The perspective of societal stakeholders - An assessment of Namibian livestock farmers' perceptions of ecosystem services and -benefits

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The perspective of societal stakeholders - An assessment of Namibian livestock farmers' perceptions of ecosystem services and -benefits

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Inhaltsverzeichnis

1. Introduction

The area of research in this thesis is the country of Namibia. The state name is derived from the Namib Desert which received its name from a term in the Nama language, translated as "vast place", giving reference to Namibia's arid landscape and the Namib as one of the driest places on earth[1,2]. The Namibian landscape is mostly arid or semi-arid, has extremely low precipitation rates, a high variability of rainfall patterns that are influenced by erratic El-Niño events[3], old soils with a high content of sand[1,2], increasing environmental issues like bush-encroachment[4], conflicts between farmers and predators[5] and extended droughts[2,6].

Mendelsohn et al.[1] describe even that even "…the most fertile" Namibian soils "… do not rate highly on a world scale of soil potential…".

The fertility of the soil in Namibia is impaired by a high content of sand but very little clay[7] resulting in a very limited ability to hold larger amounts of water making most of them unsuitable for agriculture[1].

Further hampered by the semi-arid landscape that only offers sufficient rainfall in few areas of the country[1,3], farming and herding can be, at best, described as challenging with various risks that requiring continued observation and adaptation to changing circumstances.

Understanding of the local effect of climate change in Namibia is clouded by the traditional variability of the climate that includes frequent droughts as well as El-Niño occurrences[3]. Assessing the local outcomes of climate change and developing ways to mitigate the impact is crucial to Namibia's future as nearly all aspects central to environment and society will be affected by it[8,9]. The Namibian government[6] names agriculture, human health and well-being as well as energy, infrastructure, biodiversity and ecosystems as particularly affected sectors of climate change in Namibia. It goes on to name livestock losses and reduced agricultural production among the strongest consequences.

Together with a predicted shift in rainfall patterns, increasing water scarcity and raising temperatures, this indicates that farmers in Namibia live and work in an environment that provides many challenges[10,11]. Considering the risks and benefits it may be surprising that more than 70 percent[1] of the population in Namibia is either directly or indirectly involved in agriculture and of the total land area about 38 percent is used for cattle ranching. Beef cattle ranching is therefore the most important source of income for commercial farmers in Namibia[12]. However, climate change might lead to severe changes for these activities. Reid et al.[10] estimate that climate change might result in a decrease of livestock production rates of 20 to 50 percent annually in Namibia until 2030.

While the economical side of climate change and its effect on agriculture has been discussed frequently[10,13,14], the question of how local cattle farmers assess their situation has been discussed more rarely[15,16]. Yet, farmers are key stakeholders that influence the largest and most extensive man-made ecosystem – agriculture[17].

To understand what motivates farmers and if they are aware of their position in the ecosystem and the benefits they receive from it "… have received limited attention,… " as Lamarque et al. observed[16].

The thesis analyzes interviews that were conducted during the OPTIMASS project[18] with regard to ecosystems services (ESS) and -benefits offering an opportunity to research how Namibian farmers perceive the ecosystem and its services and which benefits they reap from them. Apprehending their role and actions might contribute to developing solutions for a more efficient usage of these services and buffering the impact of climate change on farming.

The aim of this thesis is to assess how cattle farmers in Namibia perceive ESS and which benefits they receive.

1.1 Current State of Research

1.1.1 Ecosystem Service (ESS) Research

Since when humans have been understanding that they influence the environment and are influenced by it is unknown. But observations of this kind were already made in ancient Greece and probably even earlier[19]. In the modern day era the term "ecosystem services" has been coined by Ehrlich and Ehrlich[20], derived from earlier but similar terms like "environmental services" (Wilson and Matthews)[21] or "natural services" (Westman)[19].

The term became more common from the 1990s (see Fisher et al.[22]; Gómez-Baggethun et al.[19]) onwards, especially with a more direct connection to the benefits gained from these services (Costanza et al.[23]; Daily[24]).

In 2005 the Millennium Ecosystem Assessment (MA) report was published by the UN[25], following a four-year research campaign that involved 1.360 experts from 95 countries[25]. This was probably the most important step for raising the term "ecosystem services" to global public awareness while offering the most often used definition of the term: "[ecosystem services are] the functions and products of ecosystems that benefit humans, or yield welfare to society"[21]. The MA separated services into four sub-groups named: supporting, regulating, provisioning and cultural services and further divided these services into 20 categories (see Figure 6). Earlier definitions had been in use but even after publication of the MA there is no generally accepted definition on the term[26] as there has been no consensual agreement to the characteristics of

services and benefits. As has been stated by Boyd and Banshaf[27] benefits and services are not the same and do not necessarily have linear relationships as can already be seen in the MA when comparing direct and indirect services. This is evident in the cultural services where Fisher et al.[22] use the example of "Recreation". "Recreation" is strictly an anthropocentric idea as nothing in nature is made for recreational functions only. It is therefore a "…benefit of multiple inputs; often human, social and built capital inputs are necessary for recreation (Boyd 2007)"[22]. To circumnavigate this issue Fisher et al.[22] propose "… that ecosystem services are the aspects of ecosystems utilized (actively or passively) to produce human well-being" meaning that if no human being profits from these functions they are simply functions and not services. While this point is strictly anthropocentric, it is a valid and important observation especially with regard to ESS that benefit agriculture. The MA describes "Food" as a service but by Boyd and Banshaf[27] it would be a benefit as "Food" (crops that are harvested, livestock that is raised and consumed) is the final service and therefore an outcome. The services would instead be clean water, soil texture (both in quality and abundance), natural land cover (grass cover for livestock), pollination and biodiversity (which is important as different species of livestock prefer different types of grass[28]).

Much has been written in the last two decades about the valuation of ecosystems and services in economics, mostly to support policy makers in applying monetary value to ESS and giving these services an accounting representation in a monetary based world view (see for example Costanza[23,29]; Heal[30]; Landell-Mills and Porras[31]; Wunder[32]; Liu[33]; de Groot et al.[34]; Bateman et al.[35]).

But valuing ESS in monetary units has not been issue-free as counting each service individually causes some problems for valuating ESS in financial terms. Double counting, which is common practice for green GDP, might occur if one were to count the individual goods and services that lead to the final product and add them. As discussed by Boyd and Banshaf[27] in economics double counting is unacceptable as it would distort the prices for a final product. They recommend an ecosystem service index (ESI) as a better method for valuating ESS, while giving a new definition to compare those services: "Final ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human well-being."[27] This evaluation of ESS might be intriguing but so far has not come into widespread usage as the standard that has been set by the MA the generally preferred method[36] due to the fact that "The Millennium Ecosystem Assessment introduced a new framework for analyzing social– ecological systems that has had wide influence in the policy and scientific communities"[36]. As other scientists already pointed out, the MA has not solved all issues regarding the application of ESS

research[27,36,37]. One example is the fact that the MA regards ESS individually. Only rarely it pays attention to the fact that it is rare that only one ESS is in use in one system[37]. Studying the relationships between different ESS is, especially in systems that have been highly influenced by human activity, of importance as these systems usually provide basic products for human needs (i.e. agriculture produces food or forests produce timber). As Carpenter et al.[36] have shown (Figure 1), human usage of ESS is still increasing while at the same time the conditions of most ESS are in decline. They encountered that, according to the Millennium Assessment (MA), usage of all services increases with the exception for wood fuel, agricultural fibers, wild terrestrial foods and wild caught fishes. The condition for ESS is only increasing for crops, livestock, aquaculture, global climate regulation and spiritual and religious values.

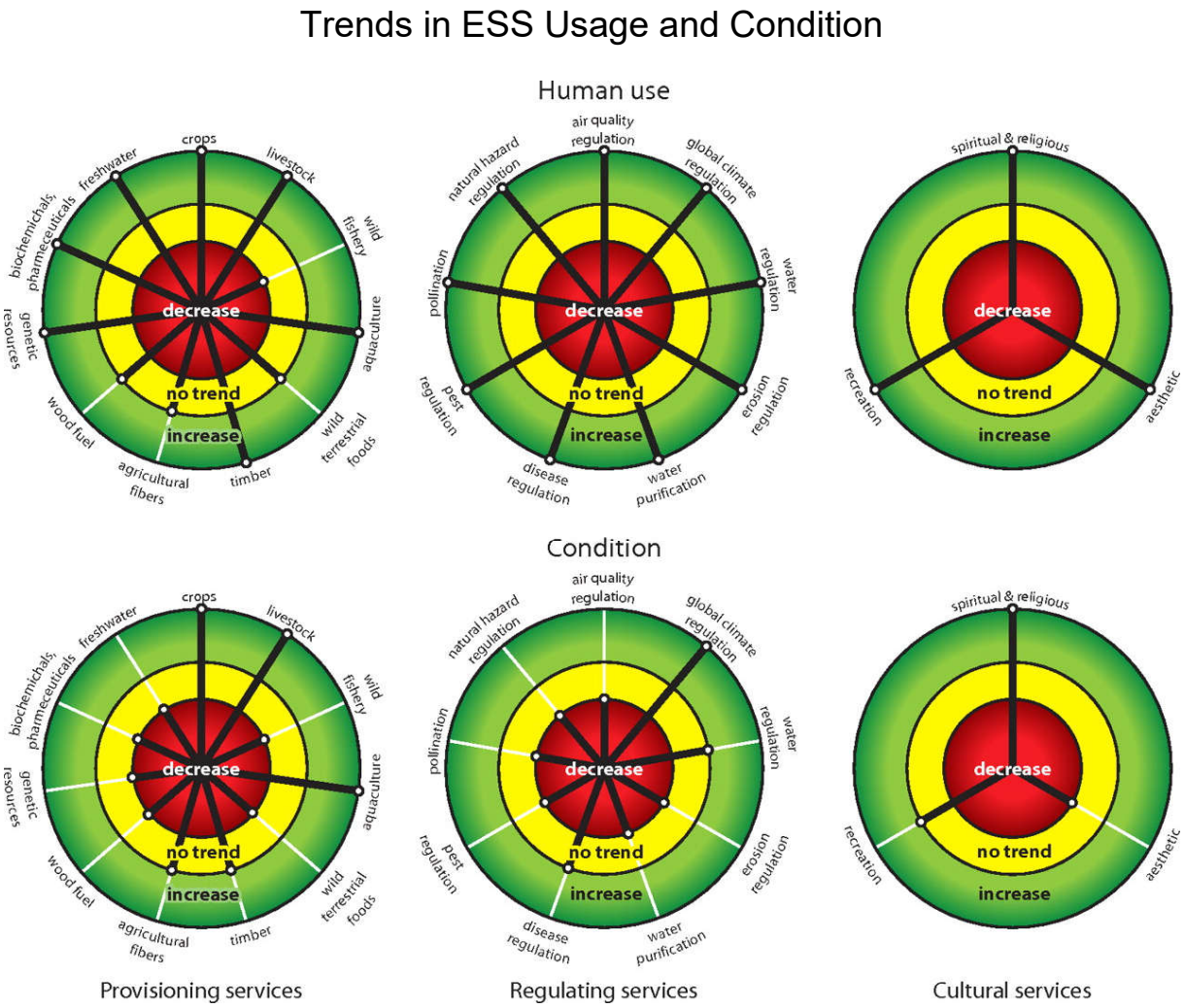

Figure 1 - Trends in human use (top row) and condition (bottom row) of ecosystem services - Source: Stephen R. Carpenter et al. PNAS 2009;106:1305-1312[36]

Carpenter et all[36] show that ESS that are connected to farm life like livestock, freshwater, pest regulation, natural hazard regulation and genetic resources increase in usage but decrease in condition. The exceptions are crops and livestock which show on the global scale an increase

of conditions as well. Whether the same can be said for Namibia as well is to be one point of examination in the following chapters.

Zhang et al.[17] note that "…agriculture represents humankind's largest engineered ecosystem", thereby demonstrating that this ecosystem is of special importance.

For ESS research this raises the question if there is need for new semantic terms that combine "ecosystem services" and "agriculture" to make it easier to include "…managed agricultural ecosystems"[38] into agricultural economics. A proposal for a new semantic would be "agrosystem services"[38]. The analysis of the interviews with the stakeholders in Namibia was conducted with keeping the aforementioned discussion in mind. It is increasingly important to understand how farmers perceive their environment, which measures they are taking and if they are ready to change their behavior as key stakeholders in an ecosystem if the environment and their own future would benefit from it.

1.1.2 Transdisclipinarity Research (TDR) and Societal Stakeholders

Research into stakeholder participation, behavior and characterization of stakeholders as well as of the connected topic of transdisciplinarity research (TDR) is of utter importance to scientists and political decision makers receiving more and more attention in recent decades. Maasen and Lieven[39] explained that "transdisciplinarity is to ensure that one identifies and solves 'real-world problems'…" but until today the research topic of transdiciplinarity has not fulfilled the expectations that were attributed to it. A possible explanation to this riddle has been given by Jahn and Keil[40] who observed that transdisciplinarity research "…lack('s) a generally accepted quality standard for TDR".

To address this issue, and provide better options of implementing transdisciplinarity into sustainability (and ecological) research, Jahn and Keil[40] propose a new mechanism which they named: "policy relevant sustainability research (PRSD)".

This mechanism is to be separated into three dimensions, the first being "systemic". "Systemic" means that nature and society are closely intertwined, system integrated, interdependencies that cannot simply be regarded as linear. The second dimension is called "scale spanning", which gives credit to the research issue that the system integrated interdependencies occur on different levels. The term "prospective" has been chosen as the third dimension due to the fact that small changes inside a complex and formerly stable system can lead to unexpected and sometimes drastic effects. According to Jahn and Keil[40] this three step processes can be considered three-dimensional.

It begins with the above mentioned "systemic" being the "quality of the research problems" while the two other "…general quality dimensions of transdiciplinarity sustainability research" are "quality of the research process" and "quality of the research results".
Jahn and Keil[40] propose using this mechanism for either "policy relevant, societally relevant and scientifically relevant" guidelines. It is more often than not that these guidelines are closely connected to each other or cross-over and mix at least two of these fields. When doing research that is ESS related it is quite likely that all three guidelines are touched.

1.1.3 Implementation of ESS Research into Policy Making

No entity exists on its own. It is always part of a larger system bound by its existence and the position contributed to it. We can call this frame nature or environment, but nature or the environment is, on the other hand, not an abstract structure but a frame that has been created by the interactions between all entities[41,42]. Therefore, researching of individual species or subjects might not yield sufficient informational gain for a system as complex as an ecosystem which only functions as the result of the relationships between its entities. Wiggering et al.[38] stated in their discussion of how we shall look at agricultural ecosystem services that "…agrosystem services, identical to anthropogenic inputs, do not make sense when considered in isolation."
In the course of living as human beings, humans often do not perceive themselves as a functional entity that lives with the living and nonliving environment but rather as an object of singularity that has social links with other humans and an environment that has to be conquered[41].
There is a long and ongoing discussion in the field of environmental ethics[41] whether nature has to be perceived from an anthropocentric perspective or from an ecocentristic one[41]. This question is of increasing importance in law[43] as well as in the field of environmental protection. The result of this discussion will decide how the protection of nature can be legally enforced and whether humans can be held accountable by human legal systems for inflicting any kind of damage in nature even if no person is directly harmed or financial impairments occurred[43,44].
For policy makers accounting the financial value of ecosystems and its services can have important consequences. An example can be found in the Paris Agreement, where preservation of intact rainforests was attributed a financial value[45].
This shows that these discussions are not solely of importance for scientists and policy makers but also for the general population as well since they define the position we attribute to nature[46,47]. Farmers have a special place in this system as they work in the nexus of ecosystems and human interferences with nature, directly harvesting the benefits of ecosystem services

(ESS). The definition by the Millennium Ecosystem Assessment (MA) for ESS is as following: "Ecosystem services are the benefits people obtain from ecosystems". This definition has been discussed by several authors as it does not give a clear definition for the term "benefits" (see Chapter 1.1.1).

1.2 Namibia

1.2.1 Country Facts

The area of Namibia is 824,292 km^2 stretching for more than 1320 km from north to south and 1440 km at its widest point[1]. Despite its large area Namibia currently only has a population of 2.2 million people of whom more than 87 percent are of indigenous ethnicity with most belonging to the Ovambo tribe. Other large ethnical groups are the Nama, Herero, Kavangos and Damara[1]. Whites comprise up to about 6 percent of the population. The urbanization rate has risen up to 46 percent with the only large urban area being Namibia's capital Windhoek[48]. The most common languages are Oshiwambo with nearly 49 percent, Nama/Damara with about 11 percent and Afrikaans with about 10 percent, which is however the most widely used language of the white part of the population[49].

Namibia gained its independence from South Africa in 1990 following a long rule by foreign powers, being occupied and colonized first by settlers from the German Empire since the end of the 19th century and then being occupied by South Africa after World War I[50]. This development is still widely reflected in the farming landscape where more than half of the livestock farmers claim to be of German heritage while speaking either Afrikaans or German[15]. The ruling political party since gaining independence is the SWAPO (South West Africa People's Organization), which originated from the former liberation movement against the ruling South African government. The SWAPO has been in power since the independence of Namibia, winning the latest general election in 2014 with more than 86 percent of all votes[48].

