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Comparison of Denali Biosphere Reserve and Sierra Nevada Biosphere Reserve

MODULE: UNESCO BIOSPHERE RESERVES COURSE

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Inhalt

Abstract

Comparing two Biosphere Reserves, which are both national parks as well, offers the possibility to study two different approaches of how to connect people with nature(“Denali National Park and Preserve Education Plan” 2017). Choosing Denali National Park and Biosphere Reserve as one of the oldest and most pristine national parks in the USA on the one hand, and Sierra Nevada Biosphere Reserve and National Park in Spain, on the other hand, has come up as good examples. Reasons are the prominence of both parks in terms of annual visitors and its mountainous character but also their rather difficult accessibility and their role as a research subject for climate change effects. While these similarities exist, other facts separate both reserves, for example, the cultural heritage, its location and the outlay of the reserve’s zoning. Understanding of how these factors interact with each other, offers possibilities for analyzing the underlying factors that contribute to the role of a biosphere reserve.

1. Description of Biosphere Reserves

1.1. Denali National Park and Biosphere Reserve

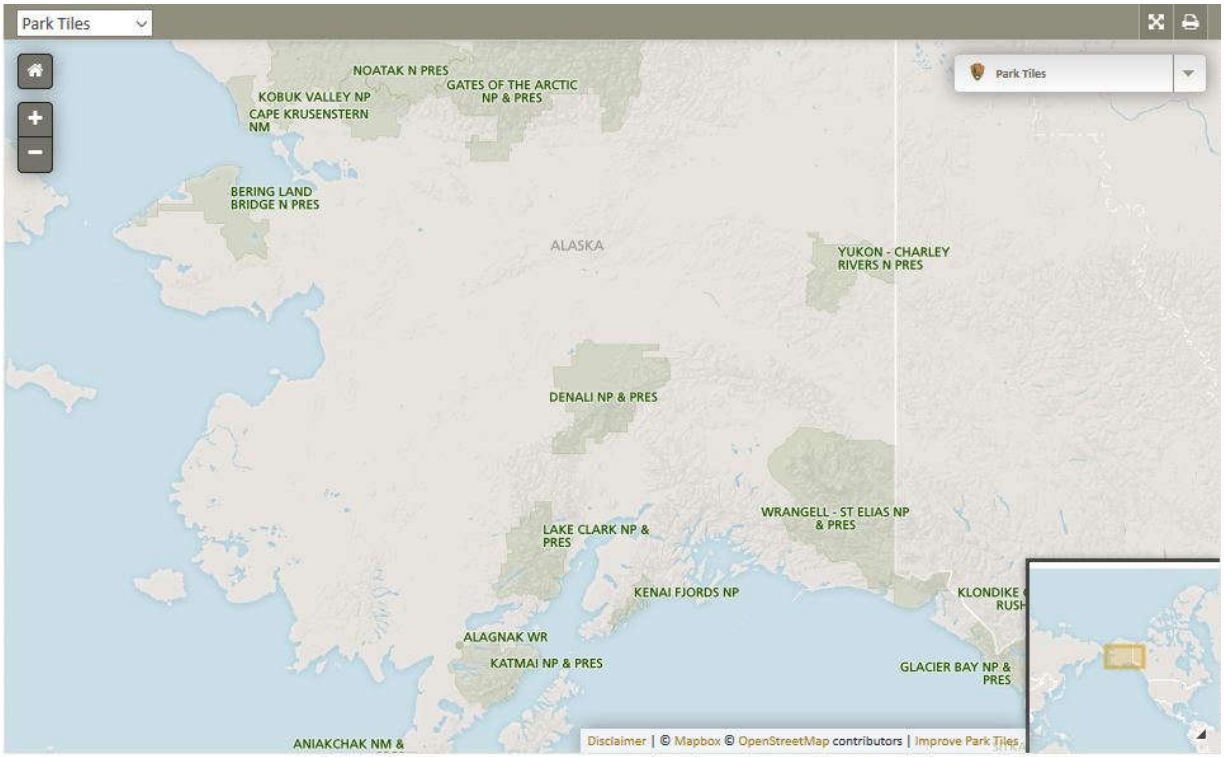

Image 1-Denali National Park and Biosphere Reserve. No Zonation exists

Denali National Park was founded as the 13th US national park in 1917 ("List of National Parks of the United States" 2017) to protect the natural beauty and wildlife in this remote part of Alaska. It surrounds the highest mountain of the North American continent, Denali (till 2015 Mt. McKinley) ("Denali or Mount McKinley? - Denali National Park & Preserve (U.S. National Park Service)" 2017) whose height is 20,310 feet (6190m). The National Park and Preserve today are formed by the core area of the national park with a size of 19,185.79 km("Denali | United Nations Educational, Scientific and Cultural Organization" 2017) and the adjusting area of the preserve with a size of 5,278.08 km ("Denali | United Nations Educational, Scientific and Cultural Organization" 2017). The National Park and Preserve was introduced as a UNESCO Biosphere Reserve in 1976 ("Denali | United Nations Educational, Scientific and Cultural Organization" 2017). No buffer- or transition zones were established leading to the effect that the national park is basically the biosphere reserve ("UNESCO's Man and the Biosphere Program: What Are Biosphere Reserves All about? | The George Wright Society :: Parks, Protected Areas, Cultural Sites" 2017). The name Denali is derived from the Athabascan language of the native inhabitants of Alaska, meaning "The Tall One" ("Denali or Mount McKinley? - Denali National Park & Preserve (U.S. National Park Service)" 2017). The national park itself stretches north and south of the Alaska Range which functions as a climate dividing

