ETH Zurich
Department of Environmental Systems Science
Master in Agricultural Sciences
Major in Food and Resource Economics

The impact of UNESCO Biosphere Reserves on biodiversity and land use changes

Master Thesis

Submitted by:
Caroline Stutz

Supervisor:
Prof. Dr. Michael Stauffacher
Department of Environmental Systems Science, Transdisciplinarity Lab,
ETH Zurich

Co-Supervisor:
Florian Knaus
Department of Environmental Systems Science, Institute of Terrestrial Ecosystems,
ETH Zurich

Zurich, August 2017

Task

There are currently more than 669 UNESCO Biosphere Reserves worldwide aiming at integrating conservation and sustainable regional development. Their impact on nature and land use, however, is not well investigated and remains elusive. The goal of this thesis is to find evidence on a) the significance of agriculturally used land in Biosphere Reserves, b) the state of these areas in respect to their value for conservation, c) the ability of the park management to influence (detrimental) land uses and d) factors that foster success. The information will be gathered through an online survey among Biosphere Reserve management bodies worldwide and analysed with quantitative statistics.

Table of contents

Abstract

Agriculture is one of the most important land use activities worldwide. It plays a significant role in UNESCO Biosphere Reserves when it comes to biodiversity conservation. Biosphere Reserves are a specific form of protected areas that foster both regional sustainable development and biodiversity conservation. There are currently 669 Biosphere Reserves worldwide. In such protected areas, agriculture can on one hand threaten biodiversity through intensive land use but on the other hand also conserve biological diversity, for instance through in-situ conservation of native species. Evidence about the specific role Biosphere Reserves play for agriculture in their perimeters is largely missing. Therefore, data on this topic were gathered through an online survey which was distributed among 398 Biosphere Reserves. 52 completely filled in questionnaires have been received from which the following results can be drawn: The significance of agriculture in Biosphere Reserves has risen over the last few years and so has the conservation value of agricultural land. Most of the Biosphere Reserves have goals in the field of sustainable agriculture, focusing on biodiversity conservation. These goals are partially or fully achieved by formulating and implementing measures which hinder harmful agricultural activities and influence land use changes in a desirable way. However, there is still a remarkable part, in particular 24%, of Biosphere Reserves which have no significant impact on land use changes. Whether and how effective Biosphere Reserve managements can influence land use changes is mostly dependent on a secure financing. Most of the Biosphere Reserves stated that their budget is not sufficient and safeguarded. This must be improved to enhance their influence on detrimental land use changes by supporting sustainable agricultural practices and making them more attractive for the local farmers in economic terms.

Introduction

Agriculture is one of the most important land use activities worldwide: In 2014, nearly 40% of the world's land area or 50,000,000 km^2 were used as agricultural land, including land that is arable, under permanent crops and under permanent pastures (Worldbank, 2017). More than half of this land is used for grazing (Bruinsma, 2003) while crop production takes up around one third and the rest is used variably (Alexandratos and Bruinsma, 2012). Overall, livestock production uses the majority of the land, either directly through grazing or indirectly through the consumption of fodder and feed grains (Alexandratos and Bruinsma, 2012). Besides feeding the world, agriculture and the downstream processing enterprises also offer jobs, income and livelihoods around the globe. Roughly 2.5 billion people derive their livelihood from agriculture (FAO, 2013). Agriculture is the main source of income for them and therefore crucial for their survival (Nautiyal *et al.*, 2002; Rao *et al.*, 2002; Marshall and Newton, 2003). Over the recent decades, agriculturally used land has expanded. At the same time, productivity has augmented due to improved cultivation technologies and an increased use of several inputs such as fertilisers and pesticides. This in turn results from pressure caused by population growth and a higher and more meat and dairy-product oriented demand of food (FAO, 2011; FAO, 2013; Bruinsma, 2003; Stoll-Kleemann and O'Riordan, 2017). Over the last few decades, the consumption of meet has increased at 5-6% per year (Bruinsma, 2003). Agricultural land expansion mainly takes place in countries where growing needs for food and employment are present while at the same time the access to modern agricultural technologies is limited. Therefore, intensification is only possible to a restricted extent and the production quantity has to be increased by using more agricultural land. An expansion can also be observed in countries with unrestrained land resources benefiting from the growth of demand for their export products (Bruinsma, 2003; Alexandratos and Bruinsma, 2012). Worldwide, the arable land as a whole expanded between 1961/63 and 2005/07 by 176,000,000 ha as a result of two opposite trends: on one hand an increase of 230,000,000 ha in developing countries and on the other hand a decrease of 54,000,000 ha in developed countries (Alexandratos and Bruinsma, 2012). To meet the forecasted demand for agricultural goods, an increase of 60% of the global agricultural production from its 2005-2007 levels is needed (FAO, 2013).

The expansion of agriculturally used land as well as agricultural practices themselves can lead to several environmental issues including land cover and land use changes. Depending on the applied practices, these activities can result either in biodiversity loss and ecosystem degradation (e.g. in biodiversity hot-spots in tropical and subtropical regions (Salafsky *et al.*, 2008; Norris, 2008)) or in the maintenance of biodiversity values (e.g. in areas with long

extensive grazing traditions (Schley and Leytem, 2004; Bruinsma, 2003)). In many countries, agriculture is successfully used to preserve biological diversity in cultural landscapes. Especially in Europe, the maintenance of biological diversity of different ecosystems depends directly on specific and often traditional types of agricultural land uses (Ostermann, 1998; Henle *et al.*, 2008). This includes for instance low input and organic farming as well as the extensification of livestock production. Furthermore, High Nature Value farming systems and their associated management practices can have positive effects on biodiversity. There are three types of High Nature Value Farmland in Europe: farmland with a semi-natural vegetation, farmland dominated by low intensity agriculture or a heterogenous structure of semi-natural and cultivated land and small-scale features and farmland supporting rare species or a high proportion of European or world populations (Ostermann, 1998). Besides the positive effects, some agricultural practices have negative impacts on biodiversity such as the reduction of genetic resources related to domesticated crops and livestock, which is problematic as these species are often used in breeding programmes to improve the survivability of domesticated crops and increase yields (FAO, 2013; Bruinsma, 2003). Additionally, all agricultural practices have impacts on the micro-organisms in the soils that ultimately sustain food and agricultural production, for instance through soil nutrient recycling or pest control (Bruinsma 2003). The choice of the individual agricultural practices is often affected by peers, external pressure, and economic factors. This includes pressure from the market, national laws, regulations and subsidy programs (Ahnström *et al.*, 2009). Farmers are in general interested in choosing practices that allow them to gain high yields and safeguard their livelihood at least in the short. Such production systems often threaten natural biodiversity due to their high land use intensity (Schmitzberger *et al.*, 2005).

An agricultural production system that fulfils both livelihood and nature conservation goals requires the implementation of beneficial framework conditions which enhance and support such compatible agricultural production systems. It is known that the conservation of biodiversity is more successful when it is interlocked with farmer’s logic, practical requirements and when it is supported by a favourable institutional environment (Gerritsen, 1998). There are farmers who are aware of the environmental problems but do not see their farming practices as part of the problem and thus have no incentives to change their behaviour. There are also farmers who might see their operation as part of the problem but cannot change anything due to economic reasons (Ahnström *et al.*, 2009). It is clear that it is desirable to have some economic growth in the respective areas so that local farmers can directly profit from it (Stoll-Kleemann and O'Riordan, 2017).

One approach to foster both economic wellbeing and biodiversity conservation is to designate specific forms of protected areas such as Biosphere Reserves (BR) which should act as a beneficial framework for sustainable agriculture in areas with high conservation values (Figueroa and Sánchez-Cordero, 2008). There are currently 669 UNESCO BRs worldwide aiming at integrating conservation and sustainable regional development. They interact with agriculture in various ways, for example through creating labelled products that are both beneficial for the farmer's income and the landscape (Knaus *et al.*, 2017) or through maintaining genetic diversity for domesticated crops, for instance through in-situ conservation of native species (Watson *et al.*, 2014; Oldfield and Alcorn, 1987; Louette *et al.*, 1997; Gerritsen, 1998). In addition, the preservation of the quantity and quality of soils is one of the main aspects of current efforts to make agriculture more sustainable and compatible with nature conservation in areas of high conservation value (Stoll-Kleemann and O'Riordan, 2017). These are only a few examples showing that specific forms of protected areas and agriculture can benefit from its interaction with each other. To successfully foster such beneficial interactions, sustainable agricultural land use practices and regional development, these BRs need to have functioning management bodies and not just exist as so called "paper parks" (Juffe-Bignoli *et al.*, 2014). Former studies have identified some factors that can foster or hinder a successful management of the BRs: enough staff with suitable training and skills, a safeguarded and sufficient budget to execute management plans, the involvement of stakeholders and affected persons in decision-making processes, corruption in the respective countries and BRs, illegal land use activities in the BRs and the involvement of the BRs in regional political decisions concerning land use issues (Stoll-Kleemann, 2010; Stoll-Kleemann, 2007; Stoll-Kleemann *et al.*, 2006; Stoll-Kleemann *et al.*, 2010; Stoll-Kleemann and Welp, 2008; Schultz *et al.*, 2011; Gerritsen, 1998; Cuong *et al.*, 2017a; Cuong *et al.*, 2017b).

Given that agriculture is the most dominant land use worldwide and this topic is, hence, very relevant in the general context of sustainable development, makes it especially important for UNESCO BRs. This is reflected by the significance the topic holds within the strategic objectives of the MAB Strategy 2020: Objective 1: conserve biodiversity, restore and enhance ecosystem services, and foster sustainable use of natural resource (UNESCO and MAB, 2015), and the Lima Action Plan, mainly Strategic Action Area A1 and A4 (UNESCO and MAB, 2016). The Strategic Action Area A1 includes the promotion of Biosphere Reserves as sites that actively contribute to the achievement of the Sustainable Development Goals and the implementation of Multilateral Environmental Agreements. The Strategic Action Area A4 relates to research, practical learning and training opportunities that

support the management of Biosphere Reserves and sustainable development in the respective areas. It includes the establishment of partnerships with universities and other research institutions to undertake research on related topics (UNESCO and MAB, 2016).

Evidence about the significance of agriculture for biodiversity conservation in BRs and the specific roles BRs play in this context in their perimeters is, despite a few examples of beneficial interactions between protected areas and agriculture (Knaus *et al.*, 2017; Watson *et al.*, 2014; Oldfield and Alcorn, 1987; Louette *et al.*, 1997; Gerritsen, 1998), largely missing. Therefore, this paper aims at examining this gap of knowledge by finding evidence on a) the significance of agriculturally used land in BRs, b) the state of these areas in respect to their value for conservation, c) the ability of the management to influence land uses and d) factors that foster success in influencing land use. Besides that, regional differences and differences between BRs that are designated before and after the Seville Strategy 1995 are of interest as well. The research questions were tackled by an online survey among the BR managements worldwide.