1.2.2 Economy

Namibia's economy has a GDP (purchasing power parity) of about 25 billion US$ and a per capita income of about 11,400 US$[48]. Namibia's income is widely dependent on first sector products such as mining and farming, even though direct sales from mining make up only about 11 percent of the GDP and agriculture only contributes about 6 percent to the GDP while the industrial sector as a whole contributes 30 percent. Income disparity is high in Namibia with a GINI index of nearly 60[48]. This is, at least partly, a result of the colonization era and the fact that about two thirds of land dwellers are depend on subsistence agriculture[48].

1.2.3 Agriculture

According to Mendelsohn et al.[12] the economic value of agriculture in Namibia has been decreasing since the beginning of the new millennium to the point of a gross agricultural value of N$ 1,878 million in 2004.

Farming in Namibia has been categorized into four farming and one production systems by Mendelsohn et al.[12] in a report for the Namibia National Farmers Union (NNFU):

Categorization of Farming Systems in Namibia

Farming System	**Land Area in Namibia**	**Size (in ha)**
Small-scale cereals and livestock	Dominant farming system in the upper north	5.5 million
Cattle ranching	North and North-Eastern parts	31.5 million
Small stock	More arid areas of the north-west and south	27 million
Intensive agriculture	Found all throughout Namibia but highly dependent on irrigation	40000
Natural resource production[1]	Mainly in game farms and conservancies or as a byproduct on other farms	Size not indicated

Table 1 - Categorization of farming systems in types and area according to Mendelsohn et al.[12]

These farming systems have to be valued and considered together with the traditional ownership of farmland in Namibia which is traditionally separated into two land tenure systems with the remaining 18 percent being used as national parks and declared urban areas:

- 44 percent of the land area is freehold (in urban areas) respectively commercial (in rural areas)
- 38 percent of the land area is communal (only in rural areas) with a population of 1.1 million people[51]

[1] Natural resource production has been described by Mendelsohn not as a farming system but a production system that becomes more and more popular for making profits due to a system that elicits strong “similarities to farming”

This separation has historical roots with commercial land being owned mostly by white settlers and allowed to be sold individually and on a personal level. Communal land on the other hand was mainly to be found in tribal areas designated for the black population and only leased out by the pre-independence government. As a consequence, ownership of this land was not possible. This disadvantage is therefore of large concern for the Namibian population where ownership of agricultural land is still seen as a status symbol, especially for the Previously Disadvantaged Namibian (PDN) population, who were barred from owning land until independence. The government tried to improve this situation by buying farms from Previously Advantaged Namibian (PAN) owners and re-distributing them to PDN owners under a program called the "Agricultural Land Reform Act (1995)"[52]. This program has been highly controversial since its inauguration as formerly large farms get divided into smaller units which are often too small to generate a sustainable income from farming alone leading to overgrazing. A further issue is that resettlement farmers are often not trained in utilizing the farm distributed to them correctly[52,53].

The disparity between commercial and communal farming is largest in cattle farming, which is traditionally the stronghold of the PAN (mostly descendants of either German or South-African heritage) who have often owned their farms for generations. This has been a factor in the study of Olbrich et al.[15] as well as of importance in the interviews where nearly all farms with a size of over 5000 ha were owned by PAN farmers.

1.2.4 Geology and Soils

The information about the geological history of Namibia is mostly taken from Mendelsohn et al.[1] while the classification of soils can be found in the FAO's "World reference base for soil resources"[7].

According to Mendelsohn et al.[1] large parts of Namibia's geological landscape are covered by sand formations from the Kalahari in the east and Namib in the west. The other parts are made up by rock formations that have changed through processes of geological activity and erosion with the oldest rock formations dating back two billion years while the youngest, in the Damaraland region, were formed as a result from igneous rock formations about 135 million years ago[1]. The geology of the research area is as followed:

- Tsumeb area: Geologically part of the Otavi Group which consists mostly of limestone, an area directly bordering the Kalahari Sands. The Otavi Group was formed between 735 and 550 million years ago[54]. The time of its formation is similar to those of other parts of the Damara Supergroup into which it has been grouped. This area mostly

consists of mollic leptosols, while the Kalahari Sands consists of ferralic arenosols and is of young geological age with a maximum of 50 million years[55].

- Waterberg Basin area: A region comprised mostly of sandstones and conglomerates, which again borders the Kalahari Sands. The Waterberg is a plateau with a height of up to 1700 m, formed during the end of the formation of the Karoo Supergroup about 180 million years ago. The sandstones absorb most of the rainwater very rapidly but are of only miniscule retention capacity leading to a fast release of the water in the form of fountains and springs, which can be found on the southern slope of the plateau[56]. Eutric cambisols can be found in the direct vicinity of the Waterberg while petric calcisols can be found east of Hochfeld and ferralic arenosols in the sand parts[55].

- Otjiwarongo and Khomas region: South of Otjiwarongo and of Khomas soils can be found which are rich in granites while the soils which belong to the Swakop Group mostly consist of schists. The Damara Granites are considered to have been formed between 650 and 470 million years ago while the Swakop Group also belongs to the Damara Supergroup with an age of approximately 850 to 600 million years. Eutric regosols are the main soil type in this area while to the west lithic leptosols can also be found[1].

- Windhoek region: The rocks to the direct east of this area were formed around 2 billion years ago and belong to the Rehoboth group. The ones to the south-west belong to the Gariep Complex, formed around the same time as the Damara Supergroup. Both rock formations consist mostly of complexes which form eutric leptosols[1].

- Gobabis region: The rocks in this region are in the area of the Naukluft Mountains part of the Damara Supergroup, with soils that mostly consist of limestones and shales. To the South of Gobabis they belong to the Nama Group (age 600 to 543 million years), consisting mostly of sandstones and conglomerates. The rocks form eutric regosols there[1].

- Kuzikus region: Kalahari Sands on petric calcisols[1].

All of these soil types do not offer much capacity for farming as they do not have any substantial profile depth which indicates that soil-forming processes are absent. According to the FAO's "world reference base for soil resources"[7] leptosols and arenosols are among the most common types of soils found in arid and semi-arid regions.

Arenosols are, as their Latin name indicates, very sandy soils (up to 70 percent) found in sandy areas all over the globe. In dry zones like Namibia there is nearly no soil development. They are formed by weathering of quartz-rich parent material. The Kalahari Sands are the vastest zone of sand in the world.

Calcisols form upon calcareous materials and are one of the most common soil-types in arid and semi-arid regions when the parent material is base rich. The FAO states that the most common usage of these soil types are for grazing, especially when the area is petric.

Cambisols show some shallow soil-forming processes that stem from medium and fine-textured materials of all kinds of rocks. While cambisols can make fertile arable land in areas with higher precipitation it is mostly used for ranching in the Waterberg area.

Leptosols can usually be found between medium to low altitude levels providing possibilities for seasonal grazing but not for agricultural farming since they are very shallow, susceptible to erosion and have low water storing capacities resulting in run-offs.

Regosols are of medium coarse fragmentation and are weakly developed, mostly found in landscapes or areas that show high erosion rates but are not sandy and are in an arid surrounding. Their parent material is fine-grained but unconsolidated. While regosols can be used for cultivating crops in temperate regions, they are mostly used for grazing in arid regions like Namibia, especially if intensive irrigation would be required to make the land arable.

1.2.5 Climate

The climate data for Namibia shows a mean annual rainfall of below 250 mm and a maximum of up to 600 mm, making Namibia the driest Sub-Saharan country[6].
The rate of average rainfall shows two patterns[2]:

- Mean annual rainfall decreases the closer the coast is
- Moving from the north to the south rainfall decreases as well

The highest average rainfall rates can be found in the border areas to Angola and Namibia with up to 600 mm per year, while the driest area is the coast with less than 50 mm of annual rainfall.

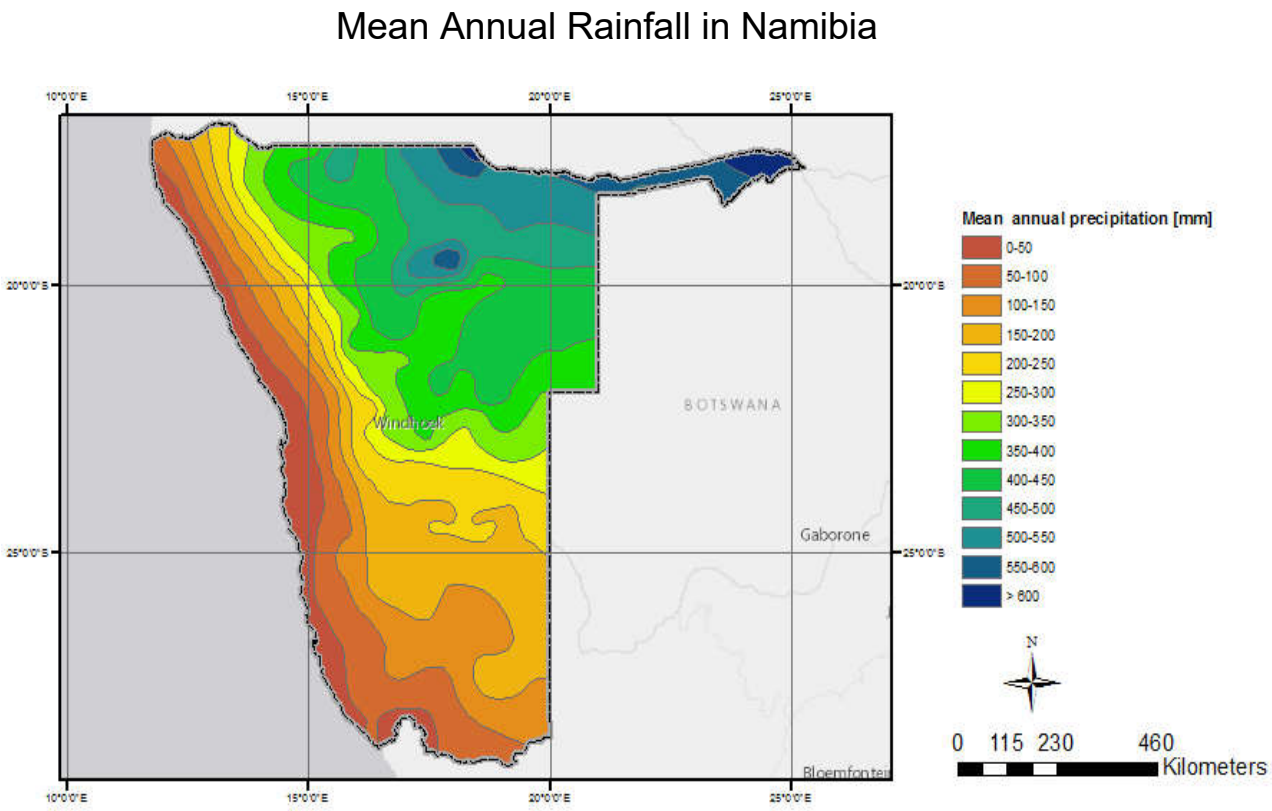

Figure 2 - Map of average annual rainfall adapted from Mendelsohn et al.[1]

Going south average rainfall rates in the capital region around Windhoek are about 250 mm declining to 100 to 150 mm around Keetmanshoop[1,2]. Nearly all of this rain falls in the summer months between November and April. But rainfall in Namibia is not only sparse, it is highly erratic, too[1,2].

Namibia has always been marked by drastic climate changes which switched from years with rainfalls that were strongly above average to prolonged years of severe droughts which makes annual average rainfall observation debatable[2,3]. An extreme example for this is given by Mendelsohn (2012) for the town of Walvish Bay where a total of 45.4 mm fell for a 10-year duration between 1990 and 2000. However, 32 mm of these 45.4 mm fell in just one year (2000)[2]. The coast might be most extreme in case of anomalies but the Sasscal (Southern African Science Service Centre for Climate Change and Adaptive Land Use) weather station for the Waterberg provides annual rainfalls that range from 142.7 mm in 2015 to 838.2 mm in 2014 while the average mean rainfall is between 450 mm and 550 mm[57]. A similar, scenario can be observed for the Windhoek weather station where the lowest rainfall with 192.2 mm was in 2013 and the highest in 2011 of 627.2 mm while the annual mean is 359 mm[58]. This high variability of the climate exists due to the combination of several factors in the climate system: First there is the Benguela Current which brings cold Antarctic water from the south. The

second and third part are two Anticyclones, the South Atlantic Anticyclone on the ocean, and the Botswana Anticyclone in the inland[2].

While the South Atlantic Cyclone is a strong high pressure cell located to the west of the coast blowing from the south and the south west inwards the Botswana Cyclone is mostly active in the winter creating pressure differences between the coast and the inner parts of Namibia[2]. These cyclones are influenced by the Inter-Tropical Convergence Zone (ITCZ) which connects the moist trade winds but moves south of the equator in summer transporting moist air and therefore rain to Namibia. Yet, the southward movement of this zone is blocked partially by the South Atlantic Cyclone but less severely in summer allowing rain to fall to the south and west of the ITCZ, a process that continuously declines in intensity towards the south.

In the coastal region wet air coming from the east evaporates while cool air that is blown inwards from the Benguela Current. This cool air cannot rise above higher layers but instead forms fog due to its coldness[2,3].

1.2.6 Climate Change

The factors described in Chapter 1.2.5 make the climate system in Namibia highly variable. Yet, it is also, to a certain degree, stable with shifts between high precipitation years and dry years. The multiple factors at play make long-term and climate change induced rainfall predictions in Namibia troublesome[6,9]. Most climate models predict decreasing rainfall, an increase of extreme weather events and an average temperature rise of 2°C to 6°C until the end of the century, leading to hotter days throughout the year[10].

In a report for the Ministry of Environment and Tourism of Namibia Dirkx et al.[9] described that livestock farming in Namibia will face increasing difficulties due to climate change. Mfune et al. stated[6] that over a 20-year period the reduction of income from livestock could be 20 to 50 percent. Climate change might lead to a change in the structural cover of pastoral areas from grassland savannas to desert and arid shrub vegetation types thereby reducing the fraction of land that is suitable for livestock farming [6,10,59]. But higher temperatures might not only change the landscape but lead to more stress for livestock animals and increase the susceptibility to diseases as well[10,13].

These climate change effects will affect many of the highly adapted ecosystems of Namibia as well as desertification and occurrences of fire events. Higher CO_2 levels might increase the production rate of C3 dominated vegetation types, leading to higher rates of bush encroachment. Nonetheless, the higher bush encroachment rate might, as a positive side effect, reduce the rate of desertification[59]. For livestock ranchers the effect could be positive in some ways and

negative in others. While higher temperatures might reduce loss rates of sheep during winter[13] it might create an even lower carrying rate that requires a downscale from cattle ranching to sheep and wild production[10] and a change from large European cattle breeds to smaller but better adapted local breads like the Sanga[13,14].

1.3 Timeframe and Background of the OPTIMASS Project

The OPTIMASS ("*Options for sustainable geo-biosphere feedback management in savanna systems under regional and global change*")[60] project was initiated in 2014 as a joint project of several universities and research institutes. The ISOE (Institute for Social-Ecological Research) oversees the research of water and ecosystem services related questions in this project[18]. For gathering the required information three semi-structured interview rounds were conducted. Interviews with the experts started in November 2014 and the results of these interviews were then used to develop a questionnaire for farmers who are the key-stakeholders in this project. Then two timetables for interview sessions, one in April 2015 and the second one in April 2016, were set for a total of 25 farmers. The first 13 farmers were selected with the help of the experts and due to personal acquaintances of other farmers. One key element of the selection was to have a presentation of a wide range of farm styles, ranging from cattle farmers to game farmers, small-livestock farmers and more exotic types of farming (for Namibia) such as ecological farming or tourism and natural conservation orientated. Among those interviewed were German heritage farmers as well as resettlement farmers, PD farmers that owned non-resettlement farms, a research station and a wildlife park.

