

Mountain-Oases Faced with New Roads: Case Studies from the Andes and the Himalayas

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Abstract In the dry regions of high mountains, communities often live in small oases; relying on rivers fed by snow/glacial melt waters, villagers develop gravity-fed networks, so as to irrigate their surrounding valleys and terraces. Our two case studies, Uspallata (12 km²) in the Mendoza River Valley of the Central Argentinian Andes, and Mustang District (almost 2000 km²) in the Kali Gandaki Valley north of the Nepalese Himalayas, illustrate the functioning of oasis systems and recent changes brought about by the development of roads, related to their position close to international boundaries.

Keywords Roads · Mountain-oases · Systems · Himalayas · Andes

1 Introduction

As seen in the previous chapters, an oasis is primarily a fertile or green area in a (semi-)arid land, made so by the presence of water. It can be found in various topographic environments: although extended and flat desert oases are those most commonly described in the literature, oases found in arid highlands and mountains cannot be neglected due to their local significance. In fact, they are the subject of many studies, dealing with different issues: access to and distribution of water for irrigation (Kreutzmann 1988), the quality of the resources (soil and water salinity, carbon dioxide) such as in the Balad Seet Oasis in the Sultanate of Oman (Wichern et al. 2004; Luedeling et al. 2004), volcanism in the Timber Mountain-Oasis in Nevada (Christiansen et al. 1977 or Snyder and Carr 1984, for the oldest ones) and,

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more generally, ecosystems, biodiversity and environmental management, such as in the Ethiopian highlands (Hurni et al. 2011) and the Central-Asian mountain-oases (Sun et al. 2007; Kreutzmann 1988, 2014). However, the term “mountain-oasis” does not appear in the now-famous oasis typology of Clouet (1995). This may partly be explained by the rather small size of such oasian spaces, which are not really included in globalised trade, especially of crop products. Therefore, what are mountain-oases? Do they have special features? How can such spaces be differentiated from other irrigated highlands?

Mountain-oases do have some special features. Firstly, their position in mountain regions limits the possibilities for spatial expansion, due to the scarcity of flat areas. In fact, most mountain-oases are located on inherited flat or gently sloping terraces, either in valleys that were formerly glaciated, and/or in intermountain depressions of varying origins (tectonics, fluvial erosion, etc.). Secondly, their elevation is a significant characteristic because it controls some environmental components: the presence of glaciers, the occurrence and duration of snowfall and frost, hence indirectly the availability of water for irrigation. Thirdly, their functioning is similar to that of piedmont oases in that they “*collect water directly from mountain rivers, by water intake and canals, whose slope is calculated so that the flow is brought to the field to be irrigated by gravity*”¹ (Clouet 1995). Finally, mountain-oases can be considered “mini”-piedmont oases, i.e. isolated piedmonts within an arid mountain environment, where both the confinement and the steepness of the slopes make the circulation along routes longer and more difficult than in the plain, and may explain their relative remoteness from the main commercial routes and urban centres. Yet, they are also privileged sites where water and soil resources, though limited, contrast sharply with the adjacent, dry and sterile mountain slopes.

Our two case studies, the Oasis of Uspallata in the Argentinian Andes and the oasian archipelago² of Mustang District in the Nepalese Himalayas, are examples of highland oases dispersed in their arid mountain environments. Yet, sited along old trade corridors, their former systems have recently changed with the development of new roads, related to the opening of an international border. These new roads could be considered the entry points of the mountain-oasis systems into globalisation. However, the two examples differ in at least two ways. Firstly, the temporalities are not the same: the changes due to the road occurred earlier in Uspallata than in the Mustang area (where the road was completed in late 2015), and therefore, their insertion into global exchanges has not yet reached the same degree

¹All translations from Spanish or French are by the authors.

²Archipelago: also see Chapter “[Liwa: The Mutation of an Agricultural Oasis into a Strategic Reserve Dedicated to a Secure Water Supply for Abu Dhabi](#)” by Cariou on Liwa. Like an island archipelago, an oasian archipelago is used to describe a group, chain or cluster of oases, generally linked to each other through a similar culture, heritage or use of resources, in a common network, forming a system.

in the two locations. Secondly, the straightforward link established between Chile and Argentina across their border cannot be compared with the sensitive geopolitical situation in which Nepal is squeezed between China and the Indian subcontinent. Although both roads were planned to develop the international trade of manufactured goods, in Mustang this project may conflict with the tourism activity closely linked to environmental conservation issues. The question then arises: how has their entry into globalisation, due to a new road development, modified these oasis systems in such a mountainous environment?

Based on fieldwork observations and a bibliographical review, rather than on a comparison between two fieldwork areas, we aim to analyse the alterations in mountain-oases following the opening of new routes: two oases with different cultures, heritages and political situations, but facing similar types of changes, with different temporalities. After a descriptive summary of these two former mountain-oasian systems (Part II), this chapter will show the transformations brought about by the development of new roads in the 1980s in Uspallata and in the 2000s in Upper Mustang (Part III).

2 An Oasis and an Oasian Archipelago Included in Continental Trade Routes

Here, we present the two “mountain-oasian” systems in their historical perspective and functioning until the recent changes of the late twentieth century. In both cases, it appears that the initial location of these village-oases is not fortuitous but related to the existence of old, natural circulation routes favoured by their relative accessibility compared to the surrounding steep mountain slopes. We show how these oasis systems, whose economy is mostly based on irrigated agriculture, husbandry and (for Mustang) seasonal nomadism, have evolved over time while still remaining open to the outside world.

2.1 Uspallata, 4000 Years of History

The Oasis of Uspallata is sited in a graben³ between the Pre-Cordillera and the Frontal Cordillera, around 2000 m asl. This depression is drained by a series of small streams with snow-rain hydrological regimes, whose main tributary, the Uspallata Stream, merges with the Mendoza River in the south (Fig. 1b). The Uspallata Stream waters were diverted to create a small mountain-oasis of 12 km² in the heart of this dry environment, which receives 156 mm of precipitation a year, in both snow and rain forms.

