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Why do Tibetan pastoralists hunt?[1]

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Abstract: The Tibetan nomads in the Aru Basin have until recently relied on hunting as an additional source for subsistence. They hunted the endangered Tibetan antelope or *chiru* (*Pantholops hodgsoni*), blue sheep (*Pseudois nayaur*), Tibetan gazelle (*Procapra picticaudata*), wild yak (*Bos grunniens*), and kiang or Tibetan wild ass (*Equus Kiang*) both for extra meat, pelts, and for cash. However, in the 1993 a general ban on hunting wildlife was declared, due to the recent dramatic decline in wildlife populations on the Tibetan Plateau. This paper argues that the repeal of traditional hunting, which was an integral part of the pastoral economy, has created an unbalance in the nomads' economic system that needs to be addressed if nomadic pastoralists and wildlife in the region are to coexist in the future.

[1] This is the accepted version of the paper and as such may differ from the final corrected proof which can be accessed at http://dx.doi.org/10.1016/j.landusepol.2016.02.004

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Keywords: chiru; Chang Tang; conservation; hunting; risk; Tibet.

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1.0 INTRODUCTION

Additional sources for subsistence, like hunting, can work as risk management strategies in variable and unpredictable environments. Following Cashdan (1990), risk can be seen to have two different aspects. First, risk may be defined as unpredictable variation in ecological or economic variables, and outcomes are viewed as riskier depending on their degree of variability. Second, risk may be related to the probability of loss, i.e. situations when falling below a minimum level of income or food intake is likely. Empirically speaking, the two aspects are not that different, like in the Aru Basin in North-Western Tibet, where unpredictable variations in ecological conditions, especially snow (Yeh et al., 2014), may increase the probability of falling below a minimum subsistence level (Næss, 2003).

Halstead & O'Shea (1989) argues that societies, in general, employ a wide range of strategies, called 'buffering mechanism', to counteract scarcities, including everything from myths to alternative modes of subsistence. Following Halstead & O'Shea (1989), strategies for countering risk can be grouped into four major categories: (1) *diversification*, ranging from the keeping of multiple livestock species (e.g. Khazanov, 1994; White, 1997) to investing in non-pastoral activities (e.g. Bayer and Waters-Bayer, 1990; Berzborn, 2007; Lesorogol, 2008; Mearns, 2004; Sperling, 1987; Thornton et al., 2007); (2) *livestock exchange networks*, such as stock-friendship (e.g. Bollig, 2006, p. 287; Göbel, 1997; White, 1997); (3) *mobility*, e.g. taking advantage of spatiotemporal heterogeneity in available forage (e.g. Behnke et al., 1993; Bollig and Göbel, 1997; McCabe, 1997; Næss, 2013; Thompson et al., 2008); and (4) *storage*, e.g. large herd size (Bollig and Göbel, 1997; Hjort, 1981; Næss and Bårdsen, 2010; 2013; Næss et al., 2011; see e.g. Colson, 1979 for other categories). The

underlying logic of these strategies is to minimize the impacts of risks and to reduce uncertainties[2] (Bollig and Göbel, 1997). The strategies usefulness depends on the social and environmental context, including both the structural characteristics of the society at large and the structure of resource failure the society is likely to experience (for a short review of other buffering mechanisms, see Bollig, 2006, p. 13-4).

This paper will show that for Tibetan nomads hunting, especially of the Tibetan antelope or chiru[3] (*Pantholops hodgsoni*, Tib.: *gtsod*[4]), can be understood as a risk management strategy where hunting must be understood as a category of diversification. While diversification includes a broad range of both passive and active practices, the underlying principle is that broadening the base of the subsistence system, either by using a wider range of plant and animal species or by exploiting broader and more varied areas (i.e. niches), reduces the risk of catastrophic shortages (Halstead and O'Shea, 1989).

[2] Risk and uncertainty are fundamentally different, e.g. uncertainty (or incomplete knowledge) can by definition be overcome by acquiring more information (Winterhalder, 2007).

[3] Because it is not an antelope (Gatesy and Arctander, 2000; Vrba and Schaller, 2000), the commonly used derivation from what is supposedly a local Tibetan name, "chiru", is used in the present study. However, the common name used in Tibetan is "*tso*" and not chiru, but chiru will be used here for simplicity (see Huber, 2005 for detailed discussion).

[4] Tibetan names are given both in simple phonetic form and proper Tibetan spellings when known, according to the Wylie (1959) system of transliteration. The Wylie form is written in italic.

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2.0 METHODS

The research reported here is based on three 2-6 week visits to the Aru Basin (Figure 1), in June 2000, September/October 2000, and May/June 2001. Information was gathered primarily through in-depth interviews with 10 out of 35 households in June 2000, 15 out of 28 households in September/October 2000, and 15 out of 23 households in May-June 2001. Informal interviews were made with all households present in the basin during one of our three trips, and interviews with local leaders and Tibet Autonomous Region (TAR) Forestry Bureau officials was also undertaken (for details, see Næss, 2003; Næss et al., 2004).

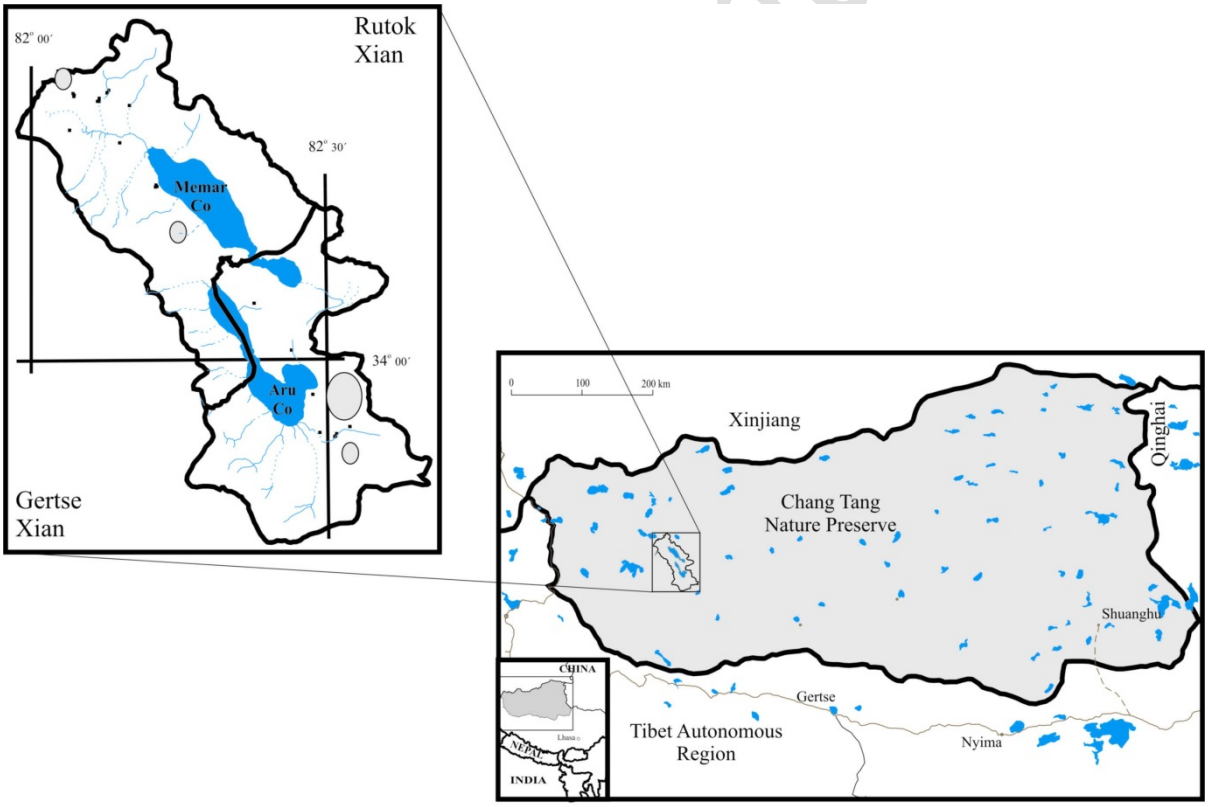

Figure 1. The ca 2 300 km^2 Aru Basin study area within the ca 300 000 km^2 Chang Tang Nature Reserve (adopted from Næss, 2003). Two administrative districts divide the basin's grazing areas: Gertse and Rutok Xian. Black squares represent winter houses. Grey polygons

indicate locations of *tseka* traps. The single polygon close to the centre of the map represents a trap claimed by the nomads to be over 1 000 years old.