range, separating the warmer and more humid area south of the range from the even colder and drier area north of it, that is mostly covered by permafrost soils (MOLNIA, n.d.). While the south receives huge loads of snow the north with its permafrost soils is covered in ice during the winter months and lakes and bogs when the ice melts but the cannot drain into the soils. Being a land of snow and ice, glaciers cover over 17 percent (4047km²) ("Melting Denali: Effects of Climate Change on Glaciers (U.S. National Park Service)" 2017) of the area of the Denali Biosphere Reserve. The largest glacier, "Kahiltna" stretches for more than 71km in length("Glaciers - Denali National Park & Preserve (U.S. National Park Service)" 2017). Yet, climate change threatens the permafrost covered areas as well as the glaciers. While a temperature rise of one to two degrees might lead to a thawing of the permafrost areas("Permafrost Landscapes (U.S. National Park Service)" 2017), the size of the glaciers has been reduced by 8 percent between 1950 and 2010 ("Glacier Monitoring in Denali (U.S. National Park Service)" 2017). Monitoring these effects of climate change is one of the most important research topics currently featured in the Biosphere Reserve. Denali's pristine and unique landscape, fauna and flora is one of the most important focal points for the Alaskan tourism industry. In 2011 about 1.6 Million visitors came to Alaska of whom Denali alone received more than 400.000("Economics of Wilderness: Contribution of Alaska Parks and Wilderness to the Alaska Economy (U.S. National Park Service)" 2017). 91 percent of these visitors came only to see Alaska's wilderness and wildlife ("Economics of Wilderness: Contribution of Alaska Parks and Wilderness to the Alaska Economy (U.S. National Park Service)" 2017). The numbers of visitors to Denali have since then risen sharply to nearly 600.000 visitors annually ("Park Statistics - Denali National Park & Preserve (U.S. National Park Service)" 2017) and the National Park remains on position four among all NPs for visitor spending in the USA ("Visitor Spending Effects - Social Science (U.S. National Park Service)" 2017). The economic importance of the tourism industry in Denali is therefore very strong and an essential factor in the supply of labor in the region. Yet, what is good for the economy is not necessarily good for nature as well. These numbers show the ambivalent nature that creates pressure on the biosphere reserve. On the one hand showing visitors the park creates a deeper and more mutual understanding of nature and the effects of climate change, while on the other hand the required logistics and infrastructure to channel these visitors creates strong forces that can hurt nature in its vicinity.