Methods

Data collection

Data were gathered by an online survey which was distributed among the BRs. Unipark (http://www.unipark.com) was used to implement the questionnaire online. The questionnaire was written in English and consisted of 25 questions (see Annex A), subdivided into the following categories: general information, agricultural land, conservation value, impact of management on land uses and success influencing factors. First, the participants were asked to give some general information about their BR such as the name, the country, the year established, the size and goals in the field of sustainable agriculture. Second, information on the topic of agricultural land were gathered: the size of the agricultural land in the BR, the importance of livestock and crops, the development of agricultural land in the last fifteen years and the reasons for this development and if goals in the field of sustainable agriculture have been reached or not. Third, questions related to the conservation value of agricultural land such as the current state and the development over the last fifteen years have been asked. Forth, the survey included questions to gather information about the impact of the BR management on land use changes: the presence of measures to influence agricultural practices, how these measures are implemented and what the overall impact of the BR management on land use changes is. Lastly, the participants had to state their agreement on some statements about success influencing factors.

The questionnaire was pre-tested by two experts from Swiss BRs. Some questions were adjusted based on the feedback of this pre-test. After that, the survey was sent out by e-mail to all corresponding BR addresses, retrieved from http://en.unesco.org. Due to missing or invalid e-mail addresses in this database, only 398 out of 669 UNESCO BRs received the survey. After the initial invitation, two reminders were sent out to enhance the participation rate. The first one was distributed two weeks after the initial e-mail and the second one again two weeks later. The survey was open for six weeks. 52 completely filled in questionnaires were returned.

Data analysis

To test whether the sample is representative concerning the designation year and the geographical distribution Chi-Square Tests were conducted using the Pearson Chi-Square:

For the designation period, the sample and the statistical population were split up according to if the designation was before or after the Seville Strategy was adopted (UNESCO, 1996). For the geographical distribution, the sample and the statistical population were divided into groups based on different world regions, particularly North America, Europe, the Arab States, Asia and the Pacific, Latin America and the Caribbean and Africa. The statistical population and the sample were tested against each other to see whether they are significantly different from each other (not representative) or not (representative).

Furthermore, data were analysed with quantitative statistics using SPSS and Excel. In particular, frequencies were determined and cross tabulations were conducted. In some cases, bivariate correlations were carried out to test whether the correlations between specific factors are significant on a significance level of $\alpha=0.05$. The following factors were included in correlations: the overall impact of the BR management on land use changes, the presence or absence of measures to prevent harmful agricultural practices, the influence of the political and legal framework conditions on the implementation of these measures, the achievement of goals in the field of sustainable agriculture and all possible success influencing factors. The Spearman correlation coefficient was used as a correlation index due to the ordinally scaled data. The effect size of the correlation was differentiated in weak, medium and strong effect by using the categorisation of Cohen (1992). In addition, where multiple pairwise tests have been done on the same data set, a Bonferroni correction has been executed on the respective significance level to reduce the chances of obtaining type I errors.

Results

Sample

186 UNESCO BRs (raw response rate: 47%) at least opened the survey but only 52 completed it (response rate: 13%) and gave valid answers that could be used for the analysis. This makes a completion rate of 28%. The information conveyed in their answers is summarized below, hence, all information represent a self-perception of the respondents, mainly based on their personal expert guess, outcome of discussions with other members of the management board or monitoring projects. BRs from different world regions took part in the survey, including the following countries: Argentina (1), Australia (1), Brazil (1), Canada (5), Chile (1), China (1), Croatia (1), Cuba (2), Czech Republic (2), Ecuador (1), Estonia (1), Finland (1), France (1), Germany (4), Ghana (1), Isle of Man (1), Kenya (1), Latvia (1), Malawi (1), Mexico (5), Myanmar (1), Paraguay (1), Peru (1), Portugal (4), Slovenia (1), South Africa (4), Spain (2), Sweden (1), Switzerland (1), USA (1), Vietnam (1) and Zanzibar-Tanzania (1). As a summary, 8 BRs from Africa, 4 from Asia and the Pacific, 21 from Europe, 6 from North America and 13 from Latin America and the Caribbean answered the questionnaire. No BRs from the Arab States took part. 46% of the BRs from the sample were designated before the Seville Strategy (1995) and 54% after. In the full population, 42% of the BRs were designated before 1995 and 58% after.

The sample is not significantly different from the statistical population both in terms of the continental distribution (Chi2=10.16, p=0.07) (Table 1) and in terms of the period of designation, i.e. before or after the Seville Strategy (Chi2=0.392, p=0.53) (Table 2). Looking at the continental distribution, the p-value is nearly significant, meaning that BRs from specific countries are under- (Asian and Pacific BRs) or overrepresented. Nevertheless, the sample can be assumed representative considering the continental distribution and the period of designation.

Table 1: Chi-Square Tests concerning the continental distribution of the sample and the statistical population

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.156[a]	5	.071
Likelihood Ratio	13.496	5	.019
N of Valid Cases	721		

a. 2 cells (16.7%) have expected count less than 5. The minimum expected count is 2.24.

Table 2: Chi-Square Tests concerning the period of designation of the sample and the statistical population

	Wert	df	Asymptotic Significance (2-sided)	Exact Significance (2-sided)	Exact Significance (1-sided)
Pearson Chi-Square	.392[a]	1	.531		
Continuity Correction[b]	.231	1	.631		
Likelihood Ratio	.389	1	.533		
Fisher's Exact Test				.561	.314
N of Valid Cases	721				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 21.85.

b. Computed only for a 2x2 table.

Significance of agriculture in BRs

The size of the responding BRs varies between 2,200 ha and 3,200,000 ha. The size of agriculturally used land differs between the BRs and ranges from 0 ha up to 1,920,000 ha in absolute terms. On average (arithmetic), approximately 36% of the BR's area is used for agricultural purposes. The percentages of agricultural land compared to the whole area of the BR differs between 0%, meaning that there is no agricultural land in the BR, up to 95%, meaning that nearly the whole area is used for agriculture. For 38% of the BRs, the agricultural area covers more than 25% of their perimeter (Figure 1). For 13% however, agriculture spans only over 0-2% which is typical for the BRs of the pre-Seville era.

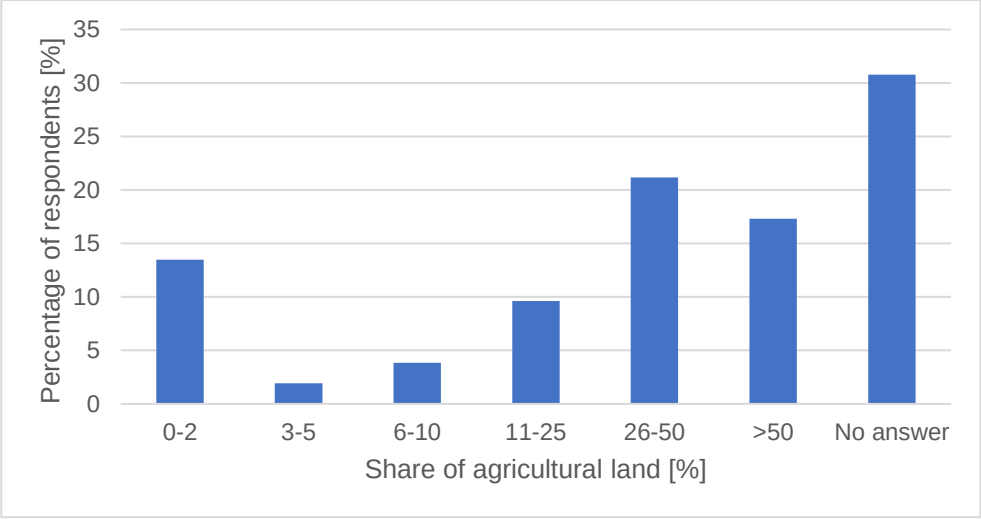

Figure 1: Distribution of the share of agricultural land in the BRs (n=52).

Agricultural land in BRs is mostly used for a combination of livestock and crops. This is the case in 42% of the BRs (Figure 2). In around 29% of the surveyed BRs crops seem to be more common than livestock. 23% of the participants stated the direct opposite, meaning that livestock is more dominant than crops.

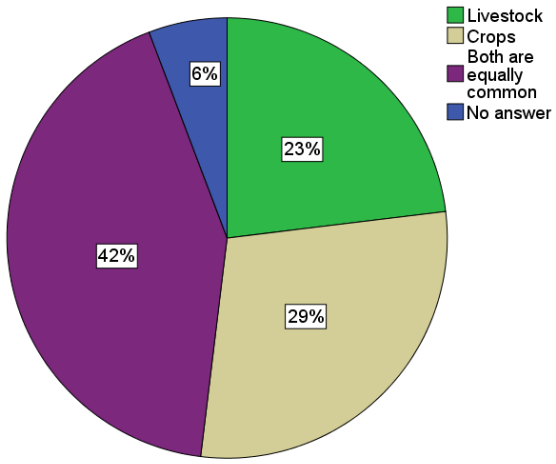

Figure 2: Most common agricultural practices in the BR (n=52) (see Annex A, question 8).

The five most mentioned livestock reared in BRs are cattle and buffaloes, goats and sheep, poultry birds (including chicken, ducks, pigeons, turkeys, geese and guinea fowls), pigs, bees and horses, asses and mules (Figure 3). The last two mentioned livestock were chosen by the same number of respondents. While cattle and buffaloes are the most common livestock in Africa, Europe, North America and Latin America and the Caribbean, cattle and buffaloes, pigs and poultry are the most important ones in Asia and the Pacific.

For crops, maize, wheat, potatoes and barley were regarded as the most common ones (Figure 4). Many BRs also mentioned other crops that were not particularly listed in the answers given in the survey. This includes different fruit and vegetable species, vineyards, oats, rye, forage, grassland, cocoa and tobacco. In Europe and North America, wheat is the most common crop whereas in Latin America and the Caribbean maize is.

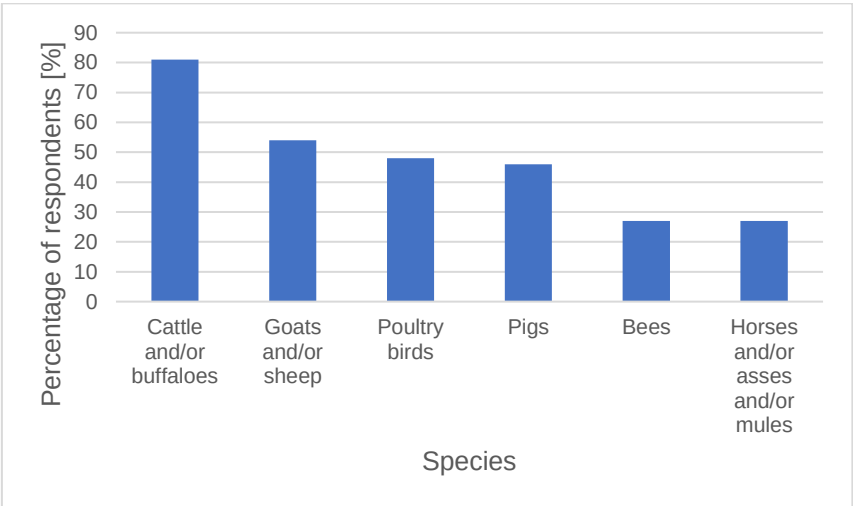

Figure 3: Most common livestock in the BR (n=52) (see Annex A, question 9).

