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目录

The study on animal husbandry social ecosystem analysis and multi - agent model based on family farm in Qilian mountains

Abstract

The Qilian Mountains Project resulted from the collaboration of ICTPEM (International Center for Tibetan Plateau Ecosystem Management, Lanzhou University, Gansu Province, China) and Agreenium (Cirad, Inra and AgroParisTech) started in 2007 during the preparation of 8th IRC/IGC (International Rangeland & Grassland Congress (Hohhot, Inner Mongolia, July 2008). Rangeland area located in the highlands of the North-Eastern Tibetan plateau. Animal breeding, especially yaks and sheep, is the main agricultural activity due to the harsh climatic conditions. As all the Tibetan Plateau, the great challenge in the Qilian Mountains is to maintain a rural activity for Chinese minorities without degraded the rangeland which is the water tower of urban and rural industrialized China. The main objective of the Qilian Mountains Project is to describe, understand and model the farming systems in the Qilian Mountains, then to assess their resilience and to draft some scenarios for the policymakers. Another objective is capacity building at post-graduate level, especially in interdisciplinary and integrated research. Develop Chinese-French partnership is also another strategic objective. Until now, three groups of research actions have been developed. First, in 2012, just after the project approval, a survey based on interviews with 25 local stakeholders (breeders, local leaders, traders, input providers, local policymakers, extension services, etc.) aimed to draft the long-term history of rural activity in the zone and identify the hopes and fears of local people regarding the future. Secondly, in 2013, another survey based also on interviews with local stakeholders allowed to better understand the main drivers of local trends, rural activities and the major constraints of farming systems in two contrasted areas, the Tianzhu and Sunan county. In 2014, a survey based on questionnaires with 50 farms in 8 villages, 4 in each county allowed to describe the different farming systems with

qualitative and quantitative data. In the same time, two specific researches have been launched, one to assess the households' economy and another focused on the supply-market chains. Two participative workshops to present and debate the results, one in each county, allowed to better define the local demand in terms of research, research-development and training. Two research actions are planned for 2015, one on the rangeland/pasture management using MODIS images along the 25-30 past years in partnership with ESO Unit Research, another on supply chain management in partnership with AgroParisTech.

Key words:Animal husbandry, social ecosystem, multi - agent model, Qilian mountains

Chapter 1 Introduction

In the Qilian Mountains, due to the cold climatic conditions and the high altitude, the rural activity is based on animal husbandry, especially the herds of yaks, sheep and goats. The first results of French-Chinese research project (called Qilian Mountains1 and financed by Cai Yuanpei program) show a important diversity of the herd productivity linked to several factors. One of them is the land access, mainly pastures and forage crops during the winter. This access depends on the land allocation decided at the community scale according to the land demand, for example for young and/or new farmers. Another factor is the available labor in the family to manage the farm, mainly the presence or lack of the kids (usually two in the minorities) and one or the two grand-parents. Another factor is the partnership with the local governance through the HRCS (House Contract Responsibility System). This contract between each household, its own community and the local administrative governance aims to control the environmental impacts of each household's herd, especially the size of the herds and the stocking rate according to the quality and the quantity of the household's pastures. In return, the household receives subsidies according to the surface of the pastures and the fields of forage crops.

The project aims to implement a monitoring of the herds in order to assess their performances and their diversity according to the land access, the family labor and the subsidies received through the HCRS. In the same time, as an efficient tool to follow-up the performances, the herd monitoring allows to test alternatives of techniques and management, and assess their impacts at farm level and on the families livelihood. The monitoring will be based on the two specific tools developed by Cirad (LASER 2 and DEMO12) and applied in different countries.

The herd monitoring gives reliable data during a defined period about:

- the demography of the herd, entrances and exits of animals during the period, the reasons (purchase, sales, barter trade, donation, mortality, …), and the prices

- the reproduction, mainly the ages and births of the animals, the herd

[1] The *QILIAN MOUNTAINS* Project aims to better understand the adaptation strategies of farming systems to global change.

genealogy with the kid-mother links and the ranks of calving or lambing per cow, ewe or goat

- the pathology and the practices to control the diseases, including local knowledge

- the feeding system with an estimation of the quantity and the quality of the feed according to the season and the category and the state of the animals

- the dairy production: quantity of milk per day and per lactation, period, quality, including the local transformation in cheese, butter, …

- the property and the distribution of the animals among the family members

- the functions and roles of the livestock, especially in the family income and savings

These data and their mid-term trends are important to evaluate the animal production parameters and the herd performances in order to improve our understanding on the livelihood and the adaptation strategies of the breeders families.