1.2. Sierra Nevada Parque Nacional and Parque Natural and Biosphere Reserve

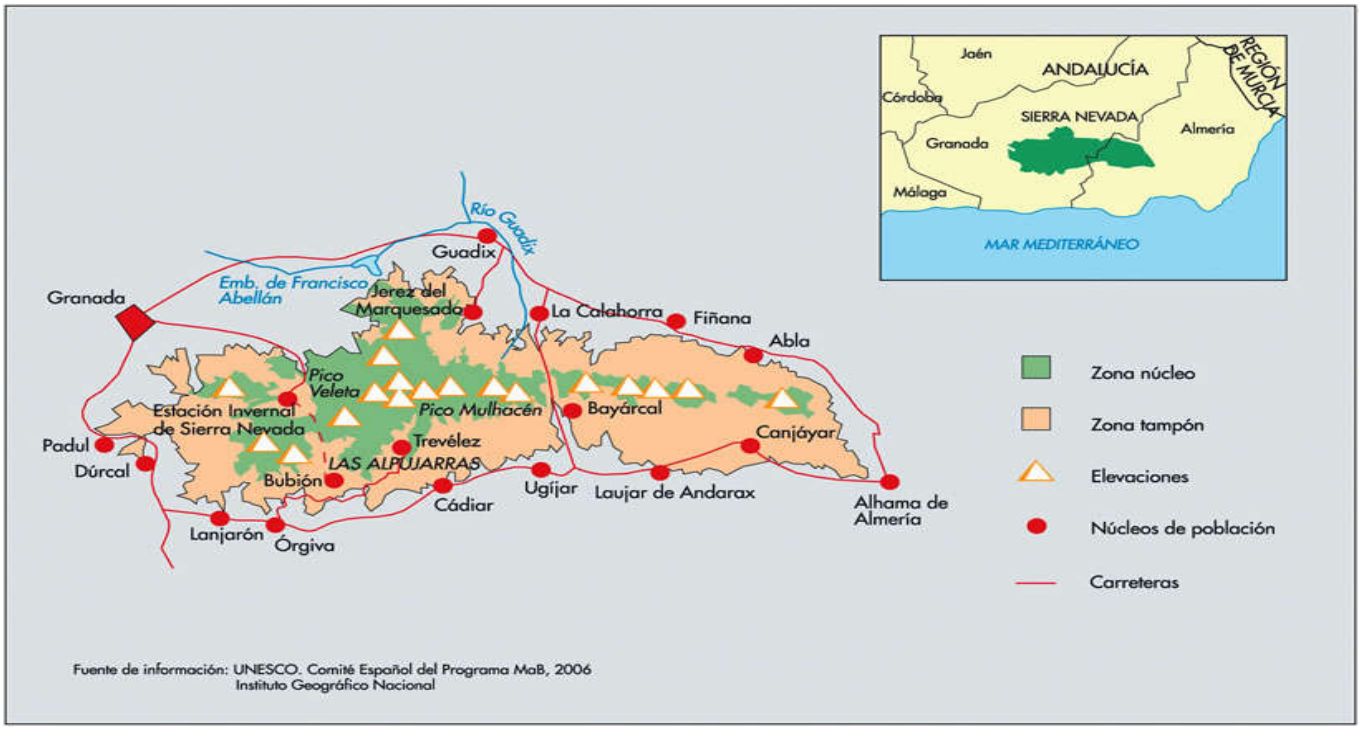

Image 2- Map of the Sierra Nevada Biosphere Reserve including core and buffer zone

The Sierra Nevada Biosphere Reserve was founded in 1986, three years before the Natural Park was established. The National Park was declared ten years later in 1999. The surface area of the biosphere reserve is 173,110.80 ha or 1731 km(“Sierra Nevada | United Nations Educational, Scientific and Cultural Organization” 2017). The core of the biosphere reserve is the national park with a size of 85.883 ha, making it the largest national park in Spain. The buffer zone has a size of about 70.738 ha, mostly consisting of the natural park and a transition zone of about 16.489 ha. Within the biosphere reserve exist 60 villages that belong to the provinces of Granada and Almeria with about 96.000 inhabitants (“CARPETA INFORMATIVA Enero 2017 PARQUE NACIONAL, PARQUE NATURAL Y RESERVA DE LA BIOSFERA DE SIERRA NEVAD” 2017). The settlement history of the area dates back to Pre-Roman times and was called Baetica during the Roman era. Later it was settled by Moorish (Muslim) people. The name Sierra Nevada has been derived from the old Moorish name Yabal-al-Tay (in Spanish “monte de la Nieve”, Mountain of snow) and Monte Helada (Mountain of Ice), while “sierra” can be translated as “mountain chain”. It was known as Sulayr or “Sun Mountain” during the Moorish times (“Naturaleza de La Alpujarra” 2017). The importance of the Sierra Nevada lies in the biodiversity and its richness in endemic species (“Assessment Report on Sierra Nevada Biosphere Reserve” 2009). During the last ice age plants species retreated southwards to escape the glaciation but were trapped when the temperature rose fast after the end of the glaciation process (Domínguez-Villar et al. 2013). Together with the different climate stages that can be found in

the Sierra Nevada this is the reason for the huge number of endemic plant and beetle (coleopteran) species ("Sierra Nevada, Parque Nacional, Parque Natural, En Waste Magazine" 2017). While in the lowest levels of the Sierra Nevada the climate is Mediterranean, it is alpine in the high altitudes, where the highest mountains on the Iberian Peninsula, Mulhacen with 3479 m (11,414 feet) and Veleta with 3396 m (11,141 feet) can be found ("The Sierra Nevada National Park | Andalucia.com" 2017a). Due to its huge and, compared with other areas of Southern Europe, consistent snowfall, the Sierra Nevada is the most important skiing area on the Iberian Peninsula, holding events like the 2017 freestyle world cup or the 1996 Alpine world cup("Sierra Nevada 2017 Will Generate €16.1 Million and 1,500 New Jobs | Sierra Nevada 2017" 2017). It also appears continually as a stage of the Vuelta ("The Climbs of the Sierra Nevada" 2017). Yet, the most drastic effect on the environment is created through agriculture, especially grazing by goats and sheep ("Assessment Report on Sierra Nevada Biosphere Reserve" 2009). Bringing together economic, social, touristic and environmental aspects in a stable way seems to be even more difficult in the case of the Sierra Nevada than for Denali due to the aforementioned factors.

2. Aim of Research

To find solutions that might enable a stable basis for tourism, research, the effects of climate change and environmental protection seems to be the key issue for most, if not all, biosphere reserves in the world. Biosphere reserves in mountain areas face unique threats that are different from those of other reserves. They are often destinations for tourists but are also used in a not sustainable way. At the same time, they face the wrath of global warming on a much more direct scale than other reserves as melting glaciers, reduced snow fall and the vanishing of their unique fauna and flora drastically change their landscape and durability ("Taking the Temperature of Mountains" 2006). To understand the impacts of climate change on Mountain Biosphere Reserves (MBR), both, the Denali Biosphere Reserve and the Sierra Nevada Biosphere Reserve, participated in the UNESCO "Global Change in Mountain Regions (GLOCHAMORE)" study in 2005("Glochamore | United Nations Educational, Scientific and Cultural Organization" 2017). While the Sierra Nevada Biosphere Reserve did participate in the follow up study "Global and Climate Change in Mountain Sites (GLOCHAMOST)", Denali Biosphere Reserve did not("Glochamost | United Nations Educational, Scientific and Cultural Organization" 2017). The way the reserves deals with the effects of climate change and its impacts shall be a part of this paper, while the effect of how the reserves deal with the onslaught of huge droves of tourists and the issues between economic usage and environmental protection shall be another. The underlying question is therefore if a Nash Equilibrium is possible in questions of environmental issues that clash in a seemingly non- cooperative way with the human desires for economical exploration, in these cases tourism and, for the Sierra Nevada, agriculture. In a Nash Equilibrium both players know the full scale of strategies that the other players are using and no player can gain a further advantage if he only chooses to change its own strategy (Osborne and Rubinstein