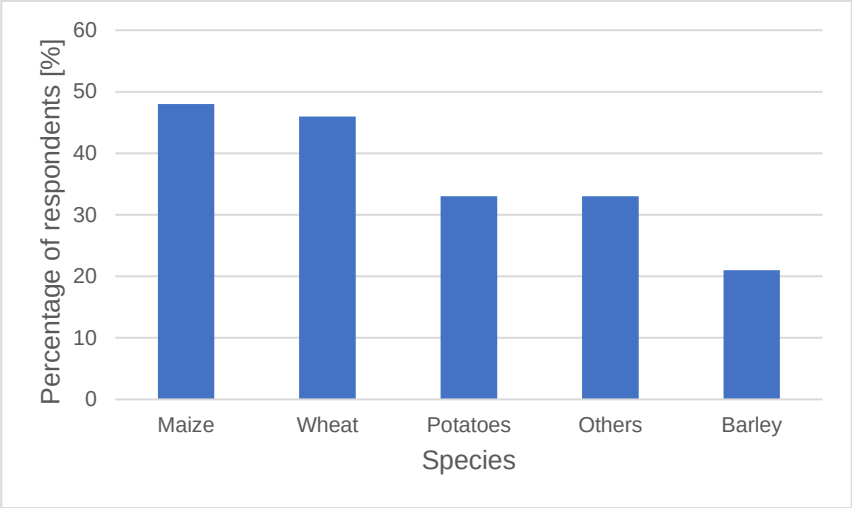

Figure 4: Most common crops in the BR (n=52) (see Annex A, question 10).

The preference for crops or livestock and the choice of specific species can have an impact on the size of area used for agricultural purposes. 46% of the BRs stated a general increase of the agricultural land over the last fifteen years whereas 29% recorded a decrease (Figure 5). Another 19% of the participating BRs stated a steady state in the development of agricultural land. This development trend differs between the regions: All African and the majority of the Latin American and Caribbean BRs stated an increase whereas BRs in Europe, North America and Asia and the Pacific indicated a general decrease or no change (see Annex B, Table A 1). This is irrespective of whether the BR was designated before or after the Seville Strategy (see Annex B, Table A 2). The stated reasons for an increase are mainly land use intensification and partly immigration of farmers (Table 3). For a decrease, extensification and emigration of farmers were mentioned as the main influencing factors. 2% of the BRs do not know the reasons for the changes in agriculturally used land.

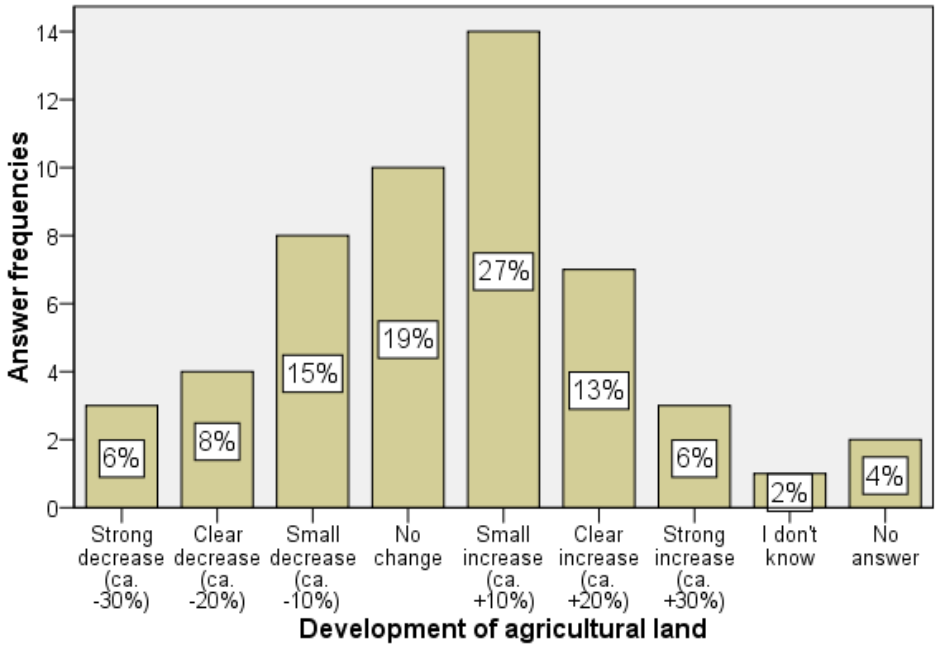

Figure 5: Development of the agriculturally used land over the last fifteen years (n=52) (see Annex A, question 11).

Table 3:Reasons for in- or decrease of agriculturally used land in BRs. Indicated are number of responses (n=52) (see Annex A, question 12).

		Reasons for development					
		Intensification	**Extensification**	**Immigration of farmers**	**Emigration of farmers**	**Alternative income sources**	**Others**
Development of agriculturally used land	**Total decrease**	1	5	5	8	2	4
	No change	1	1	0	1	0	1
	Total increase	14	4	5	3	1	8

Conservation aspects of BRs and their agricultural land

79% of the BRs have goals in the field of sustainable agricultural practices while only a small part (21%) does not (Figure 6). North America has the smallest proportion of BRs having goals in the field of sustainable agricultural practices (67%), followed by Latin America and the Caribbean (69%), Asia and the Pacific (75%), Europe (86%) and Africa (88%) (see Annex B, Table A 1). 83% of the BRs designated before the adoption of the Seville Strategy have goals in the field of sustainable agricultural practices and 75% of the ones designated after (see Annex B, Table A 2). Most of these goals are related to biodiversity conservation (Figure 7). Furthermore, goals in land use practices in agriculture seem to be important as well. Some participants stated that economic development in the agricultural sector, land use practices in agriculture and biodiversity conservation are equally important and that they

therefore focus on all of them. 27% of the participants mentioned goals that were not particularly listed. Most of them recorded sustainable regional development in some way, including the creation of value-added services and products based on environmentally sound label use and the development and promotion of the local product brands. Others mentioned the promotion of a higher number of ecological agricultural sites, for instance organic farming. Another goal described is to enhance measures that foster traditional land use practices and recover abandoned areas.

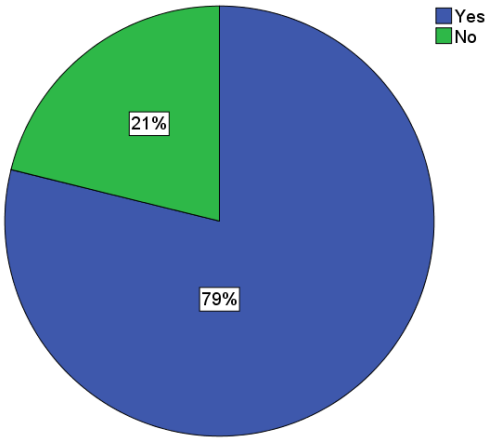

Figure 6: Number of BRs which have goals in the field of sustainable agricultural practices (n=52) (see Annex A, question 5).

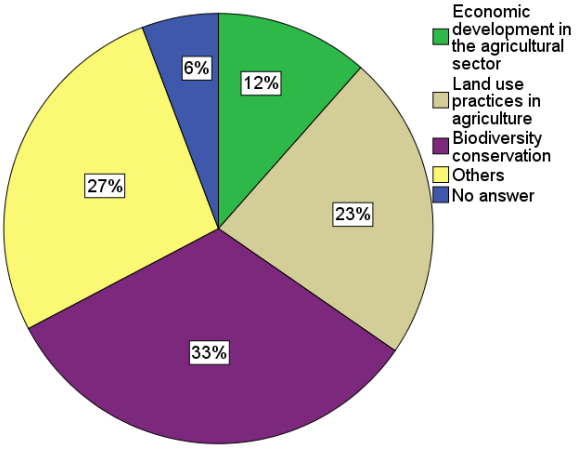

Figure 7: Topics on which the goals are mostly focusing on (n=52) (see Annex A, question 6).

Concerning the achievement of these goals, more than half of the BRs (62%) stated that they have only partially reached them (Figure 8). 14% of the BRs declared to have fully achieved their goals while the same proportion of BRs did not reach them at all. Having not or only partially fulfilled the goals can be attributed to various reasons stated by the participants: The farmers in BRs often derive their livelihood, or at least an important part of it, from agriculture and for them the conversion to a more sustainable agricultural practice is often not beneficial in economic terms. There are often not strong enough incentives to convince them and make alternative agricultural practices more attractive. Even if measures are implemented, they often do not lead to the desired effects because of a limited capacity of surveillance and law enforcement by authorities. In most of the cases, these measures are only implemented on a voluntary basis and do not underlie any control mechanisms. Since agriculturally used land usually lies within the transition area of the BRs regulative tools are limited. In addition, some of the farmers are not aware of the environmental problems caused by their farming practices due to a low educational level and poor agricultural practices taught at school. For instance, in some countries livestock production is promoted although it is related to

unsustainable agricultural practices and activities. Another reason for not fulfilling the goals can lie within the age structure of the farmers in the respective BRs: In regions were the farmers are quite old and near to their retirement, it is not their main priority to change agricultural practices. An aspect that also has to be taken into consideration is time. Some BRs stated that fifteen years are just not enough to reach all the goals related to sustainable agricultural practices. Maintaining sustainable agricultural communities while protecting biodiversity is an ongoing process that will continue over the next few years.

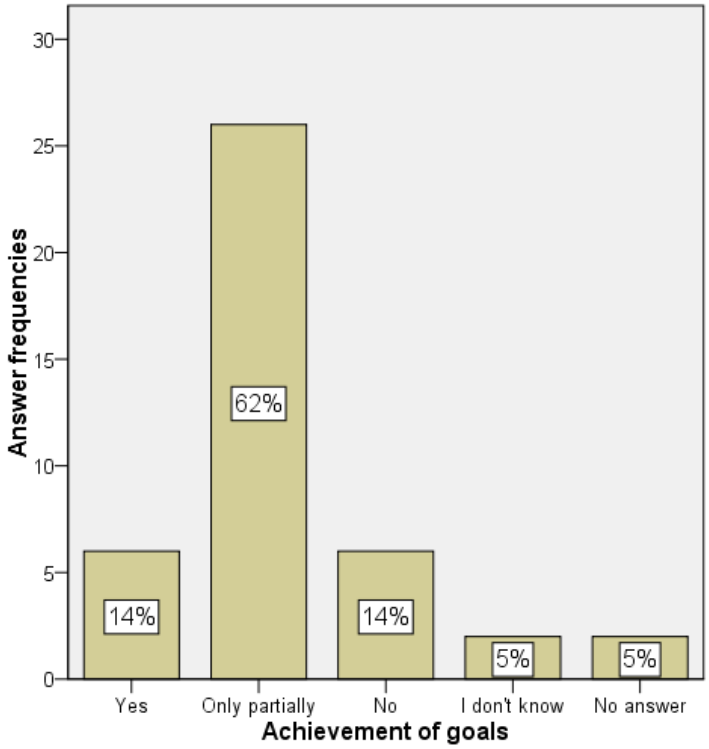

Figure 8: Number of BRs and their achievement of goals related to sustainable agricultural practices in the last fifteen years (n=42) (see Annex A, question 13).