³Graben: geological term for a depression between faults, resulting from tectonic movements.

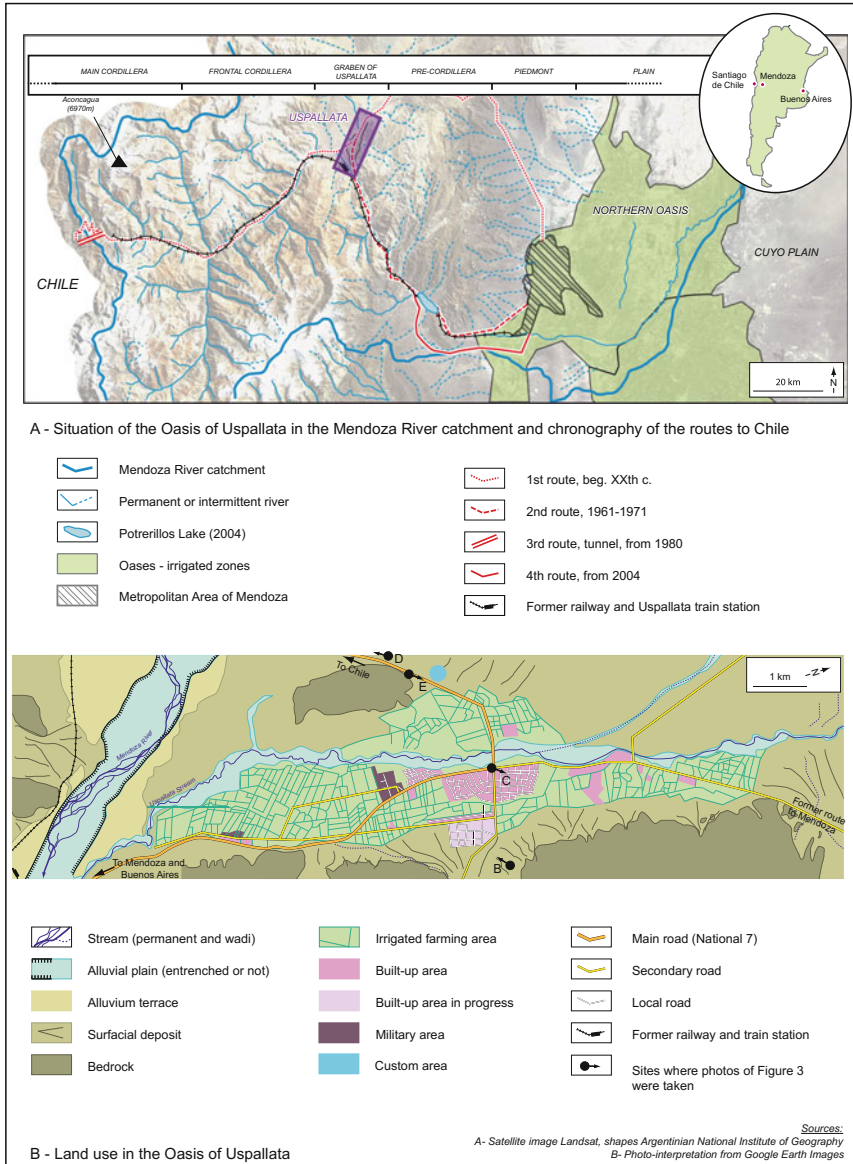


Fig. 1 Oasis of Uspallata as a node on the Andes crossing

According to some data recorded at the beginning of the Spanish colonisation at the end of the sixteenth century, a native community—named Huarpes—developed agriculture in the Cuyo region, the arid piedmont of the Central Argentinian Andes. The Province of Mendoza is now one of the three provinces of this Cuyo region.

Ponte (2006) estimates the beginning of agriculture in the Uspallata graben at around 1700 BC. By diverting small streams, people could cultivate vegetables (carrots, potatoes) and perhaps some cereals.

Then, at the end of the fifteenth century, the Incas, pursuing their Southern Conquest, arrived in Cuyo. Thus, during the 80 years preceding the arrival of Spanish colonisers in 1561, Uspallata was no longer an isolated irrigated area, but part of the road from Cuzco to the South.

During the Spanish colonisation, Argentinian mountains and piedmonts depended on the Chile Captaincy and not on the Plata Viceroyalty (which is now Argentina). Yet, at that time, the Andes and their piedmont were still the structuring axis of the roads. However, Buenos Aires could not trade directly with Europe: according to a Royal Decree, every imported product had to come from Lima. The main roads passed by Upper Peru (now Bolivia), but a more direct route from Santiago to Buenos Aires by Uspallata and Mendoza was gradually developed. Products came by boat from Lima to Valparaiso, then by road from Valparaiso to Argentina via Santiago. In the other direction, from east to west, the pampas region of Buenos Aires became a cattle-farming region from where cows were exported to Chile (Ponte 2006).

A series of rest-stops grew up in Cuyo for cattle resting and breeding. Although the main one was in Tunuyán—in the Valle de Uco, 150 km south of Uspallata (Robillard 2010)—one road passed by Uspallata. All these oases were mainly devoted to pasture crops for cattle breeding, in addition to food crops. The north–south structural axis of the Andean piedmont was replaced by a west–east axis, which is now the pan-American road from Santiago to Buenos Aires.

Argentinian National Independence in 1816, then the arrival of the railways, and with it, European migrants in Argentina (and in Mendoza in 1884: Chambouleyron 2004; Ponte 2006) did not really change the oasian landscape of Uspallata. Unlike the piedmont oases (100 km east of Uspallata following the natural axis of the Mendoza River Valley, Fig. 1a) which turned to Mediterranean crops (see Lavie et al. Chapter “The Transformation of the Oases of Mendoza (Argentina): How the Provincial Socio-Spatial Structure Was Reversed By the Crises of the 1980s and 2000s” of this volume), in Uspallata, the mountain climate and its low winter temperatures prevented a change in agriculture. Although its function as a rest-stop slowed down when Buenos Aires started to trade directly with Europe after Independence and when the railway was built, Uspallata’s economic activities remained food crops and pasture. The cadastral allocation was quite similar to the one observed today, with large trees as barriers to strong winds and small plots, mainly for subsistence crops (Figs. 1 and 3d).