1994). For environmental questions this would mean that all players agree on a sustainable outcome that puts natures interest in the center. By doing so all players would contribute to their own long term survival as they are dependent on a functional environment for fulfilling their interests. The chosen players in this game can be local policy makers, indigenous people, economical stakeholders such as enterprises working in either tourism and/ or agriculture and the UNESCO as the agent for environmental protection on a global level. While the players might act out of their own interest, a mutual deal might be in their best interest as climate change and environmental degradation poses a threat that cannot be easily calculated and forecasted for any of the players involved.

3. Importance of Mountain Biosphere Reserves

Mountain biosphere reserve are among the most important ecosystems on the planet and, like in the case of the Sierra Nevada, often function as last retreats for ice age relict plant species. Trapped in their retreat these species nowadays can only be found in certain mountain areas, isolated from plants from the same family due to geographical reasons. In the Sierra Nevada 64 endemic species of vascular plants can be found making it a hotspot of biodiversity in the Iberian region("Sierra Nevada | United Nations Educational, Scientific and Cultural Organization" 2017). But even more critical for human activities is the role that MBR play for the supply of fresh water. A significant number of major streams in the world originate from mountain ranges like the Himalaya (i.e. Ganga River), the Rocky Mountains (i.e. Colorado River) or lower mountain ranges like the black forest (i.e. Danube). Climate changes that affect mountain ranges could drastically alter the water supply in a wide area ("Taking the Temperature of Mountains" 2006). A similar effect can be observed in the Region of Andalusia in Spain. The Sierra Nevada forms the northern political border of this region of Spain and has an important role in the water supply of the whole region("Assessment Report on Sierra Nevada Biosphere Reserve" 2009). Research predicts reduced rainfall, increased temperature and possibly a shorter duration of snow cover till 2040, leading to changes in the water supply of Andalusia("Assessment Report on Sierra Nevada Biosphere Reserve" 2009). Since agricultural products are the region's most important source("Sierra Nevada: Usos Compatibles - Conservación Y Biodiversidad - Sierra Nevada - Nuestros Parques - Red de Parques Nacionales - Biodiversidad - Mapama.es" 2017) of financial income a change in water supply could alter the living conditions in this region. The importance of the Denali region on the other hand lies not in its importance for the water supply of a whole region. The part of Alaska in which it can be found is only sparsely populated and is highly rural.("Population Estimates, July 1, 2015, (V2015)" 2017) Yet, a unique and pristine landscape is the focal point for the local tourism industry to which visitors' flock in huge numbers. One of the most spectacular sights are huge glaciers. Of these glaciers, the Traleika Glacier in the north and the Kahiltna Glacier in the south have been monitored since 1954("Glaciers - Denali National Park & Preserve (U.S. National Park Service)" 2017). During this time frame, it was observed that the glaciers in the Denali region

shrank by 8 percent on average till 2010 while the thinning of the ice shield accelerated between 2008 and 2010 to 2m/ year from 1.5m/ year in the years from 2001 to 2008. The most significant reduction in the size of glaciers was observed in medium-sized glaciers in mid-elevation levels of 1400 to 1800 m("Glacier Monitoring in Denali (U.S. National Park Service)" 2017). But glacier thinning and shrinking is only factor of climate change that has been observed in the Denali Biosphere Reserve. Monitoring of the permafrost cover from 1985 shows that the discontinuous permafrost layers in the reserve are within 1°C of melting. A strong increase of the soil temperature had been observed in the 1990s, while from 1997 to 2001 a biosphere relief due to lower snow pack occurred("Natural Resources for Denali National Park & Preserve" 2017). Since then the temperatures of the soil have risen again while thawing of the permafrost continues. A change in water supply has been most drastically been observed in the shrinking of some of the Eolian Lowlands lakes. So far, no obvious single reason could be pointed out but explanations range from a change in the timing and duration of snow melt, annual rates of precipitation to permafrost degradation. A change in water chemistry (elevated nitrogen and phosphorus levels) that had been observed in about 10 percent of the lakes could also be linked to permafrost degradation. Local fauna and flora has so far been mostly undisturbed on large scale levels by these effects of climate change but it seems that aspen trees start to green-up earlier in recent years("Natural Resources for Denali National Park & Preserve" 2017). However, an increase of temperature might further impair shrub, forest and tundra plant communities. It has been further stated the length of the fire season in the lowlands has increased to 145 days since 2008 from a range from 99 to 142 days for the years before. As these effects seem to be minor and can only be observed on a long-term basis it is most likely that tourists might not grasp these changes unless being educated by before and after pictures or information boards.