Capacity building in herd monitoring is another objective of the project, related to the training of young researchers, post-graduate candidates and local extension services. Moreover, the implementation of the herd monitoring promotes the integrated research because it requires working together farmers, development agencies, research and formation. Finally, the project aims to strengthen the French-Chinese partnership launched by QILIAN MOUNTAINS Project, with the involvement of new and young French researchers, especially in herd monitoring data analysis and animal production science.

Work Plan and Schedule

The work plan includes three phases from June to December 2014.

Phase 1. Preparation for implementing the herds monitoring

Phase 2. Implementation of herds monitoring, which will be continued by Chinese partners (under the Qilian MOUNTAINS Project)

Phase 3. Analysis of collected data on the demographics of herds, the economy of farms, breeding, nutrition, pathology

Phase 1. Preparation for implementing the herds monitoring

Based on the sample of farms and communities selected by Qilian Mountains Project,

12-15 herds will be identified in contrasted farms to be followed-up during at minima two years. The herd monitoring will be presented individually to each farm. Then a workshop meeting the farmers, local stakeholders and development agencies will be held to present again the herd monitoring: objectives and expected results, actions to be developed, materials (identity card for dairy yak, farm herd book, schedule of the visits, responsibility of the different participants (farmers, researchers, development agencies, representatives, …), interest for the farms and local development, especially the impacts on the management of the herds and the implementation of future research-development actions.

Phase 2. Implementation of the herds monitoring

In each of the 12-15 farms, the herd monitoring will be implemented starting with a demographic census of the animals in the different herds (yaks, sheep and goats) and based on the data related to the females. An identity card (ID) will be made for each yak, and for the small ruminants, at least for each ewe, ram and goat. The ID includes the name (or denomination) of the animal, the age (at least the year of the birth, if possible the month and the day), the entrance in the herd (born, purchased, donation, other), the number of calving and lambing, the rank and the current status of pregnancy, the mother, the sisters and the daughters if they are in the herds. An example of ID card is presented at annex 1.

Based on the ID, an herd book will be made with a copy for the farmer, a copy for the development agency and a copy for the research. Between two visits, the farmer can register the new data in the herd book according to the changes in the demography, especially the births, sales, purchases, deaths, in the feeding and pathology.

During the first visit or the second visit, data about feeding systems is collected, mainly the time of pasturing and the feedstuffs given to the animals with the targeted animals. The data about the pathology in the herd, eventually in the community, are also registered.

During the first six months, the monitoring requires at least a visit each month, with the participation of the farmer or the member of the family responsible for the

monitoring, woman, son, grand-father. Then, according to the involvement of the farmers, their interest and competence, especially in the registration of the events and the changes, the visits can be each two months.

Phase 3. Data analysis

The herd book is an excellent tool for the farmers, but also for the technicians and the researchers. Some data analysis can be done. However, the main part of the data analysis is done through specific computer programs as LASER2 and DEMO12 which allow to calculate the different parameters of production, reproduction and economy. Young researchers and post-graduate candidates will be capacitated to manage these programs.

The herd monitoring gives excellent and reliable data after three or four months, when all the ID cards are filled and checked, even for the feeding part. However, the most interesting information and results are with a longer period, usually one or two years, in order to have registered directly, during the monitoring, the births and the reproduction of the kept females in the herd by the farmers.

Chapter 2 Literature Reviews

The Qilian Mountains are located in the northeast part of the Tibetan Plateau. They extend over approximately 1500 km long from the east to the west. The rangelands are also composed of vast pastoral areas highlighted mainly by ethnic minorities, particularly Tibetans, Mongols and Yugurs alongside pastoralists and agro-pastoralists Hans, in the case of the Qilian Mountains (Long et al., 2008). These breeders raise yaks and sheep with transhumance system adapted to the climatic conditions. In June, after the last freezing and when grass has grown, herds and breeders move to the highest lands where the alpine meadows provide the feed for animal during summer and autumn (Figure 1). In October, before the first freezing, breeders come back to the villages located in the bottom of the valleys and the herds graze the winter-spring pastures (Figure 2).