Yet, although the agricultural landscape did not evolve that much, the twentieth century saw a change in the role of Uspallata within the Province of Mendoza and in the relationship between Argentina and Chile.

In fact, the continuation of the railway between Buenos Aires/Mendoza to Chile had to pass by Uspallata (Fig. 1). Thus, the *transandino* operated from 1910 to 1984, even though some segments were destroyed by the flooding of the Mendoza

River. In 1978, however, it became quicker to take the road than the train, and although freight transport persisted for a few more years, it had to stop in the early 1980s after a landslide in Chile blocked the track.

Regarding the roads, the itineraries changed during the twentieth century but, as shown in Fig. 1, Uspallata remained the central traffic node, replacing the Valle de Uco, which had benefited from this role during the nineteenth Century (Robillard 2010).

Finally, its nodal situation, the flat topography of the graben in the heart of the Andes, and the existence of a stream essential for irrigation in this desert altogether made Uspallata a strategic place to control the region. It was a gathering point for the Andes Army before it crossed the Cordillera to boot the Spanish colonisers out of Chile at the beginning of the nineteenth century. Eventually, and most importantly, the National Military Force settled in Uspallata in the middle of the twentieth century, so as to control the frontier during the 50 years of alternating military dictatorship and democracy, on both sides of the Andes. As proof of its lasting presence, the Argentinian Army bought the main part of the pasture lands in 1955, playing a role in cattle breeding for personal use during the cross-border conflicts with Chile.

To sum up, the long-lasting agricultural usage was gradually completed by a nodal and military role with the Independence of the country, but this did not really transform either the system or the landscape. The new Republic in 1983 and the opening of a tunnel in 1985, both facilitating the relationship with Chile, radically changed the role and the former system of the Oasis of Uspallata.

History made Uspallata sometimes a dead end, sometimes a crossing-point. In any case, it played a strategic central role, either for trade or border control. This alternating situation depending on the political context is quite characteristic of territories close to a border, as will be seen in the next example, the Mustang oasian archipelago.

2.2 Mustang: A 3000 Year-Old Traditional Oasian Archipelago

The Mustang District (Nepal) extends over an area of 3573 km², with an estimated human population of 13,452 (Government of Nepal 2014), and a population density of 4.1 inhabitants/km² (the lowest in the country), living in oasian-type villages at elevations ranging from 2500 to 3800 m asl. The central and northern parts of the Mustang District consist of a large arid upland of tectonic origin (e.g. the Thakkhola–Mustang Graben; Fort et al. 1982). It is drained southward by the Kali Gandaki River (a major tributary of the Ganges), the very axis and waterway of the Mustang District, which makes it the natural link between south and central Asia, and the site of one of the ancient trade routes linking India to Tibet (von Fürer-Haimendorf 1975; Graafen and Seeber 1992–93).

The physiography of the Upper Mustang basin (north of Kagbeni), the former Kingdom of Lo (Peissel 1967), is quite dramatic, characterised by its asymmetry. In contrast to the eastern, barren and dissected gentle slopes, the steep, western flank rises to 6500 m and is covered by a few glaciers providing the melt waters to supply the oasis villages and irrigate their crops (Fort 2000). The Kali Gandaki River is deeply entrenched (>200–500 m) in a canyon across multicoloured sediments, which makes Upper Mustang a very attractive place despite its harsh climate. In fact, Middle and Upper Mustang are cold and windy mountainous deserts, due to their elevation (2500 m to more than 8000 m asl in central Mustang) and position on the northern rain-shadow side of the Greater Himalayas. A 6–7-month-long winter alternates with a rather short 3–4-month summer, with two very brief intermediate spring and autumn seasons. Mean annual temperatures vary between 5 and 16 °C (from north to south), but there are large disparities according to elevation, aspect and location, especially with regard to the alternating, desiccating winds. The precipitation (mainly snow) is less than 300 mm/year as measured at the Jomsom meteorological station (2700 m, Fig. 2) in Middle Mustang, but there is a

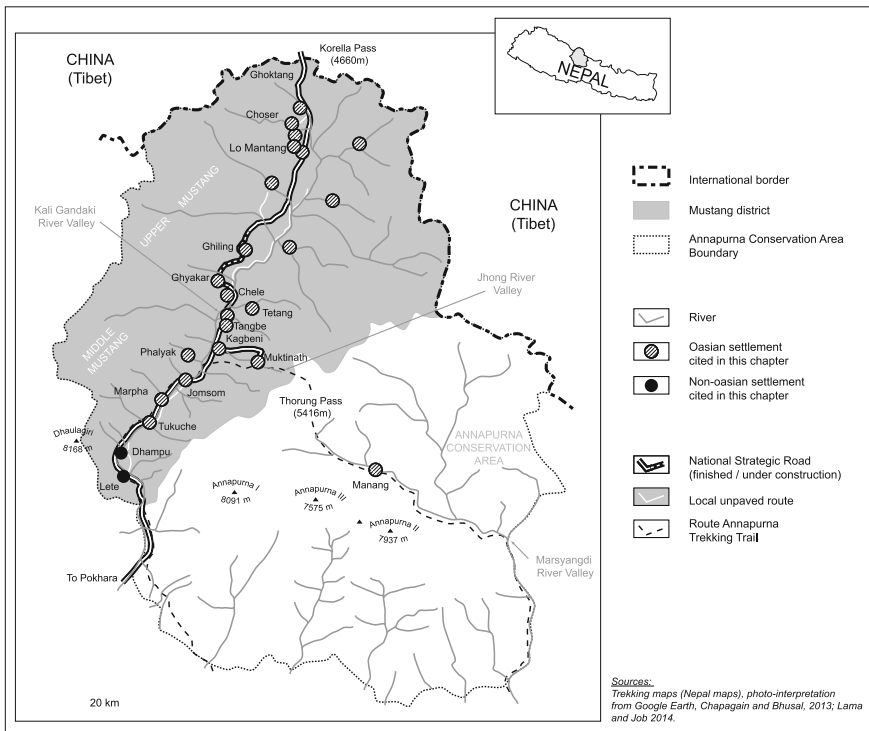


Fig. 2 Middle and Upper Mustang Archipelago, part of the Annapurna Conservation Area (ACA) Project

gradient of aridity increasing northward (<150 mm/year in Lo Mantang, 3600 m), and upward along the steep western side of the basin, limited in elevation by coldness (DHM on-line; CEPAD 2011; Fort 2014).