4. Economic Situation

The area of the Sierra Nevada, especially on its southern slopes, was traditionally used for agriculture, grazing and forestry ("Sierra Nevada: Usos Compatibles - Conservación Y Biodiversidad - Sierra Nevada - Nuestros Parques - Red de Parques Nacionales - Biodiversidad - Mapama.es" 2017). These usages formed a unique landscape marked by changing patterns of forests, irrigated and terraced fields as well as pastures("Agricultura – Alpujarra de La Sierra" 2017). The combination of these factors managed to control soil erosion and was able to support the local population with water in an area that is highly dependent on the water from melting snow on the tops of the mountains("Assessment Report on Sierra Nevada Biosphere Reserve" 2009). However, the diversity and roughness of the landscape prohibited wide scale agricultural enterprises. As not much wealth and only a limited number of jobs could be generated by these methods the region began to depopulate since the 1950s (Jimenez Olivencia, Porcel Rodríguez, and Caballero Calvo 2015). Beside of agriculture, mining had been the only large scale method of employment in this region. Today at Alquife in the Alpujarras the largest iron mine in Europe is still operating, while copper and silver mining has mostly ceased

to exist (“The Sierra Nevada National Park | Andalucia.com” 2017b). Since the 1960s the introduction of winter sports marked the beginning of wide scale tourism in the Sierra Nevada, which now hosts a number of ski resorts in an area of about 2500 ha. Important skiing events have been held here(“Sierra Nevada 2017 Will Generate €16.1 Million and 1,500 New Jobs | Sierra Nevada 2017” 2017) and with tourism booming in Andalusia, the Sierra Nevada receives a huge share of these visitors (Chaplow 2017). The foundation of the National Park in 1999 changed the social sphere in the Sierra Nevada due to the fact that the area of the Sierra Nevada received highest environmental protection status. With the new status came a governmental promoted plan to increase eco-tourism such as hiking and a limitation for rural activities like farming. While these ideas might not be bad in nature, implementation has mostly been done, without consultation of the local inhabitants leading to a situation in which the tourism industry seems to be now mostly detached from rural development. This resulted in issues in the promotion of local rural products such as the jamón serrano or fruits and almonds(Jimenez Olivencia, Porcel Rodríguez, and Caballero Calvo 2015), grown in this area for centuries. Tourism also plays a huge role in the economic landscape of Alaska(“Economics of Wilderness: Contribution of Alaska Parks and Wilderness to the Alaska Economy (U.S. National Park Service)” 2017). Most tourism in Denali Biosphere Reserve takes place in the summer months while winter outdoor activities are somewhat limited due to the closure of the main road and long arctic nights. Till 2016 the numbers of visitors to Denali has increased to close to 600.000 visitors(“Park Statistics - Denali National Park & Preserve (U.S. National Park Service)” 2017), which is about a sixth, of the 2.6 million visitors, that come to Alaska annually. The tourism industry provides about 39.000 jobs in Alaska while the visitors spent about two billion dollars annually in the state(“National Park Visitors Inject Billions into the US Economy” 2015). The percentage of tourism on the whole labor income in the southcentral region where the Denali National Park and Biosphere Reserve can be found was about 3 percent. Yet, a closer look at the data reveals the true economic importance of Denali, especially for the surrounding boroughs. About 7300 jobs are connected to the park while the job numbers increase drastically during the busy summer season. Visitor spending in the local gateway regions reached a new high in 2015 with about 567 Million Dollars for a total economic output of about 810.3 Million Dollars. These numbers place Denali on position 4 of all National Parks in the US in terms of spending and economic output(“National Park Visitors Inject Billions into the US Economy” 2015). Activities in the Park mostly center around its abundant wildlife and scenery with hiking, camping, biking and taking photos to be among the most popular. Winter activities include cross-skiing and watching of the Aurora Borealis. Dog sled activities are promoted and offered by privately owned sled dog kennels.

5. Politics, Reserve Management and Inclusion of Indigenous Interests

The Sierra Nevada Biosphere Reserve, as well as the Denali Biosphere Reserve, are both members of the UNESCO EuroMAB network. The Sierra Nevada Biosphere Reserve is also a