Along the last decades, the rural society of the Qilian Mountains has faced several significant changes, particularly in landownership, rangeland management, agriculture market chains, irrigation and other water uses, social services in education and public health. Until the mid-20th century, rangelands were owned by monasteries and pastoral tribes, the course is the resource condition for existence and lifestyle of transhumant pastoralists, nomads for some (Long et al., 2008).

Referring to this period, recent literature notes the community nature of the pastoral life, in particular the management of herds and rangeland across large families, as well as the complex relationships between different social groups based on human relationships registered in time. They also mention a certain harmony between ethnic pastoral society and its environment (Wang et al., 2010), although the band would rather be in the low animal pressure on pastoral resources, i.e. the fewer and smaller herds, at least in comparison with today.

According to Brown et al. (2008) and Squire et al. (2009) this traditional system was stable but economic returns were low. From 1949, the Chinese Revolution, then the Cultural Revolution from 1966 destroyed the traditional system, mainly by the

collectivization of resources, including the land and the herds. One consequence was the strong degradation of the rangeland due to the lack of sustainable management associated to a complex set of factors including overgrazing, higher frequency of droughts, change in the housing of farmers, etc.

The rangeland degradation is a great challenge for China because the rangeland covers an huge area, around 4,2km² until 6-7 million km², according to the source, especially in the West and the North of the country and the rangeland is both the water tower and the mining resource reserve of the country. So this is a key-factor of the downstream economic development, supporting the irrigated agriculture, industry expansion and the cities, justifying the great interest of national governance for the pastoral area. So, from the beginning of the 1980s, the Chinese government implemented a new set of policies aiming to reduce rangeland degradation, better use of natural resources as water, soil and biodiversity. In the same time, they improved the livelihoods of breeder's population, considering the high rate of ethnic minorities in the pastoral area. Recently, specific public policies have been implemented aiming to reduce the rangeland degradation and to better use of natural resources.

These public policies are based on contracts between farmer's households and local governance in order to adapt herd size to the feed capacity of the pastures and forage crops. So, according to the terms of the contracts and the norms of production, land is allocated to households who officially become the users, but they do not have the landownership. These land allocations regard to winter/spring pasture, but also to summer and autumn pasture. In other villages, the land use continues to be common. Moreover almost all the households accessed to cropland in order to produce fodders to feed their herds during winter and reduce the pasture degradation.

Additionally, farmers have access to supports, to improve their equipment and to adopt sustainable practices. For example, build greenhouses barns (Figure 3) for the cold protection of females and young animals during the calving and lambing periods. They can also produce fodders to feed their herds during winter and reduce the pasture degradation. These public policies havealso specific subsidies to develop collective activities, as dairy farms or fattening units for bulls and lambs.

Another significant change is the willingness of many parents to plan the future their kids out of the traditional agriculture. In 2012, French-Chinese research team showed that 25-40% of the farm income is used to support young people learning at the university (Ding et al., 2014). Many farmers hope that their kids will have a good job in urban area. Some of them think that their kids are some real opportunities in agricultural sector, particularly in intensive livestock farming systems based on irrigation for feed production. So, they imagine new farming systems with breeding in the rangeland and fattening of bull and lambs in feedlots (figure 4). Other farmers propose to develop dairy farms with milking period in barns near of the irrigated fields, and in the mountains meadows during the summer.

In this environment constantly varying, it becomes interesting to understand how, in the midst of all the current changes taking place, these families operate on an economic point of view and what about their livelihood that's the improvement was an objective of policies. This study aims to identify the main inputs and outputs money of these farming families/households to understand their business operation facing the changing context.

From a conceptual point of view, our research is based on the concepts of vulnerability and resilience, more especially "… the three dimensional vulnerability coordination framework by referring to Frazer (2007) and Dougill et al. (2010) …" (cited by Dong, 2014).

In the first session, we will present the research with brief geo-historic overview of China giving more details about the agriculture sector, then the description of the Qilian Mountains, followed by the Cai YuanpeiResearch Project, which coordinates and supports our research. In the second session, we will introduce the main concepts, the research question and the hypothesis. The third session will be dedicated to the methods, especially the general survey to describe and understand the livelihoods in the Qilian Mountains, and the specific survey to assess the household economy. The main results will be presented in the fourth session. Three points of discussion have been selected and will be presented in the Fifth session, before the conclusion.