These different environmental characteristics explain why most of the oasis settlements are located either on the edges of wide tributary fans of the Kali Gandaki River in Middle Mustang (such as Marpha, Fig. 2), or on the gently sloping wide terrace benches built up at the end of the last Quaternary glacial period and now perched several hundred metres above the Kali Gandaki River in Upper Mustang (such as Ghyakar, Fig. 3f). This situation has made it necessary to divert waters supplied by the tributaries of the Kali Gandaki River and/or by groundwater emergences, in order to develop gravity-fed irrigation systems. Although between Tukuche and Kagbeni (Fig. 2), the village-oases sited in the arid Kali Gandaki plain are still partly overlooked by open forests of cedar or juniper trees, north of Kagbeni, at the entry of Upper Mustang, the villages appear as green islands in an otherwise wild, barren, dissected mountain landscape (such as Tetang, Fig. 3g).

The first evidence of human presence in Mustang has been provided by archaeological findings. Early occupants probably migrated from West Central Asia (Xinjiang), as attested by petroglyphs (Pohle 2000), and first settled in caves carved out of the Quaternary consolidated debris, as can be observed in many places (Simons and Schön 1998; Simons et al. 1998). In the Jhong Valley, a left-bank tributary of the Kali Gandaki River at the transition between Middle and Upper Mustang, significant remnants of early settlements (1000–800 BC) confirm at least 3000 years of permanent occupancy (Alt et al. 2003). It seems that, after clearing the natural forests (mostly pine, juniper and birch trees; Miehe 1984; Miehe et al. 2009), these early settlers developed irrigated agricultural practices based on alternating crops of buckwheat and barley in much the same way as is still done today (Knörzer 2000). Palaeo-botanical investigations also indicate the presence of other crops such as true millet and peas, and including plants derived from tropical and subtropical regions (rice, soya beans, lentils, bamboo), which indirectly demonstrates the existence of an early trading route from the southern Indian subcontinent following the Kali Gandaki Valley upstream. In addition, recent research on the spread of Buddhism from Lumbini (Lord Buddha's birthplace in southern Central Nepal) to, and connected with, the Silk Road has shown that Mustang was the most frequented of the three roads through Nepal (von der Heide 2012), because of its easy access, without high mountain passes but with a small plateau at 4660 m, the Korella Pass.

At that time and as mentioned above, the main bases of the traditional way of life in Mustang were irrigated agriculture in summer and out-migration in winter, combined with animal husbandry throughout the year, a system which, to a certain extent, still persists today. The irrigation system is composed of a series of gravity-fed canals, which usually branch out from glacial tributaries of the Kali Gandaki and run for long distances down to the villages, situated on alluvial fans or terraces (Fort 2000) (Fig. 3). The take-off canals are either carved into the bedrock (such as in Ghyakar; Fig. 3f) or more often appear as simple diversions of the