member of the IberoMAB network. Both Biosphere Reserves participated in the GLOCHAMORE(“Glochamore | United Nations Educational, Scientific and Cultural Organization” 2017) project but only the Sierra Nevada Biosphere Reserve participated in the follow-up project GLOCHAMOST (“Glochamost | United Nations Educational, Scientific and Cultural Organization” 2017). A further similarity in the structure of the biosphere reserves can be found in the fact that both are national parks as well as biosphere reserves while only the Sierra Nevada possesses buffer- and transition zones. However, as can be seen in chapter 1, the history of why and when both reserves where established as national parks differs distinctively. The Sierra Nevada Biosphere Reserve is currently run by the ministry of environmental affairs of the regional government of the autonomous community of Andalusia in Spain(“NATURA 2000 - Standard Data Form ES6140004 Sierra Nevada” 2016). The 60 municipalities that exist inside of the biosphere reserve belong to the provinces of Almería and Granada which creates some issues regarding environmental and economical questions (see chapter 3). No indigenous population can be found in the area of the biosphere reserve as history has stirred up the population homogeneity in this region regularly. Yet, a long standing traditional population, that mostly lived from agricultural products, can be traced back to Moorish times, especially in the Alpujarras Region. As can be seen in chapters 1 and 3 this population has dwindled since the mid-20th century due to the isolation of the region and limited economic possibilities. Tourism and the foundation of the park brought new possibilities for living. But so far, a harmonious and collaborative development has not taken place, leaving room for improvement. The Denali National Park and Biosphere Reserve is in the Southcentral Region of Alaska. Due to the fact of it being a national park it is supervised by the US ministry of the interior and managed by the National Park Service (NPS). The purpose, function and aims of the park regarding education, research, environmental and economic affairs as well as road and visitor management have been laid out in a portfolio of management plans (“Management - Denali National Park & Preserve (U.S. National Park Service)” 2017). The main aims of the park are education and protection. The park states that: “…education is both a means to achieving the wilderness resource protection goals of the park and a means of providing, through enjoyment and inspiration, opportunities for experience and growth that benefit the individual and society irrespective of benefits to specific parks.”(“Denali National Park and Preserve Education Plan” 2017) The NPS developed a new educational strategy that includes usage of modern educational facilities such as distant learning and teacher-student programs and hopes to engage visitors by making enduring connections to “America’s Special Places”. Denali National Park and Biosphere Reserve is strongly integrated into these programs and has developed its own and unique research aims to study scientific question like climate change, melting of glaciers and human and wildlife interactions. The MISSION STATEMENT for Denali National Park and Preserve states that: “We protect intact, the globally significant Denali ecosystems, including their cultural, aesthetic, and wilderness values, and ensure opportunities for inspiration, education, research, recreation, and subsistence for this and future generations.”

("FoundationDoc_Denali_2014_corrected_final.pdf" 2017) This statement includes that the native population of this region, the Athabaskan people, have a right to participate in the management of the park in questions that might influence their traditional ways of living. To achieve this, the Denali's National Park Subsistence Resource Commission has been founded. It is made up by native and non-native subsistence users and advises in questions of subsistence hunting in the park area. These recommendations are then directly conveyed to the Secretary of the Interior and the Governor [of Alaska]("The Role of the Subsistence Resource Commission - Denali National Park & Preserve (U.S. National Park Service)" 2017). The first periodic review process by the UNESCO for the Sierra Nevada was in 2006 and for Denali in 2014 ("Biosphere Reserves Which Have Provided Periodic Review Reports Examined by the MAB ICC as June 2014" 2017).

6. Marketing and Infrastructure

The Sierra Nevada can be reached via two main roads by car or bus. The A-44 connects Granada in the north with the coast on the south and bypasses the mountain range. From either direction, visitors then must take smaller roads to reach the reserve or the ski resorts. The alternative road bypasses the Sierra Nevada in the north and the north east, connecting Granada with the coastal town of Almeria. Visitors from outside the country usually arrive in Malaga or Sevilla by plane. Marketing for the Sierra Nevada focusses mostly on the outdoor activities with no good central website that would channel information about the reserve and its attractions. While a few private websites exist, most sites that provide information for tourists are connected to the government of Andalusia and the tourism board of Andalusia. Scientific information can be either obtained through the UNESCO website or the website of Spanish National Parks, mapama.gob.es.[a]

Denali National Park and Biosphere Reserve can be found 240 miles north of Anchorage and 120 miles south of Fairbanks in Alaska. It can be reached by using the Alaska Highway 3 or the train that connects Fairbanks with Anchorage. Inside the park there is only one road, but most traffic is channeled through the usage of shuttle busses. Most visitors today reach Alaska by plane (47 percent) or cruise ships (48 percent). The website of the Denali National Park is run by the NPS[b] and provides extensive information about all kinds of topics that are central to visitors but also scientists. It offers information regarding tourism, nature, the environment, research, education, history and the park economy as well as management goals. Further information can be obtained by private sites or sites that are connected to the Alaskan government.

[a] (http://www.mapama.gob.es/fr/red-parques-nacionales/nuestros-parques/sierra-nevada/#)
[b] (https://www.nps.gov/dena/index.htm)