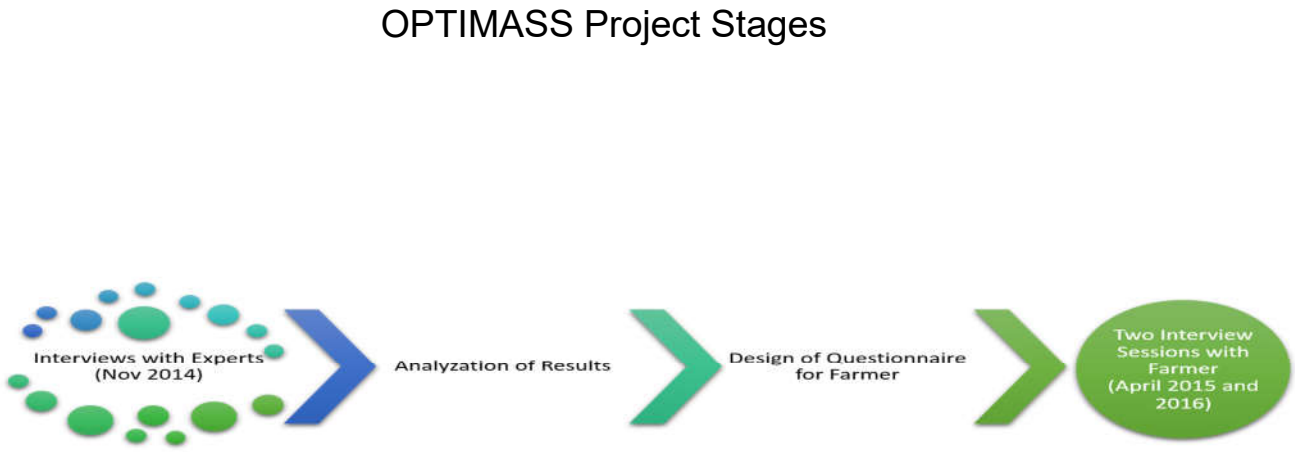

Figure 3 - Development Stages of Interviews (Own Figure)

The aim of the study of the ISOE OPTIMASS team was to understand the relationships between the cattle farmers, the land they work on and the ecosystem they farm in. While the general idea had been clear due to the project description the exact questions had yet to be formulated and potential stakeholders to be identified and contacted. Developing the questionnaire has been a continuous work that started with the formulation of a number of questions (see appendix A) for 12 Namibian experts who work with MAWF (Ministry of Agriculture, Water and Forestry), NAU (Namibia Agricultural Union), GIZ (Deutsche Gesellschaft für internationale Zusammenarbeit) and NUST (Namibia University of Science and Technology), some of whom were known to the team either personally or by papers published by them.

The required objective analysis of the research has been established through the interviews with the experts and due to knowledge of NRMPS (National Rangeland Management Policy and Strategy)[61] in Namibia. These interviews have been designed to gather information about the living conditions, behaviors and personal background of the stakeholders, their farms and infrastructures, ranching methods, changes and adaptability in case of droughts, the political and socio-economic settings and outlooks, environmental factors like soil and grass quality as well as their perception of the environment in which they exist and the importance of this environment for them. At the beginning the primary intention of the interviews was not to directly gather knowledge about the position of the farmers in the environment but rather to distinguish different methods of farming and ranching and their effects for the success of the farmer and the environment in mid- and long term range scenarios which should be used as a foundation for modelling programs in the OPTIMASS project.

2. Materials and Methods

2.1 Methodological Framework

The database of the thesis are semi-guided interviews that were conducted with experts and farmers in Namibia from November 2014 to April 2016. These interviews followed a thematic guideline that has been used to assess which management approaches for farming local cattle ranchers use and what knowledge about connections of ecological topics they possess.

As the author of this thesis was neither involved in the design of the original questionnaires nor in the interview procedures, the analysis of the interview can be best described as a documentation analysis. The methods were drawn from social scientific standard work like Baur and Blasius[62] who write that "… social sciences are reality based sciences" meaning that one has to conduct research in a way that it can be resampled and reconstructed empirically by

others. In this Chapter 2 the outlining of the interviews, the analyzation method and usage of keyword cards will be explained resulting in the presentation of results in Chapter 3. In Chapter 4 results, used methods and a proposal for an alternative questionnaire will be discussed.

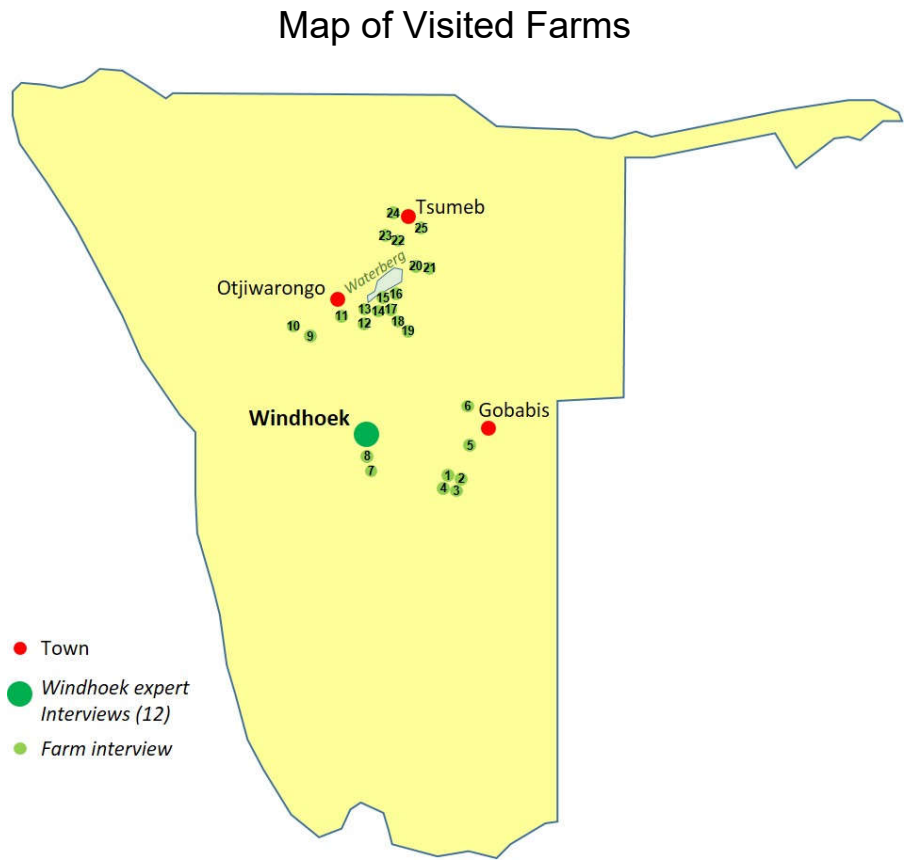

Figure 4 - Map of Namibia with approximate location of the 25 visited farms. For more information regarding the farms see Chapter 3.2.3 and appendix D. Map and legend from: OPTIMASS Project[18]

2.2 Design of Study

The background of information for this thesis results from analyzing and evaluating problem centered interviews that followed loosely the description given by Mayring[63]. The study was designed to deduce quantifiable data from qualitative information as the questionnaires were designed to be semi-structured giving the interviewees a guidance through the interviews while offering the chance to give secondary information that was not directly asked in the basic outlining of the interviews. Baur and Blasius[62] state that "… a combined discussion of qualitative and quantitative methods" can be a better alternative as it might lead to more reliable results that approach a question from different perspectives which is the main interest of social sciences. The main idea behind conducting the interviews was to understand how farmers in Namibia see their lifestyle, how they ranch, which management methods they use in normal

and in dry years, what are their most pressing issues (either natural, political or economic) and what they would like to change.

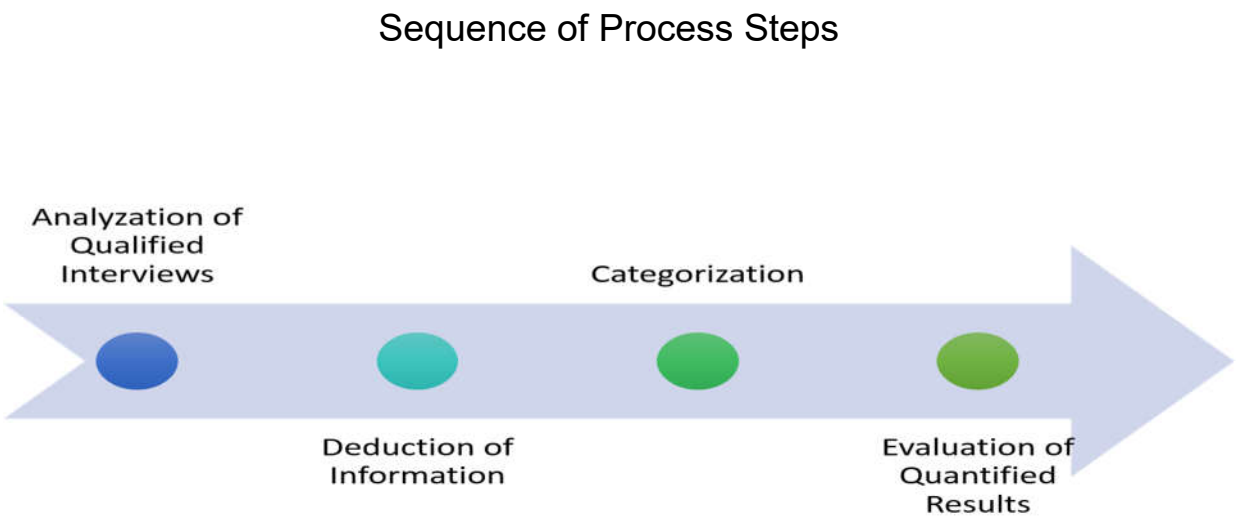

Figure 5 - Process steps to achieve quantifiable data from qualitative interviews (Own Graph)

The idea to research how the farmers understand nature and what they think of their influences on the ecosystem in which they are active has emerged as a relevant question due to the questionnaires being partly designed to cover ESS related questions.

Yet, the main aim of the questionnaire was not to answer these questions in depth but to understand the motivations of livestock farmers. The methodological procedure therefore uses several social scientific methods of which using interpretational methods to categorize the qualitative answers into a quantitative system is the most important[62].

The deduction process was adapted from the steps for a content analysis as explained by Krippendorf[64] with the addition of step 7, which is the interpretation of results according to Früh[65] and Mayring[66]:

1. Which source material shall be analyzed?
2. In which code is the source material available?
3. What background information about the interviewees is available?
4. In which context shall the data be analyzed?
5. Are their limits to the available source material?
6. What is the goal of the inferences?
7. Interpretation of results

The source materials were, as written in Chapter 2.1, the semi-structured, problem centered interviews, the code that had to be translated was the transfer from qualitative into quantified form. Not many characteristic traits (age, location, size of farm) were available, therefore the data was not clustered with the sole exceptions of clustering by regional allocation (Chapter 3.2.2) as well as by farm size (Chapter 3.2.3). The study resulted from the context that was given in the OPTIMASS project which is stakeholders (local cattle farmers) in Namibia. Step 5 will be discussed in Chapter 4. Goal of inferences was to find out which ESS are used by farmers and how they value them. The method for interpretation of results can be found in Chapter 2.4.

2.3 Questionnaire Design

The questionnaires were developed in an iterative process beginning with the design of a questionnaire for interviews with experts from academia and administration in November 2014 (see appendix A). The interview setting followed a guideline structure favoring the usage of a package of themes instead of pre-formulated questions to enhance the comparability of the data.[67]

A key element of guideline structured interviews are pre-tests to enhance the adaptability and comprehensibility of the questions.

For the experts interviews the questionnaires were divided into four parts:

- Introduction
- Open Interview
- Specific Questions
- Conclusion of Interviews

Questions regarding managing strategies of land and water were asked and questions about the character of the farm and possible issues with policies and policy makers as well as Namibia's future were raised.

Based on the expert interviews and literature from the NRMPS[61] a questionnaire was developed for the farmers with the following structure (for the questionnaire, see appendix B):

1. Introduction
2. Background of farm and farmer
3. How do you manage your land? Including challenges and outlook
4. Infrastructure related to water
5. Bush encroachment, including rangeland condition & indicators
6. Benefits

7. Knowledge exchange
8. Visual aid/ Summary

The introduction was used to gather some information about the background of the farmer and the farm but also to break the ice at the beginning making the interview atmosphere more relaxed.

The frame of the interviews were semi-structured questions that gave the stakeholders the opportunity to express themselves freely but did not provide quantitative answers.

Since the ISOE working group of the OPTIMASS project is supposed to provide parameters for a simulation model regarding the procession of environmental changes due to farming in Namibia it became obvious that qualitative answers would not suffice and quantitative answers were also required.

To counter this issue two methods were considered and used. On the one hand it was tried to transfer the information from the qualitative interviews into a quantitative form in this thesis. On the other hand, an additional survey method was developed prior to the April 2016 interviews. Farmers were requested to rank keyword cards[68] with different management options and effects on the ecosystem services according to their own judgment. The keywords for these cards were chosen as a result from a literature analysis of the NRMPS[61] and were open to write-ins by the side of the stakeholders.

2.4 Working with the Questionnaire

The answered questionnaires were available as memos, notes, minutes and audio tapes, some of them gathered during the interviews, others written as minutes from memory.

Analyzation of the interviews was conducted by a qualitative text analysis of the content of the questionnaires according to Baur and Blasius[62].

The procedure is based on basic principles from Mayring[63,66] and is was to read the interviews (the text), followed by transcription extraction of quotes, which are then categorized with the help of an Excel©-table. This Excel©-table was designed to roughly represent the categories from the interviews but separated into a data part (such as size of farm, size of herds, rotation time) and a written part with quotes from the interviewees in which methods and behaviors were categorized (like methods used for camp rotation intervals, personal background or farm management strategies). This method was used for the interviews with the farmers as well as the ones with the experts but due to differences in the questionnaires it was not possible to use the exact same categories for both and therefore separate Excel©-tables were created.

After these primary steps had been taken the interviews were analyzed more fully again and the answers adjusted so that a more conclusive structure of the interviews could be constructed.
As can be seen in the file that is available on the CD many more tables were created, for example for measures of farming activities, agreement and usage of measures not directly related to ESS research and so on. Yet, due to the limited space and time available for a bachelor thesis these tables had to be discarded for this thesis. Usage of these tables might provide additional information for understanding the usage and adaptation of farming methods in Namibia.

2.5 Categorization and Evaluation of Interviews

The standard categorization for ESS is still the Millennium Ecosystem Assessment (MA) which was published in 2005[36]. Since then other categorizations like TEEB[69] and CICES[70] have been established as well but using an adaption (see Figure 6) of the MA categories as a frame of reference made most sense since the MA is still the most widely used categorization. The categories were chosen to combine common answers regarding ESS and -benefits given during the interviews. The detour of development of these headers was needed since a quantitative analysis of the interviews was simply not possible due to their nature of being semi-structured. This led to a wide range of answers that can be interpreted as comparable but not congruent since they were often too differently expressed.
The quantitative data was grouped into predefined categories (see Figure 6) to determine which services were mentioned most often by the farmers. However, the sub-categories were adjusted slightly as the definitions of the farmers were more agricultural. But to receive quantitative data it was necessary to translate the answers which were given as qualitative expressions into a quantitative mode. Mayring and Fenzel[62] explain that the qualitative analysis of the text follows strong interpretational approaches that are then categorized. Values were assigned to the expressions as either plus, minus or empty value:

- Plus means that the farmers are conscious of the service and use it or at least plan to use it
- Minus means that the farmers are conscious of the service but do not use it or have tried to use it but the result was negative
- Empty value means that the questionnaire does not provide an answer for the particular farmer in this regard

The empty values can neither be interpreted as yes, no, maybe, yes and no since no information is available for them, therefore leaving them blank is the only option.

ESS Categories adapted from Millennium Ecosystem Assessment

	Ecosystem Service	Sub-Category Based on MA
Provisioning Services	Food	Livestock, Game
	Fiber	Firewood, Charcoal, Wood Products
	Genetic Resources	Livestock Breeds, Grass Species
	Biochemicals, Natural Medicines, Pharmaceuti	Natural Medicines
	Fresh Water	Reservoirs,Dams, Su cient Rainfall, Natural Springs
Regulating Services	Air Quality Regulation	Cleansing of Air
	Climate Regulation	CO2 Regulation, Temperature Regulation (Shadow), Climate Change
	Water Regulation	Run O , Flood Regulation, Groundwater Recharge
	Erosion Regulation	Control of Soil Degradation and Water Run Off effects
	Water Purification and Waste Treatment	Clean Water, Salination, Waste Water Treatment
	Disease Regulation	Animal Diseases like Rabies, Vaccination of Livestock, Human Diseases
	Pest Regulation	Invasive Species i.e. Bush Encroachment, Predators
	Pollination	Pollination of Grasses and Shrubs
	Natural Hazard Regulation	Drought, Fire
Cultural Services	Spiritual and Religious Values	Experience of Farm Life, Appreciation of Nature, Holistic World View
	Aesthetic Values	Intact Nature, Game, Wildlife
	Recreation and Ecotourism	Trophy Hunting, Ecotourism
Supporting Services	Soil Formation	Increase of Soil Quality
	Nutrient Cycling	Availability of Nutrients and Embedment into Cycle
	Primary Production	Natural Growth of Grass, Grass Production

Figure 6 - Adaptation of ESS categories based on Millennium Ecosystem Assessment (MA)[25] (own Figure)

2.6 Introduction of Keyword Cards

As briefly mentioned in Chapter 2.3 keyword cards were introduced for the last interview session in April 2016 only. The aim was to receive a more complete understanding about the interests of the farmers and the importance of ESS for them. Therefore, it was decided to offer the stakeholders a possibility to evaluate services directly and rank them themselves. An advantage of this method is that it removes the necessity for interpretation by the researchers and gives the stakeholder an opportunity to express themselves more directly. While several farmers of the previous interview session were contacted and willing to work with the keywords cards it was impossible to receive participation from all farmers leading to some inconsistencies like a very narrow regional focus (3 farmers in Grootfontein, 8 in Waterberg and 1 in Windhoek region).