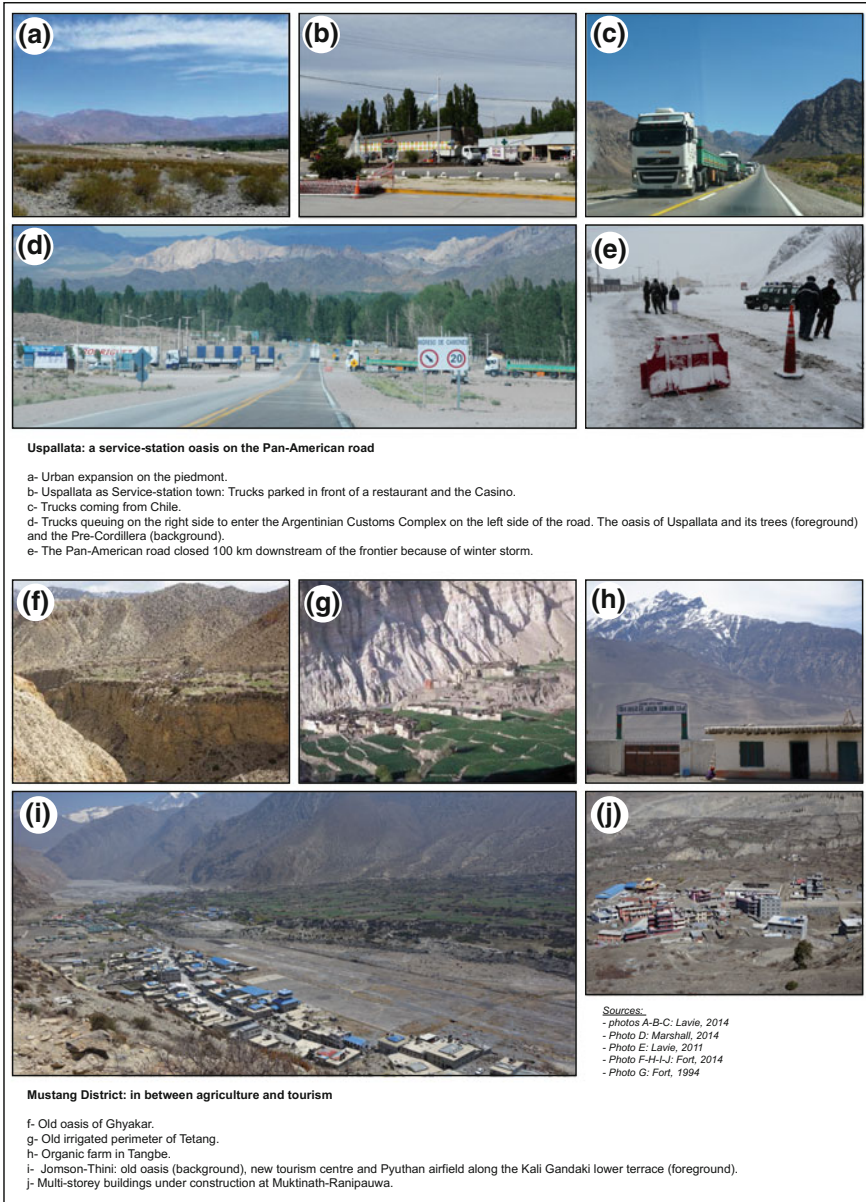


Fig. 3 Transformation of Uspallata and Mustang Oases

streams, going from the streambed down to the irrigated areas. Where the tributaries originate from underground springs, they supply a limited amount of water, which needs to be stored in reservoirs, such as in Ghilling or Phalyak. The irrigation system and allocation of water over time depend mostly on socio-economic and

political factors, and on the status of the land ownership and rights to water and other resources (Chalaune 2009). In Upper Mustang, the Raja used to own most of the land (and still does, even after the advent of democracy), whereas in Central Mustang the landowners belong to the highest castes. Unlike in Central Mustang where two crops a year are grown, only one crop a year is grown in Upper Mustang, primarily naked barley and buckwheat, and additional vegetables (potato, cabbage, tomato, pumpkin etc.). Agricultural work requires a high labour input and careful attention and management, including the use of natural fertilisers such as compost, manure or cattle dung.

Animal husbandry (mostly yaks, dzos, horses, mules, donkeys, sheep and goats) has always been associated with agricultural activities (Blamont 1996; Lama 2011) as it is the major source of fertiliser. It also provides many products that are used for food (meat, butter), clothes (wool, hide) and transport (yaks, horses), both on an everyday basis and with seasonal pastoral practices in the upper rangelands. Moreover, until recently, it was a major source of income during the summer transhumance across the Korella Pass with goat and sheep trading in Tibet (China), bartered with Tibetan salt (von Fürer-Haimendorf 1975). Then, after the harvest, people started to migrate south by mid-November, with Tibetan salt and wool, highly valued products sold in India. They returned to Mustang in early spring, loaded with rice and other food grains or sugar from India. It should be underlined that although winter out-migration still exists, the summer trade declined drastically after the Chinese occupation of Tibet (1959) and the closing of the northern border: the former Kingdom of Lo was declared a restricted area, Mustang lost its main source of income, and limited herding resulted in a progressive degradation of the rangelands on the Nepal side (Aryal et al. 2013).

In the following decades, several turning points occurred, initiated by decisions taken at the national level.

Firstly, in Central Mustang where a similar agricultural livelihood existed, based on irrigated crops and cattle herding to the upstream pastures of the tributaries of the Kali Gandaki, a significant change took place in the late sixties, with the setting up of the Agricultural Farm of Marpha (now Marpha Horticultural Centre). The farm brought innovative practices: for the first time in Nepal, apple, apricot and peach trees were grown, and the farm also produced vegetable seeds (Gurung 1980). This experimental farm was so successful that in the 1970s, every villager started planting orchards on their land and selling their products (fresh and dry fruits) to tourist lodges. Yet, there was a risk of over-production due to the lack of a transportation network, a concern that had already been raised in informal discussions in the early 1980s (Byers 1985). Only a limited part of the apple production could be exported, carried by porters to the closest main market of Pokhara (the second largest town in Nepal), requiring a 5-day walk.

Secondly, and in parallel with this new agricultural trend, the Annapurna Conservation Area Project (ACAP, Fig. 2) was launched in 1986 to achieve a “*sustained balance between nature conservation and socio-economic improvement*”; in particular, to reduce the pressure on open forest resources used as fuel wood and for construction (mainly lodges), and to protect the exceptional biological

diversity in the rangelands of Upper Mustang. This region is a key trans-Himalayan corridor for the migration of species such as the wild ass (*Equus kiang*), the famous Tibetan Sand Grouse and the Demoiselle Crane (NTNC 2008), many of which are endangered and protected species (UNDP 2006). Managed on a participatory basis at different administrative levels, the ACAP project's aim was to protect Mustang's fragile environment while promoting economic development, a real challenge.

Thirdly, the opening of the Mustang District to tourism was certainly the main factor of socio-economic change, and a kind of compensation after the closing of the Tibetan border and the collapse of the trans-boundary traditional trade. In 1964, the former King Mahendra allowed the first foreigners to visit the Kali Gandaki Valley up to Jomsom (Sacareau 1999), then the valley was closed again from 1975 to late 1976, to avoid conflict with the Tibetan "khampas" rebels occupying the entire Mustang District. In autumn 1976, the area was again opened to foreigners up to Kagbeni and the Jhong Valley, with its famous pilgrimage site of Muktinath (for both Hindus and Buddhists coming from the entire Indian subcontinent). For the first time, the link could also be made with the adjacent, newly opened Manang Valley, hence initiating the world-famous trekking route "around the Annapurna" massif through the Marsyangdi Valley and the Thorung Pass (5416 m) (Fig. 2). This led to the building of lodges and the development of a tourism economy (food and lodging, sale of souvenirs and locally made warm clothes to visitors). At the same time, Jomsom, the District administrative headquarters with its airport strip (Fig. 3i), military camps and other governmental institutions, started growing rapidly. Thanks to tourism, the middle part of Mustang District became very successful economically, because of the proximity of the >8000 m asl Annapurna and Dhaulagiri peaks, and the overall attractive landscape with its villages of flat-roofed, white-washed adobe houses nestled among green, cereal fields and orchards, contrasting with the bare and dissected valley slopes. Eventually, this tourism boom helped to develop basic infrastructures useful for the local people (health and education services, electricity and telephone facilities; Sacareau 2009).