7. Flora and Fauna

A geographical and geological comparison between both biosphere reserves shows similarities and differences. In both cases a mountain range with different climatic levels has been the subject of analysis. Sierra Nevada lies in the south of the Iberian Peninsula in an area influenced by a warm, continental Mediterranean climate ("Sierra Nevada | United Nations Educational, Scientific and Cultural Organization" 2017) in its lower slopes and a harsher, alpine climate with tree free zones in its higher levels that reach up to 3400m. The major ecosystem type is a "mixed mountain and highland system"("UNESCO - MAB Biosphere Reserves Directory" 2017) with "cold montane deserts"("UNESCO - MAB Biosphere Reserves Directory" 2017). Denali ("The Tall (or Great) One") is the native Athabaskan name of the highest mountain in the USA that was known till 2015 as Mt. McKinley. It lies in a geological active area with up to 3.000 measured earthquakes per year. The national park and biosphere reserve stretches to both sides of the Alaskan Range. The range divides the reserve into a warmer and wetter southern and a colder and drier northern part, dominated by permafrost soil. Its most distinguished ecosystem is the "northern boreal forest biome" on the southern slopes of the Alaskan Range and a tundra vegetation in the area of the northern slopes ("Climate & Weather History - Denali National Park & Preserve (U.S. National Park Service)" 2017). Both reserves are marked by glacial movements. In case of the Sierra Nevada these glacial movements have nearly vanished after the last ice age with no glaciers left since the early 20th century (Domínguez-Villar et al. 2013). Glacial processes, together with earth movements, still play a major role in the shaping of the area of the Denali region("Denali | United Nations Educational, Scientific and Cultural Organization" 2017). The limit for plant growth in the Denali region can be found at an altitude of 2290m. The Sierra Nevada is a hotspot for plant diversity in Europe with more than 1700 different species of which 64 are endemic to the mountain range("Sierra Nevada | United Nations Educational, Scientific and Cultural Organization" 2017). Native wildflowers are i.e. the Sierra Nevada violet (*Viola crassiuscula*) and the Sierra Nevada chamomile (*Artemisia granatensis*). On the lower slopes, there are Holm oak *(Quercus ilex)*, Pyrenean oak (*Quercus pyrenaica)*, Sweet Chestnut *(Castanea sativa)* and Spanish Fir *(Abies Pinsapo)*. However, due to the long settlement history and usage of trees, the native forest flora has nearly vanished("Sierra Nevada, Parque Nacional, Parque Natural, En Waste Magazine" 2017). The Sierra Nevada is also inhabited by a diverse array of animal species among with a high number of endemic beetle species and about 15 species of butterflies. Reptiles and amphibians include ladder snakes *(Rhinechis scalaris)*, southern smooth snakes *(Coronella girondica)*, ocellated lizards (*Timon Lepidus)* and natterjack toads (*Bufo calamita*). Birds of prey include the Golden Eagle (*Aquila chrysaetos*), Bonelli's Eagle (*Aquila fasciata*), Common Kestrel (*Falco tinnunculus*), Little Owl (*Athene noctua*) and Eurasian Eagle-owl (*Bubo bubo*). Among the over 60 species of birds are also the European Goldfinch (*Carduelis carduelis*), Serin (*Serinus serinus*), Ortolan (*Emberiza hortulana*), Dartford Warbler (*Sylvia undata*) and Wheateater (*Oenanthe leucura)*.

Large and medium-sized mammals include the Spanish ibex *(Capra pyrenaica)*, wild boars *(Sus scrofa)*, foxes (*Vulpes vulpes*), badgers *(Meles meles)*, martens (*Martes foina)* and wildcats (*Felis silvestris tartessia)*("Sierra Nevada Flora and Fauna" 2017). There are 39 mammal species in Denali national park, including grizzly bears (*Ursus arctos* ssp.), gray wolves (*Canis lupus*), caribou (*Rangifer tarandus caribou)*, moose *(Alces alces)* and Dall's sheep (*Ovis dalli*). It is well known for its bird diversity with more than 168 species, including bald eagle (*Haliaeetus leucocephalus)* and golden eagle, different species of hawks, gooses, owls and woodpeckers. Due to the harsh winter conditions, there are no reptiles and only one amphibian specie, the wood frog *(Lithobates sylvaticus* or *Rana sylvatica)* ("Wildlife - Denali National Park & Preserve (U.S. National Park Service)" 2017). In the park exist 754 vascular plants, among them eight tree species, and approximately 600 species of mosses, lichens, and liverworts ("Plants - Denali National Park & Preserve (U.S. National Park Service)" 2017).

8. Comparison and Analysis

Comparing Sierra Nevada Biosphere Reserve and Denali Biosphere Reserve offers a wide array of differences with a few similarities. Both reserves are visitor magnets, albeit to very different seasons. While the Denali Biosphere Reserve receives the majority of its visitors during the short summer months, the Sierra Nevada is a unique attraction for winter enthusiasts who enjoy all kind of winter sport activities, but especially alpine skiing. Yet, due to the establishment of the national park in 1999, skiing inside a National Park seems to be a critical pastime behavior for environmentalists who would like to preserve an area rich in endemic wildlife. Summer ecotourism activities like hiking has been on the rise and is encouraged by the Andalusian government. The main focus of the Sierra Nevada National Park and Biosphere Reserve seems to be more economic than ecologic and skiing seems to be the most important source of income in this region. But the skiing industry only seems to favor a few selected companies while the majority of the local population seems to be excluded from the tourism business. The government of Andalusia so far has only reluctantly supported measures to support a wide scale tourism industry other than skiing and only recently started to advert tourism to the Sierra Nevada region more widely. The reason for this behavior remains unclear but might not come as a surprise since investments in infrastructure for the remote villages are high due to the geographical environment. Further issues might arise if more tourists choose to visit the Sierra Nevada during the summer months as water availability is already an issue and might become even more severe due to reduced snowfall in winter. Investment in the remote regions of the Sierra Nevada might not be of further interest for the regional government, as Andalusia already hosts a number of world famous tourism spots like the towns of Sevilla, Granada and Cordoba, the Doñana National Park or the Costa del Sol. Winter sport activities at the ski resort of Solynieve, however, have been widely promoted and supported. Repeatedly hosting important skiing events created a picture of a winter wonderland. Protecting the environmental landscape of the Sierra Nevada might become even more difficult if more tourists choose to visit this