The interview process with the keyword cards was not standardized, meaning that some farmers choose to rank the cards more equally while others preferred a hierarchical ranking. A mixture of both styles was common. It was also possible to write in cards with self-defined ESS and, as

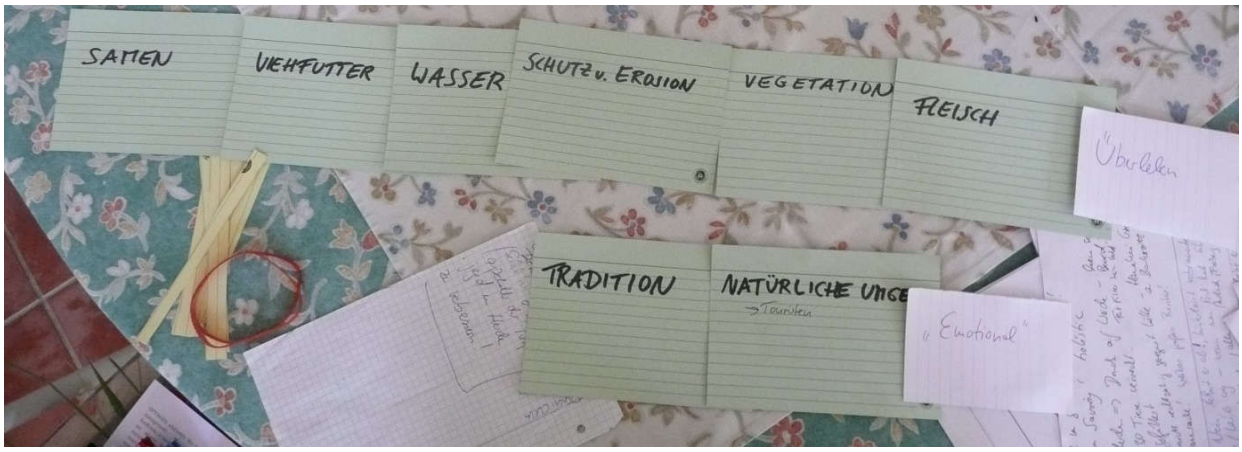

Figure 7 - Peer Ranking method of ESS keyword cards

can be seen in the pictures, cards were available in German and English to accommodate the different languages used in Namibia's farming society. According to the interviewer the interpretation of what each card signified was up to the interpretation of the stakeholder.

The mixture of styles of self-evaluation leads to multiple issues of which comparability is the most serious. It was not fully possible to counter this issue but for comparison the results are ranked in two methods:

1. Peer Ranking
2. Hierarchically Structured

These methods can be best understood by looking at Figures 7 and 8. In the peer ranking the first six cards all received rank 1 and the next two rank 2. In the hierarchical ranking the first six cards still have rank 1 but the next two rank 7. Figure 8 shows a ranking that is strictly hierarchically structured ranging from ranks 1 to 7. The results in Chapter 3.3 consist of these rankings which were analyzed separately. For details of the values please see appendix. A comparison of the valuation of the importance of ESS in the interviews with the results of the self-evaluation by the farmers can be found in Chapter 3.4. However, a clear comparison cannot be made since:

Figure 8 – Hierarchically Structured method for ranking ESS keyword cards

a. the keyword card evaluation uses a weighting system and the interviews do not

b. not all categories of the MA were available for evaluation

c. peer ranking and hierarchically structured was used to confront the issue that a 2 in a ranking that used peer structure might not have the same value as one that does use a hierarchically structured ranking

d. the keyword cards combine several categories into one (like freshwater which combines all factors of water but one farmer chose to exclude rain from it and made it a separate category). In total a maximum of 12 answers for each category was possible. Farmers made 5 to 10 entries, with a median of 7 for a total of 89 entries.

2.7 Evaluation of Keyword Cards

The first step was to insert the rankings as given by the stakeholders into the respective category. In a next step the numbers of answers were counted. A maximum of 12 possible answers was possible for each category since 12 stakeholders expressed their view by using the cards. The sum was calculated by counting the value of all answers in a category. By dividing the sum through the numbers the average was achieved. This average was the basis for the basic ranking. Since this evaluation include all keyword cards provided by the stakeholders it was decided to include a weighted ranking to account for the possibility that rarely mentioned ESS were over- or undervalued due to their rareness. For this reason, a weighting system was introduced which is explained in Chapter 3.3.1, while an example for analyzation can be found in Figure 20 in appendix C.

2.8 Creation of Graphs

In the final steps the received quantified data in Chapter 2.6 had to be ranked and visualized. For all data absolute numbers and percentages were calculated, yet a different method was used for the calculation of the keyword cards (see Chapter 2.5).

In a first step the results were counted for farmers and experts according to all provided answers irrelevant of them being plus or minus. Empty values were counted extra. The maximum possible number of entries was 25 for farmers and 12 for experts. Experts ranking was only possible for ESS but not for clustering according to region or size of farms. Theoretically all results could have been ranked but this would have provided a vast amount of low value data. Therefore, rankings were only conducted for topics like the awareness of ESS (Figure 9) and usually denominated with "Relevance". In a next step the Excel© tables were again scanned, looking for the amount of entries that were plus or minus, respectively. Results for entries that were marked as "plus" resulted in graphs that received the denomination "Of Concern". Entries that were marked as "minus" resulted in graphs that were denominated as "Not of Concern" (see Figures 10 and 11 for examples). The next steps were either the comparison with the results from the keyword cards (see Figure 19, for example) or a classification by clustering into regions and size of farms.

3. Results

3.1 Personal and Economical Background of the Stakeholders

The livestock farmers that were interviewed belong in the categories 2, 3 and 5 of table 1 mentioned in Chapter 1.2.3.

Of the 13 farms visited in April 2015, 12 were owned by the farmer or the whole family and 8 of them had been in possession for more than 25 years. For 8 of the farmers farming was the only source of income. The focus of farming was for 9 of 13 farmers' cattle farming, while two had extensive small-livestock (sheep), one was tourism orientated (including game hunting) and one was ecological farming with their own production chain. Mixtures of farming styles occurred but were not the norm as 8 of the farmers emphasized on cow calf production.

The size of the peer group was nearly the same (12 instead of 13 farmers) and results regarding orientation were similar as well: 10 of 12 stated that cattle farming was the main source of income, one of whom was an employee of a breeding station, one farmer owned a game farm that was not exploited commercially and one was a ranger from a wildlife center. However, discrepancies between the first and second interview sessions could be observed in the length

of ownership (in the second session only 4 farms were owned for more than 25 years), farming as the main source of income (5 of 12 farmers gained their income only from farming) and a mixture of farming styles when small livestock (goats) came into play. Educational and lifestyle background was not provided in all cases. While in some of the interviews the personal background information was given, it was inconclusive due to not being asked directly. In a general summary, it can be stated that about half of the farms were owned by people who were or still are businessmen, academics with an agricultural profession or government employees. The other half had either been raised on farms or had worked on other farms before.

Cattle farming is traditionally the stronghold of the PAN who are mostly descendants of German or South African heritage, having often owned their farms for generations.

Nearly all farmers that owned a farm with a size of over 5000 ha were owned by PAN farmers, an observation already made during other projects[15].

14 of the 25 farmers were interested in a scientific exchange between farmers and experts or between farmers themselves. A key concern was the diminishing quality of extension offices. Together with legal uncertainties like the "Agricultural Land Reform Act (1995)"[52], inadequate government support was one factor that contributed to dissatisfaction with the legislative and political situation, cited by 15 of 25 farmers (see Chapter 4.2 for discussion).

3.2 Rankings for ESS as Results from the Interviews

3.2.1 Ranking of ESS Awareness

Different stakeholders might take different perspectives when assessing a topic[71]. To assess if strong deviations in ESS awareness occur, the preferences of farmers and experts were compared and ranked.

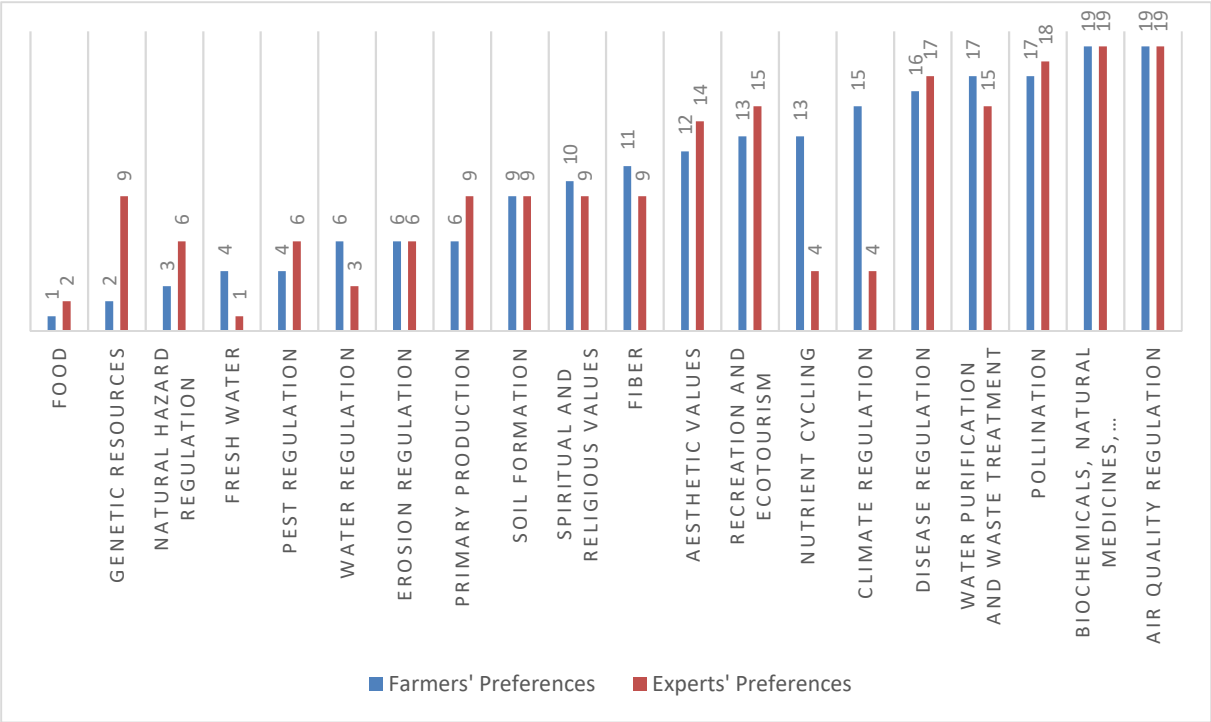

Figure 9 - Awareness of ESS for farmers and experts with rank 1 representing highest importance. Ranking generated from evaluation of interviews as described in Chapter 2.6. For an explanation of ESS see Figure 6. All given mentions were counted irrespective of whether they were being "plus" or "minus". For farmers n=25, for experts n=12

Comparison of the results shows that farmers and experts generally agree about the order of the ESS with a few notable differences:

- "Food" is considered the most important service by the farmers and second most important service by the experts
- "Fresh Water" is considered the most important service for the experts but only ranked 4th by the farmers
- "Genetic Resources" is considered the second most important service by the farmer but only as rank 9 for the experts
- "Natural Hazard Regulation" is ranked 3rd by the farmers but ranked 6 by the experts
- "Water Regulation" is considered as the 3rd most important factor for experts (farmers: rank 6)

- "Nutrient Cycling" and "Climate Regulation" are both ranked 4th by the experts but in rank 13 and rank 15 by the farmers respectively
- Neither farmers nor experts consider "Pollination", "Biochemicals" and "Air Quality Regulation" as important facts, placing them at the end of the ranking table

While farmers considered "Food" (meat production) to be of highest importance, "Fresh Water" was the number one for experts who ranked "Food" second. It seems surprising that "Fresh Water" was of highest concern for the experts but ranked fourth by the farmers who live in a very arid environment. This could plausibly be explained by the fact that most farms are located in the Waterberg region and receive a more stable water supply due to springs at the Waterberg. For "Genetic Resources" being cited as the second most important service by the farmers but only ranked 9 by the experts there might be two reasons:

1. Farmers nowadays often consider changing their European cattle breeds to local ones like the Nguni.
2. Variation of grass, as not all grass species are suitable for all husbandry species (see Rothauge[72]) and especially perennial grass species like *Stipagrostis uniplumis* are needed for feeding.

"Natural Hazard Regulation" ranked 3rd for the farmers as especially droughts can contain a high risk with uncertain length and severity, making preparation difficult. "Pest Regulation" (especially bush encroachment) is considered to be of more importance by farmers while "Water Regulation" (run-offs, groundwater recharge) is considered to be more important for experts. "Primary Production" (growth of grass and hay production) seems to have gained interest by farmers lately.

In the second interview session, conducted in April 2016, more farmers considered starting their own hay production. One striking difference between farmers and experts can be observed for the ESS "Nutrient Cycling" and "Climate Regulation" (CO_2 regulation, shade for animals, climate change effects). The reasons for these differences are unclear. It might be that the experts consider the system more holistically and scientific than the farmers. Surprisingly, "Pollination" was not of interest for either farmers or experts but again the reasons are not obvious.

3.2.2 Ranking of ESS' Relevance

The relevance of ESS cannot simply be derived from the frequency being mentioned but is also influenced by the importance that is contributed to each ESS. Ranking of ESS by the scale of being of concern was necessary to evaluate if some ESS are more relevant than others.

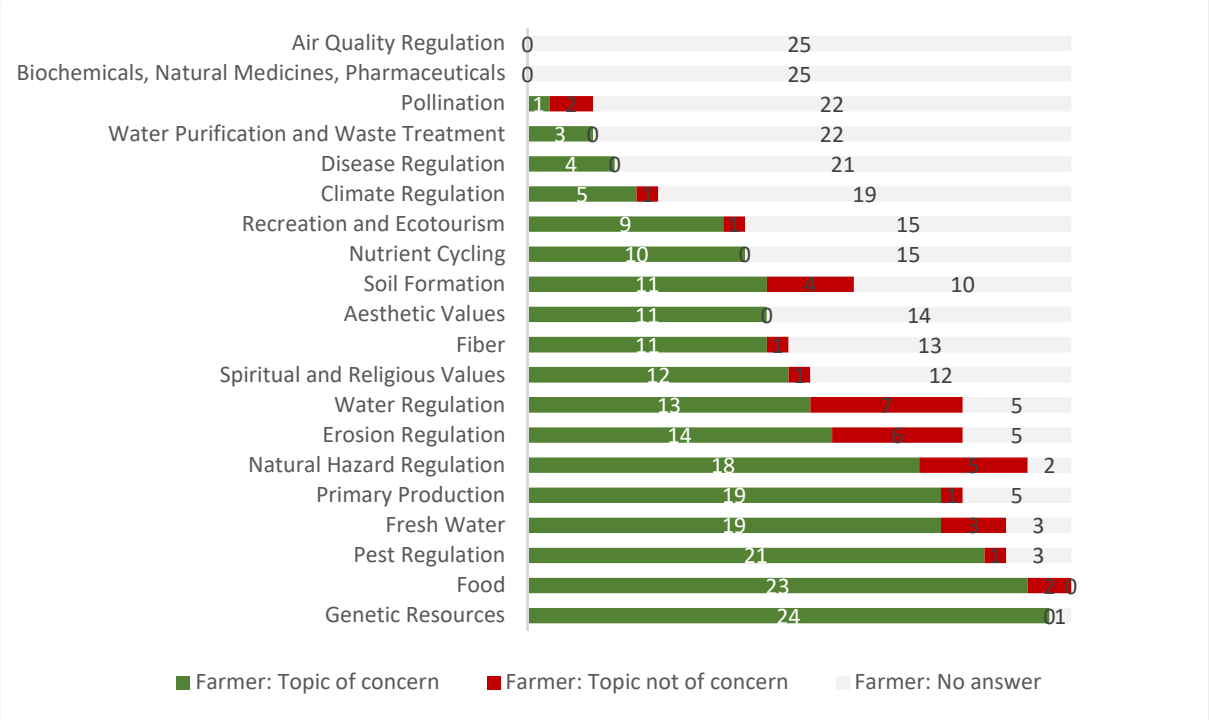

Figure 10 - Relevance of ESS for the 25 farmers with assessment of the topic being of concern or not- n=25

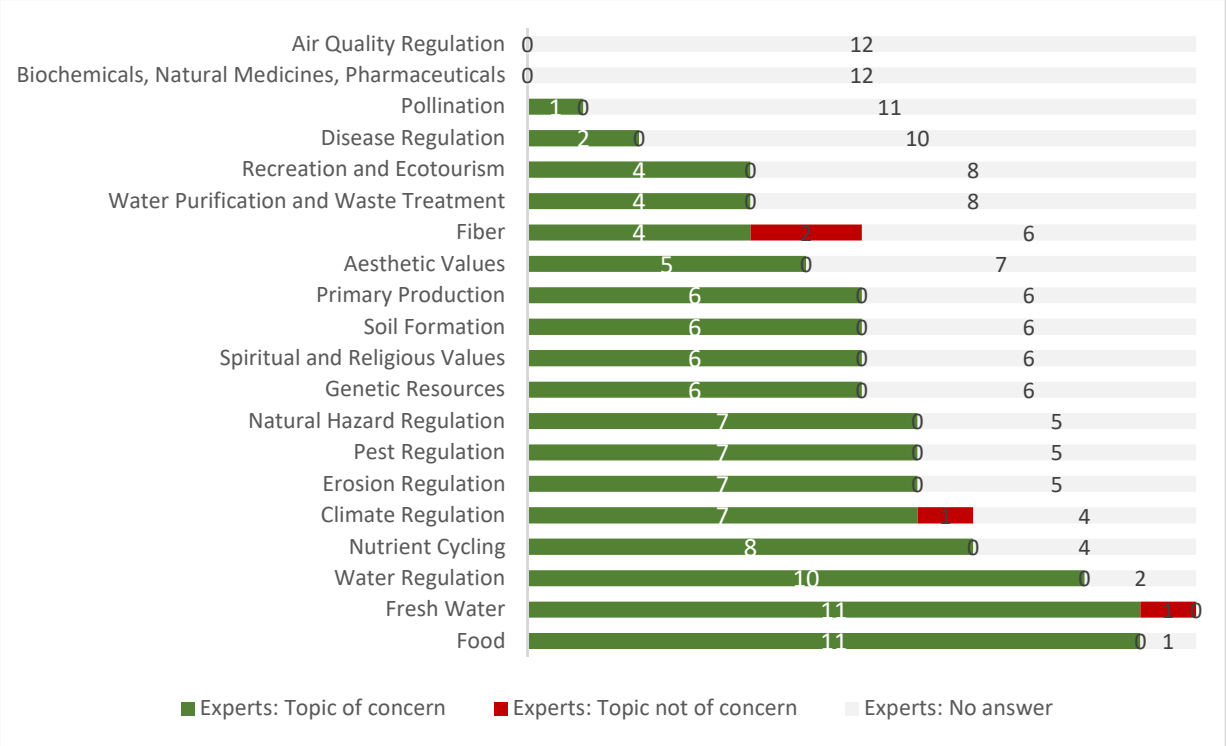

Figure 11 - Relevance of ESS for the 12 experts with assessment of the topic being of concern or not – n=12

Figure 10 and 11 show which ESS were of concern or of no concern for farmers and experts, respectively. It is obvious that for the experts a service that was named was of concern while for the farmers a more diverse picture emerged by stating that for individual farmers several services are of no concern.