The fourth important step occurred in late 1992, when the "very" (Upper) Mustang was opened to foreigners, attracted both by the perspective of new trekking routes across breathtaking landscapes (the multicoloured Kali Gandaki gorges are often compared to the Grand Canyon of Colorado), and by a unique Buddhism tradition and an authentic Tibetan lifestyle (NTNC 2008; von der Heide 2012; Seiter, sd). Tourism was not immediately economically positive because visitors were obliged to be self-sufficient, i.e. to arrive with all their food, equipment, guides and porters, for trips organised by trekking agencies. Gradually, however, the possibility of selling local products, renting horses and providing seasonal employment as guides or porters began to be beneficial for the locals. In addition, NGOs started to develop solar energy successfully (Blamont and Amado 2000), a good sustainable practice to compensate for the scarcity of wood (mostly bushes) traditionally used for cooking. This new tourism-oriented evolution still did not stop winter out-migration to India with donkey or horse caravans: it only diversified the nature of the products that were imported from the subcontinent and helped to improve housing facilities (roof water tanks, solar cookers, TV, etc.).

To sum up, the Mustang District Oases archipelago consists of distinct, isolated villages where, despite a harsher climate in the upper part, livelihood practices are rather similar, and are based on irrigated agriculture and livestock, combined with seasonal migration. These oases are a network occupying a key position along the ancient trade route between India and Central Asia (Peissel 1967; Manzardo 1977), their inhabitants playing a key role along the Kali Gandaki Valley. Since 1993, the opening of Upper Mustang to tourism has progressively prepared local people for the globalisation of their local economy, and they are positively looking for a road connection linking Mustang over the Korella Pass to the existing Chinese road (UNDP 2006), a good way for them to escape the remoteness of their villages and small towns resulting from the closing of the Tibet border.

3 Bifurcation of the Systems: Development of Roads

The Upper Mustang Oases have undergone a slower evolution and more recent changes than the Oasis of Uspallata. In Mustang, the oasian system was based on summer irrigation and winter migrations with a recent opening to tourism, whereas for Uspallata, the stopover role in the Andean crossing route and the strategic military site was possible thanks to food crop cultures.

In both cases, the opening of an international route—or the improvement of an existing one—completely transformed the structure of the former system. Although the entry into globalisation was neither sudden nor similar, both areas have experienced a new position in the global trade network (for Uspallata) and, more specifically, in the international tourism network (Mustang).

3.1 *Uspallata: An Oasis that Has Become a Service Station on the Pan-American Road*

As shown in Fig. 1, the opening of the new route via the south of Mendoza in the 1960s (following the railway) then of the tunnel crossing the Main Cordillera in 1984 (partly using the *transandino* tunnel) and finally the new route in the early 2000s circumventing the new Potrerillos Lake that submerged the former route have progressively decreased the Mendoza–Santiago crossing time.⁴ Nowadays, despite the increase in the transit, from Mendoza it only takes: 1.5 h to Uspallata,

⁴Firstly, it was very difficult to find quantitative data on Uspallata. This settlement is part of the Municipality of Las Heras (close to 9000 km² wide from the Chilean border to the heart of the Oasis of Mendoza). Most of the inhabitants live in the urban part of the Municipality [203,507 out of 207,507 in the total Municipality, according to the last 2010 Census (INDEC)], that is to say the northern part of the metropolitan area of Mendoza. Yet, data are available either at the municipality scale or at the urban area scale. Consequently, we will not give official data but figures taken from

2.5 h to the International Border and 5 h to Santiago de Chile (to which immigration formalities have to be added). Now, it takes only one day either for thousands of Argentinian tourists to go to the beach in summer, or for Chileans to go to Mendoza for some sightseeing. From Mendoza, Uspallata is also the last stop to fill up with petrol, buy souvenirs or go to a restaurant.

Moreover, although there are fewer tourists than at Mendoza or Potrerillos Lake, Uspallata offers some tourist attractions: it is the entry point to the Aconcagua Mount National Park, for trekkers coming to climb the highest mountain of all the Southern Hemisphere and the American Continent (6970 m) or for other less prestigious treks. Close to Uspallata, tourists can also visit pre-Inca and Inca petroglyphs, or geological sites with fossil stumps. Some of the routes were part of the 2009 Dakar race and now attract some four-wheel drives. Finally, the film *Seven years in Tibet* was not shot in the Himalayas but in Uspallata.

However, concomitant with the digging of the tunnel in 1984 and the new road in the early 2000s, two events changed the face of the pan-American road, as an aftermath of the return to democracy in 1983. In 1985, Argentina entered the Southern American Common Market, the MERCOSUR⁵; then, between 1988 and 1990, the organised return to democracy on the other side of the Andes, in Chile, re-opened the relationships between the two countries.

Yet, the MERCOSUR was quite a good opportunity for Brazil and Argentina to trade (each is the main trade partner of the other) and to undergo good economic growth (at least in the 1990s). Chile is not part of the MERCOSUR but has a privileged partnership, especially with Brazil. Moreover, for trucks, the fastest way to go from Santiago de Chile to the main Brazilian cities, such as Sao Paulo or Rio, is now the pan-American road via Uspallata. This small oasis remains a nodal point, not only between the two bordering countries, as presented above, but also in the whole Southern Cone. This is the situation that has really transformed the long-lasting system based on crops and military surveillance into a new one: all the economy of Uspallata is now turned towards truck traffic: a customs complex, larger-scale rest-stops (Fig. 3b), hotels, etc. According to the INDEC 2010 census, the number of inhabitants in Uspallata has risen from about 3000 in 1991 to almost 10,000 now, representing a growth rate of 17% between the 1991 and 2001 census, and 180% between 2001 and 2010. Because of the lack of land with irrigation water rights inside the oasis, new allotments are under construction in the margins of the irrigated area, that is to say without the possibility of watering gardens or trees with Uspallata Stream waters (Figs. 1 and 3a). Only drinking water will be supplied. This is not the subject of this chapter, but we can add that climatic changes and the associated decrease in snow precipitation in the watershed (as observed by remote

(Footnote 4 continued)

local newspapers (*Los Andes*, *El Uno* or *Mendoza On Line*). The majority of the given information is based on our own observations.