2.1 General context of the study

China is a country in East Asia, including two contemporary states that currently claim to have sovereignty: the People's Republic of China, which controls 99.6% of its territory and the Republic of China, which mainly control Taiwan. China extends from the coast of the Pacific Ocean Pamir and Tian Shan, and the Gobi desert to the Himalayas and the borders of the Indochinese peninsula, covering 9,596 560 square kilometres2.

The geographic diversity of China includes just about every topographical feature imaginable. Including mountains, plateaus, broad plains, grasslands, basins, gentle hills, islands, tidal flatlands, desert, glaciers, and frozen tundra (Caraway, 2010). Its population of over 1, 366 million3 is the first in the world; it represents a little less than a fifth of the world population. The population density of China is 139.5 inhabitants per km2. China, long a highly advanced civilization, has been and remains home to many innovations in the fields of science and arts. Chinese civilization had a strong influence throughout East Asia, including religious levels (Confucianism and Taoism) and linguistic (the sinograms were used throughout the region and many Chinese words are present in the languages that are spoken).

Chinese civilization, which has lasted almost five thousand years, is one of the oldest civilizations in the world and is sometimes cited as the oldest continue. Its origin lies in the valley of the Huang He then spread southward (conquest of the territories south of the Yangtze River from the Han Dynasty), west (first incursions in Central Asia during the Han, temporary extension until ' the Caspian Sea under the Tang conquest of Xinjiang and Tibet under Qing) and north (the Qing dynasty Manchu origin brought to China Manchuria and Mongolia).

During its history, China has been repeatedly divided and reunited; she has twice been completely conquered by foreigners (by the Mongols in the thirteenth century and by the Manchus in the seventeenth century), although they have finally adopted the customs and the Chinese administrative system to govern the empire. The last

[2]statistiquesmondiale.com
[3] http://countrymeters.info/fr/China

imperial dynasty, the Qing (Manchu Dynasty origin who ruled the country since 1644), has experienced a period of decline during the colonial expansion phase Western countries, leading the country from one defeat from opium Wars. It was only after the victory against the Japanese army in 1945, China was able to free foreign interventions.

Politically, both states claim to have today sovereignty over China. People's Republic of China, commonly known as "China", has more than 98% of the population and 99.6% of the total area; the Communist leader Mao Zedong in Beijing founded it in 1949. It includes Mainland China, Hong Kong and Macao. Today, economic development, initiated in 1978 by the reforms of Deng Xiaoping and his successors, in fact a major global economic and geopolitical actors, symbolized by the oil giant Petro China became the first global market capitalization. To finish, from an ecological point of view, the western China is very rich in natural resources. It represents 82.5% of national water resources, 36% of coal reserves, 12% of oil reserves and 53% of its reserves in natural gas. In addition, there are 120 on 140 minerals identified at the national level including some rare metals in which China reached the top ranks in the world rankings (Michel & Chevalier 2011).

2.2 The agricultural sector in China

Agriculture in China is an important economic sector; estimates of the number of rural people employed in farming and rural nonfarm industries vary widely. In 2000, official statistics reported a rural agricultural labour force (including forestry and fishing) of 328 million and a rural non-agricultural labour force of about 170 million (Gale et al, 2000). In a 1998 paper, Rawski and Mead argued that official statistics published in China’s statistical yearbooks underestimate rural employment in nonfarm industries and overestimate farm employment by perhaps 100 million.

However, China’s 1997 agricultural census, the first attempt to obtain a comprehensive nationwide count of rural employment, reported an even larger number of 425 million persons primarily employed in agriculture, forestry, and fishing and 136 million rural persons employed in non-agricultural (including 57

million working primarily in urban areas) (Gale, 2000). China ranks first in agricultural production, including cereals, mainly producing rice, wheat, potatoes, sorghum, peanuts, tea, millet, barley, cotton, oilseeds, pork and fish. According to estimates by the Organization for Economic Cooperation and Development, the agricultural sector still represents 15% of gross domestic product of China and accounts for 40 % of all jobs.