The farmers:

- mentioned 10 or less than 10 of the 21 ESS in more than 50 percent of the interviews
- named "Food" as an ESS in all cases
- consider "Genetic Resources" to be of utmost concern, followed by "Food" (23 mentions), "Pest Regulation" (21 mentions), "Fresh Water" and "Primary Production" (both 19 mentions)

The experts:

- mentioned 13 of 21 ESS in at least 50 percent of the interviews
- named "Fresh Water" in all cases
- consider "Fresh Water" and "Food" (both 11 mentions) to be of most concern, followed by "Water Regulation" (10 mentions) and "Nutrient Cycling" (8 mentions)

Farmers and experts considered the ESS "Air Quality Regulation", "Biochemicals and Natural Medicine" or "Pollination" as of least concern. Disparities between farmers and experts were strongest between "Genetic Resources" and "Primary Production" which are more often cited by farmers and "Water Regulation" and "Nutrient Cycling" which appear to have been of more concern for the experts.

3.2.3 Ranking of ESS According to Region

To see if regional disparities in the data result in significant different results, farms were categorized into three regions: Northern Namibia, Central Namibia and Southern Namibia.

Location of Farms

Region	Number of Farms
Northern Namibia	4
Central Namibia	12
Southern Namibia	8

Table 2 - Number of farms in each region (own table)

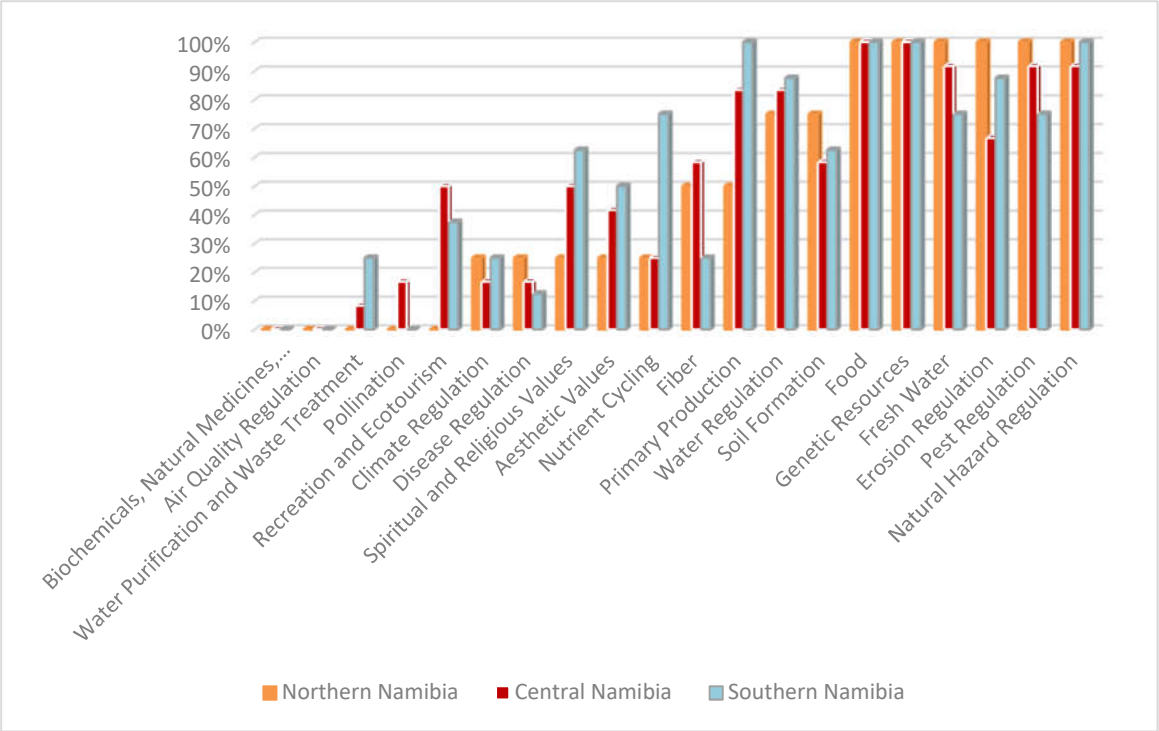

Figure 12 – Ranking of Citations of ESS for farmers by region. Arrayed by "Northern Namibia" – n=24

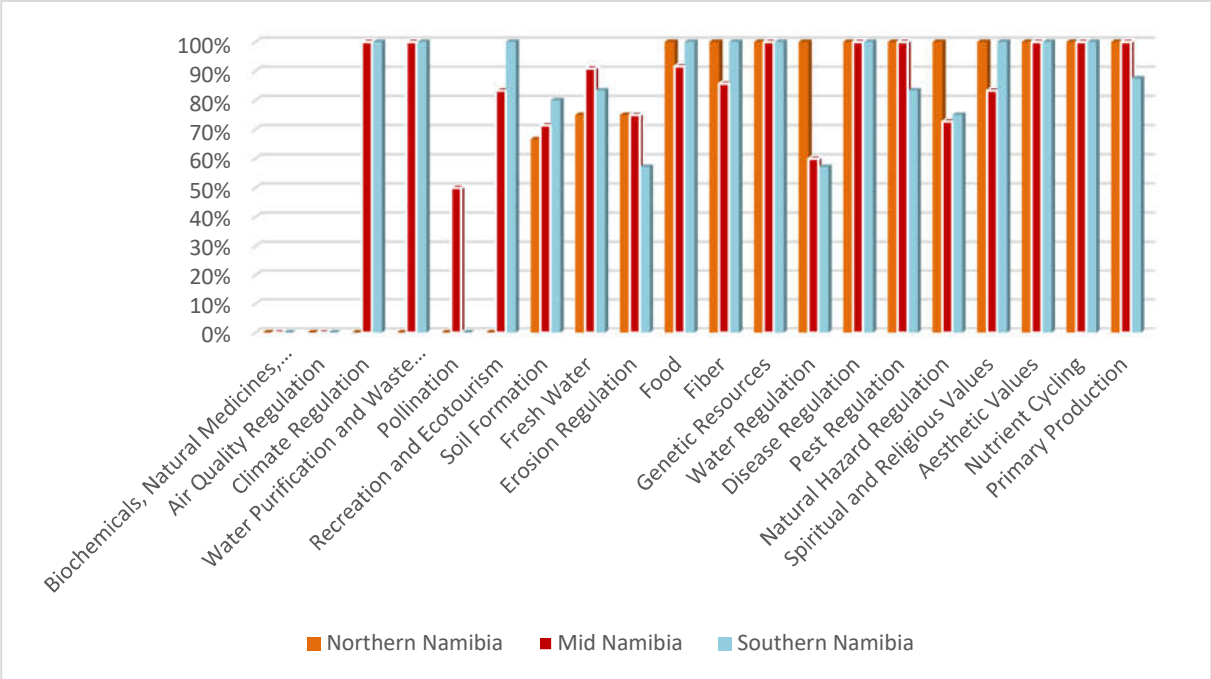

Figure 13 - Ranking of Topic of Concern of ESS for farmers by region. Arrayed by "Northern Namibia" – n=24

Figure 12 shows how often a ESS was named in each region, Figure 13 shows whether the ESS was of concern.

Results show some regional differences:

- Categories that were answered by all participants ("Genetic Resources", "Food") were of concern in all regions

- “Natural Hazard Regulation” was cited in nearly all regions yet seems to have been of more concern in the North (100 percent)
- “Pest Regulation” was cited by 100 percent in Northern Namibia, 92 percent in Central Namibia but only 75 percent in Southern Namibia. The ranking for the topic being of concern confirmed this trend
- “Water Regulation” was most often cited in the South (88 percent) and “Fresh Water” in the north (100 percent), yet “Water Regulation” was 100 percent of concern in the North, while only 60 percent in Central and 57 percent in the South. “Fresh Water” on the other hand was most often mentioned as being of concern in Central Namibia (91 percent)
- “Nutrient Cycling” (75 percent), “Aesthetic Values” (50 percent), “Spiritual and Religious Values” (63 percent) and “Primary Production” (100 percent) were most often cited in the South and least often in the North, yet no huge differences could be found in the topic being of concern
- “Recreation and Ecotourism” was never cited in the North, 50 percent in Central and 38 percent in the South while deemed of utmost concern most in the South
- “Fiber” was most often cited in Central (58 percent) and the North (50 percent) while being cited only by 25 percent in South Namibia

These results show that differences between regions occurred, yet the two ESS most closely connected to water availability showed unclear results:
While “Fresh Water” was most often cited in the North, “Water Regulation” was most often mentioned in the South. This could indicate that water saving measures are of more interest in the more arid South, while water availability due to rain is better in the North. Of special interest are the cultural ESS as these showed a clear trend to be mentioned more often in the South. This might indicate that regions that named those services rarely are less suitable for using touristic activities due to natural circumstances or being more distant from Namibia’s central traffic hub, Windhoek.
“Fiber” was only being rarely mentioned in the South. This might indicate that farmers there either do not have many issues with bush encroachment at that point or do not see any practical way to use this raw material. The second answer seems to be more credible since “Pest Regulation” was often named in the South as well, albeit less regularly than in the North. Why “Nutrient Cycling” was more often mentioned in the South is hard to answer. Reasons could be due soil erosion or salinization but no clear indication was given in the interviews.

As can be seen in table 2 the sample size is rather small. This indicates that statistical deviations that are not related to the location of farms might also contribute to the effects. These factors could include examples like the personality of the interviewer, effects of farm size, climate relate facts or personal backgrounds and divergent management styles (see Chapter 3.2.4 as well for this issue).

3.2.4 Rankings of ESS According to Farm Size

Farms were categorized into four sizes representing small, medium, large and huge farms to see if any inference could be drawn from the size of the farm and mentioning of ESS. In total 24 farms were selected as one farm did neither provide size nor location. Farms in this setting were not grouped by location.

The dataset in use was produced from the information given by the farmers. Where no information was given during the interviews, data provided by the Namibian Agricultural Union (NAU) was used. It is noteworthy that divergent farm sizes were given by the NAU in several cases (see table 2). Farmers noted during the interviews that the minimum farm size required for successful cattle farming would be at least 5000 ha.

As shown in table 2 two thirds of the farms are either small or medium. The total combined size of all farms was 242724ha (NAU: 128676 ha) with an average size of 10113 ha (NAU: 5361.5 ha).

Table 3 shows that 25 percent (according to the data provided in the interviews) or 38 percent (according to the data provided by the NAU) of the farms are smaller than 5000 ha and would be deemed too small to support successful farming according to the estimation given by the farmers.

Categorization of Farm Sizes

Size Term	Size Range in ha	Farms (Interviews)	Percentage (Interviews)	Farms (NAU)	Percentage (NAU)
Small	**1 to 5000**	**6**	**25%**	**9**	**38%**
Medium	**5001 to 7500**	**8**	**33%**	**10**	**42%**
Large	**7501 to 10000**	**4**	**17%**	**4**	**17%**
Huge	**10000 or more**	**6**	**25%**	**1**	**4%**

Table 3 - Categorization of farm sizes according to data provided by interviews and support of NAU, size categorization adapted from Olbrich et al.[15] (own table)

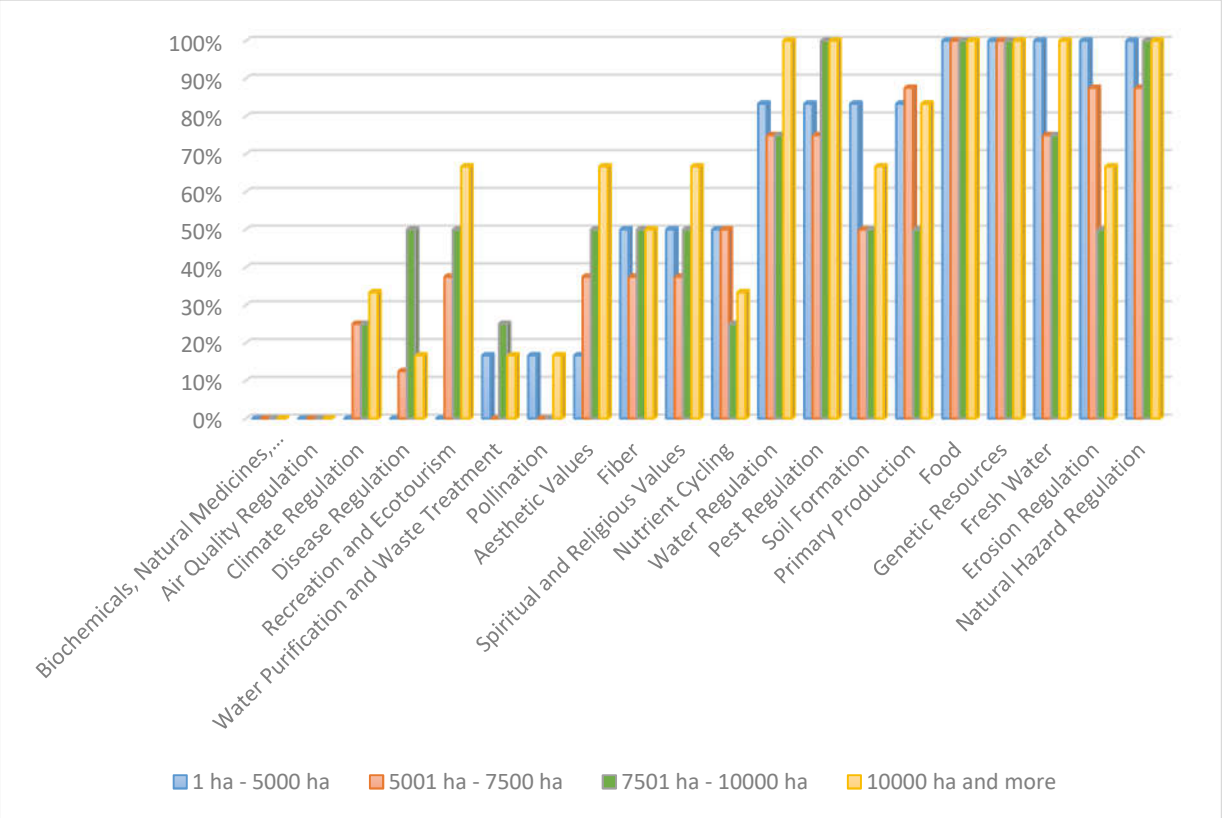

Figure 14 - Citations of ESS by farm size. Categories with 0 percent were never mentioned, with 100 percent always. Arrayed by farm range "1 ha – 5000 ha" – n=24