⁵MERCOSUR: *Mercado Común del Sur* or Southern Common Market, is a sub-regional trade bloc with customs union, comprising Argentina, Brazil, Paraguay, Uruguay and Venezuela, and associating bordering countries, such as Chile.

sensing or field surveys; Leiva 1999; Delbart et al. 2014) are challenges for the long-term water supply to this oasis, all the more so with the increase in population.

One of the problems is the excessive traffic: this pan-American road is often overloaded with cars in the summer and with trucks throughout the year. The mountain environment limits the widening of traffic lanes, so that a slow lorry reduces the speed of other vehicles (Fig. 3c) and creates a traffic jam. Moreover, the tunnel traversing the border is not wide enough to allow so much traffic. Travellers have to wait for hours on both sides to cross the Andes. Even the customs cannot sustain so much freight. The Argentinian Customs Complex, a 3 ha area some kilometres upstream of Uspallata (Fig. 1b), where trucks pass under an X-ray hangar and go through an anti-drug search, is very often full, and trucks have to wait on the other side of the road (Fig. 3d). In addition, although daily queues are quite long, they are generally worse when a winter storm, named *Viento blanco* (white wind), occurs as access to the upstream part of the watershed is closed (Fig. 3e). Private vehicles, but more often heavy trucks in transit, are blocked before Uspallata's Customs Complex. According to newspapers, on *Viento blanco* days, about 2000 trucks are waiting in the small Oasis of Uspallata (12 km²), sometimes for a whole week. Drivers have to wait in the mountains, with negative temperatures night and day, for the re-opening of the road. Sometimes the authorities stop trucks in the plain, close to Mendoza, to prevent congestion in Uspallata.

To deal with this recurrent problem on the main route between the three most important countries of South America, already lasting a decade, the authorities and the media are discussing a new tunnel (named John-Paul II), starting from Uspallata or 20 km downstream from the current tunnel. Another project mentioned is the restoration of the *transandino* train, so as to limit road freight. The state of the remaining railways, following 30 years of landslides, makes one wonder about the feasibility of such works. One of the reasons is the funding of these road and rail infrastructures: for example, except for the tunnel fee (3 \$AR = 0.35 \$US = 0.30 € for cars and 15 \$AR = 1.75 \$US = 1.5 € for trucks), the route from Mendoza to Chile is totally free!

3.2 *In Mustang*

After the opening of the trekking route up to Kagbeni in 1977, then of the northern Kali Gandaki Valley by the end of 1992, the Mustang District was increasingly frequented by tourist groups, when the project of building a road from the southern Himalayas to the north took shape. The locals saw this project as a chance for development and a better livelihood, providing them with an opportunity to increase trade and cultural exchanges with the outside world. They had no perception of the potential adverse impacts of the road. After presenting the historical

background of this project, we will consider the positive and negative consequences of the road for Mustang development.

After the closing of the northern border in 1959 by the Chinese Government, and after a 15-month-long trade and transit embargo imposed by the Indian Government in 1989–1990 (Ramirez 2009), the Government of Nepal suddenly became aware of the landlocked situation of the country. In order to expand the road network across the mountains and improve access to rural areas and market sectors, the Department of Roads planned in 2004 a Strategic Road Network along the main Himalayan valleys (NTNC 2008). It is in this context that the Beni-Jomsom road (linking the Kali Gandaki Valley to Pokhara) was first constructed with the help of the Nepal Army. The next step was to establish a road link between the Nepal national highway network and the road from the Tibetan Autonomous Region of China. By the word “road” we do not mean a metal/tarred road with heavy traffic, but a dusty, carriage track for trucks and all-terrain vehicles. The construction was initiated by the Mustang Development District Committee as a response to demands from farmers and traders of Mustang district, and the project was supported by local politicians and approved at the national level (Lama and Job 2014). The first part of the Kali Gandaki road was opened in late 2007 from Ghasa in the south of Mustang District up to Jomsom, but since then it has occasionally been blocked by landslides or debris flows during the summer monsoon. The Upper District part of the road was opened in late 2015, and vehicles can theoretically go up to Ghoktang, just 1 km south of Korella Pass, at the Tibet–China border, strictly controlled by the Chinese. With the full opening of this strategic road, Mustang District is no longer a remote area operating at the pace of mule caravans and trekkers, as can be observed from the rapid evolution of the economy in the last few years. Lo Manthang, the capital city of Upper Mustang, can now be reached by truck from Kagbeni in less than one day, while Jomsom can be reached within a day’s drive from Kathmandu.

The impacts of the road are multifold and sometimes contradictory.

Firstly, the road is an important factor in triggering changes and, as pointed out by Lama and Job (2014), “*the road connectivity has intensified the integration of the local economy with the global*”. This is particularly true of the evolution in tourism and farming, which both provide new sources of income to the local population.

More facilities are now offered to tourists, who can either trek or be transported rapidly up to Lo Manthang and the surrounding sites, attracted by the exceptional landscapes, the Buddhism cultural heritage and, more generally, by ecotourism and wilderness (Lama 2011; Devkota 2011). Pilgrims to Muktinath (Jhong Valley) can now reach the temples in less than 2 h from Kagbeni. Multistorey, concrete buildings are now part of the new landscape (Fig. 3j). Running tourist lodges is mostly beneficial to the richest landowners who can invest money to improve the accommodation with facilities that meet western standards (toilets, hot showers, electricity). Yet, it also offers more job opportunities to socially disadvantaged people, such as service activities in the lodges and guiding services for trekking groups (NTNC 2008; Poudel 2008).