Village communities who rent to farmers, often with leases thirty years, currently hold holdings. A boom has accompanied this semi-privatization in productivity and production.Chinese agriculture is hampered by the lack of cultivable areas. In addition, it has only 10% of the world's arable land and has to feed 22 % of the world population.

Chinese agriculture is also handicapped by its fragmentation, with 200 million households each operator, on average, an area of 65 acres. In addition, due to increasing urbanization, pollution and desertification, it is estimated that arable land decreases by approximately 2,500 km ² per year. However, between 1990 and 2003, agricultural production increased by 90 %. The low-income elasticity of demand for farm products and the ability of farmers to increase labour productivity (and economic growth), requires that farm employment decline, if farmers are to share in the benefits of such growth. In 1952 approximately 84 % of China's workers were engaged in agriculture; in 1997 the figure had declined to 41 %. By 2030 farm employment may account for only 10 % of the total. If the 63% decline in farm employment doesn’t adversely affect the rate of growth of farm output, the agricultural labor productivity will increase rapidly. But with over 5,000 years of history, it would be difficult to approach this study not to mention a little historical summary.

2.3 Historical approach to the study area

Chinese history of the twentieth century was marked by the creation of a new state: the Popular China’s Republic, there are now 60 years. Two land reforms took place during the second half of the twentieth century and there is even talk of a third

agrarian reform with the changes related to land ownership. This chapter wills therefore designed to study these changes experienced in the regions and villages studied, with first a reminder of the great historical events of the country. Finally, some critical points will be described in order to understand the current organization of agriculture and its development such as access to land, or the intervention of the State to production systems encountered, concerning the different land reforms.

2.3.1 Before 1949: The Empire of lords

In 1911 the last emperor of the Qing dynasty abdicates, weakened by the war with Japan, for European concessions, the Peasants' Revolt (Boxer Rebellion).
Follows a period of clashes opposing two ideologies: the revolutionary one side and liberals on the other side. These two groups, although opposed, fighting both the Japanese forces during the Second World War.

2.3.2 From 1949 to 1980: first agrarian reform and collectivist period

In 1949, Mao Zedong and the Communist Party formed the Popular China’s Republic. Then install a communist organization in the country: benefits of the highest classes of society fade, landowners are deprived of their propertyand are redistributed to peasants. The nobles were expelled. At the end of the year takes place the great leap forward which should enable agriculture to produce more. Peasant families are grouped into "support group". First of all, where farmers work together on some projects, and then "production team" with a similar administrative structure throughout the country. All means of production: land, animals, tools and even labor are combined and family farming disappears with collectivization. Families gathered in production teams and the head of the team divided the work of each farmer during the year. Above production teams, the Brigade is usually a village and allows the management of several production teams. Finally, the City includes several Brigades and distribute to each quotas and production targets them controlled by the Central State.

Major operations are conducted throughout China to make agriculture possible technically in the country: the large irrigation projects in particular, or flattening of land to make them more easily cultivated and mechanized. It is during this period that develops the "Industrialization of agriculture". Indeed, the production teams, or state farms (another form of collective management) are very often connected to processing companies, directly installed in the village and brings the outside labor.

2.3.3 After 1980: second agrarian reform

For many reasons, including declining agricultural productivity of the country, the collectivist system is considered detrimental to the development of the country. It is therefore left to the death of Mao Zedong (1979) in favor of a second reform of the agrarian system, with the return of peasant agriculture. Collectivization of the means of production in the villages is abandoned. The government has left open the possibility that the cantons redistributethe land to individual farmers. After 25 years of collectivization, optics for families to have their own pasture was, in most cases, the choice highlighted in each village. With this system of "family responsibility", the government hoped to raise the productivity of agriculture and livestock Chinese.This idea is based on the theory that, if farmers have animals but access to land is common, they will not limit the load per hectare of grassland.

According to the "tragedy of the commons" (Hardin, 1968) free access to a limited resource leads maximizing its use and exploitation until his death. It is sometimes preferable to "privatize" the land to make farmers responsible for its quality. Actually, in the Chinese case, the land is not private because it still owned (through villages) but families have a right of use granted by the village collective or individual. The means of production, i.e. animals, tools and land production teams were distributed to families. They have been shared "fairly" in villages, depending on the number of people in each family. The land has been redistributed and allocated to families. This took place later in the pastoral areas of western China than in other regions less remote and more productive (from 1984 to 1979).