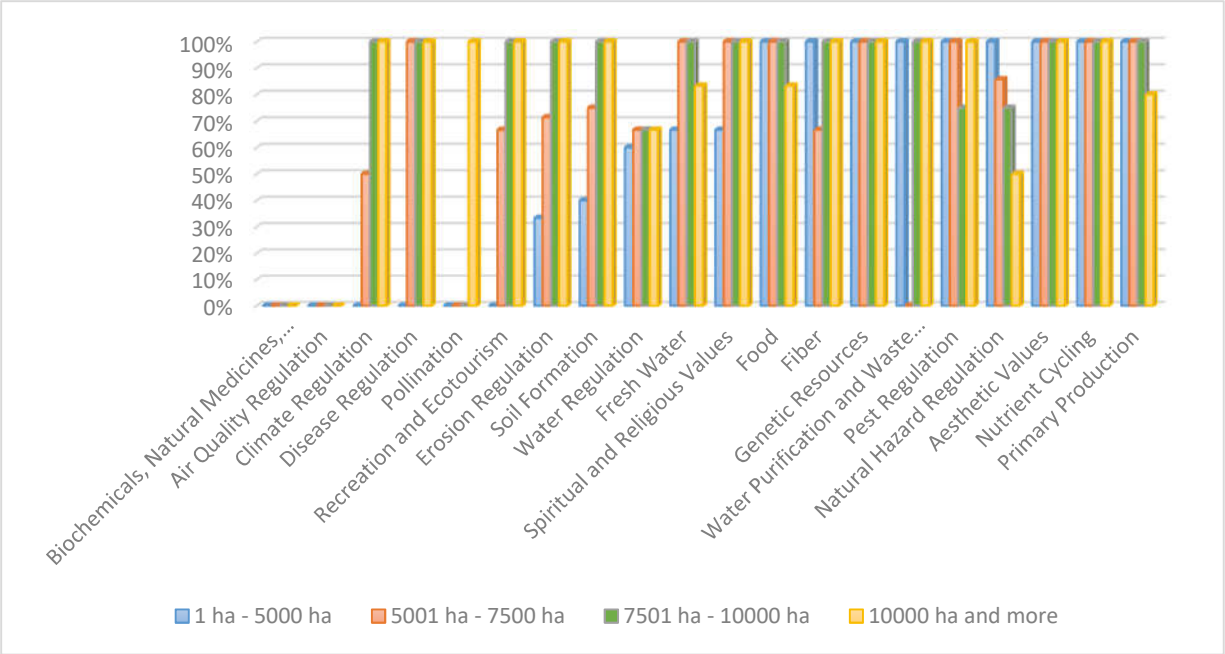

Figure 15 - Topic of concern of ESS by Farm Size. Categories with 0 percent were not mentioned, with 100 percent where always of concern. Arrayed by farm range "1 ha – 5000 ha" – n=24

Analyzation of farms according to size produced a mixed outcome. Clear size dependent differentiations in citations (Figure 14) could only be seen for few ESS:

- "Water Regulation", "Aesthetic Values", "Recreation and Ecotourism" were most often cited on huge farms
- "Soil Formation", "Fresh Water", "Spiritual and Religious Values" were most often cited on huge and small farms
- "Disease Regulation" were most often cited on large farms
- "Nutrient Cycling" and "Erosion Regulation" were most often cited on small and medium sized farms
- "Food" and "Genetic Resources" were cited in all farms, while "Natural Hazard Regulation" was cited 88 percent on medium sized farms and 100 percent on all other farms
- "Primary Production" was only mentioned in 50 percent of the cases in medium sized farms while above 80 percent on all other sizes

Results for Topic of Concern (see Figure 15) showed similar rankings:

- If cited "Nutrient Cycling", "Genetic Resources" and "Aesthetic Values" were always of concern

- "Food" was always of concern except on huge farms, where it gained 83 percent, "Fiber" on all farms except medium sized farms, where it received 67 percent, "Pest Regulation" on all farms except large sized farms, where it received 75 percent and "Aesthetic Values" was always of concern except on small farms, where it received 67 percent
- "Natural Hazard Regulation" showed a clear trend from small to huge with being 100 percent on concern on small farms but only 50 percent on huge farms
- "Recreation and Ecotourism", "Soil Formation" and "Erosion Regulation" showed a clear trend of being of less concern on small farms but of concern in all cases on large and huge farms

These mixed results seem to be too weak to draw a conclusion that size has any significant effect on usage of ESS as the mentioned differences could be the results of differentiations in location as well. Noteworthy are the first mentioned cultural ESS. These might be significant size correlated effects as "Aesthetic Values" could be linked to "Ecotourism" which might be usable only on farms having a certain size. The reason might be in wildlife conservation as it is unlikely that a diverse fauna can be found on small farms.

3.3 Ranking of ESS as Results of Keyword Cards

3.3.1 Comparison of Methods and General Occurrences

The first step in analyzing the keyword cards was to calculate how often each ESS was mentioned. The result can be seen in Figure 16. In a next step it was analyzed whether the usage of different methods would alter the results (for further explanation regarding the methods see Chapter 2.6).

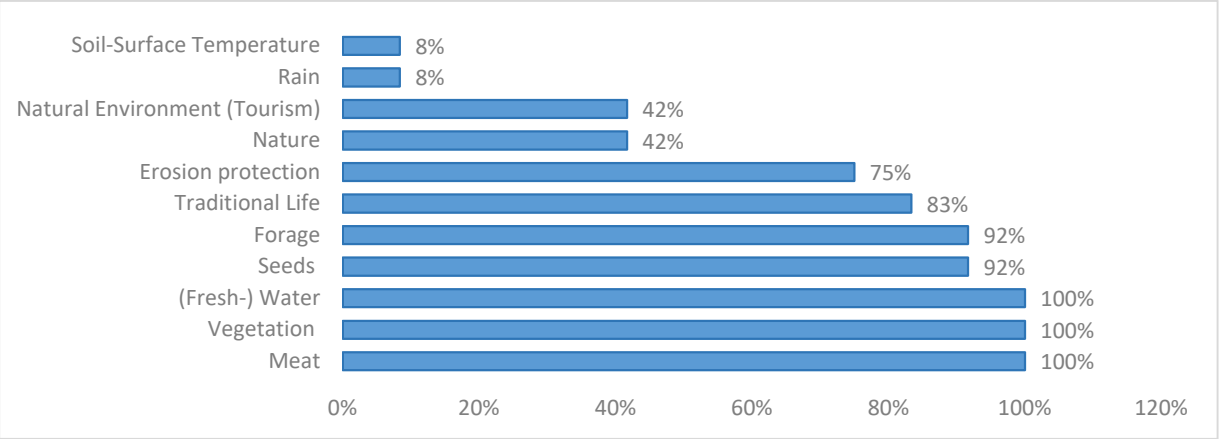

Figure 16 - Comparison of how often an ESS keyword card was used and evaluated by the farmers (maximum of provided answers was 12 mentions which equals 100 percent) - n=12.

Ranking of the ESS keyword cards showed that the services “Meat”, “Vegetation” and “(Fresh-) Water” were always mentioned, while “Rain” and “Soil-Surface Temperature” were only mentioned once due to the fact that these two services were write-in cards that were created by two stakeholders themselves.

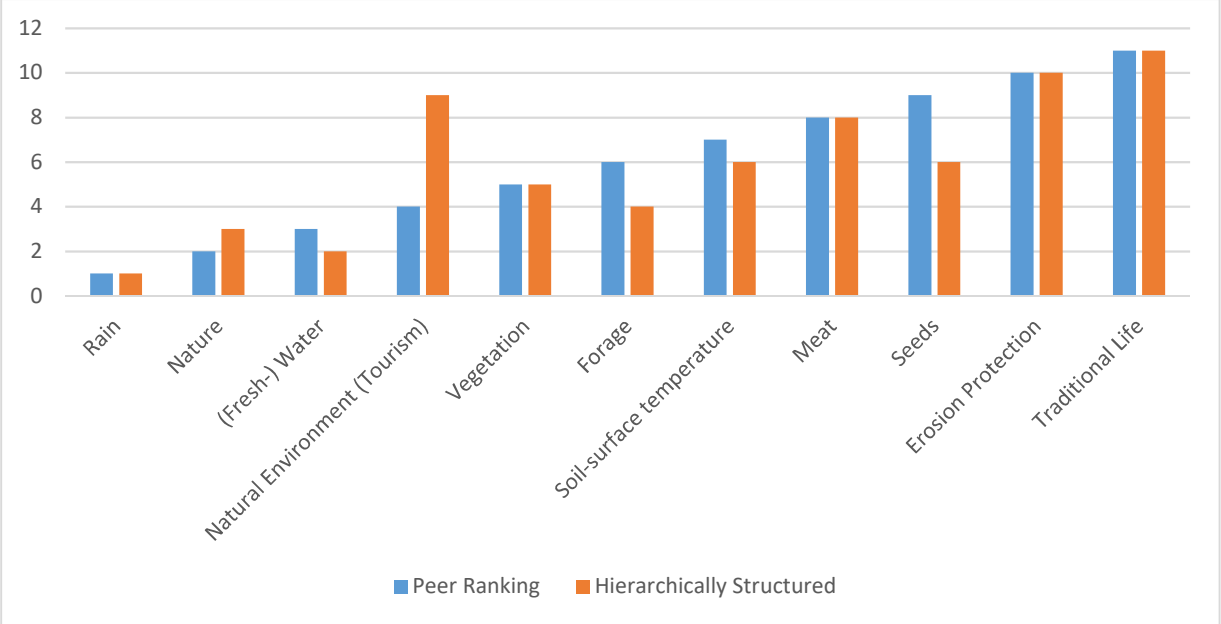

Figure 17 - Comparison of “Peer Ranking” and “Hierarchically Structured” Ranking methods according to unweighted average. Lowest rankings were judged most favorably - n=12.

As “Rain” was only mentioned once but placed on highest position by this farmer it was placed on position 1. This was done because all cards were counted for the ranking in Figure 17, irrespective of their occurrences.

Methodically the rankings obtained with the help of the keyword cards were generally similar irrespective of whether the “peer ranking” or the “hierarchically structured” ranking method was used.

There were only two discrepancies which were “Natural Environment” shifting from rank 4 to rank 9 in the hierarchical ranking and “Seeds” shifting from 9 to 6. It is further noteworthy that only seven of the eleven categories received more than 50 percent of the maximum possible entries, while the two categories “Soil-Surface Temperature” and “Rain” were named by individual farmers themselves.

“(Fresh-) Water” seems to be the most important service for the farmers as it received the highest number of entries as well as, depending on the method, the highest or second highest

average score (leaving out “Rain”). “Nature” also received high average scores but was only mentioned five times, leaving room for speculation about why it was not named more often.

3.3.2 Usage of Multiplier

Rarely mentioned ESS were accorded a high ranking by some stakeholders and therefore received a position that might be disproportionate. To honor this issue a multiplier ranging in steps of size 0.1 from 0.1 to 1.2 was introduced. This multiplier was chosen since a maximum of 12 entries was possible for each category. A category that had 12 entries received the lowest possible multiplier (0.1) while an answer like “Rain” that received only 1 entry was given the highest possible multiplier (1.2) to account for the possibility that some ESS were often cited.

Calculation of Weighted and Unweighted Average

Ecosystem Service	Average Position	Occurences	Muliplier	Weighted Value	Weighted Rank	Unweighted Rank
Meat	3,50	12	0,1	0,35	3	8
Seeds	3,55	11	0,2	0,71	5	9
Vegetation	2,83	12	0,1	0,28	2	5
(Fresh-) Water	1,67	12	0,1	0,17	1	3
Rain	1,00	1	1,2	1,20	6	1
Soil-surface temperature	3,00	1	1,2	3,60	11	7
Erosion Protection	4,33	9	0,4	1,73	9	10
Nature	1,60	5	0,8	1,28	7	2
NaturalEnvironment (Tourism)	2,40	5	0,8	1,92	10	4
Traditional Life	4,80	10	0,3	1,44	8	11
Forage	2,91	11	0,1	0,29	4	6

Table 4 - Calculation of weighted and unweighted ranking. Unweighted rank is based on the rank following the average position. Average position was multiplied with a factor of 0.1 to 1.2 depending of the number of mentions. The result of this calculation leads to weighted value, which is the basis for weighted rank

The change in the ranking is significant as can be seen in Figure 18:

- “(Fresh-) Water” was ranked on place 3 in the unweighted ranking due to the fact that rare ESS like “Rain” (a write in of one stakeholder) and “Nature” received good average rankings by a few selected stakeholders. In the weighted ranking it is placed on position 1, followed by “Vegetation” (from 5 to 2), “Meat” (from 8 to 3), “Forage” (from 6 to 4) and “Seeds” (from 9 to 5)
- “Nature” on the other hand dropped form position 2 to 7, “Natural Environment” from 4 to 10 and “Rain” from 1 to 6

This might indicate that several stakeholders evaluated “supporting services” as basic needs but did not rank them as high due to their general availability.

3.3.3 Breakdown by Regions

Keyword cards were only used for farmers in a few regions with highly ambiguous sample groups. Three farmers were asked to give their evaluation in Grootfontein, eight in Waterberg but only one in the Windhoek region. Since "peer ranking" and "hierarchically structured ranking" did not result in significant differences this ranking was only conducted for the "peer ranking" method.

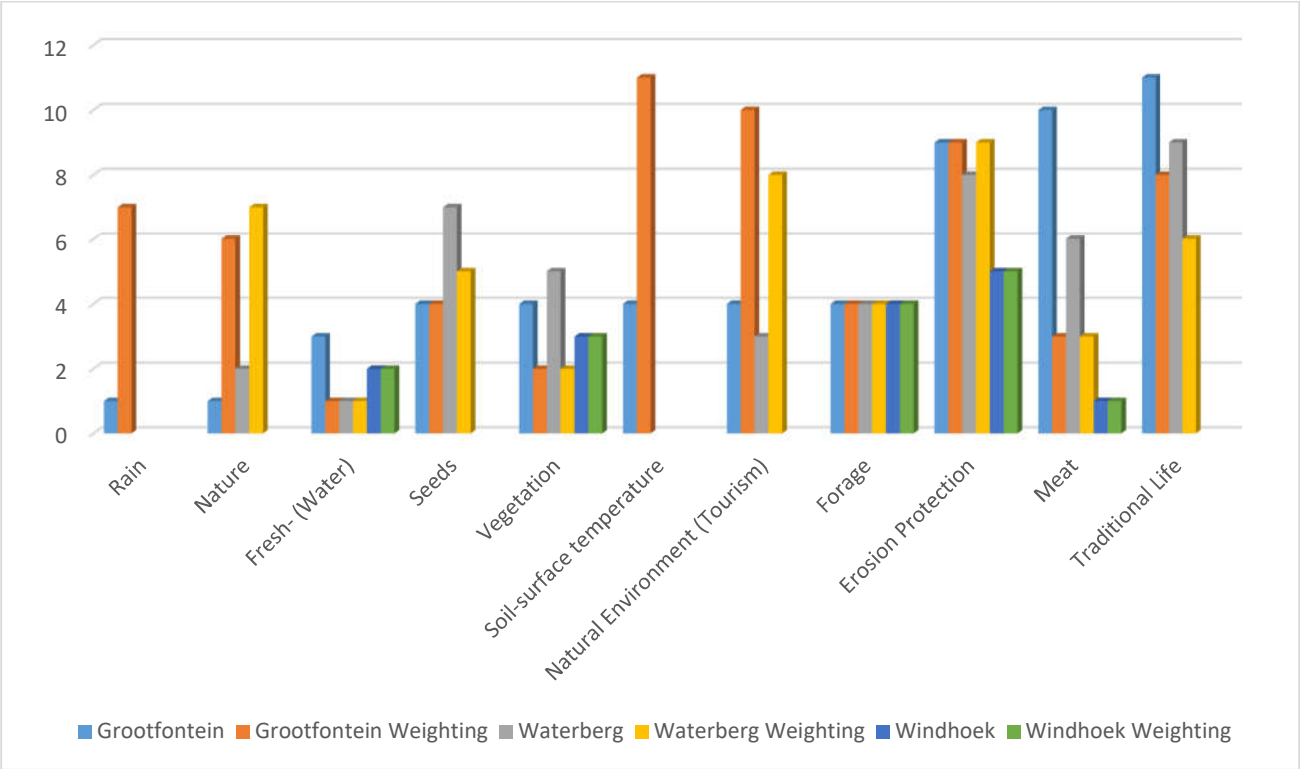

Figure 18 - Comparison of weighted and unweighted ranking by region. For method see Chapter 3.3.1 – n=12

- In the unweighted ranking "Rain" and "Nature" are the most important services in Grootfontein while in Waterberg "(Fresh)-Water" was considered to be of the highest importance. In the Windhoek area one farmer placed "Meat" on position 1
- Weighting of results produced a similar outcome as in Chapter 3.3.1 with "Rain", "Nature" and "Natural Environment" dropping while "(Fresh-) Water", "Meat" and "Vegetation" rose to higher positions
- No clear pattern emerged for cultural services since "Traditional Life" rose three positions in Grootfontein and Waterberg while "Natural Environment" dropped from 4 to 10 and 3 to 8, respectively

3.4 Comparison of Results from Interviews and Keyword Cards

To receive an overview over whether the self-evaluation of the stakeholders in the keyword cards matches the evaluation obtained from the content analysis of the interviews an overlay was produced which can be seen in Figure 19.

