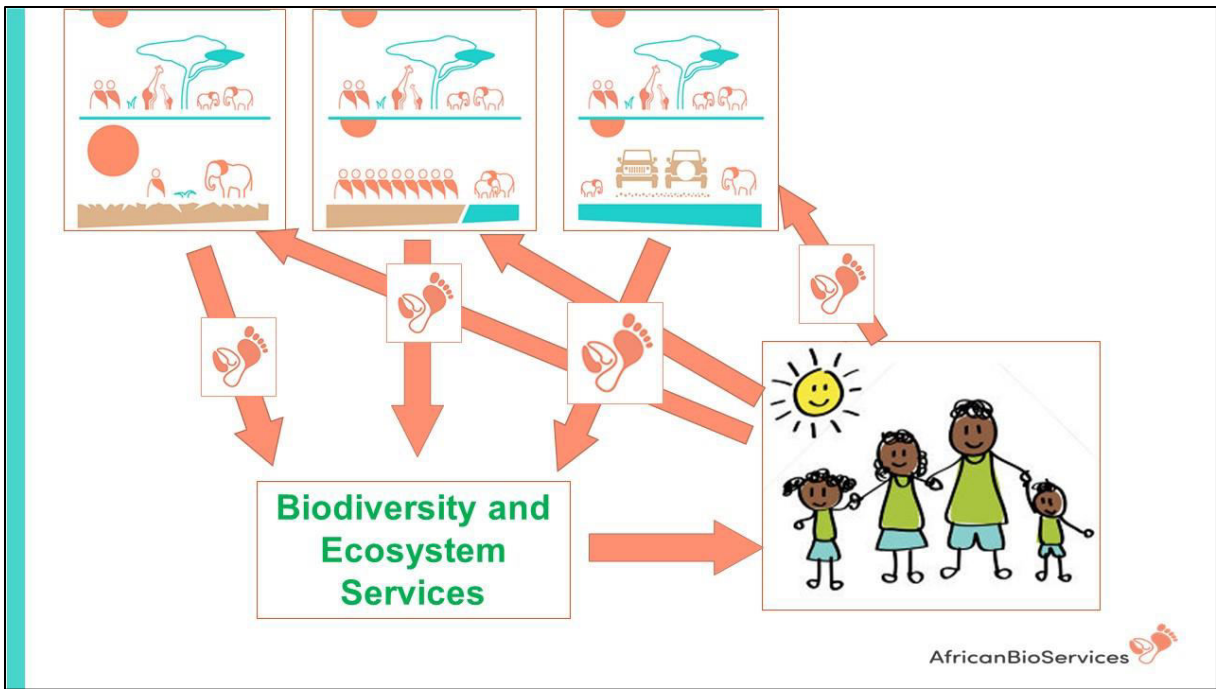
Appendix 4
The certificate given out in Tanzania

DIPLOMA

This certifies that

_____

has attended a 2-day course on ecosystem services, biodiversity and threats to these organized by the EU-financed project *AfricanBioServices*.

_____   _____
Prof. Eivin Røskaft   Dr. Robert Fyumagwa

TAWIRI
Tanzania Wildlife Research Institute

NTNU

AfricanBioServices

Appendix 5
The certificate given out in the two villages in Narok, Kenya

Appendix 6
Tables with all the ticking frequencies

Question 1: What kind of services does nature provide?

	% ticked pre-test (N = 308)	% ticked post-test (N = 289)	% change	χ2	P ≤
Food[1]	51,9	66,8	+14,8	13,58	0.000
Water[1]	61,7	62,6	+0,9	0.06	0.813
Roads[2]	27,3	20,8	-6,5	3.45	0.063
Timber[1]	53,2	57,8	+4,5	1.24	0.265
Pollution[2]	8,8	4,5	-4,3	4.35	0.037
Houses[1]	33,8	31,1	-2,6	0.43	0.512
Medicins[1]	52,3	65,7	+13,5	11.17	0.001
Land[1]	42,5	35,3	-7,2	3.17	0.075
Grazing[1]	39,6	40,5	+0,9	0.05	0.828
Firewood[1]	53,6	52,2	-1,3	0.11	0.746
Tourism[1]	65,3	56,1	-9,2	5.30	0.021
Cars[2]	14,9	8,7	-6,3	5.62	0.018
No benefits	8,8	0,7	-8,1	21.03	0.000

Question 4: What do you regard as consequences to climate change?