2.1 The Aru Basin and the Chang Tang Nature Reserve

The Qinghai-Tibetan Plateau (QTP) reaches around 1 500 km North-South and around 3 000 km East-West, and is around 2.5 million km^2. Over 80% of the plateau is located above 3 000 m in elevation, and about 50% is >4 500 m (Miller, 1998; Schaller, 1998b). The Tibetan nomadic pastoral area encompasses a sub-region where the rangelands of the QTP includes all of TAR and Qinghai, most of the rangeland areas of Gansu and Sichuan, and parts of southern Xinjiang; an estimated 1.6 million km^2 (Miller, 2000). During winter, temperatures around -30°C are not uncommon and snowstorms occur even during summer (Schaller, 1996), and might have severe negative effects on both livestock (Goldstein and Beall, 1990; Miller, 2000; Nori, 2004 ; Næss, 2003, 2013; Yeh et al., 2014) and wildlife (Schaller and Ren, 1988). Annual precipitation varies from 700 mm in the east to less than 100 mm in the west, mostly falling as snow and hail during summer (Miller, 1998). An estimated 12 million yaks and 30 million sheep and goats inhabit the Tibetan Plateau supporting around 5 million pastoralists and agropastoralists (Harris, 2010, p. 3; Sheehy et al., 2006, p. 143). Tibetan pastoralism is found at elevations of 3 500-5 400 m, in environments too cold for crop cultivation but which supports extensive, productive rangelands where nomads continue to thrive (Barfield, 1993; Goldstein and Beall, 1990; Næss, 2003; Næss et al., 2004).

The ca. 300 000 km^2 Chang Tang Nature Reserve (Fig. 1) was established in 1993 (Miller and Schaller, 1996) to protect the endangered chiru, and other wildlife inhabiting the

Tibetan Plateau (Schaller, 1998b). The Aru Basin is approximately 2 300-km^2 with most of its area lying >5 000 m. The basin is northwest-southeast trending, encompassing two lakes, Aru Co (4 960 m) and Memar Co or Di-Ngorok Co (4 940 m). The 6 000 permanently snow-covered mountains along the western edge of the basin create a moist and productive environment compared to other areas on the Chang Tang Plateau (meaning "the Northern Plateau"), and consequently the basin is an attractive place for both wild herbivores and nomadic pastoralists. The Aru Basin is an important wildlife area in the Chang Tang Nature Reserve (Schaller and Gu, 1994), and parts of it have therefore been designated as a core area for wildlife protection within the reserve (Bårdsen and Fox, 2006; Fox and Bårdsen, 2005; Fox et al., 2009; Fox and Dorji, 2009; Fox et al., 2004).

2.2 The Aru Nomads

While the Aru Basin have probably used for several thousands of years by nomadic hunters and by nomadic pastoralists for perhaps the past thousand years, little is known regarding this early phase of use (but see Fox and Dorji, 2009; Huber, 2005 for the surrounding area). Hedin (1903) met nomads in a valley southeast of the Aru Basin, in the beginning of the 20th century. At this time the basin had a reputation of being inhabited by bandits and robbers. According to Rawling (1905) five bandits were caught and beheaded in this area by Tibetan officials at the beginning of the 20th century. Deasy (1901) also reports that his camp was attacked and looted for baggage and animals in this area at the end of the 19th century. One of the Aru nomads actually claimed that his grandfather had played a part in the robbing of

"a few foreigners" at this time. It is thus likely that these "bandits" were in fact nomads that raided a camp of foreigners because the opportunity for extra income presented itself.

According to the old Aru nomads, their forefathers used the basin seasonally. The exact timeframe for this use is somewhat uncertain, but present inhabitants claim that their ancestors have used the basin for at least the last 200 years. Although they were nomadic pastoralists, the main reason for using the basin was its great hunting opportunities; wildlife was abundant. Accordingly, the basin was used mainly during winter, when hunting was at its peak. However, the extent of the use of the basin is unknown, local estimates ranges from 10 families to 200 families (Næss, 2003). Human presence in the Aru Basin for a substantial amount of time is further witnessed by the fact that one of the oldest nomads claimed that the basin was under the jurisdiction of the Sera monastery in Lhasa prior to the Chinese occupation in 1959[5]. This area was formally recognized by the authorities since as

[5] In 1950 the People's Liberation Army (PLA) embarked upon what has been termed the 'Liberation' of Tibet from imperialistic and feudal influences. They quickly succeeded in making the Tibetan government to accept a '17 Point Agreement for the Peaceful Liberation of Tibet'. This agreement left the old politico-economic system intact, in exchange for Tibet's acknowledgement of Chinese sovereignty over Tibet. This agreement was more or less intact until 1959, when the Dalai Lama, fearing that the autonomy guarantied in the 17 Point Agreement would not be kept by the Chinese, fled into exile in India. From then on, PRC assumed direct and complete control, and the old political system in Tibet came to an end (Goldstein and Beall, 1990; Shakya, 1999).

subjects of the Sera monastery in Lhasa the Aru nomads were obligated to pay a part of their production to the monastery as annual taxes[6].

Although a small number pastoralists and hunters have used the Aru Basin for several thousand years, its use has changed in recent time. During the Cultural Revolution[7] in western Tibet, nomads in the Aru Basin were relocated and the area was left uninhabited for around 15-20 years. During this period private ownership of animals was banned and nomads were settled in communes close to already existing government centers (Næss, 2003, 2013; Næss et al., 2004). From the early 1990's and onwards, pastoralists moved back into the basin, and today administrative responsibilities for the basin is divided between two counties (Chin.: *xian*), namely Rutok and Gertse (Fig. 1). During the summer of 2000, counts and interviews indicate that the basin is inhabited by around 222 nomads with 10,000 sheep and goats and 500 yaks. During autumn and winter[8] in 2000, there were 127 nomads in the basin, with 7,000 sheep and goats, and 330 yaks (Næss, 2003; Næss et al., 2004). The use of the basin changes seasonally, with the highest density of both livestock and people during the summer (see Figure 2 for distribution of livestock numbers across households).

[6] A household owning 100 heads of livestock could choose to pay in live animals (1 yak or 6 sheep or 7 goats), butter and cheese (around 2.5 kg of cheese or 5 kg butter), or one bag of goat cashmere wool (see Næss, 2003).

7 A campaign to destroy the four olds, i.e. old ideas, old culture, old customs and old habits (see Shakya, 1999), lasting from around 1972 to 1983 in this area (Næss, 2003).

8 However, the number of people and animals within the basin during winter is extrapolated from the numbers from autumn since no data is currently available for that season.

The domestication of the yak was probably the single most important factor for enabling people to adapt to the marginal Tibetan Plateau (Ekvall, 1968; Goldstein and Beall, 1990; Miller, 1998). The yak is endemic to the Tibetan Plateau, and is well adapted to the cold and high altitude of the Chang Tang. Yaks provide the nomads with transportation (although trucks are now more common); food (the female yak provide milk all year-round and meat), shelter and clothing (see Næss, 2003 for details). Nevertheless, yaks comprise only 4% of the total herds in the Aru Basin, which is probably linked to the amount and quality of vegetation available (herd composition varies from west to east on the QTP, with herders keeping predominately yaks in the east and sheep and goats in the west, Næss, 2012b, p. 99). The Aru nomads rely mainly on sheep and goats for subsistence, while horses are few due to the fact that they are left untended due to labor shortages and are consequently at high risk from predators such as wolves (*Canis lupus*). Consequently, both sheep and goats are the primary producers of milk, meat and wool and skins for the Aru nomads (Næss, 2003). While goats produce more milk and for longer time periods than sheep, nomads in the Aru Basin prefer milk and meat from sheep (Næss, 2003). Nevertheless, goats have increased in importance due to an increased demand for cashmere wool, which provides a substantial part of the nomads cash income (Næss, 2003, 2013; Næss et al., 2004). Goldstein and Beall (1990) noted that among the Phala (Shigatse Prefecture) nomads, the percentage of goats in the herds had increased, suggesting that goats may have become a new economic basis. Figure 2 presents information pertaining to variability in livestock numbers for the Aru nomads.