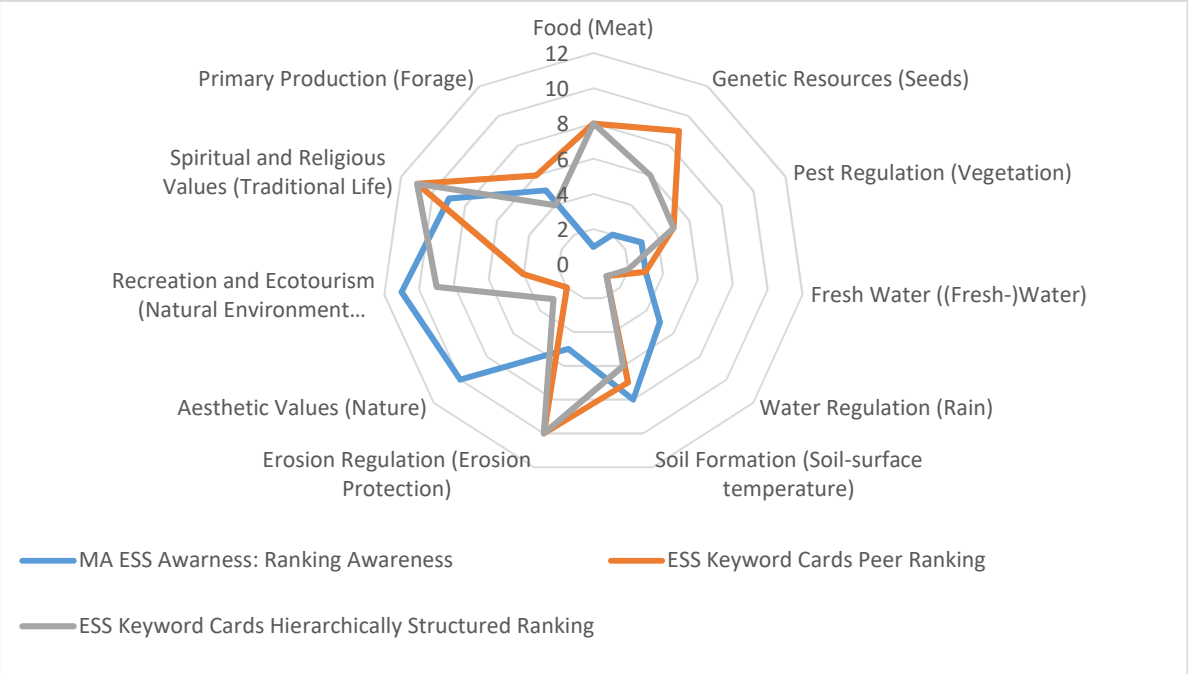

Figure 19 - Comparison of ESS according to the categories that were used in the analyzation of the interviews (see Figure 6), with the terms used by OPTIMASS (in brackets). For the interviews n=25, for the keyword cards n=12

To make comparison possible the categories of the interviews (see Figure 6) had to be adjusted by:

a. using only categories that seemed to be comparable (like food which equals meat) and
b. re-ranking, meaning that categories from the interviews, which were not included in the keyword cards, were left out, thereby creating a new ranking from 1 to 12 for the interviews.

The comparison has been made difficult due to issues of categorization in the different studies, which leaves too much room for interpretation. “Genetic Resources” comprise more than simply “Seeds” which might be, on the other hand, best translated into “Primary Production”. Yet, there was no equivalent to “Genetic Resources” in the keyword cards so “Seeds” might include the interview categories “Pollination”, “Primary Production” and “Genetic Resources” while “Vegetation” could also include “Natural Hazard Regulation”, “Pest Regulation” or “Primary Production”.

The results seem to indicate that cultural services like “Aesthetic Values”, “Recreation and Ecotourism” were undervalued in the content analysis while “Genetic Resources” and “Pest Regulation” were overvalued. Yet, in categories that can be more easily transferred like “Food” (“Meat”) and “Spiritual Values” matching values can be observed. This is a rather strong indication that the content analysis in itself was supported by the results of the keyword cards and that the observed mismatch in culture values results in a definition issue. Methodically, it indicates therefore that if comparable data is required, it is better to use pre-defined categories that are already in use.

4. Discussion and Outlook

4.1 Methodological Discussion

4.1.1 Design of Questionnaires and Evaluation Methods

Working with the questionnaires, transcription of quotes and evaluation of results according to the defined categories (see Figure 6) provided a lot of background information about methods and possible approaches as well as steep learning process.

As written in Chapter 2 two main methods were used for gathering information with the first being the semi-guided interviews and the second the usage of keyword cards.

Using a guided interview process seems to be a very reasonable approach to receive a general understanding of the situation in loci. Yet, if comparable results are required more extensive methods would be recommended to receive quantitative results as well. Asking more than one stakeholder group (in this case experts and farmers) is clearly a good idea as it provides a broader perception of the situation and a direction for the questionnaire as knowing your research object is key to understand.

On a further note Baur and Blasius[62] explained the importance of using interviewers who conduct the interviews in a comparable way. If this is not done, different interests in the character of the interviewer might lead to incomparable results, especially if the time-frame for interviews is not flexible or the interviewees do not have much time to spare.

The second issue was transferring the qualitative information into quantitative data since the content analysis repeatedly encountered the issue of missing and therefore incomprehensive or incomparable data and information.

Olbrich et al.[15] already showed in a similar study that a mixture of qualitative and quantitative methods is possible in a survey that was closely related to the original idea of the OPTIMASS scientists.

This combined approach of the two methods would have probably resulted in more expedient results in this case as well. The researcher tried to approach this issue in the second interview session with the farmers by introducing the keyword cards. Generally, usage of keyword cards was a welcomed and well-accepted method and offered the interviewees a playful way to interact and categorize ESS. However, it leads to another big question in analyzing the results: how to credit the ranking value stated by the stakeholders, as described in Chapters 2.5 and 3.3. The main issue in the adaptation can be seen in Figure 17: "Hierarchically structured" ranking and "peer ranking" was required due to the fact that no single method was used for all stakeholders - instead a mixture in the rankings occurred. This led to the issue that having several ESS with the highest ranking (peer ranking) might have either a stronger, weaker or a flat evaluation compared to being ranked hierarchically. But this entanglement cannot be disentangled retroactively. A second issue for valuation was the possibility for individual farmers to fill in cards as well as letting them choose which cards they would use. The issue and a possible solution has been described in Chapter 3.3.1 but it might be desirable to have the participants in the study rank ESS with all cards.

In a next step it might then be offered to remove or add cards that the stakeholders consider to be of value or of no value at all, creating a second ranking. This would then be comparable to the content analysis in the interviews with one ranking that shows all provided answers while the second ranking would be compatible to the categorization of a service of being "of concern".

A third issue, not connected to the keyword cards per se, can be seen in Figure 19.

Scientific terms often cannot be understood by laypeople. An example would be the term "benefits" which was asked in the interviews but was rarely answered, according to the interviewers. The reason was that the stakeholders simply did not understand the implication of the term. A similar observation could be made with regard to the terms used by the MA, which are often too abstract to be used in loci. The scientists in the OPTIMASS project decided therefore to use terms that were derived from the NRMPS which seemed in line with the MA terms but are not completely congruent. An example for this entanglement can be seen in Figure 19 in Chapter 3.4.

There seems to be no perfect for solution for all the issues described in this Chapter but a few recommendations can be made. To gather quantitative results a combination of keyword cards and a Likert scale[73] could be used. While the keyword cards would offer the opportunity to receive rankings, a Likert scale would allow stakeholders to evaluate the importance of services and methods used by them on a five step scale ranging, for example, from "of utmost concern" to "of no concern at all". This combination of methods would enable the stakeholders to

evaluate their methods and usage of ESS themselves while providing a more in-depth understanding of the ranking. Qualitative questions should then be used to develop a more comprehensive understanding by letting the stakeholders express themselves verbally, clearing up uncertainties or questions that have not been raised otherwise.

4.1.2 Design of a Future Questionnaire Frame

The results of the methodical analysis provide an alternative, theoretical, basis for a questionnaire. This alternative shall be proposed here to include quantitative methods into the stakeholder perspective with regard to the assessment of ESS and -benefits. While this questionnaire would include qualitative and quantitative measures for the assessment of larger groups of stakeholders, it should be adjusted according to circumstances:

1. Define the focus and the end goal of the study
2. Review the literature for comparable studies, not only topical but also structural
3. Develop a questionnaire that follows social scientific standards which includes:
    a. Similar or, preferably, the same questions for all interview sessions
    b. Distinguish between qualitative and quantitative questions
    c. For quantified questions include evaluation methods like the Likert-Scale
    d. Do not change the questionnaire in case it is not suitable.
    e. It can be supplemented with additional questions or evaluation methods but if the supplementation is used the interviewees from the earlier interview rounds should be asked as well
    f. Depending on the initial aim of the research it can be highly helpful to give the stakeholders the option to use evaluation methods like working with the keyword cards. But using such methods should be planned ahead and follow categories that are standard or pre-defined to avoid confusion about the intention of the interviewees
    g. These categories shall be defined and made available to the interviewees
4. During the interview process:
    a. Ask all interviewees the same questions regardless of personal interest of the interviewers
    b. If one interviewee does not respond to a question, try to record the reason (i.e. no time, not of interest, no knowledge about the topic, etc.)
    c. All interviewers have to follow the same method (i.e. if it is decided that audio records are used they should be used by all)

d. The guidelines for using evaluation methods like the keyword cards should be the same for all interviewees. An implementation that does not follow the guidelines for all participants will not yield comparable data.

4.2 Results of Qualitative Analysis

Bennett at al.[37] discussed the importance of considering ESS in a broader view and called for an integration of a two-step mechanism for monitoring the effects of multiple ecosystem services paying respect to the varying degrees in which they influence each other. They described a unilateral interaction where one service affects the success of another and a bidirectional one where two factors influence each other. They give the example of small scale farming in dryland areas in sub-Saharan Africa where over-usage and destruction of biomass leads to an increased pressure of land usage and further degradation of soil quality. The same issue has been cited in the interviews as well. Farmers and experts alike mentioned the increasing erosion on small farms that do not possess sufficient funds for financing anti-erosion and anti-bush encroachment measures. The issue was said to further accelerate due to overgrazing leading to further soil destruction.

The "socio-political dimension" of land ownership is of increasing importance in Namibia since challenging environmental situations are highly influenced by political decisions such as the Agricultural Land Reform Act[51,52]. Problems for the stability of the ecosystem arise when the new owners of the land either receive a patch of land that cannot be farmed sustainably or lack the knowledge or financial background to successfully manage the farm[52]. Farmers of all races in the interviews were talking about degrading soils, desertification, an increase in the number of predators, more severe bush encroachment and maintenance issues of infrastructure in adjacent resettlement farms, fearing that those issues might inflict damage on their farms as well. They attributed this issue mostly to the rather small farm size leading to over usage of ESS and resources.

A further issue that was cited by farmers as well as experts was missing scientific expertise due to the deterioration of the extension offices. Several farmers stated that they would like to either receive more scientific support or converse on a scientific basis with experts as well as other farmers, especially in researching the cause for and measures against bush encroachment. The introduction of the Namibian Rangeland Forum was positively mentioned but effective local facilities are required.

This result was echoed by the experts who were sometimes educated in pre-independence Namibia and recommended the same methods.

Currently farmers in Namibia do not always make use of available scientific information like the NRMPS[61] and do not apply it in their working routine. The reason for not implementing scientific knowledge into the working routine seems to be multifaceted - reaching from simple unawareness to the consideration that some of the proposed guidelines are not practical on a day-to-day basis or are incompatible with the empirical knowledge of the stakeholders.

An example cited several times was the usage of bushfires as a countermeasure to bush encroachment. While experts have developed a strategy for implementing bushfire into the working routine[74] the farmers were not open to the usage of bushfires due to the scarcity of grass and damage done to infrastructure.

Few farmers in the interviews used scientific methods, yet many still rely on empirical knowledge. This is most obvious in the rotational time of camps used for herds. Every farmer asked in the interviews used a different system, although the differences were sometimes small. Variations differed from fast change every 10 to 14 days to a length of up to 6 months with rest times of an individual camp of a few months to a few years. This topic has already been paid attention to in the NRMPS but more research would be required to investigate optimal growth conditions for grass species and better soil protection. Specific scientific education of farmers would be generally recommended to prevent over-usage of ESS and strengthening the knowledge that farmers require to sustain farm overlapping ESS like “Soil Formation”, “Water Regulation” and “Primary Production”.

4.3 Results of Quantitative Analysis

While the MA has emerged as the scientific standard for ESS, a comprehensive and generally accepted scientific standard that differentiates ESS and benefits still does not exist (see Chapter 1.1.2). In literature the same ecosystem is sometimes considered either as an ESS or a benefit, depending on the situation[27,36].

Examples for such difficulties include the production of food which is clearly a benefit if it is produced for a consumers’ market but a ESS when it is consumed by wildlife, and “(Eco-) tourism” as well as “Aesthetic Values” which can be seen as benefits of an intact nature dependent on abundant wildlife.

Farmers therefore benefit in various ways from the products that nature provides in terms of services like water availability, climate stability and resilient soils[38].

The most often cited ESS in both the results of the interviews as well as in the evaluation of the keyword cards were services that are directly connected to farming activities such as “Food”, “Genetic Resources”, “Primary Production”, “Pest Control”, “Fresh Water” and “Water

Regulation". "Food" in the form of livestock or game is probably of utmost concern as it provides the farmers with the results by which they generate their living. While a mixture of farm types such as livestock and game farming occurred in the survey, not a single farmer stated that he would abandon ranching totally in favor of any other activity such as tourism. Carpenter et al.[36] stated in their research (see Figure 1) that livestock is one of the few ESS that increases globally in condition as well as demand. Apparently that would seem like a promising future for cattle farmers in Namibia. Yet, as described by Reid et al.[10] and several other researchers, cattle farming in Namibia is threatened by a multitude of factors:

- The forecasted effects of climate change[8,11,13,28]
- Bush encroachment[4,74]
- Stronger and more erratic El-Niño events[3]
- Issues in water regulation
- Soil degradation[75]
- Import restrictions for meat in South Africa[76,77]

To combat these issues experts recommended in their interviews a diversification of farming income. While some farmers already invest in real estate or manage non-farm related businesses, others already shifted to a mixture of farm styles. These styles could either be a mixture of large and small livestock (goats, sheep, etc.), ecotourism and game hunting as well as the most often recommended combination of livestock and game farming. However, it is questionable whether these solutions are possible for all farmers.

As can be seen in Chapters 1.2.4 to 1.2.6 as well as in appendix D most farms were found in areas that did not receive huge amounts of annual rainfall and were prone to shifting rainfall events as well as occasional droughts. These factors are further exacerbated by the soils which are unable to store water for a long time. Several farmers stated that they use different methods to approach these issues, among them usage of more locally adjusted livestock species, water enrichment measures, and a mixture of cattle- and game farming. But at the same time farmers stated that other social, political or natural developments such as overhunting or climate change might make such models not financially viable in the future.

The regional and size assessment of ESS (see Chapters 3.2.3 and 3.2.4) showed that mentioning of cultural services and especially "Ecotourism" only occurred in Central and Southern Namibia and on larger farms. It seems logical that the required funds and infrastructure for starting a business based on tourism can only be raised by large scale farmers. It might also be that only certain landscapes are suitable for tourism, due to their natural beauty.

Import restrictions and climate change as well as water availability are most likely the reason that “Genetic Resources”, “Fresh Water” and “Water Regulation” were often cited by the farmers. The changes in nature seem to be accompanied by a change in conscience. While, according to some farmers and experts, the market still desires larger cattle breeds of European heritage, the environment makes ranching with them more difficult as they are more prone to diseases and require more water[10,13]. A change to local breeds and small livestock might make sense nowadays since the loss incurred through the smaller weight of animals must be weighed against the higher survival rates and easier export mechanisms. Similarly, “Primary Production” might change in the near future as more farmers mentioned plans to introduce hay production in the second interview session. While some investments are needed to be better prepared for climatic changes and extreme events like droughts they might now consider these investments as viable and justified.

A further important problem that severely threatens livestock production is bush encroachment which has been often cited by farmers in the North but was of concern in the whole area of research. Usage of “Fiber” products might increase in the future since farmers are increasingly interested in finding ways to finance their fight against bush encroachment. So far the only financial gain from bush encroachment was producing charcoal but the financial outcome is, according to the interviewees, vanishingly low compared to the costs for battling bush encroachment.

While diversification seems to be necessary to prepare for the forecasted shifts in livestock production it remains unclear if they are the remedy for the issues that livestock farming faces in Namibia. A market-connected example would be the usage of venison and other game-related products. Having a back-up option for years with issues for livestock production seems like a good idea but as can be seen in Figure 1 it is unclear whether a sufficiently deep market for wildlife products exists. Similarly, tourism does require investments, natural resources as well as good and safe infrastructure to flourish. The results show that farmers have recognized that changes to traditional farming methods have to be made but political instability and legal issues were often cited as limiting issues for making investments.