While some BRs are already advanced in the process of biodiversity conservation, others are still in an initial phase. Therefore, the current distribution of areas of high, low and no specific conservation value varies extremely between the different BRs (Table 4). Irrespective of the conservation value, the shares vary between 0% and 90% or 100%, meaning that the agricultural area in BRs ranges from completely impoverished to extremely rich in biodiversity. Besides that, approximately 29% of the whole sample were not able to indicate data on the conservation value of their agricultural land.

Table 4: Maximum, minimum, mean and median of the share of agricultural land with high, low and no specific conservation value (n=52, fifteen BRs did not answer the question) (see Annex A, question 15).

Share of BR area [%]	Conservation value		
	High value (high biodiversity, many threatened species, important habitats of conservation concern)	**Low value** (average biodiversity, some threatened species, a few important habitats of conservation concern)	**No specific value** (low biodiversity, no threatened species, little important habitats of conservation concern)
Maximum	90	95	100
Minimum	0	1	0
Mean	43	33	30
Median	30	30	20

Looking at the development of the conservation value in agriculturally used land in the last fifteen years, in more than half of the BRs the value was improved or at least maintained (Figure 9): 12% stated a clear increase, meaning that areas of high conservation value have been maintained and the conservation value of the other agricultural land has been improved. In 25% of the cases, a minor increase of the conservation value can be observed which relates to a partly restoration of areas of high conservation value and the maintenance or improvement of the conservation value of the other agricultural land. 23% of the BRs recorded a minor decrease meaning that areas of high conservation value have been partly lost and that the conservation value of the other agricultural land has been maintained or has decreased. 6% of the participants stated a clear decrease of the conservation value in agricultural land over the last fifteen years: Areas of high conservation value have been lost and the conservation value of the other agricultural land has decreased. In 20% of the BRs the conservation value of the agriculturally used land has not remarkably changed in the last fifteen years. Concerning the geographical differences (see Annex B, Table A 1), the majority of the African BRs (75%) stated an increase of the conservation value of agricultural land. In North America two stated an increase, one a decrease and one no change. In Latin America and the Caribbean five BRs stated an increase, four a decrease and three no change. In Asia and the Pacific every participant gave another answer, meaning that no specific development was dominant. In Europe seven BRs recorded a decrease of the conservation value, six no change and five an increase. Concerning the designation period, the majority of the BRs designated before the Seville Strategy recorded an increase (42%) of the conservation value of agricultural land whereas the majority of the ones designated after the Seville Strategy stated a decrease (39%) (see Annex B, Table A 2).

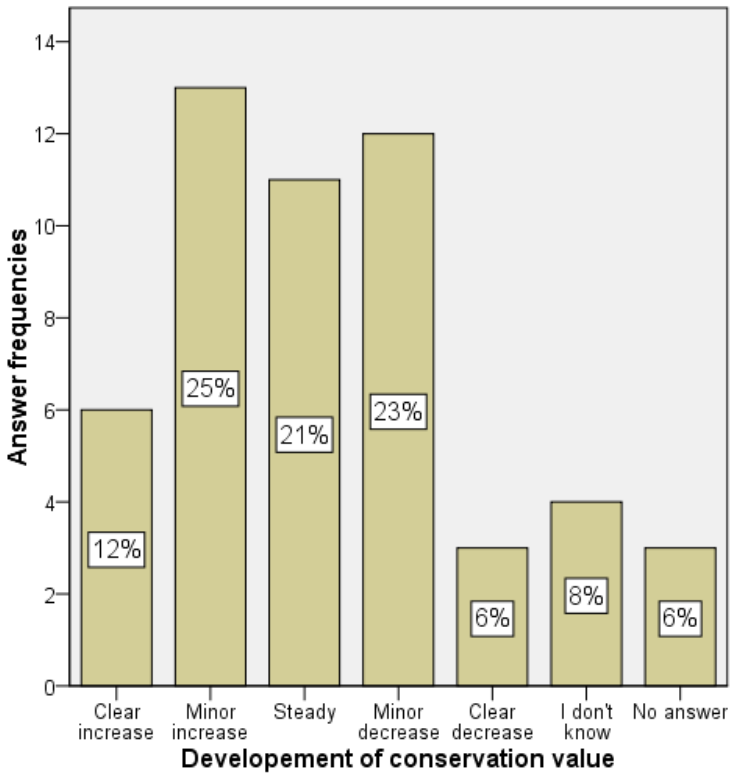

Figure 9: Development of the conservation value of agricultural land in the last fifteen years (n=52) (see Annex A, question 16).

BR's influence on land use

Most of the BRs have formulated specific measures trying to prevent harmful agricultural land use practices and activities (Figure 10). From the total number of participants 21% do not have any measures formulated. The presence or absence of these measures stands in relation with the achievement of goals in the field of sustainable agricultural practices: 67% of the BRs which stated that they have not achieved their goals in the field of sustainable agriculture, have formulated measures. For the ones which have partially reached their goals, 77% of them have formulated measures that can influence land use practices. In 83% of the cases where the goals have been fully achieved, measures have been formulated as well. Not all of the formulated measures are also established, implemented and monitored. Out of the BRs which have formulated measures, 19% also establish their measures, meaning that the measures are known and accepted by the farmers and other affected persons, 15% further implement them and 17% also monitor the implementation. When looking at the influence of the designation period on the implementation of these measures, there is no impact: The same proportion of BRs designated before and after the Seville Strategy stated that there are at least measures formulated (see Annex B, Table A 2).

Looking at regional differences (see Annex B, Table A 1), Asian and Pacific BRs stated that they only formulate and establish the measures but do not implement them and therefore, no monitoring is done, either. Especially African and European BRs, in particular 38% in both of the cases, further implement the measures and also monitor the implementation. 33% of the North American BRs implement the measures but no monitoring is done. For the cases in which the measures are implemented, the implementation of these measures is done by the farmers voluntarily (50%) or based on financial incentives (44%). The amount of financial incentives is often defined by the legislation or the agricultural policy. In general, the implementation is strongly influenced by the political and legal framework conditions of the BRs and of agriculture (Figure 11). In 50% of the BRs the political and legal framework has a strong impact on the implementation (if, how, etc.). 28% of the participants stated a minor influence. 6% stated no influence. 11% do not know if the political and legal framework impacts the implementation of measures. In some cases, only the legal framework has a strong influence, for example due to laws on all aspects of the BR functionality, while the political framework conditions do not play a large role. In other BRs, the opposite is the case. Especially the regional agricultural policy can influence the implementation, for instance through subsidies to livestock, which hinders the implementation of good, environmental friendly agricultural practices.

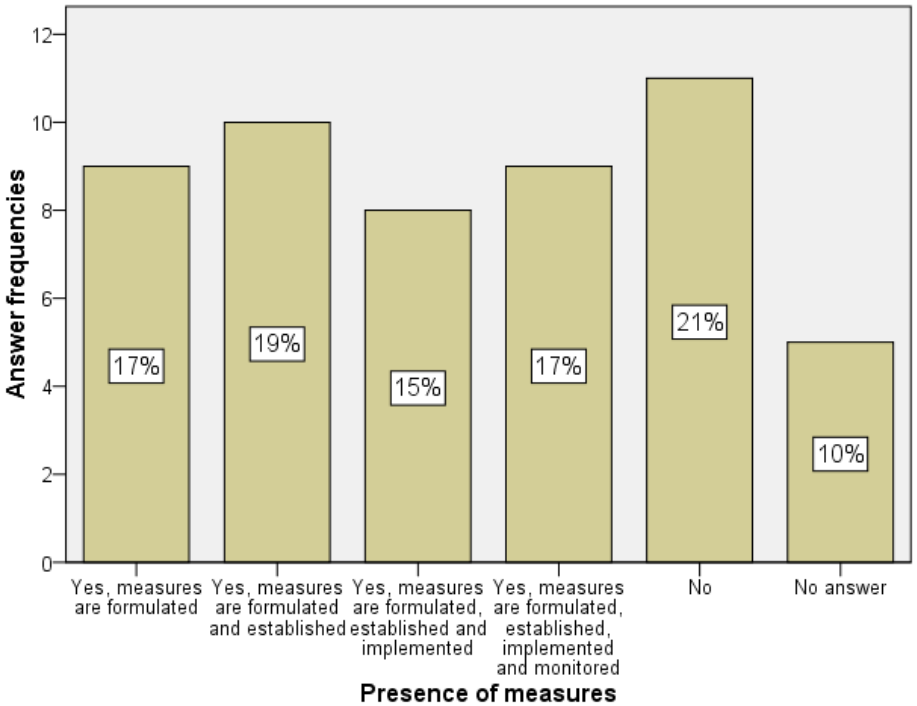

Figure 10: Presence of formulated, established, implemented and monitored measures concerning agricultural practices and activities which harm biodiversity (n=52) (see Annex A, question 18).

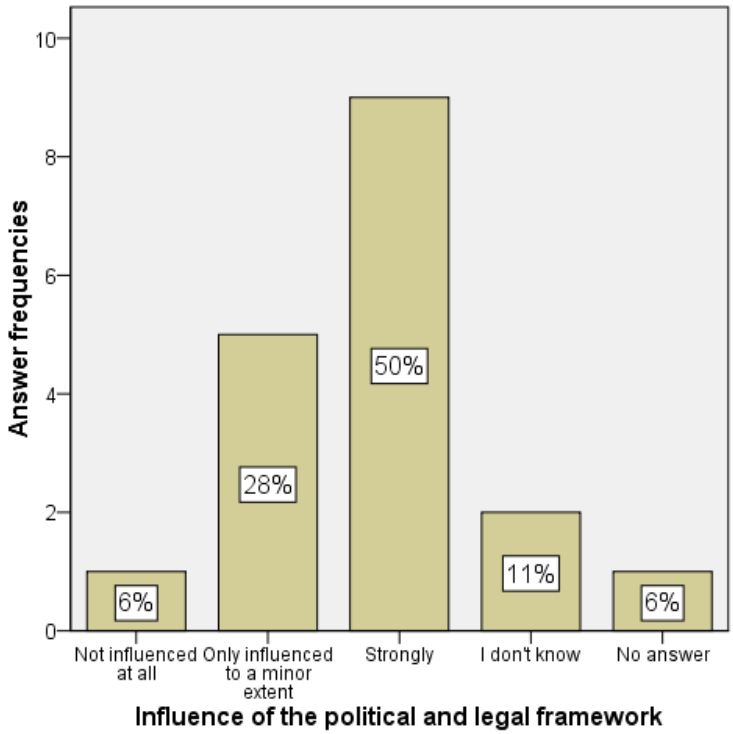

Figure 11: Influence of the political and legal framework on the implementation of measures concerning agricultural practices and activities which harm biodiversity (n=18) (see Annex A, question 20).

Going from specific measures and framework conditions to a general view on the impact of BR management bodies on land use changes, the majority of the BR managements consider having an impact on land use changes in agriculturally used land (Figure 12): 29% stated a minor impact (i.e. the BR has only a minor impact on agricultural land use without a clear role of the BR management) and another 29% stated a moderate impact (i.e. agricultural land use is importantly and directly influenced by the BR management in a small spatial extent). 13% of the BRs have a strong (i.e. agricultural land use is importantly and directly influenced by the BR management on a considerable extent) and 2% a very strong impact (i.e. agricultural land use is importantly and directly influenced by the BR management on a large scale) through their management. In 10% of the cases the BR managements do not have a significant impact on land use and in another 10% their impact is unclear. 4% stated that they do not know if they can influence land use changes in agricultural land. Looking at regional differences, the management of African BRs mostly stated a moderate impact, European and North American BR managements a minor to moderate while Latin American and Caribbean BR managements stated a moderate to strong impact on agricultural land use changes (see Annex B, Table A 1). The designation era also indicates a differentiation (see Annex B, Table A 2): The majority of the BRs designated before 1995 recorded a moderate impact while the

majority of the BRs designated after the Seville Strategy stated a minor impact. While there are hardly any BRs designated before 1995 who have no or an unclear impact, 32% of the ones designated after 1995 have no or an unclear impact on land use changes in agricultural land.