The road opening from Kagbeni southwards now provides a good way to export horticultural products (mainly vegetables and fruits) to the main markets of Pokhara and Kathmandu, as well as to India. Thanks to the ideal climatic conditions (sunshine most of the year and cold winters enabling vernalisation), the “orchard” trend, initiated a few decades ago in Marpha, has spread rapidly in Upper Mustang. Fruit trees (mostly apple) have developed on any arable land available and farmers have built large water tanks accordingly, as observed in Pangling and Chele (Chapagain and Bhusal 2013), to ensure sufficient irrigation hence sufficient yields and profit (in 2013, the price of 1 kg of apples—120 NR—was 20 times higher than in the period before the opening of the road; Fort 2014). Transport times and costs have been reduced by about 75%, indirectly causing a decrease in the number of horses and other pack animals reared in Upper Mustang. New developments, such as the Organic Apple Farm south of Tangbe (Fig. 3h), should be even more profitable (it is too recent to be productive yet). More generally, the road has led to a series of changes in land use and cropping patterns, hence an increase in the demand for agricultural labour, all the more essential as a large proportion of the young, active people (25–40 years old) have emigrated either to other regions of Nepal or abroad.

However, the success of this road does not mean a real trans-boundary exchange. In fact, while the road has improved the accessibility of Upper Mustang to the external world, it has mostly increased trade with India and does not represent a real trans-Himalayan link between India and China. The explanations rest on both sides. On the Nepal side, there seems to be no policy at any level governing the development of the road (UNDP 2006), and the Government of Nepal requires trucks coming from China to pay taxes if they go beyond the Nepal checkpost and customs, whereas foreigners coming from the Mustang Nepal side are required by the Chinese authorities not to go beyond Ghoktang, less than 1 km from the Pass (as observed in 2014). In addition, on both the Nepal and China sides, there has been a border conflict with the local herders since 2004, when the Chinese authorities erected 34 km of 2.5 m high security fencing just inside their territory along the border at the head of the Pass (UNDP 2006). Closing the border has resulted in a decline in the number of grazing stock and the overgrazing and degradation of the rangeland of Upper Mustang (Paudel and Andersen 2010; Aryal et al. 2013) together with a significant loss in biodiversity (Lama 2011).

Other unexpected, adverse impacts are related to the environment resources and quality, which have to be considered in the context of climate change (Su et al. 2013) and a tourist-based economy. (i) Any new road brings noise and pollution, which are additional threats not only to wild species, but also to people, either locals or visitors. This is all the more important as Upper Mustang lies at the core of the ACA protected zone, and the very presence of this strategic road attracts more activities, more specifically at bus or vehicle stops: tea shops, lodges, stores of raw materials and chemicals, local food factories, carpet industries, etc. (ii) The road has also widened the range of tourists both in demography and origin: there are now many Indian and Chinese, besides the Western and Domestic tourists (Lama and Job 2014). Senior tourists are now increasing in number, with higher requirements for accommodation as well. This results in greater pressure on water resources

(Pandeya et al. 2015), all the more serious as there is still no system to either monitor water quality or treat it (absence of sewerage facilities, toilets without safety tanks, etc.). Collectively, this evolution is generating more solid waste and more air, ground, and water pollution. (iii) Whereas in Upper Mustang tourism is growing rapidly, in Middle Mustang, the road is now considered the main factor responsible for the reduction in trekking tourism, which was still the main source of income ten years ago. Trekkers do not like to walk along a noisy, dusty and windy road, and they are now more attracted towards Upper Mustang, and most of them no longer stop in places such as Tukuhe or Marpha (Middle Mustang) where most of the lodges are now almost empty. (iv) In addition, the new road is more vulnerable to natural hazards than a foot trail and can be seriously damaged during extreme events (avalanches, landslides, debris flows and torrential floods) as already observed in Middle Mustang (Fort 2014): the losses induced by the interruption of traffic and the road maintenance might considerably increase the costs of the road for such a country as Nepal. (v) In contrast, water scarcity, together with the attraction of the road, has encouraged some local communities to move closer to it (Bernet 2012).

Ultimately, whatever the decisions already made to adjust to the new socio-economic changes generated by the strategic road, the long-term trend of climate warming and uncertainty about water resources in Mustang raise the issue of sustainable development in both farming and tourism activities, and question the preservation of this unique cultural and natural environment.

4 Conclusion: Facing a New Organisation

The two examples developed here are finally quite different in their transformations:

- In Uspallata, a self-sufficient oasis for thousands of years, alternately playing the role of a rest-stop (during the Inca and Spanish occupations and with the first European migration waves) or a dead end/military centre (second half of the twentieth century), became, with the opening of the Chile–Argentina frontier and the MERCOSUR in the 1980s, a huge service station for trucks. In the end, agriculture has been overshadowed: water is mainly used to irrigate the barrier trees and for the drinking-water supply. Other products are brought from Mendoza but not produced locally.
- In Upper Mustang, oases were summer production places, with out-migrations in winter combined with animal husbandry throughout the year. The opening of the Kali Gandaki Valley to tourism then the construction of the national Strategic Road during the last decade including the perspective of trade with Tibet have partly shifted the socio-economic purpose of such spaces. In fact, the interest in tourism and orchards has been beneficial to the richest landowners who could take the “apple turn”, while most other families had no choice but to accept

service activities (renting lodges, becoming farm employees) or to migrate to Nepalese metropolitan areas such as Kathmandu or Pokhara, or abroad.

Nevertheless, although the geographical structures of these two systems are quite different, a similar bifurcation can be observed: the international route has transformed the role of these oases, their traditional actors and their position vis-à-vis the urban decision-making centres.

These oasian areas have experienced adaptations, like many other systems faced with an anthropogenic or natural disruption. The agricultural vocation in Uspallata is now secondary, and we may ask: is it still an oasis? Finally, their mountainous location close to international borders seems to be more important than the type of oasian landscape and organisation. In contrast, the fragility of the oases and their strong dependency on water and land resources for a very dense population on a small area make them particularly vulnerable to climate changes and to the associated reduction in water discharge.

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