A final word shall be directed at the ESS at the other end of the spectrum. Nearly no farmer paid attention to services like “Pollination”, “Climate Regulation” or “Nutrient Cycling”. While “Pollination” was also of no interest for the experts they considered “Nutrient Cycling” and “Climate Regulation” to be of at least medium importance. These results might indicate that the experts consider ESS more spatial and comprehensively than the farmers. The comparison of results from keyword cards and content analysis (see Chapter 3.4) indicate that farmers are

aware that they use several ESS. Yet, the results also support the hypothesis that farmers consider ESS more from an anthropocentric point of view with ESS as benefits that can be reaped. Recommendations for future analyses of ESS in the agricultural sector would include to first Figure out what is indeed an ESS and what is a benefit. In a second step stakeholders should be provided with this definition and asked about their opinion. The third step could be letting farmers rank ESS financially - either by what farmers would be willing to pay for usage of each service or by the profit they generate from each ESS.

5. References

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5.2 List of Figures

5.3 List of Tables

6. Annex

Appendix A – Questionnaire for Interviews with Experts

Interview on current and future use of Namibia's savannas for rangeland farming with focus on water-related management options and ecosystem services

Challenges, visions, strategies, (research) priorities & desired (research) outcomes

Windhoek/Namibia, 24.-28. November 2014

Interview conducted by

Oliver Schulz, ISOE – Institute for Social-Ecological Research, Frankfurt/Germany

within the sub-project S4 of the BMBF-funded OPTIMASS project (2014-2017)

Structure of interview

1. Introduction (5 minutes)
    a. Introduction to interviewer and OPTIMASS project *by interviewer*
    b. Introduction to interview *by interviewer*
        i. What are framing and purpose of the interview?
        ii. Confidentiality and use of interview statements
    c. Introduction to interviewee and institution *by interviewee*
2. Interview Part 1 – Open interview (10-15 minutes)
   In this part *the interviewee* is invited *by the interviewer* to
    - list associations/connotations when thinking about "savanna"
    - explain his/her point of view on current situation of Namibian savannas in general and with focus on farming and farmers (satisfied?), compared to the past
    - share view about current and future problems/challenges/risks and priorities regarding savanna use and management (all users)
    - set his/her own focus on relevant topics
    - optionally state on lacks of knowledge, suggest research questions and specify desired support & helpful OPTIMASS project outcomes/products
3. Interview Part 2 – Specific questions (30-35 minutes)
   In this part *the interviewer* guides *the interviewee* through a catalogue of prepared questions (see below) and
    - explains and refines the questions (if necessary)
    - checks and discusses answers with interviewee to "get the message" (if necessary)
    - keeps track of relevance and timing which includes interrupting the interviewee and guiding back to the specific question (if necessary)
4. Conclusion of the interview (2-5 minutes)

a. Short summary of main interview topics/outcomes *by interviewer* and thank to interviewee, optionally summarizing statement of *the interviewee*
b. Outlook for application of interview outcomes in further project activities
c. Invitation to interviewee to hold contact to the OPTIMASS project, be informed about and possibly participate in future project activities

Questions for Interview Part 2 – Specific questions (7-8 minutes each)

(1) What are the (recent) challenges/problems of rangeland farming (cattle, game, *crop*) in Namibia and what are the reasons for this?

→ Think of problems in environment, society, economy, legislation, administration.

→ Which benefits/goods of the savanna ecosystems to rangeland farming are in danger?

→ Differentiate (if possible) between past, current and future situation and changes.

(2) Which visions and strategies are being promoted to face the before mentioned challenges or adapt to changes?

→ Think of policy documents and recommendations and how they are applied. Who does promote what? Personal opinion of the interviewee/expert

→ Are there contradictions between visions and needs of the population (please specify)?

→ What is needed to support policy/farmers (research, education, cooperation)?

(3) Which management strategies do farmers have/use to secure their livelihood and to react to variability/changes? How do these strategies affect environment and society?

→ Think of current and future strategies and their environmental and organizational impact.

→ Which strategies assure sustainable use of the savanna (now and in future)?

→ Which of these strategies are water-related and what is the knowledge background?

(4) Are there water management options for rangeland farming that you have not mentioned yet?

→ Think of old and innovative techniques and strategies already applied or worth to be tried.

→ Are there restrictions/regulations/incentives regarding these options?

→ Is there a local/regional differentiation (environmental conditions, administration)?

→ How do these water management options influence the ecosystems and their services?

Appendix B – Questionnaire for Interviews with Farmers

Guideline Questions Stakeholder/Farmer

Time frame 1 to 2 hours

Structure:

1. Introduction

2. Background of farm and farmer

3. How do you manage your land? Incl challenges and outlook

4. Infrastructure related to water

5. Bush encroachment, incl rangeland condition & indicators

6. Benefits

7. Knowledge exchange

8. Visual aid/ Summary

Introduction, why are we here? What can we provide, 10 Minutes

- Short explanation of **Optimass**. Our base is the **NRS** und such. We ask for farmer's **knowledge** and experience on (sustainable) **rangeland management**. Especially concerning the management decisions and impacts within the context of the individual farms. Thus we look for additional, complementary or contradictory information
- We have prepared an interview structure incl. open questions. We encourage mentioning related aspects that are important for the interviewee. We may need to get back to previous sections to clarify questions.

  We would like to record the interview, ok? All information and the record is confidential.

  Background Farm, general overview about farm and activities 15/ 25 Minutes

  - **Name** of farmer and farm location
  - **Rain**; mean? Variation in time & space? (slightly, moderate, strongly) (*rainfall records?)later?*
  - **Since when** do you manage and own the farm? history of family and farming
  - Is farming your main activity?
  - **Focus** of farming activities? Commercial livestock production?

  Mixed with, game farming, tourism, cropping?

  - Management focus? trophy hunting, meat production, … ?

Rate proportion of the management focus (e.g. focus on hunting 8 (i.e. 80%), meat 2 (i.e. 20%).

1. **"How do you manage your land" -** Management **Options** incl. **challenges 20 / 45 Min**

Grazing

- *What **production system** /management* do you apply?
- Do you know of any management options you consider important but do ***not* apply**?
    - If so, which are these and why don't you make use of them?
- What are your general management options to respond to ***drought*/ extreme** rainfall year?
    - **Change of management** within the last 5 years? If so, why?

- Past and current ***stocking rates*** for (sensitive)
    - cattle
    - small livestock
    - Wildlife? Ratios (bulk/ selective grazers)?
    - *On what does the number depend?*

Vision/Outlook

- The next 10 years, do you consider a **change in management**?
    - If so, *what* are possible changes?
    - *Why* do you consider them as alternatives to your current management?

Detail check:

- Do you apply **rotational grazing**? Camp size? 1 borehole per camp? Resting? Spatial scale? Time scale?
    - **Variation** in rainy/dry season; in good rainfall years and drought years?)
    - How do you decide where livestock will graze next?
    - How do you decide when you take animals away from a camp? (which indicators, time, monitoring of vegetation condition) [***duration and intensification* of grazing**]
    - Does it happen that you would prefer to give *rest* to a camp but can´t? When and why does this happen?
        - Annual *removal rates*? When do you **sell cattle** during a year. How do you decide when and how much?
        - When do you ***buy new* cattle**? How do you decide when and how much?
        - Do you use *supplemental feeding*? When? (sensitive?)

2. **What water infrastructure? 15/ 60 Min**

- Sometimes **water shortage**? Watering animals, tap water
    - If so, how often?
    - Strategies to deal with this shortage?

- What **soils** on farm? How do you rate/value them?
- Strategies to **protect soil** / decrease erosion? Which ones?
- Successful?
- Strategies to **increase** the amount of **rainwater**/floodwater held back on your farm? Which ones? (gabions, dams…)
- Successful?
- **Location**, size, camps, boreholes (map)?
- How many places to **water** the animals on your farm? (sensitive?)

3. **Bush encroachment** on your farm**? 15/ 75/ 1,15h**

If so, how do you rate the **degree** of bush encroachment on your farm?

- **What** bushes on your farm?
    - **Value /Problem**s do they pose? [fodder resource, use bushes as firewood/ charcoal]

- Do you actively **control** bushes on your farm?
    - How do you rate the **success** of your measure? Rate (excellent, vg,g,p, useless)

Rate the overall ***rangeland condition*** on your farm? (excellent, very good, g,poor,ul)

- How strongly does this vary? And why?

Indicators to assess this *condition?*

- What is your **reference**?

Check:

- Do you use rangeland quality indicators for management ***decisions***?
- If so, which indicators are applied? (e.g. **bare ground**, …)?

- **Thresholds** for management decisions?

Challenges - Impacts on ecosystem 5/ 80

- If you try to manage your rangeland in order to maintain or restore a good rangeland condition, what are the three most important **challenges** for you? [Could include legislation, market constraints etc.]

4. **Benefits 10/ 90/ 1,5 h**

In the previous section you have already mentioned the focus of your land use activity. Now we would like to know more specifically about your management goals and what resources you value important on your farm.

- When you think about the savanna as an ecosystem that provides resources / services to you, what is important? Check with **Visual aid**

    - Are you **successful** with that? (excellent,vg,g,p,useless)

- What influences your success and why? Environmental aspects, Market, Legislation labour availability

5. **Do you share knowledge** between farmers and other stakeholders? 10/ 100 Min

- If so, how?

- If not, why not?

    - Are you interested in being **supported** by farming experts (e.g. NAU, extension offices, others) with knowledge in specific topics? In which topics? How?

        - In the new National Rangeland Management Strategy they propose the goal of increasing the productivity of an area (hectare) instead of the productivity of an animal. What do you think about this?

6. **"Visual Aid", adapted to expert model structure, to let farmer draw the links, rate the effect of a MO on an ESF/ESS:**

    Draft to be designed on a paper with main results of the interview.

- May we come back to you for mapping or sampling activities (vegetation, water sources) at a later stage of our project?

- ***Purpose: In contrast to the first expert interviews, we want to get more precise answers to a pre-structured variables (MO and their effects on the ecosystem, background information on the selected farms) but also leave room for new input (benefits, additional MO). Furthermore we want to incorporate farmers knowledge for the first time.***

Appendix C – Example for Analyzation of Index Cards

Farm Style	Ecosystem services/ Stakeholder	Region	Meat	Seeds	egetation	(Fresh-) Water
Cattle Farmer	Farmer 19	Grootfontein	3	2	2	1
Cattle Farmer	Farmer 23	Grootfontein	4	3	4	2
Cattle Farmer	Farmer 25	Grootfontein	7	4	3	2
Cattle Farmer	Farmer 1	Waterberg	1	1	1	1
Cattle Farmer and Tourism	Farmer 10	Waterberg	2	3	3	1
Cattle Farmer	Farmer 14	Waterberg	3	2	2	1
Cattle Farmer	Farmer 17	Waterberg	4	5	1	3
Cattle Farmer	Farmer 20	Waterberg	8	5	3	2
Cattle Farmer	Farmer 21	Waterberg	3	5	6	2
Cattle Breeding Station	Farmer 24	Waterberg	3	6	4	2
Cattle Farmer	Farmer 3	Waterberg	3	3	2	1
Cattle Farmer	Farmer 22	Windhoek	1		3	2
Number			12	11	12	12
Sum			42	39	34	20
Average			3,50	3,55	2,83	1,67
Rank			8	9	5	3
Weighting			0,35	0,71	0,28	0,17
Rank Weighting			3	5	2	1

Figure 20 - Example for analysis of keyword cards (for usage see Chapters 2.6, 2.7 and 3.3)

Appendix D – Climatic, Geological and Political Key Facts

Regions (as used in Chapter 3.2)	Northern Namibia	Central Namibia	Southern Namibia
Administrative Region (from North to South)	Oshikoto Region: (Grootfontein), Otjozondjupa Region (for farms north of Waterberg Plateau)	Otjozondjupa Region (Kalkfeld, Waterberg)	Kavango West Region (Windhoek), Omaheke Region (Gobabis, Kuzikus)
Number of Farms	Oshikoto Region: 2 Grootfontein Otjozondjupa Region: 2 Waterberg	Otjozondjupa Region: 10 Waterberg 2 Kalkfeld	Kavango West Region: 2 Windhoek Omaheke Region: 2 Gobabis 4 Kuzikus
Annual Mean Rainfall	Grootfontein: 450 – 600mm Oshikoto: 500 – 550mm	Waterberg: 400 – 450mm Kalkfeld: 350 – 400mm	Gobabis: 400 – 450mm Windhoek: 300 – 350mm Kuzikus: 250mm - 300mm
Geology	Oshana: Limestone Oshikoto: Sandstone and Konglomerates	Waterberg: Sandstone and Konglomerates Kalkfeld: Granites	North of Gobabis: Limestones and Shales South of Gobabis: Sandstones, Conglomerates Windhoek: Complexes Kuzikus: Kalahari Sands
Soils	Oshana: Mollic Leptosols, Ferralic Arenosols Oshikoto: Eutric Cambisols, Petric Cambisols, Ferralic Arenosols	Waterberg: Eutric Cambisols, Petric Cambisols, Ferralic Arenosols Kalkfeld: Eutric Regosols, Lithic Leptosols	Gobabis: Eutric Regosols Windhoek: Eutric Leptosols Kuzikus: Petric Calcisols

Table 5 - Climatic, geological and political key facts (own table)

Appendix E – Map of Mean Annual Rainfall in Research Area

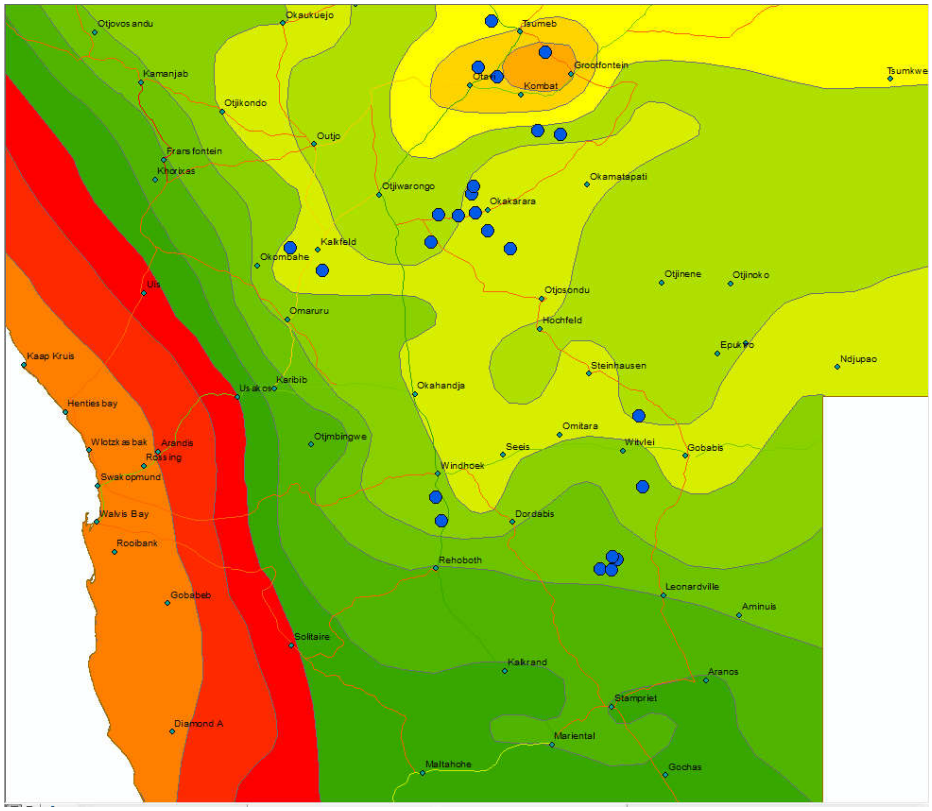

Figure 21 - Mean annual rainfall in Namibia, blue dots signal approximate locations of farms. Adapted with Arc-GIS© from Mendelsohn et al. [1]

Appendix F – List of Excel©-Tables on CD

TABLE 1 - FARMERS NOT ANONYMISED

TABLE 2 - EXPERTS NOT ANONYMISED

TABLE 3 – INTERVIEW QUOTES FARMERS

TABLE 4 – INTERVIEW QUOTES EXPERTS

TABLE 5 – FARMER SCHEMATIC ANALYZATION

TABLE 6 - EXPERTS SCHEMATIC ANALYZATION

TABLE 7 -MA-ESS OF CONCERN

TABLE 8 - MA-ESS REGION

TABLE 9 - MA-ESS SIZE

TABLE 10 - ESS OTHER RESULTS AND GRAPHICS

TABLE 11 - ESS PEER RANKING

TABLE 12 - ESS HIERARCHICALLY STRUCTURED

TABLE 13 - ESS KEYWORD CARDS RESULTS GRAPH

TABLE 14 - FARM MANAGEMENT MEASURES

TABLE 15 - FARM MANAGEMENT MEASURES DROUGHT

TABLE 16 - AGREEMENT TO ALL MEASURES

TABLE 17 - FARMERS MEASURES CBD