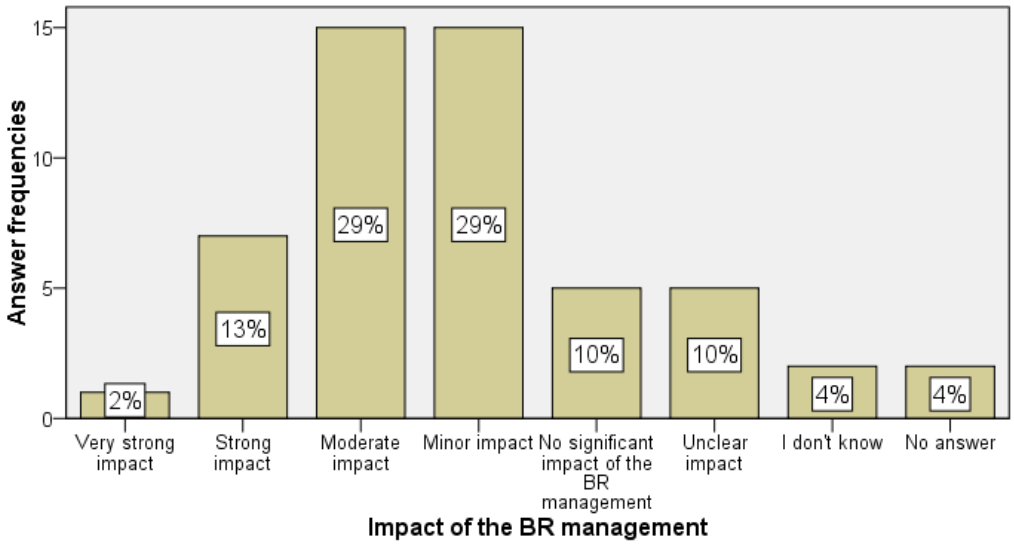

Figure 12: Impact of the BR management on land use changes in agriculturally used land (n=52) (see Annex A, question 22).

To see whether this overall impact can influence or is influenced by other factors, the following factors have been tested for a correlation with the overall impact: The influence of the political and legal framework conditions, the presence of measures that can influence land use changes and the achievement of goals in the field of sustainable agricultural practices. The overall impact of the management on land use changes is not significantly correlated (p=0.840) to the influence of the political and legal framework conditions and it is not significantly correlated (p=0.989) to the presence of measures that can influence land use, either, whereas the correlation between the impact of the management on land use changes and the achievement of goals in the field of sustainable agriculture is significant (p=0.003, r=0.45) (see Annex B, Table A 3). The following describes the significant correlation of the overall impact and the achievement of goals in more detail: 43% of the BRs which stated that they did not achieve their goals in the field of sustainable agricultural practices have a minor impact on land use changes (Table 5). 14% recorded a moderate impact while a strong or very strong impact was not mentioned at all. 50% of the BRs which have fully achieved their goals stated a strong impact of their management on land use changes. Additionally, 17% have a very strong influence. For the BRs which have only

partially fulfilled their goals related to sustainable agriculture, mostly a minor (34%) to moderate (38%) impact of the management was recorded.

Table 5: Correlation between goal achievement and overall impact on land use. Indicated are number of responses (n=42).

		Goal achievement (Question: Given the goals related to sustainable agricultural practices: Have you reached these goals in the field of agriculture in the last fifteen years?)			
		Yes	**Only partially**	**No**	**I don't know**
Impact on land use	**Very strong impact**	1	0	0	0
	Strong impact	3	2	0	0
	Moderate impact	1	10	1	0
	Minor impact	1	9	3	1
	No significant impact	0	0	0	1
	Unclear impact	0	4	1	0
	I don't know	0	1	1	0
	Total impact	6 (100%)	21 (81%)	4 (67%)	1 (50%)

Important influencing factors

The participants have been asked to state whether they agree with the given statements on the topic of staff, financing, decision-making processes, corruption and illegal land use activities (Figure 13) (see Annex A, question 24). The following results have been found: Around 85% of the BRs develop their projects in a participative manner, which means that they involve stakeholders and affected persons, such as farmers and local people living in the area, in their decision-making processes. Furthermore, in around 55% of the cases, the BRs themselves are involved in regional political decisions concerning land use issues. 69% of the BRs from Latin America and the Caribbean, 63% from Africa, 50% from China and the Pacific, 52% of the BRs from Europe and 33% from North America are involved in regional political decisions concerning land use (see Annex B, Table A 1). Looking at the topic of corruption, in roughly 50% of the countries corruption does not seem to be an issue and over 70% of the BRs are not directly affected by corruption. Corruption is especially a topic in African (88% are affected) and Latin American and Caribbean countries (77% are affected) whereas in North American and European countries corruption does not seem to be a problem (100%, respectively, 62% are unaffected) (see Annex B, Table A 1). Additionally, illegal land use activities are not a topic in more than 60% of the BRs, either. It seems to be mainly a problem in African BRs (75% are affected) while European and North American

BRs are hardly affected by illegal land use activities in agricultural land (81%, respectively, 83% are unaffected) (see Annex B, Table A 1). Concerning the budget, nearly 70% of the BRs do not have a sufficient budget to execute their management plans and the yearly budget is not safeguarded over the next five years in more than 50% of the cases. Looking at the staff, approximately 40% of the BRs consider having enough staff with suitable training and skills for their BR whereas more than 50% stated the direct opposite. There are regional differences observable: 25% of the African, 57% of the European, 53% of the Latin American and Caribbean, 50% of the North American and 25% of the Asian and Pacific BRs do not have enough staff (see Annex B, Table A 1).

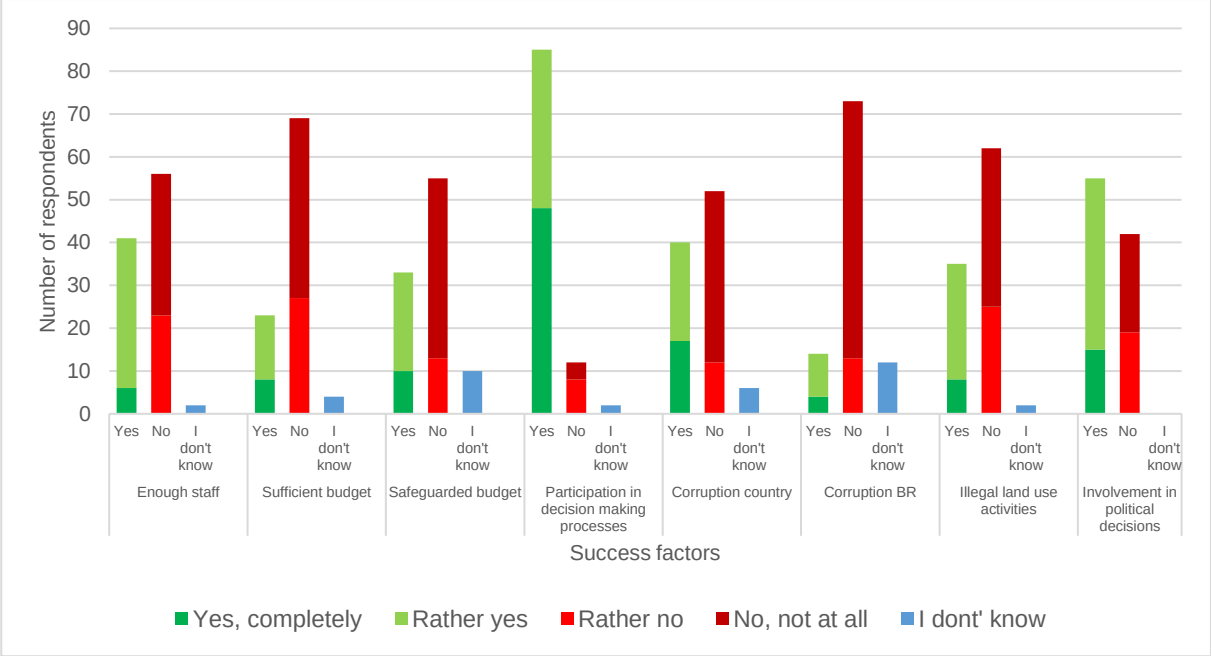

Figure 13: Statement of the participants whether the given factors are present in their BR or not (n=52).

Some of the parameter values of the above described influencing factors are correlating significantly (Table 6). Having enough staff is significantly and strongly positively ($p<0.0001$, $r=0.60$) correlated to a sufficient budget. It is also significantly ($p<0.0001$) correlated to a safeguarded budget with a medium effect size ($r=0.48$). Furthermore, the correlation between a sufficient and safeguarded budget is significant and strong ($p<0.0001$, $r=0.51$), meaning that the BRs that are safely financed in the longer term have sufficient money for the current year. Additionally, a significant correlation can be found between illegal land use activities and corruption in the BR ($p=0.004$, $r=0.39$). Corruption at BR level is further strongly correlated to countrywide corruption issues ($p<0.0001$, $r=0.50$). In addition, corruption in the country is also significantly positively correlated to illegal land use activities in the BRs

(p=0.001, r=0.47). Furthermore, there is a significant positive correlation between the participation of stakeholders in decision making processes and illegal land use activities (p=0.003, r=0.41), as well as between the involvement in regional political decisions and illegal land use activities (p=0.002, r=0.43). This means that in BRs where illegal land use practices are more prominent, the management is more strongly involved in regional decision-making processes concerning land use and stakeholders can participate more in the decision-making process of the BRs. Lastly, the involvement of the BR managements in regional political decisions concerning land use issues and sthe participation of stakeholders in decision-making processes of the BRs is significantly positively correlated (p=0.001, r=0.44), indicating that in BRs where the management is allowed to take part in regional political decisions, stakeholders are more strongly involved in decision making processes of the BR.

Table 6: Bivariate correlation with Spearman correlation coefficient between different success influencing factors. Significance level with Bonferroni correction is 0.007. Significant results are highlighted in yellow.