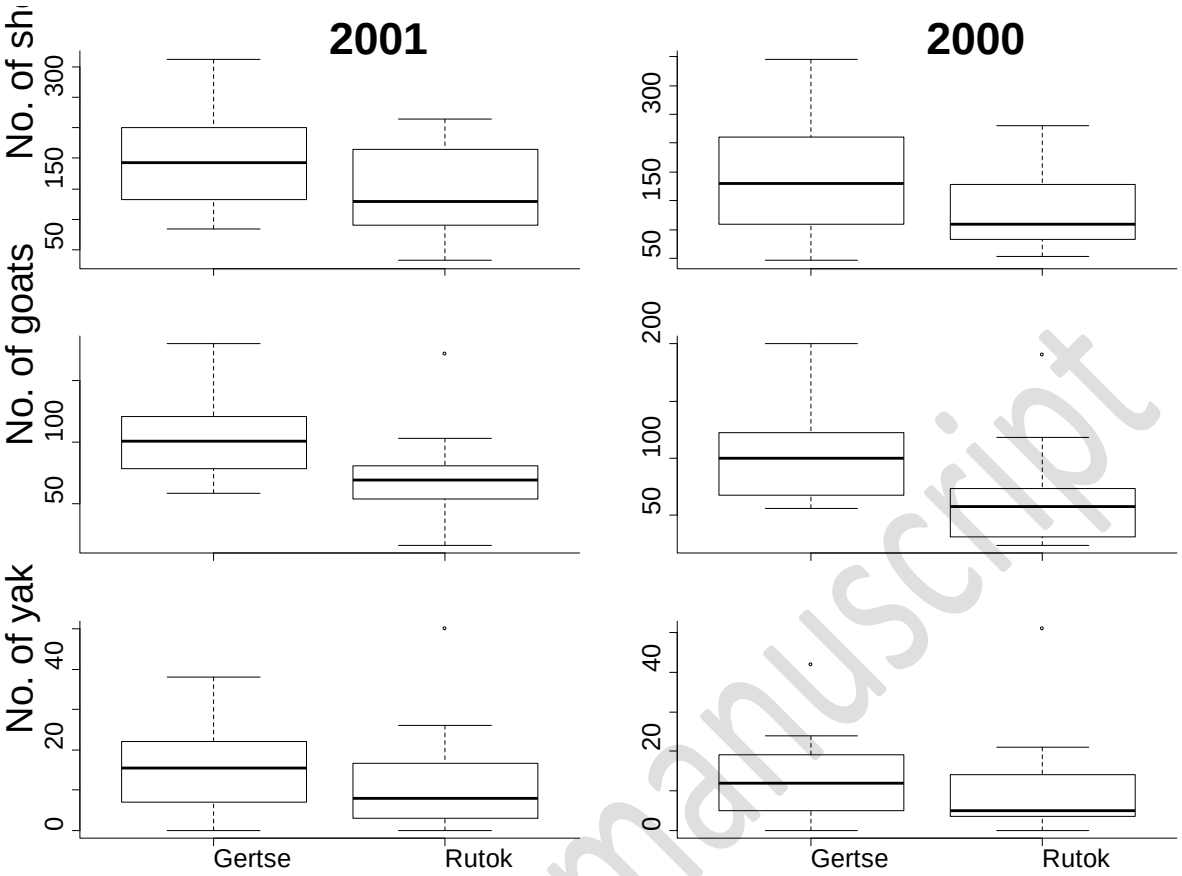

Figure 2. Boxplots showing the distribution of sheep, goats and yak across households for the Aru nomads from Gertse and Rutok xian during 2001 and 2000 (Rutok: *n* = 12 for 2001; *n* = 15 for 2000; Gertse: *n* = 10 for 2001; *n* = 13 for 2000). Data from interviews only.

2.3 Wildlife in the Aru Basin

The Tibetan Plateau supports several threatened endemic species (Schaller and Gu, 1994), the survival of which depends on protection within the Chang Tang Reserve (Schaller, 1998a). The Tibetan antelope or chiru is a moderate-sized bovid, endemic to the Tibetan Plateau (Schaller, 1998b). A dramatic decimation in the number of chiru, from >1 000 000 before 1900 to the most recent estimate of <75 000 (Schaller, 1998b, p. 59), has been wrought primarily by excessive non-local hunting to obtain the animal's fine under-wool

known as 'shahtoosh' (Li et al., 2000). The chiru is a single-species genus with no close relatives (Vrba and Schaller, 2000), which greatly increases its conservation value. Consequently, the chiru is currently considered endangered both internationally (Mallon, 2008), and by the national authorities (Feng, 1993). The chiru prefer flat to rolling terrain, although they readily ascend high rounded hills and penetrate mountains and cross passes by following valleys. As for the Aru Basin, the chiru is the numerically dominant wildlife species (Schaller, 1998b), but its abundance is highly variable across seasons (Bårdsen, 2003). To our knowledge, recent large-scale assessment of temporal trends in chiru numbers is lacking (but see e.g. Fox and Bårdsen, 2005 for an example of a single-year study), and due to a large high between-year and -season variation in numbers (see also Bårdsen and Fox, 2006; Fox et al., 2009) it is impossible to draw inference on overall population trends based on local counts. There seems, however, to be accepted in the literature that chiru populations declined during the 1990's, mainly due to poaching, but is now recovering due to successful conservation (see also Gao et al., 2011 for a study in Xinjiang; Schaller et al., 2007). In the Aru Basin, however, Fox et al. (Fox et al., 2009, p. 189) reports increased numbers of chiru in 2000-2001 (15 000, but see Fox et al., 2004 who reports the number to vary from 1 500 in the summer to >11 000 in the autumn in 2000-2002) compared to what Schaller (1998b) reported a decade earlier[9], and decreasing numbers in 2000-2007 in which

[9] Schaller and Gu, (1994, p. 276) reports that at least 8000 individuals passing the Aru Basin in July/August 1990, whereas 69 migrants were observed within the basin on 18 August 1992 whereas 2000 were seen just outside the basin a few days later.

chiru seems to concentrate in areas outside the basin (25-30 000 individuals were scattered across northern Gertse County).

The wild yak (*Bos grunniens,* Tib.: *'brong*), a large bovid endemic to the Tibetan Plateau, is shyer than domestic yaks. Wild yak were once abundant in western Tibet, but a dramatic decimation in the number of wild yaks has occurred over the last few decades as a consequence of an extensive hunt for meat, horns, and pelts (Schaller, 1998b). Wild yaks stay away from areas with people and livestock (Schaller and Liu, 1996), which has also contributed to the decrease in their numbers. The Aru Basin is still populated by wild yaks (Fox et al., 2004; Schaller, 1998b), but the exact number is currently unknown. Schaller and Gu (1994, p. 279), however, reports the presence of at least 1000 yaks in the basin in 1990 and 315 in 1992, and in 2000-2002 this number was less than 200 (Fox et al., 2004, p. 23). Only small groups of wild yaks were seen in this area (own observations). Estimates of the total number of wild yaks vary dramatically, from 500 to 20 000-40 000 (cf. Schaller, 1998b, p. 136), and is hard to substantiate which of these population estimates is the most reliable.

The blue sheep (*Pseudois nayaur*, Tib.: *gna '-ba*), a medium sized bovid intermediate to *Capra* and *Ovis* but probably more closely related to *Capra* (Vrba and Schaller, 2000), is endemic to the Tibetan Plateau. It is found in and near the mountains on the western side of the Aru Basin (own observation). We do not have any local recent population estimates for this species, but Schaller and Gu (1994, p. 274) reports to have seen 121 in 1990 and 105 in 1992 whereas Fox et al. (2004, p. 23) reported around 350 blue sheep to be present in the Aru Basin in 2000-2002.

The Tibetan gazelle (*Procapra picticaudata*, Tib.: *dgo-ba*), a small bovid that is endemic to the region, was regularly observed within the Aru Basin. Tibetan gazelle prefers open landscapes, plains, hills, and even mountains where they may be found in broad valleys and on ridges at high elevations if the terrain is not precipitous (Schaller, 1998b). Schaller and Gu (1994, p. 278) speculates that the abundance of gazelles was at least 200 in 1990, whereas Fox et al. (2004, p. 23) reported the number to be around 250 in 2000-2002.

Kiang (*Equus Kiang* Tib.: *rkyang*), a large equid, is still common in some areas of the Chang Tang (Schaller, 1998b). We often encountered kiangs in groups, varying from solitary to >100 individuals, in and near the Aru Basin, but Schaller and Gu (1994, p. 280) estimated 250 kiangs in the basin in 1990. The kiang lives in open terrains, plains, basins, broad valleys and hills, foraging on grasses and sedges (Schaller, 1998b). Kiang has generally decreased in numbers during the past century; however they seem to increase in numbers in some areas (Schaller, 1998b; Wulin, 1999).

The relatively common large predators present include wolf (*Canis lupus*), snow leopard (*Unica unica*), brown bear (*Ursus arctos*), red fox (*Vulpes vulpes*), sand fox (*Vulpes ferrilata*), and lynx (*Lynx lynx*) (Schaller, 1998b). The Aru nomads were mostly concerned about the number of wolves, which they classified as ”numerous”, and bears; because both predators attack and kill livestock (Næss, 2003).

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3.0 RESULTS

3.1 Hunting for subsistence

Hunting has been a subsidiary occupation for nomads in several parts of Tibet. Ekvall (1968) describes Tibetan nomads (in what is now the Qinghai Province situated in the north-eastern part of the QTP) as enthusiastic hunters always prepared for the hunt, both to protect their herds from predators and to obtain extra meat and pelts. Ekvall (1968) also describes communities that hunted wild yak, subsiding mostly on their meat during winter. He describes the people living in the north plains as half huntsmen and half pastoralists, subsiding basically on chiru, and even kiang, which were not considered edible by other nomads, but were hunted for their skins. Ekvall (1968, p. 53-4, italics added) writes:

> "Everywhere wild sheep and gazelle, as opportunity affords, are hunted for their meat and skins. Game animals take on flesh faster in the spring than domesticated stock and are full fleshed when domesticated sheep are still too thin to be worth the killing. *The pastoralist eats their flesh with particular relish for it is both good and does not entail the sacrifice of any animals in his herd*"

All this holds true for the Aru nomads; traditionally they relied on hunting as a supplementary way of making a living, primarily because they were poor. Predators such as bears, snow leopards and wolves were hunted because they prey on the nomads' livestock. The Aru nomads traditionally relied on the hunting of herbivores as a supplementary source of meat, skins and furs. One nomad, for example, emphatically stated that:

> "*When I was young we had no choice but to hunt, if I didn't hunt my family would starve and maybe die*" (Næss, 2003, p. 83, italics in original),

and

> "*When my children were young they had to wear clothes made out of skins from wildlife. I was so poor that I couldn't afford to make clothes out of sheep and goat skins*" (Næss, 2003, p. 83, italics in original).