	% ticked pre-test (N=285)	% ticked post-test (N=259)	% change	χ2	df	P-value
Change in weather	66.8	71.2	+4.4	1.264	1	0.261
Reduced human livelihood	30.6	33.3	+2.7	0.489	1	0.484
More tourists	7.6	8.0	+0.4	0.023	1	0.881
More plants	15.2	10.6	-4.6	2.559	1	0.107

and animals						
Changes in temperature	54.9	68.2	+13.3	11.782	1	0.003
Better roads	5.9	9.5	+3.6	2.530	1	0.112
No consequences	1.4	1.9	+0.5	0.224	1	0.636

Question 5: What do you regard as cosequences to human population growth

	% ticked pre-test (N=289)	% ticked post-test (N=264)	% change	χ2	df	P-value
Overexploitation	61.9	67.4	+4.0	1.815	1	0.178
Land use change	48.6	63.3	+14.7	11.970	1	0.001
More space for crops	13.8	12.9	-0.9	0.099	1	0.753
More space for each individual	8.3	7.2	-1.1	0.236	1	0.627
More livestock	34.6	38.6	+4.0	0.969	1	0.325
Less pressure on natural resources	24.9	28.0	+3.1	0.690	1	0.406
No consequences	0.4	0.5	+0.1	0.300	1	0.584

Question 6: What do you regard as consequences to land use change?

	% ticked pre-test (N=289)	% ticked post-test (N=264)	% change	χ2	df	P-value
Habitat degradation	64.1	58.5	-5.6	1.976	1	0.160
Population growth	49.8	67.8	+18.0	19.893	1	0.000
Human-wildlife conflicts	35.3	35.3	-0.2	0.000	1	0.996
Increased dispersal of wildlife	21.4	17.3	-4.1	1.573	1	0.210
More tourism	3.9	5.2	+1.3	0.592	1	0.442
Easier to travel	3.2	10.4	7.1	12.212	1	0.000

More grazing	17.8	21.1	+2.3	1.045	1	0.307
No consequences	1.9	0.7	-1.2	1.767	1	0.184

Question 8: Nature [Statements about nature]

Statements	Pre-test		Post-test		% change	χ2	df	p-value
	N	% yes	N	% yes				
I depend on things provided by nature	290	87.2	279	95.7	+8.5	12.924	1	0.000
I think it is important to protect nature	289	98.3	276	98.6	+0.3	0.071	1	0.790
All human actions are reversible	279	93.9	271	93.7	-0.2	0.008	1	0.930
Humans can cause irreversible changes to nature	286	55.9	266	62.4	+6.5	2.380	1	0.123
Benefits I get from nature is mostly here for human use	287	87.8	273	93.0	+5.2	4.401	1	0.036
Plants and animals are mostly here for human use	293	84.0	269	87.7	+3.7	1.636	1	0.201
Benefits from nature are not important to me	281	29.2	265	22.3	-6.9	3.407	1	0.065
It is important to protect nature due to the benefits it provides me	294	93.2	269	95.5	+2.3	1.437	1	0.231
Benefits from nature is helping me make money	284	84.5	266	91.4	+6.9	6.018	1	0.014
I think it is wise to spread information anout nature and threats to nature	295	95.9	267	98.5	+2.6	3.346	1	0.067
I want benefits from nature to be present also in the future	296	95.9	271	97.8	+1.9	1.558	1	0.212
Threats to nature will in turn affect me	289	80.6	264	79.5	-1.1	0.101	1	0.751

Question 9: What are main threats to nature?

	Pre-test		Post-test		% change	χ2	df	p-value
	N	% yes	N	% yes				
New infrastructure	278	41.7	269	61.3	+19.4	39.280	1	0.000
Pollution	297	85.5	264	92.0	+6.5	5.885	1	0.015
Unpredictable weather	286	89.2	265	89.1	-0.1	0.002	1	0.969
Human diseases	269	39.4	257	50.6	+11.2	6.639	1	0.010
Overexploitation of resources due to human population growth	284	83.8	269	93.3	+9.5	12.198	1	0.000
Harvesting of wildlife	284	60.2	257	68.1	+7.9	3.636	1	0.057
Schools and education	282	22.7	261	27.6	+4.9	1.727	1	0.189
Protected areas	283	30.4	256	27.0	-3.6	0.774	1	0.379

Question 10: What are the three most important benefits nature provide you with?

	% ticked pre-test (N = 286)	% ticked post-test (N = 236)	% change	χ2	df	P-value
Food	45.8	57.6	+11.8	7.233	1	0.007
Water	55.2	49.6	-5.6	1.667	1	0.197
Timber	22.7	26.7	+4.9	1.100	1	0.294
Firewood	19.9	22.9	+3.0	0.673	1	0.412
Hunting	1.7	1.7	0	0.002	1	0.963
Land to build	18.2	17.8	-0.4	0.013	1	0.909
Crops	14.0	8.1	-7.9	4.543	1	0.033
Medicins	23.1	36.9	+13.8	11.863	1	0.001

Clean air	49.0	42.8	-6.2	1.971	1	0.160
Licestock	5.9	3.8	-2.1	1.240	1	0.265
Grazing	11.9	11.4	-0.5	0.025	1	0.874
Water storage	25.9	16.5	-9.4	6.663	1	0.010