			Enough staff	Sufficient budget	Safeguarded budget	Participation in decision making processes	Corruption country	Corruption BR	Illegal land use activities	Involvement in political decisions
Spearman's rho	Enough staff	Correlation Coefficient	1.000	.597**	.480**	.211	-.301*	-.171	.133	.299*
	Sufficient budget	Correlation Coefficient	.597**	1.000	.505**	-.074	-.249	-.099	-.034	.094
	Safeguarded budget	Correlation Coefficient	.480**	.505**	1.000	.166	-.095	.032	.114	.205
	Participation in decision making processes	Correlation Coefficient	.211	-.074	.166	1.000	.163	.203	.410**	.437**
	Corruption country	Correlation Coefficient	-.301*	-.249	-.095	.163	1.000	.504**	.466**	.156
	Corruption BR	Correlation Coefficient	-.171	-.099	.032	.203	.504**	1.000	.389**	-.007
	Illegal land use activities	Correlation Coefficient	.133	-.034	.114	.410**	.466**	.389**	1.000	.429**
	Involvement in regional political decisions	Correlation Coefficient	.299*	.094	.205	.437**	.156	-.007	.429**	1.000

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

Looking at the relationship of the influencing factors above and the overall impact on land use changes: Concerning the significance of the correlation between the impact of the management on land use changes and specific success factors (enough staff, safeguarded budget, participation in decision making processes, corruption BR, illegal land use activities, involvement in political decisions), there are no significant results on a Bonferroni corrected significance level of α=0.007 (Table 7). Only independent success factors were included in

this correlation. The strong correlations between a sufficient and a safeguarded budget and between corruption in the BR and corruption in the country indicate that these factors are not independent from each other and therefore only one of these has to be taken into account, in particular safeguarded budget and corruption in the BR. However, both the strongest correlation and highest significance level are stemming from the safeguarded budget, meaning that out of all influencing factors, a secure financing of the BR is mostly contributing to BR's effect on land use.

Table 7: Bivariate correlation with Spearman correlation coefficient between goal achievement, impact of management on land use changes and different influencing factors. Significance level with Bonferroni correction is 0.007.

			Impact of management on land use changes
Spearman's rho	Influence political and legal framework	Correlation Coefficient	.051
		Sig. (2-tailed)	.840
	Enough staff	Correlation Coefficient	.106
		Sig. (2- tailed)	.453
	Safeguarded budget	Correlation Coefficient	.290*
		Sig. (2- tailed)	.037
	Participation in decision making processes	Correlation Coefficient	.169
		Sig. (2- tailed)	.231
	Corruption BR	Correlation Coefficient	.248
		Sig. (2- tailed)	.076
	Illegal land use activities	Correlation Coefficient	.219
		Sig. (2- tailed)	.119
	Involvement in regional political decisions	Correlation Coefficient	.182
		Sig. (2- tailed)	.197

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

Discussion

Significance of agriculture in BRs

Agricultural land in BRs covers more than one third of the total area and has generally increased in the last fifteen years, especially in African and Latin American and Caribbean BRs. It can be assumed that the significance of agriculture has risen in these areas. Agriculture is expanding while at the same time, other areas such as forests, are being lost (Walker and Solecki, 1999; Carr, 2008; Ohnesorge *et al.*, 2013). When asking the participants to state reasons for this development, they mentioned intensification and the immigration of farmers. While it is clear that the immigration of farmers leads to an increase of used land, intensification is a rather surprising factor for increasing the size of used land. Agricultural intensification is related to a higher production per unit of input, in this particular case land. Therefore, intensification occurs when more is produced on the same space of land or when the production is maintained while land use decreases (FAO, 2004). A similar phenomenon can be observed for the reasons stated when agricultural land has decreased over the last fifteen years. Extensification and emigration of farmers were the most prominent factors. While it is clear that the emigration of farmers leads to a decrease of used land, it is rather surprising that extensification should lead to a decrease as well. In some cases, like for instance in Switzerland, extensification can be associated with a decrease of land. This is related to the reduction of the number of cattle which leads to a smaller space needed (Baur *et al.*, 2007) but usually, extensification means that more land is used while inputs and expenditures of capital and labour are kept on a minimum level (Beranger, 2017).

Currently, in most of the cases, agricultural land in BRs is used for a combination of crops and livestock. The most important livestock are cattle and buffaloes, goats and sheep, poultry birds, pigs, bees and horses, asses and mules. The most important crops are maize, wheat, potatoes and barley. The importance of these livestock and crops does not remarkably differ from agriculture that is practiced outside of the BRs (FAOSTAT, 2017).

Conservation aspects of BRs and their agricultural land

The majority of the BRs have goals in the field of sustainable agricultural practices, mostly focusing on biodiversity conservation. This high importance of biodiversity conservation in agricultural land can be explained by the negative effects of some agricultural practices that

has led to biodiversity loss in these areas (Stoll-Kleemann *et al.*, 2006; Stoll-Kleemann *et al.*, 2010). Furthermore, biodiversity conservation in agricultural land is also important because of the significance of in-situ conservation of native species which is essential for the genetic improvement of domesticated crops (Oldfield and Alcorn, 1987; Louette *et al.*, 1997; Gerritsen, 1998; Watson *et al.*, 2014). Therefore, the current conservation value of agricultural land differs between the BRs and there are surprisingly many BRs not knowing about the state of their agricultural land in respect to biodiversity conservation. For those who know, the conservation value of agricultural land has increased or at least stayed the same over the last fifteen years. The majority of the BRs designated before the Seville Strategy recorded an increase, which might lead to the conclusion that the Seville Strategy has had a positive effect on the conservation value of agricultural land. This impact is probably related to some of the key directions of the Seville Strategy: All zones, including the transition zone where agriculture is usually practiced, should contribute appropriately to conservation and sustainable development. The transition area should be extended and more attention should be given to this area. Genetic resources and traditional knowledge should be conserved (UNESCO, 1996). By following these guidelines, areas with higher conservation value have been included in the transition area and efforts have been made to keep the conservation value on a higher level. It might appear contradicting, however, that more of the BRs designated before the Seville Strategy have goals related to sustainable agricultural land use practices. This can be explained by the fact that with the adoption of the Seville Strategy, the BRs had to include a clearly defined transition zone, where agricultural practices can take place (Price, 2017). This indicates that the pre-Seville BRs who took part in the survey are the more successful and seriously managed one, meaning that they are interested in maintaining and improving the quality of their full perimeter and therefore they follow the guidelines of the Seville Strategy while the ones not functioning might have already been delisted and therefore did not take part in the survey.

BR’s influence on land use

Most of the BRs have formulated specific measures favouring sustainable agricultural practices and reducing activities that harm biodiversity, meaning that they are aware of certain detrimental land use activities which they want to influence. The presence of such measures seems to have a positive effect when it comes to the achievement of goals in the field of sustainable agricultural practices. This is only suitable for BRs which have formulated such goals and indicates that BRs which specifically know what kind of measures they need

to implement to get the desired effects have a stronger impact on land use changes. Furthermore, the strong positive correlation between the impact of the management on land use changes and the achievement of goals in the field of sustainable agriculture suggests that those BRs are better able to achieve their goals. They can direct the development of land use changes according to their goals.

While a remarkable part of the BRs stated a moderate to strong overall impact of their management on land use changes, another considerable part does not have a significant or has an unclear impact or they do not know if and how they influence land use. It can be assumed that the ones who stated an unclear or unknown impact rather have no influence on land use changes because otherwise, they would probably know about it. As a result, nearly the same proportion of BRs as the ones stated a moderate to strong impact, have no or only a minor impact on land use changes. When taking into account the essential role of agriculture in biodiversity conservation (Oldfield and Alcorn, 1987; Louette *et al.*, 1997; Gerritsen, 1998; Watson *et al.*, 2014; Stoll-Kleemann, 2010; Stoll-Kleemann *et al.*, 2006), it is not desirable that nearly half of the BRs have no or only a small impact. Therefore, biodiversity conservation in agricultural land is not safeguarded in nearly half of the cases because the managements are not able to prevent detrimental land use practices. In contradiction to this rather negative conclusion, it should be positively mentioned that approximately half of the BRs have a moderate to strong impact on land use changes although the implementation of measures against harmful land use practices is strongly influenced by the political and legal framework conditions. When looking at the designation period, it might appear that the BRs designated before 1995 have a stronger impact than the ones designated after 1995. In this case, it has to be taken into account that the ones designated before the Seville Strategy have existed for a longer time period. It is therefore easier for them to see how the area has changed over time and identify trends while for the ones who do not exist that long, no clear impact of their activities undertaken might yet be visible because it is still an ongoing process. Furthermore, these BRs might have better developed and established networks with local producers, governmental and non-governmental organisations which enhances their impact. The organisation of such functioning networks takes a lot of time (Knaus *et al.*, 2017). So, the chance of having this network and the size of it is bigger for longer existing BRs.

Important influencing factors

Former studies have suggested various success factors for an effective BR management: enough staff, sufficient and safeguarded budget, participation of stakeholders in decision-making processes, no corruption issues in the country and the BRs, no illegal land use activities in the BRs and the involvement of the BRs in regional political decisions (Stoll-Kleemann *et al.*, 2006; Stoll-Kleemann *et al.*, 2010; Stoll-Kleemann and Welp, 2008; Schultz *et al.*, 2011; Stoll-Kleemann, 2007; Gerritsen, 1998; Cuong *et al.*, 2017a; Cuong *et al.*, 2017b). In this study, none of these factors is significantly correlated to the impact of the management but some of these factors are correlating among themselves. Having a sufficient budget is strongly correlated to having a safeguarded budget, meaning that if one of these factors is present, the other is as well. It can be assumed that in those BRs where the budget is safeguarded over the next 5 years the available budget is sufficient to execute their management plans as well. These BRs have a tendency to really achieve an impact on land use as well. Furthermore, the strong positive correlation between corruption in the country and corruption in the BR in the respective country shows that if corruption is an issue countrywide, the BR is mostly affected, too. This might lead to the conclusion, that the BR managements are not able to protect the area from corruptive activities. The correlation between the participation of stakeholders in decision making processes of the BR and illegal land use activities in the BR indicates that in BRs where illegal land use activities are common, the management tries to reduce it by involving stakeholders in decision making processes so that jointly solutions can be found on sustainable land use. In addition, the involvement of stakeholders in decision making processes of the BRs and the involvement of the BR management in regional political decisions is significantly correlated, indicating that the participative project development approach is implemented from a local to a regional scale. This is important for the success and functionality of the BRs (Stoll-Kleemann *et al.*, 2010; Schultz *et al.*, 2011).

The absence of a significant correlation between these factors and the impact of the management indicates that they are neither benefiting nor hindering the influence of BR managements on detrimental land use practices. Expanding the significance level slightly reveals that a secure financing is mostly contributing to BR’s effect on land use changes. The importance of a safeguarded and sufficient budget is further underlined by the fact that having or not having goals in the field of sustainable agriculture does not change the overall impact of the BRs on land use while having or not having finances does most likely.

Method limitation

Out of the 669 initially included BRs, 186 at least opened the survey and only 52 completed it. This makes a response rate of approximately 13% which is rather low. Nevertheless, the Chi-Square Tests showed that the sample is representative concerning the continental distribution of the BRs and the designation period. There are several factors which have led to the rather small sample: The survey was only set up in English. Some BRs have asked for a translation of the questionnaire into their respective language. They stated that their English was not sufficient to fill in the survey and the terminology used was rather hard for them to understand. For instance, the results from asking the participants about the reasons for a decrease or increase of their agricultural land were rather surprising. A probable reason for these contradictory results could be the misunderstanding of the used terminology. In the questionnaire, the meaning of intensification was not explained. Extensification was declared as a less intensive production on the same area. Therefore, if someone did not correctly understand the meaning of intensification, he or she also misunderstood extensification which was explained as the opposite of intensification. Such difficulties could be one of the reasons, why the completion of the questionnaire on average took longer than actually stated in the invitation. Other BRs just did not have the time to fill in the survey. Sometimes the person who is responsible for agricultural topics was absent and could not be reached. Further, some of the BRs do not have functioning management bodies at all, representing the “paper parks” among the BRs (Juffe-Bignoli *et al.*, 2014). Some Latin American BRs have recorded that they could not fill in the survey due to a bad internet connection. Besides a bad internet connection, some BRs might not have participated because they did not receive the invitation due to spam filters. Finally, in some BRs agriculture might just not exist or the knowledge about agriculture in their BR is limited. This might be the reason for a rather low completion rate (28%) of those who have started but not finished the survey. To enhance the participation rate, all 398 potential participants were in total contacted three times to fill in the survey (invitation, two reminders).