The long standing of hunting in the area is also noted in one local legend:

> "In ancient time, one mountain surrounding the Aru basin and Aru Tso [Lake] were considered the holiest mountain and lake in the whole of Tibet. The place was abundant with wildlife and our ancestors used to come here to hunt. However, our ancestors became greedy and hunted too many animals, making the gods angry. The gods decided that they should move the holy mountains and lake to another part of Tibet, and that is how *Kang Rinpoche* [Mt. Kailash] today is the holiest place in Tibet, and *Mapang Yumtso* [Lake Manasarovar, Tib.: *ma-pham g.yu-mtsho*] is the holiest lake" (Næss, 2003, p. 79).

The nomads primarily hunted the chiru to get extra meat, but also for trading hides with Ladakh, India. The chirus' hides were valuable trading objects due to the shahtoosh wool (called the "king of wool"). From Ladakh the wool was traded to Kashmir, India where the

shahtoosh wool was woven into high quality shawls, a popular bridal gift for the Indian elite (Schaller, 1998b).

The Aru nomads relied mostly on leg-hold traps [*Goktse* (*khog-rtse*[10])] and the Tibetan matchlock-style rifle [*Ponda* (*bod-mda'*)] for hunting. The leg-hold trap consists of a ring, about 15-20 cm in diameter mainly made from small brush branches[11], or anything available, covered with yak fiber. Up to a dozen sharpened prongs made from chiru horns converge down and inward so that when animals step into the trap, the prongs prevent the animal from withdrawing its leg. The trap is usually tied to a stone in summer—to secure the trap from being torn lose—while during winter water is poured over the rope, freezing it to the ground. The Aru nomads used the *goktse* of different sizes to catch antelopes, gazelles, blue sheep[12] and kiangs. When an animal was caught in the trap, they were usually killed by stoning. Another common way for hunting chiru was the *tseka* or *dzaekha*[13], a trap made of long lines of piled up dirt and stones, arranged to funnel animals. At the traps' end, holes with leg-hold traps were placed, or a number of nomads would lay in wait with their matchlock-style rifles. The *tseka* was used only to hunt chiru, and was directed in accordance with the chiru's migratory patterns (Schaller and Gu, 1994). Remains of many traps were observed on the northeast side of the Aru Basin during our field trip in 2001 (Figure 1), giving evidence to the use of this hunting method (see Fox and Dorji, 2009, p. 208 for more details

[10] Please note that literary spelling is highly uncertain for the gokste (see Huber, 2005, footnote 7).

[11] However, Schaller (1998b) mentions that the ring can be made out of horns.

[12] Huber (2012) notes that dogs were also used for hunting blue sheep and other wild sheep.

[13] Tibetan spelling is unknown; see Huber (2005) for a discussion.

of trap locations). We also came across one trap that the nomads claimed was over 1 000 years old. Chiru dig out hollows or bowls in the dust or sand and lay down in them during the daytime when it is warm, or when they want to escape flies [*tsedung* (*tsher-dong*)][14]. According to the nomads, individual chiru only has one of these special holes in one area, and whenever the individual comes back to the same area, it will use the same hole. The nomads made these holes deeper and put a leg-hold trap inside (or placed them around the holes, see Huber, 2005), then covered the trap with sand. When the chiru came back, it would lie down, and when it wanted to leave, its leg would get stuck in the leg-hold trap. This trap was used in summer, but the nomads claim that they stopped using this way of hunting in the late 1960s, mainly because it was not very effective: it could take a long time before they managed to catch a chiru in a *tsedung*, if they managed at all.

The Aru nomads also hunted wild yaks, from which they used the meat and made shoes from its skins. The only weapon capable of killing wild yaks was the Tibetan matchlock-style rifle. Apart from the wild yak, it was used to hunt all other wildlife present in the Aru Basin, and was (until very recently) the only means by which the nomads could kill/scare off wolves and bears. However, it is not an efficient weapon: after one shot the remaining animals would be long gone before the rifle was ready for another shot as reloading usually took 3-5 minutes (Huber, 2005 estimates the time to reload being seldom less than 2 minutes). Blue sheep, kiang and Tibetan gazelle were mainly hunted for meat. Some people also used the skins from blue sheep to decorate their dresses, and some monks bought the skins because they made good material for making drums. Blue sheep were

[14] Meaning, according to Huber (2005, p. 13), “affliction hollows”.

hunted in the Aru Basin, but because their natural habitat is in close proximity to and in steep mountains, they were never hunted extensively, and were insignificant as a source of meat. The Tibetan gazelle has also been hunted in the Aru Basin, but not to the same extent as the chiru. The various wildlife species were also hunted in different seasons: blue sheep and gazelle were only hunted during February, chiru of both sexes in winter and male chiru primarily during summer, after the females have migrated north for calving. The kiang was hunted throughout the winter, even though it was not a preferred target for hunting.

3.2 The commercialization of hunting

By the late 1980's the hunting of chiru changed to become a cash motivated activity. During this time the popularity of the shahtoosh wool increased internationally. Bergdorf Goodman, a New York store, advertised in 1995 that shahtoosh was obtained sustainably by poor hardworking indigenous people that collected wool that was shed naturally by the chiru, making shahtoosh an ecologically and politically correct luxury item (Schaller, 1998b). In reality, however, hunters have to kill the animals to be able to collect the shahtoosh wool. Consequently, the international trade of shahtoosh has been illegal since 1979 when the chiru was put on the list of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), where it as of 5 February 2015 is situated in CITES' Appendix I (www.cites.org/eng/app/appendices.php).

Due to the increased foreign demand for shahtoosh products, the price increased dramatically during the early 1990's (Kumar and Wright, 1998; Schaller, 1998b). Prior to

1990 one skin could be sold for RMB 60-70[15], but in the early 1990 one skin would sell for RMB 400 (Fox et al., 2009 estimates that the price for a good skin can range from RMB 500 to 1000). Faced with the opportunity to earn extra cash, some families in the Aru Basin invested in modern rifles. With the traditional matchlock-style rifle and leg-hold traps, individual hunters could typically kill 8-30 chiru per year depending on individual skill; with modern rifles the take could easily increase to >100 (Næss, 2003). As a consequence, a household in the Aru Basin—with a modern rifle—could potentially make RMB 40 000 annually by selling skins from the chiru, significantly more than a household could make by selling livestock products alone (Næss, 2003). Fox et al. (2009, p. 188) estimates that annual per capita income ranges from RMB 2 471 to RMB 2 844 in the northwestern parts of TAR[16]. For the Aru nomads, Næss (2003, p. 121) estimates that a well-off household could make RMB ~8 600 while a poor only RMB ~860 from sale of cashmere wool from goats and sheep wool alone in 2001. Hunting thus provided the nomads with a potential for a substantial increase in income.

By 1990, roads had made the Aru Basin (and other secluded areas in TAR) more accessible, making wildlife attractive to non-local hunters like officials, truck drivers, and soldiers. For example, Schaller (1998b, p. 295) writes that local officials and the military organized killing of chiru on an annual basis in Baingoinm, with annual takes being at least 1000 chirus. Also, Aru nomads claim that Khamba traders from the eastern parts of Tibet, or

[15] RMB 100 = US $16.04 per 23.01.2015

[16] Based on Gertse County government statistics encompassing 6 villages in Shenchen Township, Gertse County, Ngari Prefecture.

Muslims from Xinjiang Province came to the basin on a regular basis to hunt. Consequently, local Forestry Bureau Law Enforcers tried to elicit the help of local nomads to counter illegal hunting. One household in the basin is in the possession of a radio, by which they can contact the local town centers if they see illegal hunting, but:

> *It is very dangerous for us to report the Muslims or the Khamba. If we call (by radio) to Rutok and report them as hunters, it will take a very long time before the police arrive. Also, Muslims sometimes steal livestock from us and threaten us, and if they then know that we have reported them they could kill us. Also, if the police arrest them, they know we reported them and after a couple of years in prison they could come back and take revenge*.

Although the threat may seem to be exaggerated, poachers have been known to kill humans. In 2002, for example, eight hunters encountered three rangers from Nyima County, which borders on to Gertse County in the east. They laid an ambush and shot one ranger dead (Liang, 2002).

3.3 The ban on hunting

Not surprisingly, the number of wildlife decreased dramatically, and in 1993 a national ban was declared on all hunting in the nature reserve. Some hunting continued until the middle of 1990's when, with the help of substantial fines, confiscation of trucks and jail sentences, the ban started to be heavily enforced by Forestry Bureau Law Enforcers. This resulted in an almost complete stop of hunting by local nomads in the Aru Basin and a decrease in

poaching (see Appendix A for details). The Aru nomads, who until then had relied on hunting, experienced a decrease in living standard, and several stated that their livestock did not produce enough milk, wool or meat to sustain them throughout the year. Also, the ban created resentment toward wildlife, and then especially toward the chiru. While hunting gave the Aru nomads a feeling of getting something substantially back from the presence of wildlife, the ban has resulted in the view that wildlife competes with their livestock for forage. As one nomad said:

> "*Whenever we move to summer grazing, the tso [chiru] moves to our winter pasture and eats up all of the grass. When we then come back in winter, there is almost no grass left for our animals*" (Næss, 2003, p. 136, italics in original).