region during the summer months more often or if winter sport activities are expanded even further. This creates a situation, which is ambiguous in the way that the local population requires more and higher income job possibilities, that might arrive with increased tourism but in the long-term might even further weaken the environmental resilience of this region by increasing soil erosion and shrinking available water resources. But other opportunities to support job growth to keep the local population stable are limited as well. An increase in agriculture might ultimately result in the same effects as a growth in tourism with overgrazing already being among the top environmental issues in the Sierra Nevada. Industrial activities like mining have existed in the Sierra Nevada for millennia but take a heavy toll from nature. Mining in Alquife is planned to continue for at least 20 more years as preliminary results showed promising iron deposits(“Project” 2017). Climate change might weaken the tourism industry in the future if climate change leads to lower precipitation and snow fall, reducing the possibilities for winter sport activities. The focus of the government has so far not been on environmental protection but on the usage of the Sierra Nevada for economic measures. The importance of the region for biodiversity seems to be well known by people interested in the subject, but have not been widely advertised by the Andalusian government. Hunting in the park remains an important outdoor activity, while education of visitors in questions regarding climate change and environmental protection, remains rather underdeveloped. The Denali Biosphere Reserve is to be found in a remote area in the north-west of the American continent. As travel distances are long and no larger settlements can be found in its vicinity, it would be most logical to assume that not many people will come to visit this area. Yet, the exact opposite occurs. Alaska has itself branded as one of the most pristine areas on the planet, with a unique wildlife that attracts people who cannot find this combination of nature and wilderness at home. Close to 600.000 visitors annually come to visit the reserve, often connected with a cruise tour that lets people feel the wild history of the Klondike gold rush and the Alaskan fjords. But bringing people for economic gain seems to be not the main interest of the park management. Education, research and protection are of, at least, equal importance. It may prove a test for resilience in the future, how the park will deal with the onslaught of even more visitors but so far it has been a win-win situation for the local economy and nature. Sensitizing people for the beauty and importance of nature is the main object of the park and reserve management. This is of utter importance as people who feel connected to the area might be more willing to contribute to its protection. When the national park was founded in 1917 it was this personal connection of Charles Sheldon that made people and the government aware of the importance of this area. This legacy still seems to connect people with this landscape, thereby providing a strong protection for the area. Including the indigenous population into the management supports the resilience of this approach, where economic interests are not of the highest importance. Comparing the Sierra Nevada Biosphere Reserve with Denali Biosphere Reserve does not produce a clear result, but in terms of protection and park management Denali clearly stands out, at least if the judgement is done by sources that can be found in the internet. No

clear management scheme was available for Sierra Nevada and it remains ominous if there are further governmental plans towards environmental friendly tourism. Denali clearly shows the importance of sensitizing visitors to issues like global warming and biodiversity and offers methods of how to implement those questions into the parks outlay. The reason for the better management in this regard might be found in the organization that manages Denali, the National Park Service of the USA. Having a countrywide organization that is run by experts might have a drastic impact for better management options due to the adaptation of standardized methods and ideas. There seems to be no central authority that manages national parks and biosphere reserves in Spain, mostly they are run by local state governments and advertised by tourism boards. International networking seems to be a strong point for the Sierra Nevada as Denali appears to be somewhat more isolated in this regard, again maybe due to the organizational structure which, in this case, limits its freedom. Access to the park seems again to be better managed in Denali where only one controlled access exists, albeit it might be possible to enter the park on foot through other ways. Sierra Nevada clearly shows signs of an old human settlement that has been mostly left on its own with limited controls and only a general conservation aspect that is more centered around human issues. Reforestation to recreate the once common oak forests has only begun recently ("Assessment Report on Sierra Nevada Biosphere Reserve" 2009). A final verdict might reach the conclusion that the Sierra Nevada Biosphere Reserve nevertheless puts human interests into the center of its actions while Denali Biosphere Reserve already is one step ahead by putting natures interest first. Both positions might have advantages for now, yet in general it remains unclear if there is any plan that keeps the cultural history of the Sierra Nevada alive. Protecting the environment is a must for both regions as it is the only viable economic future for either area. If we would include real calculations based upon the Nash equilibrium it might be logical to assume that only a scenario that puts nature at its core might lead to long term survival for the local population as well as the source of its income, nature. However, if we consider the Sierra Nevada as an example, this thinking might prove too difficult to be implemented if more and more varied interests are taken into place. Individuals and even policy makers might not think in long-term, maybe not even mid-term strategies. If their short-term survival is at stake, either physical and/or economic, there will most likely not even be a chance to implement strategies for mid- or long-term scenarios. The solution has then to be found in projects introduced and led by policy makers that take the local population with them. If this foundation is stable it offers more opportunities to grow from then on. Possible scenarios are shown by Denali National Park and Biosphere Reserve, which offers spectacular nature, but also ways to take visitors on a journey into the scientific world. Nature will most likely not be left alone in a world shaped by humans, so the huge challenge for all biosphere reserves will be to find ways that will offer humans possibilities for interaction with nature in a sensible way. Economic output should not be the most important aspect but neglecting it will most likely also produce undesirable outcomes for reserves.

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