The factors mentioned above have not only led to a rather small sample but probably also to an overrepresentation of BRs that are actually interested in the topic of agricultural land use and biodiversity conservation. It can be assumed that the management of these BRs manage their BRs seriously, have ambitions in the field of agriculture, and are aware of certain problems and how to theoretically solve them. As a result, the sample might be overrepresented by more successful BRs in the realm of agriculture. It has also to be taken into account that the answers given in the survey represent a self-perception of the respondents. These factors have probably led to more optimistic results. Therefore,

estimating such counterfactual conditions is an important step in effectiveness evaluations like it has been done in this and other studies (Ferraro and Pressey, 2015). For further studies in this field, assessing impacts in the field and relating them on a causal base to the activities of BRs would improve the validity of these results.

Conclusions

Agriculture is an important land use in BRs generally and when it comes to biodiversity conservation. Hence, most of the BRs have goals in the field of sustainable agricultural practices, mostly focusing on biodiversity conservation. The general conservation value of agricultural land varies strongly between the different BRs covering the full range of no to a high value. While a remarkable part of the BRs does not know about the state and development of their agricultural land in respect to biodiversity conservation, the ones who do, stated a general increase or at least a steady state of the conservation value. Most of the BRs have formulated measures favouring sustainable agricultural practices and reducing biodiversity-harming activities. However, only in approximately half of the cases, the BRs stated a moderate to strong impact on land use changes. Nearly the same number of BRs stated no or only a small impact, meaning that biodiversity conservation in agricultural land is not safeguarded for the future. While former studies found many factors that can benefit or hinder the success of the BR management, none of these was significantly correlated to the overall impact in this study. However, both the strongest correlation and the highest significance level were stemming from the safeguarded budget indicating that if BRs are supposed to have an impact on land use, the most important factor is a secure short- and long-term financing of the BR. Unfortunately, the majority of the BRs stated that their budget is neither sufficient to execute their management plans nor safeguarded over the next five years, explaining why the current impact of BRs on land use in agriculture is limited. Therefore, a sufficient and safeguarded financing of the BRs should be improved so that sustainable agricultural practices can be supported to achieve better biodiversity conservation in agricultural land.

Annex A

General information:

1. Name of the Biosphere Reserve (BR)

2. Country

3. Year established

4. Size of BR [ha]

5. Does your BR have goals in the field of sustainable agricultural practices?
    a. Yes
    b. No

6. What are these goals mostly focusing on?
    a. Economic development in the agricultural sector
    b. Land use practices in agriculture
    c. Biodiversity conservation
    d. Others, please state

Agricultural land:

7. Size of agriculturally used land in the BR [ha]. Agriculturally used land consists of arable land, land under permanent crops and land under permanent meadows and pastures. *If you don't know exactly the size, add an estimation by providing a range*:

8. Which of the two agricultural practices is more common in the BR?
    a. Livestock
    b. Crops
    c. Both are equally common

9. Please choose the most common livestock (up to five) in your BR.
    a. Cattle and/or buffaloes
    b. Poultry birds (incl. chickens, ducks, pigeons, turkeys, geese, guinea fowls)
    c. Pigs
    d. Goats and/or sheep
    e. Rabbits and/or hares
    f. Rodents
    g. Bees
    h. Horses and/or asses and/or mules
    i. Camels and/or camelids
    j. Others, please state
    k. I don't know

10. Please choose the most common crops (up to five) in your BR.
    a. Wheat
    b. Maize
    c. Barley
    d. Rice
    e. Soybeans
    f. Rapeseed
    g. Sorghum
    h. Cotton
    i. Sugar cane
    j. Sugar beet
    k. Cassava
    l. Yams
    m. Potatoes
    n. Sweet potatoes
    o. Oil palms
    p. Bananas
    q. Plantains
    r. Others, please state
    s. I don't know

11. How has the agriculturally used land in the BR changed over the last 15 years?
    a. Strong decrease (ca. -30%)
    b. Clear decrease (ca. -20%)
    c. Small decrease (ca. -10%)
    d. No change
    e. Small increase (ca. +10%)
    f. Clear increase (ca. +20%)
    g. Strong increase (ca. +30%)
    h. I don't know

12. What are the reasons for this development? Several answers are possible.
    a. Intensification
    b. Extensification (Less intensive production)
    c. Immigration of farmers
    d. Emigration of farmers
    e. Stricter regulations and legislation
    f. Alternative income sources
    g. Others
    h. I don't know

13. Given the goals related to sustainable agricultural practices mentioned in the question in the beginning: Have you reached these goals in the field of agriculture in the last 15 years?
    a. Yes
    b. Only partially
    c. No
    d. I don't know

14. In your opinion, why didn't you (fully) reach the goals?

Conservation value:

15. Considering the value for conservation of the agriculturally used land (AUL) in your BR, what is the distribution of the respective areas? Please indicate the best estimate in percentages so that all values sum up to 100%.
    a. % of AUL are of high value (high biodiversity, many threatened species, important habitats of conservation concern)
    b. % of AUL are of low value (average biodiversity, some threatened species, a few important habitats of conservation concern)
    c. % of AUL are of no specific value (low biodiversity, no threatened species, little important habitats of conservation concern)
    d. I don't know

16. How has the value for conservation changed in the agricultural land in the last 15 years?
    a. Clear increase: areas of high conservation value have been restored, the conservation value of the other agricultural land has been improved
    b. Minor increase: areas of high conservation value have been partly restored, the conservation value of the other agricultural land has been maintained or improved
    c. Steady: the protected areas as well as the conservation value of the matrix has been maintained
    d. Minor decrease: areas of high conservation value have been partly lost, the conservation value of the other agricultural land has been maintained or decreased
    e. Clear decrease: areas of high conservation value have been lost, the conservation value of the other agriculturally used land has decreased
    f. I don't know

17. What information source do you base the answer of the previous two questions on? Several answers are possible.
    a. My personal expert guess
    b. Outcome of discussions with other members of the management team
    c. Information gathered in a research project
    d. Evidence from our monitoring
    e. Others, please state

Impact of park management on land use:

18. Are there any measures that influence agricultural land use practices and activities harming biodiversity?
    a. No
    b. Yes, measures are formulated
    c. Yes, measures are formulated and established
    d. Yes, measures are formulated, established and implemented
    e. Yes, measures are formulated, established, implemented and monitored

19. How are these measures implemented?
    a. The BR/NP management implements measures on the farmland itself.

b. The farmers implement measures on a voluntary basis.
c. The farmers implement measures based on financial incentives provided by the BR/NP.
d. The farmers are forced to implement the measures by law that was established by the BR/NP
e. Others, please state

20. How strongly is the implementation of these measures influenced by the political and legal framework conditions (e.g. national and regional agricultural policy)?
    a. Not influenced at all
    b. Only to a minor extent
    c. Strongly
    d. I don't know

21. How does the political and legal framework influence the implementation? *(This question is voluntary)*

22. Overall, what is the impact of the BR/NP management on land use changes in agriculturally used land?
    a. Very strong impact: agricultural land use is importantly and directly influenced by the BR/NP measures on a large scale
    b. Strong impact: agricultural land use is importantly and directly influenced by the BR/NP measures on a considerable scale
    c. Moderate impact: agricultural land use is importantly and directly influenced by the BR/NP measures in a small spatial extent
    d. Minor impact: BR/NP has only a minor impact on agricultural land use without a clear role of the BR/NP management
    e. No significant impact of the BR/NP management
    f. I don't know
    g. Unclear impact: the role of the BR management and its impact on agricultural land use cannot be clearly defined

23. What information source do you base the answer of the previous questions on? Several answers are possible.
    a. My personal expert guess
    b. Outcome of discussions with other members of the management team
    c. Information gathered in a research project
    d. Evidence from our monitoring
    e. Others, please state

One short last question:

24. Please rate how much you agree with the following statements. *(4 Point scale: yes, completely – rather yes – rather no – no, not at all; I don't know)*
    a. There is enough staff with suitable training and skills for our BR/NP
    b. The budget of our BR/NP is sufficient to execute our management plans
    c. The yearly budget for our BR/NP is safeguarded over the next 5 years

d. We develop our projects in a participative manner, involving stakeholders and affected persons (farmers, local people living in the area) in decision making processes
e. Corruption is an issue in our country
f. Our BR/NP is directly affected by corruption
g. Illegal land use activities are a topic in our BR/NP
h. Our BR/NP is involved in regional political decisions concerning land-use issues

25. Further comments

Annex B

Table A 1: Share of African, Asian and Pacific, European, Latin American and Caribbean and North American BRs which have chosen the given answers of the questions 5, 11, 16, 18 and 22.

			Africa [%]	Asia and the Pacific [%]	Europe [%]	Latin America and the Caribbean [%]	North America [%]
Question 5 Does your BR have goals in the field of sustainable agricultural practices?	Yes		88	75	86	69	67
	No		12	25	14	31	33
Question 11 How has the agriculturally used land in the BR changed in the last 15 years?	Total increase		100	25	19	77	17
	Total decrease		0	75	43	15	17
	Total no change		0	0	19	8	66
Question 16 How has the value for conservation changed in the agricultural land in the last 15 years?	Total increase		75	25	24	39	33
	Total decrease		13	25	33	31	17
	Total steady		12	25	29	23	17
Question 18 Are there any measures that influence agricultural land use practices and activities harming biodiversity?	Formulated		25	50	10	31	17
	Formulated, established		12	50	19	23	0
	Formulated, established, implemented		13	0	5	23	33
	Formulated, established, implemented, monitored		25	0	33	8	0
	No measures		25	0	19	15	17
Question 22 Overall, what is the impact of the BR management on land use changes in agriculturally used land?	Minor impact		12	25	43	15	33
	Moderate impact		50	0	19	39	33
	Strong impact		13	25	10	23	0
	Very strong impact		0	0	0	8	0
	No or unclear impact		25	50	19	8	17
Question 24 Please rate how much you agree with the following statements.	Enough staff	Yes	75	75	38	39	50
		No	25	25	57	53	50
	Sufficient budget	Yes	12	75	29	8	17
		No	88	25	52	77	83
	Safeguarded budget	Yes	12	75	43	30	0
		No	88	25	33	62	100
	Participation in decision-making processes	Yes	100	75	86	77	83
		No	0	25	10	15	17
	Corruption country	Yes	88	0	19	77	0
		No	12	100	62	23	100
	Corruption BR	Yes	25	0	0	39	0
		No	75	100	81	46	100
	Illegal land use activities	Yes	75	50	14	46	17
		No	25	50	81	46	83
	Involvement in political decisions	Yes	63	50	52	69	33
		No	37	50	43	31	67

Table A 2: Share of BRs before and after the adoption of the Seville Strategy which have chosen the given answers of the questions 5, 11, 16, 18 and 22.