As a consequence, some nomads want support from the regional government to fence in their winter pasture and thereby secure exclusive user right for their livestock and late in 2006 fences were being erected within the Aru Basin, some cutting across the chirus migratory route and thus negatively impacting wildlife (Fox et al., 2009; Fox et al., 2008).

While current status of hunting in the Aru Basin is uncertain, Huber (2005, p. 16) writes with regard to the surrounding areas that in 2002 police and officers of the Forestry Bureau "visited every rural district and confiscated all firearms and khogtse traps in the possession of local pastoralists. The seized hunting equipment was then destroyed by the authorities". For the Chang Tang Reserve in general, Fox and Dorji (2009) argues that antelopes inside the reserve are still being hunted and while traditional techniques are still

being used, more commonly modern rifles are used as well as motorcycles to chase down animals and/or run them into fences (also within the Aru basin).

4.0 DISCUSSION

Huber (2012, p. 196) argues that for Tibetan pastoralists hunting served 4 principal goals: as a source of (1) animal protein and fat for both humans and domestic animal consumption; (2) hides, hairs and horns; (3) organs, blood, flesh, horns and fine wool from particular species used for trading (so-called high valued wild animal products); and (4) predator and pest control, i.e. the removal of wild animals that either kill livestock or compete with livestock for forage.

4.1 Typologies of Tibetan hunting

Huber (2012) isolates four different phases or typologies of Tibetan hunting: (1) *subsistence hunting*—a food source supplement when pastoral production falls to a critical level (due to e.g. environmental induced livestock losses, see e.g. Næss, 2013; Næss et al., 2004 and Table A.1). (2) *Wealth-dependent hunting*—i.e. while wealthy pastoralists were primarily occupied with livestock production, poor pastoralists were primarily occupied with hunting and secondarily with livestock production[17]. Notably, this distinction had a geographic gradient

[17] The same pattern has been noted for the Phala nomads: "Two other components of the production system are salt trading and hunting. Both are in part backup activities, utilized widely in bad times but less so when the yield from domestic livestock provides a satisfactory livelihood. Since economic conditions have improved since

with poor pastoralists inhabiting areas around latitude 33° and above during the coldest periods when grazing was reduced but hunting was at its peak (Huber, 2012, p. 202-3). (3) *Communal hunting*—during the 1960s pastoralists was collectivized into people's communes. During this time, pastoral tasks were divided into different types of work, for which responsibility was allocated to different people. Pastoralists received work points, or "stars", for doing their allocated work, which again provided the basis on which they got food, goods and cash (Huber, 2012; Næss, 2003). This was also the case with hunting; units called 'hunting brigades' were formed, consisting of five to six men selected by the commune leaders because of their hunting skills (Huber, 2012, p. 204). (4) *Commercial hunting*—following the abandonment of the communes in the 1980s hunting again seemed to revert to a subsistence pattern. While following the de-collectivization period kill rates were relatively low, this would not last. As described above, in the mid-1980s international demand for shatoosh exploded, resulting in increased kill rates (Huber, 2012; Næss, 2003; Næss et al., 2004). Consequently:

> "The ongoing consequences of commercial antelope hunting have had profound local effects, including an indefinite ban on all hunting, confiscation and destruction of all hunting equipment and increasing official stigmatization of the practice, which is criminalized and heavily punished in the breech. Nowadays, a long history of pastoralist subsistence hunting has effectively come to an end" (Huber, 2012, p. 207).

1981, most of the wealthy and middle income nomads have forsaken hunting for religious reasons, leaving mainly the stratum of poor nomads who still hunt" (Goldstein and Beall, 1989, p. 631).

4.2 Hunting as a subsistence diversification strategy

The disbandment of subsistence hunting is disconcerting when viewed in relation to climate change. Pastoralists live in marginal areas and are experienced at coping with climatic variability (Galvin, 2009). Scenarios for future climate change generally predict an increased average, variance and even a changed distribution of important climatic variables like precipitation and temperature (e.g. Rowell, 2005; Sun et al., 2007), a trend that is evident for the Qinghai-Tibet Plateau (Chen et al., 2013). Moreover, these changes are predicted to vary both temporally (e.g. Rowell, 2005) and spatially (e.g. Hanssen-Bauer et al., 2005). Climate change is expected to result in increased frequencies of extreme weather events (e.g. Sun et al., 2007; Tebaldi et al., 2006), a trend that is already empirically evident on several continents (e.g. Sun et al., 2007). The Tibetan Plateau is no exception as both increased annual temperatures (as much as 2.6-5.9°C by 2100 where the most drastic changes occur in the autumn and winter) and annual precipitation (38-272 mm) is predicted to happen (cf. Chen et al., 2013). As for pastoralists in general, Galvin (2009) argues that severe events are occurring with increased frequency and longer duration on the worlds' dry grasslands. For Asia specifically, long series of droughts and winter disasters of 1999-2002 in Mongolia have been argued to be unprecedented (Marin, 2010). Importantly, droughts have almost doubled in frequency during the last 60 years and the worst droughts on record (>50-70% of the country) have occurred during the last decade (Marin, 2010, p. 171). In 2007, western parts of the Tibetan Plateau experienced nine continuous days of gale force wind and dust storms, a 20-year record high. In June the same year, western areas reported an average

temperature increase of 1-2°C and an average decrease in precipitation by 20-90% (Anonymous, 2009, p. 15). In general, during the past few decades evidence indicates increased spring snow accumulation as well increased frequencies of large snowstorms on the Tibetan Plateau (cf. Yeh et al., 2014).

While the socio-economic implications of global climate change is poorly understood and difficult to predict (Morton, 2007; Næss, 2012b) there is a growing body of evidence showing the detrimental effects of environmental hazards like snowstorms and drought on nomadic pastoralists (Table A.1). Tibetan nomads have always had to deal with snowstorms and cold weather, making nomadic pastoralism on the Tibetan Plateau a high-risk enterprise (Goldstein and Beall, 1990; Miller, 2000) where decisions have always been aimed at mitigating risks and averting disasters (Sheehy et al., 2006). While environmental induced risks are problematic for pastoralists in general, according to Sheehy *et al.* (2006), these risks are an especially critical constraint for nomadic pastoralists in Tibet: the winter of 1997-1998, for example, resulted in a loss of up to 70% of the total livestock population for some townships in TAR. By April 1998 it was estimated that the region had lost over 3 million head of livestock, estimated as a loss of US $ 125 000 000 (Miller, 2000, see Table A.1 for more examples). Snow, and especially blizzards, affects the Aru nomads as well. During the winter of 1997-1998 one household lost 50% of around 1 200 sheep and goats while another lost ~50% of its herd of 1 000 during one night in 1997. Another group in the basin reported that they lost around 500 animals during the same winter. In the spring of 2001, one group of nomads (*n* = 11 households) reported an average of 34.93% mortality (range 5.04-63.29%), against an average recruitment of new-borns of 21.33% (range 8.83-56.12%) based on herd

size from previous year (Næss, 2003). The high losses were primarily attributed to severe snowfall conditions especially during April and May (many carcasses of sheep and goats were observed near some of the late winter encampments, Næss, 2003). In general, Yangzong (2006, p. 37) argues that '[t]he impacts of animal mortality from snowstorm disasters are a major cause for rural poverty in the region' (see Appendix A for a discussion of poverty and appendix A in Næss, 2013 for a presentation of average number of people and animals per household from different locations on the QTP)[18].

Combined with other ecological factors such as predation and poisonous grass (*Oxytropis stracheyana*), the production system in the Aru Basin can be viewed as highly variable and unpredictable, necessitating the adoption alternative subsistence strategies to obtain a reliable food source. The Aru nomads agree that one adult needs meat from ten sheep or goats to last through the winter (see Appendix A for a discussion on this estimate). For poor households this is impossible: one household consisting of 2 adults and one infant in the Aru Basin had 79 animals (2 yaks, 53 sheep and 24 goats) in September 2000, and by summer 2001 this number had been reduced to a total of 51 (2 yaks, 33 sheep and 16 goats), a 35% loss, primarily due to large amounts of snow. If this household had slaughtered[19] 20 animals before the winter of 2000/2001 the total reduction would be almost 50% (Næss,

[18] Despite the fact that the Aru nomads experience environmental induced losses quite frequently, only one household reported that they had received governmental support: one family received 50 kg flour, 50 kg barley and 3 kg tea as welfare in 2000 (Næss, 2003).

[19] Only sheep and goats are considered here since the Aru nomads usually do not slaughter yaks unless they are very old.

2003). Also, an average household in the Aru Basin in 2001 consisted of 4.50 ± 2.84 SD people, 14.18 ± 12.87 SD yaks, 173.09 ±85.75 SD sheep, and 88.09 ± 42.38SD goats (*n* = 22 households). To eat well, households of this size should slaughter around 45 animals, depending on the age structure of people in the household, making up around 19% of the total herds. At the same time the average recruitment of sheep and goats made up only 20% of total herd size. To eat well, the off-take of the herd would thus be almost equal to the recruitment. Considering the heavy losses that they regularly experience this could be the start of a downward spiral ending up below minimum subsistence level. Since they are constantly under the threat of losing parts of their herds due to environmental factors, which again negatively affects the number of animals needed to survive a disaster, i.e. the minimum number of animals needed to recover when struck by e.g. snowstorms (Goldstein et al., 1990), hunting played such an important role in their economy (Næss, 2003).

Hunting thus had a direct consequence for capital growth, as measured in number of livestock. With no hunting, the nomads have to consume a larger part of the yield of their capital than they would otherwise have. In other words, hunting gave the Aru nomads an opportunity to get meat without cutting into the capital (i.e. animal). As such hunting was an effective way to diversify the subsistence base and reduce the risk of falling below a minimum subsistence level. Hunting was also a means of reducing the effect of disasters; when livestock was lost due to e.g. a snowstorm, they could compensate for this by hunting (Næss, 2003). This is especially important considering the fact that a growing body of evidence shows that, for nomadic pastoralists, herd accumulation is an efficient strategy for buffering environmental variation. Among Saami reindeer herders in Norway, for example,

studies have shown that herders with large herds have comparable larger herds from one year to the next compared to those with smaller herds (Næss and Bårdsen, 2010) as well as during crisis periods because herders with large herds before a collapse also have the largest herds after the collapse (Næss and Bårdsen, 2013). The underlying logic is simple: to paraphrase Fratkin and Roth (Fratkin and Roth, 1990), 'a rich herder may lose 70% of 100 animals and survive, where a poor herder may lose 50% of twenty and perish'. In short, herd accumulation maximizes long-term survival for pastoralists (see also Mace and Houston, 1989).

A case has been made that pastoralists are in a unique position to tackle climate change due to extensive experience managing environmental variability in marginal areas (Nori et al., 2008) and it has been argued that the ability to withstand environmental shocks is a *defining* feature of pastoralism (Hatfield and Davies, 2006, p. 27). Nevertheless, traditional pastoral risk management, such as herd accumulation, may be insufficient for dealing with climate change. This because climate change does not simply entail increased environmental variation but also increased frequencies of extreme events. While herd accumulation seems to be an efficient strategy, it is predicated on periods of recuperation when herd growth is possible. In fact, a delay in recuperation after environmental-induced losses has been argued to be one of the main problems of pastoral production (Bollig and Göbel, 1997, p. 8). Herd accumulation can thus be expected to work less efficiently, if at all, when the frequency of extreme events increases, necessitating the adoption of additional sources of subsistence.

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5.0 CONCLUDING REMARKS

Chiru, Tibetan gazelle, and wild yaks are currently considered endangered, near threatened and vulnerable (Harris and Leslie, 2008; Mallon, 2008; Mallon and Bhatnagar, 2008) . As the Aru Basin is considered a core area for wildlife within the reserve it is important to integrate local knowledge and local people in management goals and strategies. Chatty (2001) argues that sustainable conservation requires developing the "good will" of local human populations. It is also important to recognize the importance of local management and land-use practice in sustaining and protecting biodiversity (Chatty, 2001). If long-term sustainable conservation and development is to be successful, it will be vital to incorporate local needs in management strategies (Adams, 1998). While necessary to stop a further decline in the already protected wildlife populations, the ban on hunting has had a negative impact on the local nomads' lives, a consequence which may not have been foreseen or wished for, but nevertheless has to be dealt with. While the Aru nomads themselves understand perfectly well the need for reducing hunting on a commercial basis, they feel that hunting the "old way", i.e. subsistence hunting, poses no threat to the wildlife populations in the area. Accordingly, the ban on hunting has reduced some of the nomads' potential for making a living, which was previously partly based on wildlife resources.

This does not, however, mean that the ban on hunting must be abandoned, but rather that the nomads should be given some compensation for their loss of livelihood. As McCabe *et al.* (1992) argues, protected areas are situated in local contexts. If the economic situation for local people is in decline, long-term sustainable conservation has a limited

chance of success. Nevertheless, Goldstein (2012, p. 268) writes that for the nomads in Phala, the economic situation has recently improved and that by 2009:

> "[…] almost 50% of the households had motorcycles, many had cell phones and five had trucks or tractor-pulled carts. Roads to this remote area have been improved markedly, and in 2009 the government paid for 224 new houses (at a cost of 5.5 million RMB) in the township that Phala is part of along with community centres for each nomad village".

This improved living standard is primarily tied to increased economic value of livestock products. Of special importance for the Aru nomads is the fact that from 1986 to 2005 the price for cashmere wool increased by 669% (see Goldstein, 2012, Table 14.4 for more information). In light of this, hunting might become less economically important. Nevertheless, prices for livestock products fluctuate annually: the Aru nomads reported that during the years 1993-2000 cashmere prices ranged from RMB 65 per jin[20] in 1995 to RMB 170 per jin in 1998; and while prices, in general, seems to have increased during this period, they varied substantially from year to year (Fig. 3).

[20] 1 jin is around 0.5 kg.

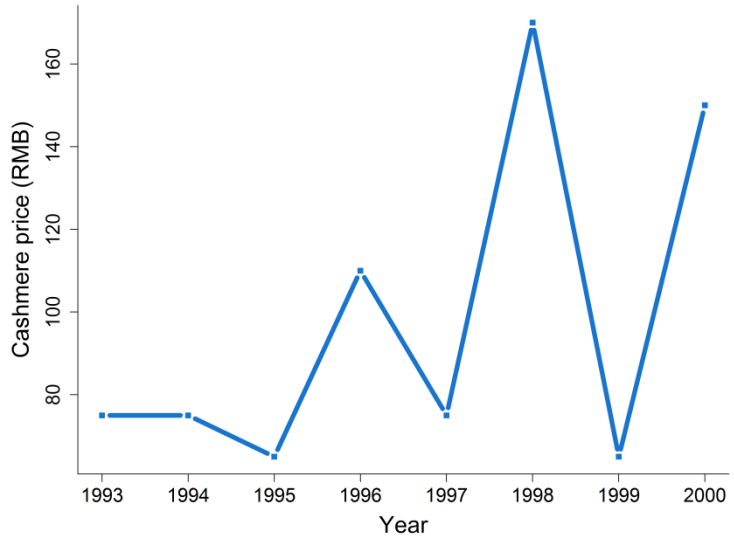

Figure 3. Temporal trends in cashmere wool prices 1993-2000 as reported by the Aru nomads. Prices are RMB per jin. Linear regression showed an increase in price over year, but this increase was not statistically significant (results not shown). Source: Table 3 in Næss et al. (2004).

Cashmere prices are dependent on both international and national markets outside of the Aru nomads' control. Cashmere prices also reflect quality of the product, with white, for example, giving a better price than colored cashmere. The quality is also dependent on the amount of fodder that the animals get; during years with heavy snowfall and scarce access to fodder, the cashmere will be of poorer quality, again giving a lower price. As a consequence, the sale of cashmere wool is an uncertain and risky enterprise necessitating the adoption of alternative sources of income and/or subsistence such as hunting (Næss, 2003; Næss et al., 2004).

The aim of this paper is to contribute to an understanding of traditional hunting as an integrated part of the Aru nomads' economy. First, hunting worked as a safety measure by which they could decrease the capital off-take of their herds for subsistence, and thereby decrease the probability of falling below a minimum subsistence level. Second, hunting could also reduce the effect of animal loss caused by snowstorms. As such the paper addresses a larger debate pertaining to the role of economic diversification—combining pastoralism with, for example, wage labor and agriculture—and pastoralism; a topic that has been vividly discussed in the literature (e.g. Bayer and Waters-Bayer, 1990; Berhanu et al., 2007; Berzborn, 2007; Hjort, 1981; Lesorogol, 2008; Little et al., 2007; Marx, 2006; Næss, 2012a; Sperling, 1987; Thornton et al., 2007). Some even goes as far as arguing that the traditional point of view of treating is pastoralism as a primarily subsistence economy geared towards livestock is misguided because pastoralists engage in a variety of occupations, the relative importance of which change according to socio-economic changes (Marx, 2006).

Ban et al.(2013) argue that conservation failure often stems from the fact that social considerations are not integrated in management plans and when incorporating social considerations, plans are more likely to achieve their goals and to be sustainable. Taking the local perspective into account may also help reducing some of the resentment toward wildlife which the ban has created, especially towards the chiru. While hunting gave the Aru nomads a feeling of getting something substantial back from the presence of wildlife, the ban has not only resulted in the view that wildlife competes with their livestock for forage, but also that they are not wanted in the basin. Several nomads stated that they did not believe that life for both humans and chiru is possible in the Aru Basin. Consequently, it can

be argued that local attitudes at present do not present an ideal context for successful conservation initiatives, and measures for improving local attitudes towards wildlife need to be initiated.