		Before Seville Strategy [%]	After Seville Strategy [%]
Question 5 Does your BR have goals in the field of sustainable agricultural practices?	Yes	83	75
	No	17	25
Question 11 How has the agriculturally used land in the BR changed over the last 15 years?	Total increase	42	50
	Total decrease	25	32
	Total no change	25	14
Question 16 How has the value for conservation changed in the agricultural land in the last 15 years?	Total increase	42	32
	Total decrease	17	39
	Total steady	17	25
Question 18 Are there any measures that influence agricultural land use practices and activities harming biodiversity?	Formulated	13	21
	Formulated, established	13	25
	Formulated, established, implemented	17	14
	Formulated, established, implemented, monitored	21	14
	No measures	21	21
Question 22 Overall, what is the impact of the BR management on land use changes in agriculturally used land?	Minor impact	17	36
	Moderate impact	42	18
	Strong impact	17	11
	Very strong impact	4	0
	No or unclear impact	0	32

Table A 3: Bivariate correlations with Spearman correlation coefficient between questions 13, 18, 20 and 22. Significance level with Bonferroni correction is 0.02.

			Achievement of goals (Q13)	Influence of the political and legal framework (Q20)	Overall impact of the management (Q22)	Presence of measures (Q18)
Spearman's rho	Achievement of goals (Q13)	Correlation Coefficient	1.000	.432	.445**	.113
		Sig. (2- tailed)	.	.108	.003	.478
		N	42	15	42	42
	Influence of the political and legal framework (Q20)	Correlation Coefficient	.432	1.000	.051	.246
		Sig. (2- tailed)	.108	.	.840	.326
		N	15	18	18	18
	Overall impact of the management (Q22)	Correlation Coefficient	.445**	.051	1.000	-.002
		Sig. (2- tailed)	.003	.840	.	.989
		N	42	18	52	52
	Presence of measures (Q18)	Correlation Coefficient	.113	.246	-.002	1.000
		Sig. (2- tailed)	.478	.326	.989	.
		N	42	18	52	52

**. Correlation is significant at the 0.01 level (2-tailed)

References

Ahnström, J., Höckert, J., Bergeå, H. L., Francis, C. A., Skelton, P. & Hallgren, L. (2009). Farmers and nature conservation: What is known about attitudes, context factors and actions affecting conservation? *Renewable Agriculture and Food Systems* 24(01): 38-47.

Alexandratos, N. & Bruinsma, J. (2012). World agriculture towards 2030/2050: the 2012 revision. ESA Working Paper Rome, FAO.

Baur, P., Müller, P. & Herzog, F. (2007). Alpweiden im Wandel. *Agrarforschung* 14(6): 254-259.

Beranger, C. (2017). Sustainable Agriculture: Extensive Systems and Extensification. http://www.infrc.or.jp/english/KNF_Data_Base_Web/4th_Conf_S_3_5.html (access date: 08/08/2017): International Nature Farming Research Center.

Bruinsma, J. (2003). World agriculture: towards 2015/2030: an FAO perspective. Earthscan, London.

Carr, D. L. (2008). Farm households and land use in a core conservation zone of the Maya Biosphere Reserve, Guatemala. *Human Ecology* 36: 231-248.

Cohen, J. (1992). Statistical power analysis. *Current Directions in Psychological Science* 1(3): 98-101.

Cuong, C. V., Dart, P., Dudley, N. & Hockings, M. (2017a). Factors influencing successful implementation of Biosphere Reserves in Vietnam: Challenges, opportunities and lessons learnt. *Environmental Science & Policy* 67: 16-26.

Cuong, C. V., Dart, P. & Hockings, M. (2017b). Biosphere reserves: Attributes for success. *Journal of Environmental Management* 188: 9-17.

FAO (2004). The ethics of sustainable agricultural intensification. *FAO Ethics Series* 3. Food and Agriculture Organization of the United Nations, Rome.

FAO (2011). The state of the world's land and water resources for food and agriculture (SOLAW) - Managing systems at risk. Food and Agriculture Organization of the United Nations, Rome and Earthscan, London.

FAO (2013). FAO Statistical Yearbook - World Food and Agriculture. Food and Agriculture Organization of the United Nations, Rome.

FAOSTAT (2017).http://www.fao.org/faostat/en/#data (access date: 04/04/2017).

Ferraro, P. J. & Pressey, R. L. (2015). Measuring the difference made by conservation initiatives: protected areas and their environmental and social impacts. *Philosophical Transactions of the Royal Society B* 370: 1-5.

Figueroa, F. & Sánchez-Cordero, V. (2008). Effectiveness of natural protected areas to prevent land use and land cover change in Mexico. *Biodiversity and Conservation* 17(13): 3223-3240.

Gerritsen, P. (1998). Community development, natural resource management and biodiversity conservation in the Sierra de Manantlan biosphere reserve, Mexico. *Community Development Journal* 33(4): 314-324.

Henle, K., Alard, D., Clitherow, J., Cobb, P., Firbank, L., Kull, T., McCracken, D., Moritz, R. F., Niemelä, J. & Rebane, M. (2008). Identifying and managing the conflicts between agriculture and biodiversity conservation in Europe – A review. *Agriculture, Ecosystems & Environment* 124(1): 60-71.

Juffe-Bignoli, D., Burgess, N., Bingham, H., Belle, E., De Lima, M., Deguignet, M., Bertzky, B., Milam, A., Martinez-Lopez, J., Lewis, E., Eassom, A., Wicander S., Geldmann, J., van Soesbergen, A., Arnell, A. P., O'Connor, B., Park, S., Shi, Y. N., Danks, F. S., MacSharry, B., Kingston, N. (2014). Protected Planet Report 2014 – Tracking progress towards global targets for protected areas. UNEP-WCMC: Cambridge, UK.

Knaus, F., Bonnelame, L. K. & Siegrist, D. (2017). The Economic Impact of Labeled Regional Products: The Experience of the UNESCO Biosphere Reserve Entlebuch. *Mountain Research and Development* 37(1): 121-130.

Louette, D., Charrier, A. & Berthaud, J. (1997). In situ conservation of maize in Mexico: genetic diversity and maize seed management in a traditional community. *Economic Botany* 51(1): 20-38.

Marshall, E. & Newton, A. C. (2003). Non-timber forest products in the community of El Terrero, Sierra de Manantlán Biosphere Reserve, Mexico: Is their use sustainable? *Economic Botany* 57(2): 262-278.

Nautiyal, S., Maikhuri, R., Rao, K., Semwal, R. & Saxena, K. (2002). Agroecosystem function around a Himalayan biosphere reserve. *Journal of Environmental Systems* 29(1): 71-100.

Norris, K. (2008). Agriculture and biodiversity conservation: opportunity knocks. *Conservation Letters* 1(1): 2-11.

Ohnesorge, B., Plieninger, T. & Hostert, P. (2013). Management Effectiveness and Land Cover Change in Dynamic Cultural Landscapes — Assessing a Central European Biosphere Reserve. *Ecology and Society* 18(4): 23.

Oldfield, M. L. & Alcorn, J. B. (1987). Conservation of traditional agroecosystems. *BioScience* 37(3): 199-208.

Ostermann, O. P. (1998). The need for management of nature conservation sites designated under Natura 2000. *Journal of Applied Ecology* 35(6): 968-973.

Price, M. F. (2017). The re-territorialisation of Biosphere Reserves: The case of Wester Ross, Northwest Scotland. *Environmental Science & Policy* 72: 30-40.

Rao, K., Maikhuri, R., Nautiyal, S. & Saxena, K. G. (2002). Crop damage and livestock depredation by wildlife: a case study from Nanda Devi Biosphere Reserve, India. *Journal of Environmental Management* 66(3): 317-327.

Salafsky, N., Salzer, D., Stattersfield, A. J., Hilton-Taylor, C., Neugarten, R., Butchart, S. H., Collen, B., Cox, N., Master, L. L. & O'Connor, S. (2008). A standard lexicon for biodiversity conservation: unified classifications of threats and actions. *Conservation Biology* 22(4): 897-911.

Schley, L. & Leytem, M. (2004). Extensive Beweidung mit Rindern im Naturschutz: eine kurze Literaturauswertung hinsichtlich der Einflüsse auf die Biodiversität. *Bulletin de Société des Naturalistes Luxembourgeois* 105: 65-85.

Schmitzberger, I., Wrbka, T., Steurer, B., Aschenbrenner, G., Peterseil, J. & Zechmeister, H. (2005). How farming styles influence biodiversity maintenance in Austrian agricultural landscapes. *Agriculture, Ecosystems & Environment* 108(3): 274-290.

Schultz, L., Duit, A. & Folke, C. (2011). Participation, adaptive co-management, and management performance in the world network of biosphere reserves. *World Development* 39(4): 662-671.

Stoll-Kleemann, S. (2007). UNESCO-Biosphärenreservate: Modellregionen von Weltrang. Faktoren eines erfolgreichen Managements von Biosphärenreservaten. UNESCO heute, 38-40.

Stoll-Kleemann, S. (2010). Evaluation of management effectiveness in protected areas: methodologies and results. *Basic and Applied Ecology* 11(5): 377-382.

Stoll-Kleemann, S., Bender, S., Berghöfer, A., Bertzky, M., Fritz-Vietta, N., Schliep, R. & Thierfelder, B. (2006). Linking Governance and Management Perspectives with Conservation Success in Protected Areas and Biosphere Reserves. *Perspectives on Biodiversity Governance and Management* 01, Berlin.

Stoll-Kleemann, S., de la Vega-Leinert, A. C. & Schultz, L. (2010). The role of community participation in the effectiveness of UNESCO Biosphere Reserve management: evidence and reflections from two parallel global surveys. *Environmental Conservation* 37(03): 227-238.

Stoll-Kleemann, S. & O'Riordan, T. (2017). The Challenges of the Anthropocene for Biosphere Reserves. *Parks* 23(1): 89-100.

Stoll-Kleemann, S. & Welp, M. (2008). Participatory and integrated management of biosphere reserves: Lessons from case studies and a global survey. *GAIA-Ecological Perspectives for Science and Society* 17(1): 161-168.

UNESCO (1996). Biosphere Reserves: The Seville Strategy and the Statutory Framework of the World Network. UNESCO, Paris.

UNESCO & MAB (2015). MAB Strategy 2015-2025.

UNESCO & MAB (2016). Lima Action Plan. UNESCO's Man and the Biosphere (MAB) Programme and its World Network of Biosphere Reserves (2016-2025).

Walker, R. T. & Solecki, W. D. (1999). Managing Land Use and Land-Cover Change: The New Jersey Pinelands Biosphere Reserve. *Annals of the Association of American Geographers* 89(2): 220-237.

Watson, J. E., Dudley, N., Segan, D. B. & Hockings, M. (2014). The performance and potential of protected areas. *Nature* 515(7525): 67-73.

Worldbank (2017).http://data.worldbank.org/indicator/AG.LND.AGRI.ZS (access date: 13/04/2017).