6.0 COMPLIANCE WITH ETHICAL STANDARDS

This study was undertaken in accordance with the "General guidelines for research ethics" as stipulated by the Norwegian National Research Ethics Committee (NNREC; https://www.etikkom.no/en/). Specifically, interviews where undertaken in accordance with NNREC's ethical checklist/summary by: (1) obtaining informed consent (verbal in this case); (2) ensuring that no dependent relationship exists that could influence the subjects' decision to give consent; and (3) guaranteeing anonymity and confidentiality of the informants.

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Appendix A – Additional information

Poaching

In 1996 more than 20 poachers were arrested in Arjin Shan Reserve (in Xianjiang Province). Among the confiscated material were seven rifles, 10 000 rounds of ammunition and 1 100 chiru carcasses (Popham, 1998). Also, from 1990-1998, Chinese authorities have documented 100 cases of chiru poaching, with the confiscation of 17 000 chiru pelts, 1 100 kg of chiru wool, 300 guns and 153 vehicles used by poachers (Li et al., 2000). Also, during our first fieldtrip in June 2000, the Forestry Police officer that came with us spotted what he referred to as “a suspicious looking truck”, which was chased down. In the back of the truck we found 13 antelope skins and 19 heads. The people in the truck claimed that they bought the skins and heads from nomads in the surrounding area, RMB 150 for one skin and RMB 50 for one head. According to the Chinese law of wildlife protection, they are supposed to pay RMB 10 000 as a fine, but since they were poor the policeman agreed upon a fine of RMB 1 000 for the driver of the truck. However, the perpetrator claimed they have no money. The policeman then said he would confiscate the truck if the driver didn’t pay up. The other people in the truck were given a fine of seven times the price they paid for the individual skins and heads. However, they pleaded for mercy and the policeman settled with getting RMB 3 000 from the buyer of the skins and heads. The driver still had no money, but he borrowed RMB 800 from the buyer, which satisfied the policeman. He went on to say that he needed to punish them hard; if he were too kind with them then maybe they would continue buying illegal wildlife products. Further east, in the Kekexili nature reserve (Qinghai), 15 additional police officers and 4 new stations has been added to guard against poaching and illegal mining. The reserve, that previously was a favorite target for illegal

hunting, have experienced an increase in chiru population and since 2006 police officers have discovered no more poachers (Shuang, 2012). Nevertheless, Khandal (2012) writes that the illegal trading of shatoosh is still a problem in the Tibetan region. A news report form china.org reported on February 15, 2012 that the customs office in Lhasa confiscated 85 kg of Tibetan antelope cashmere culled from about 567 chiru in 2011 (China.org, 2012). Another news report from January 8, 2013 states that Nepali officials confiscated 1150 kg (estimated to come from ~7000 chiru since only ~150 g can be collected per individual) of shatoosh from smuggler, estimated to be worth USD 4 000 000 (Phayul, 2013). The World Wide Fund for Nature has estimated that the population of chiru have declined by more than 50% during the last 20 years of the 20th century due to the demand for shatoosh (Phayul 2013).

Calorie and protein needs

The Aru nomads' estimate that one adult needs meat from ten sheep or goats to last them through the winter may seem to be unrealistically high, e.g. a reference family from Dahl & Hjort (1976) consisting of 4.9 adults equivalents would need about 318 g protein and 13 800 kcal per day to survive. Also, for reference, a slaughtered male sheep of 20 kg in northern Sudan or Somalia may on average yield 80 700 kcal and 2 kg protein (for comparison: the average carcass weight of Tibetan sheep aged 4 years has been estimated to 20.1 kg, see Yingchun and Qingping 2002 for details). The season where the Aru nomads need most meat is from November to May (when milking starts), giving an estimate of 210 days when meat plays the substantial part of the diet. Using the numbers from Dahl and Hjort (1976) the Aru nomads would need to slaughter around 36 sheep equivalent to cover calorie and

protein needs for 210 days. However, it is uncertain at what level Tibetan sheep and goats lie in relation to calorie and protein yields. Due to high altitudes and grassland conditions it is unlikely that sheep yield the same amount of protein and calories as that of Sudan or Somalia. Consequently, it is probable that the Aru nomads have to slaughter more animals to cover their calorie and protein needs. Also, the estimates discussed in the main text is based on the Aru nomads subjective preferences and they are most likely based on more than just covering basic needs[21]. For nomads in Nachu (Amdo Xian) "According to the nomads' standard, a herd of 50 sheep or 6-7 yak would be enough to meet the protein needs of an adult […]. It takes a considerably larger number to meet caloric needs […]" (Liu, 2002, p. 12). Moreover, "In Doma, grain is a seasonal replacement for milk and meat, but also a regular supplement and ultimate reserve for bad years. Because roughly 40%-60% of these nomads' annual calories derive from barley and other grains, trade for grain has always been an integral component of their subsistence economy" (Liu, 2002, p. 12). Moreover, Beall and Goldstein (1993:478) found that source of calories for the nomads in Phala vary seasonally, with winter being the season where meat provides the largest amount of calories: median of 36-53% which is approximately 200-500 g of boiled mutton daily. In contrast meat comprises only 4-8% and 10-33% during summer and spring respectively.

[21] In Phala, for example, Goldstein and Beall (1990, p. 97) argues that the number of animals slaughtered varies by wealth: on average the number of sheep/goats slaughtered per person was 4.4 in 1986 through 1988; rich households slaughtered 8-10 while poor only 1-2 per person. Also, ~9% of the total livestock population in Phala was slaughtered for meat in 1987.

Poverty on the Tibetan Plateau

According to Miller (2000:88), in the Tibetan Autonomous region households with number of animals below 25 sheep equivalent units[22] (SEUs, approximately US$80) per person are considered poor, since families with less than 25 SEUs would not be able to meet their basic needs. According to this definition, few of the nomads in the Aru Basin can be considered as poor, since almost all of them have a higher SEU than that (Fig. A.1). Furthermore, Miller (2000:91) reports a rich family of nomads in Phala, Shigatse Prefecture in 1997—consisting of 6 persons—as having 944 SEUs in total, with 157.3 SEUs per person. In contrast, the wealthiest household in the Aru Basin—in terms of SEU—had in May 2001 697 SEUs, with 116 SEUs per person (6 people in the household). At the same time, the poorest household had 57.4 SEUs, with 19.1 SEUs per person (3 people in the household). In general, however, few of the interviewed household in the Aru Basin can be classified as poor with reference to having below 25 SEU per person (Figure A.1). Moreover, compared to other pastoral communities on the QTP, the Aru nomads are neither the poorest nor richest (Figure A.2 and A.3).

With specific reference to the Tibetan Autonomous Region (TAR), Miller (2001) argues that while China has experienced a remarkable economic growth in recent decades, poverty is still a problem. Specifically, Miller (2001) writes that "[s]ome of the poorest people in China remain the minority herders of Tibet, who are struggling to eke out a living in a harsh environment where animal husbandry is one of the few options they have".

[22] In general, there are different ways of standardizing the value of livestock across species. Following Miller (2000, p. 88) SEUs are calculated on the basis that one adult sheep is 1 SEU; one yak is 5 SEUs; one goat is 0.9 SEUs and one horse equals 6 SEUs.

Furthermore, the per capita income in TAR is arguably half of the average of China (Miller, 2001). More recently, the proposal for Tibet Development and Poverty Alleviation Program under the United Nations Development Programme (UNDP, 2006) reports that while The Human Development Index (HDI) has risen from 0.387 in 1990 to 0.586 in 2003 (moving the region from the low development level to the threshold of medium development), TAR continues to be ranked last among the 31 provinces and regions of China. On 16th October 2014 tibetanreview.net (2014) reported that despite major poverty alleviation efforts, 34.4 percent of Tibetans in farming and pastoral areas of TAR are still stuck below poverty line and accounts for the highest poverty rate in the People's Republic of China. In sum then, poverty seems to be a prevalent problem for herders on the QTP, making subsistence diversification important.

Tables

Table A.1. A selected overview of environmental induced losses among nomadic pastoralists.

Period	**Area/Region**	**Loss** (sample size and number included if present)	**Source of loss**
1955-1990	Tibetan Plateau	20-30% livestock[1]	6 harsh winters w/heavy snowfall
1988	Phala (Shigatse)	100% neonatal mortality of sheep and goats[2]	NA
1996-1997	Phala (Shigatse)	70% of juvenile goats and 20% of lambs and the loss of one quarter of their adult goats[3]	Winter
1986	Phala (Shigatse)	30% of livestock[4]	5 days of snow in summer
1997-1998	Nyerong (Naqu)	23.8% yaks; 19.1% sheep and 15.3% goats[5]	Severe winter
1997-1998	TAR	some lost up to 70% of their total livestock, the region lost over 3 million head of livestock[6]	Severe winter
1980-1990	Naqu	1 050 000 heads of livestock[7]	Snowstorms
1967-1957	Yushu (Qinghai)	30% loss of livestock (926 876 heads) [8]	Snow disasters
1971-1972	Yushu (Qinghai)	9.17% and 26.7% loss of adult and young respectively (724 000 heads) [8]	Snow disasters
1974-1975	Yushu (Qinghai)	15.54% and 24.3% loss of adult and young respectively (787 000 heads) [8]	Snow disasters
1981-1982	Yushu (Qinghai)	9.9% livestock loss (1 320 000 heads) [8]	Snow disasters
1984-1985	Yushu (Qinghai)	17% livestock loss (990 000 heads) [8]	Snow disasters
1995-1996	Yushu (Qinghai)	33.37% livestock loss (1.290.000 heads) [8]	Snow disasters
2005	Amboseli, Kenya	32% cattle mortality[9]	Drought
2000	Kajiado, Kenya	50% cattle mortality[9]	Drought
1976	Kaputiei, Kenya	8-75% cattle mortality[9]	Drought
1961	Kajiado, Kenya	70% cattle mortality[9]	Drought
1927	Kajiado, Kenya	13-15% cattle mortality[9]	Drought
1927	Narok, Kenya	30% cattle mortality[9]	Drought
2000-2001	Ethiopia and Kenya	25% of herds (average). Number of stockless households increased from 7 to 12%[10]	Drought
1996-1997	Somalia and Kenya	10-25% cattle mortality; 24.2% sheep mortality; and 16.6% goat mortality on average[11]	Drought
1993	Mongolia	750 000 livestock; 110 households all animals; and 2090 households lost >70%[12]	Icing
1999-2002	Mongolia	12 000 0000 livestock died[13]	Winter disasters
1990-1992	Kenya	64% (n = 178) and 32% (n = 137) loss of tagged sheep and goat mothers[14]	Drought

[1] Jiang (in Miller, 2000, p. 87).

[2] Goldstein & Beall (1990, p. 70).

[3] Miller (2000, p. 88).

[4] Goldstein & Beall (1990, p. 70).

[5] Miller (2001, table 12). Before the winter, 20% of the pastoral population in Naqu Prefecture lived in poverty while the following year this number had doubled to 40%.

[6] Miller (2000, p. 88).

[7] Yeh et al. (2014, p. 64). The area experienced 11 severe winters with serious snowstorms between 1956 and 1998, of which five occurred between 1985 and 1998.

[8] Nori (2004, p. 13).

[9] Nkedianye et al.(2011, table 5).

[10] McPeak and Little (2005, p. 91).

[11] Little et al. (2001, p. 157). Note that averages are based on 5 locations.

[12] Templer et al. (1993, p. 113).

[13] Janes (2010, p. 239).

[14] Mace (1993, p. 331).

Figures

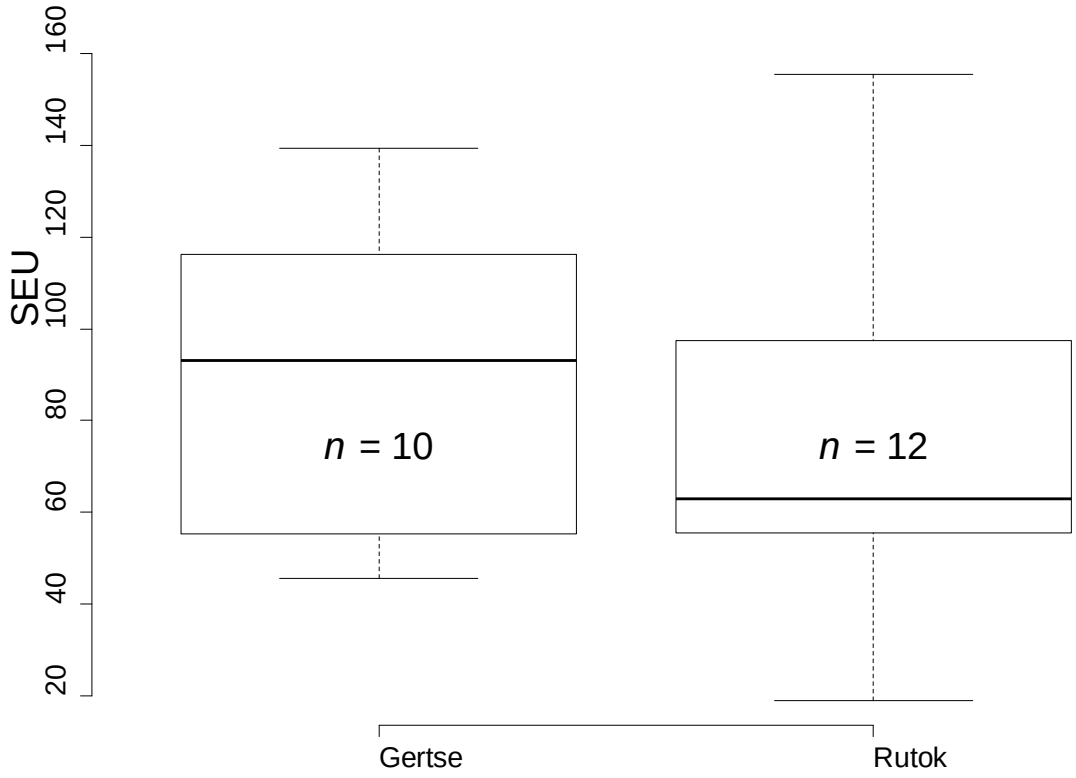

Figure A.1. Distribution of sheep equivalent units (SEU) per household for the nomads in the Aru Basin May 2001.

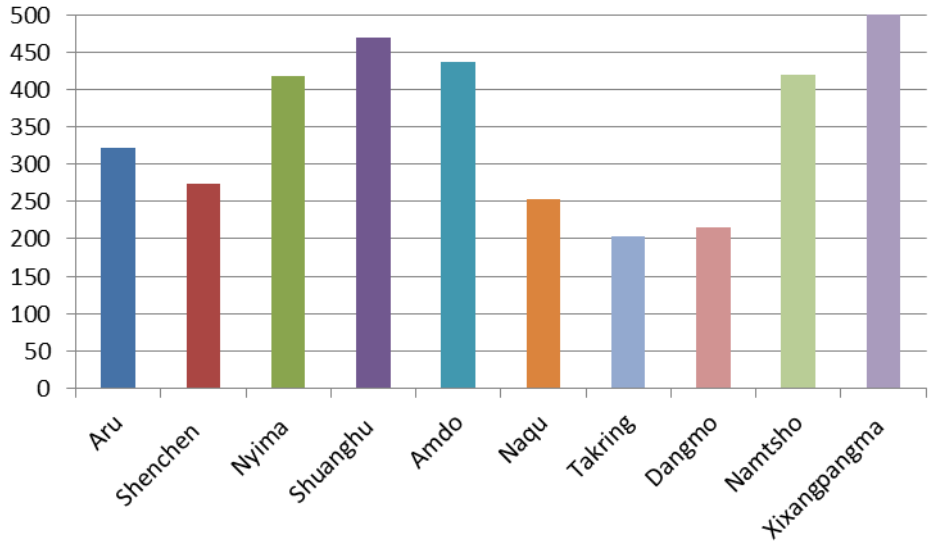

Figure A.2. Total SEU per household for different locations on the Qinghai-Tibetan Plateau.

Source: adapted from Appendix A, Table A1 in Næss (2013).

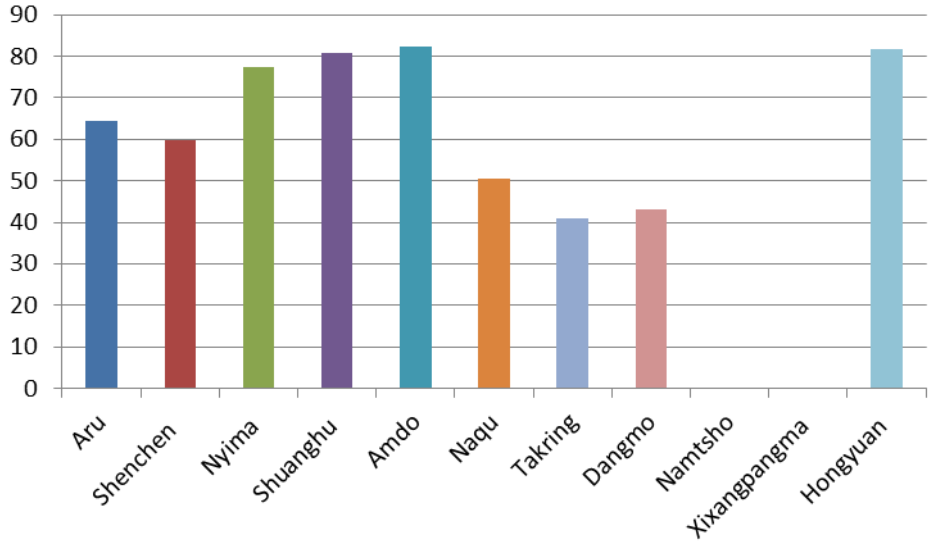

Figure A.3. Average SEU per household for different locations on the Qinghai-Tibetan Plateau. Adapted from Appendix A, Table A1 in Næss (2013). Missing bars indicate unavailable data in relation to number of people in households.

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