2.4 The context of the Qilian Mountains

Located in the northeastern part of the Tibetan plateau along the Silk Road, the Qilian Mountains have a recent turbulent history related. Especially changing political context from the 1949 (Chinese Revolution)because the priority of the public authority was given to rangelands, which are part of the Qilian Mountains (figure 6). Indeed, according to the qualification and source paths represent 40-65 % of the country's surface, or from 4 to 6.5 million km ², mostly in the north and west (Hu & Zhang, 2003). The priority is the protection of rangelands because this area is a large water tower and the subsoil is rich in various minerals (uranium, lithium, etc.). Moreover, hydrocarbons are alsoimportant for the industrial, agricultural and economic characteristics of countries.

The courses are also a vast pastoral areas highlighted mainly by ethnic minorities, particularly Tibetans and Mongols Yugus alongside pastoralists and agro -pastoralists Hans, in the case of the Qilian Mountains (Long et al., 2008). Until the mid- 20th century, rangelands were owned by monasteries and pastoral tribes, the course is the resource condition for existence and lifestyle of transhumant pastoralists, nomads for some (Long et al., 2008). Referring to this period, recent literature notes the community nature of the pastoral life, in particular the management of herds and rangeland across large families, as well as the complex relationships between different social groups based on human relationships registered in time. They also mention a certain harmony between ethnic pastoral society and its environment (Wang et al., 2010), although the band would rather be in the low animal pressure on pastoral resources, that is to say the fewer and smaller herds, at least in comparison with today.

From the beginning of the 1980s, once the post-revolutionary period initiated several measures of public policies aimed both at improving the lives of pastors and to take into account the environmental dimension of socio- ecosystems. This including degradation of course because it was considered a major cause of soil erosion and significant loss of material aggravating flooding and catastrophic flooding downstream consequences and the entire Chinese economy.In the Qilian Mountains, we are witnessing the last thirty years a significant improvement in socio -ecosystem,

that is to say both better life for pastors, their families and communities, but also greater attention to management practices course. From a geographic perspective, the Qilian Mountains form the northeastern edge of the Tibetan Plateau (Figure7). However, from an economic point of view, they are largely oriented ancient Silk Road (red line), economic axis of Gansu Province, which surrounds the Tibetan plateau to the east and north.

But now, the Silk Road is the main route of road and rail transport of men and property, linking the Far East with the pastoral lands of Central Asia between the Tibetan plateau and central China, in fact an excellent field observation of rural pastoral dynamics in China. Indeed, many ethnic minorities living farming coexist alongside the Hans, especially Tibetans, Mongols and Yugurs. While many agro Hans occur mainly in irrigated areas along the Silk Road, many pastors are also similar to ethnic minority pastors who meet throughout the region, predominantly in areas of altitude along the Silk Road. In addition, the former to China's Silk Road, crossed by the Great Wall (Figure 6), and its surrounding areas, especially the Qilian Mountains anchor can be located on the margins of social and political question Tibet, thorniest issue in the autonomous regions of Tibet and to a lesser extent in the province of Qinghai.

2.5 Land management

Land management, support for pastoral resource at the heart of public action. Following the 1949 Revolution, the collectivization of the means of production has changed the status of the land and therefore the pastoral resource. Indeed, even if the passage of a tribal land and / or status to a monastic community, status was not a big change in terms of collective management, the reins of power had changed hands in the new communities of especially as the collectivization also concerned herds. Early in 1953, the deterioration of common land was limited by policy measures.

In 1963, a comprehensive national program for sustainable rangeland management emerges, echoing a similar program established in 1958 for agricultural land across the country.This policy recognizes that the path must be protected, especially their major role in the water cycle, whereas the stocking has already doubled in some

areas, particularly those near urban centers, which was originally to a strong soil erosion and a net decrease of vegetation cover (Longworth & Williamson, 1993).

Two decades later, rangeland management is still far from satisfactory, in particular the existence of a sharp deterioration in overexploited areas. A policy of de-collectivization was implemented usually with the allocation of rights use to households, all remaining still owned and community control, in conjunction with the local administrative authority land (Wang et al., 2010).

In this study, when we are speaking about “household” it means the family unit as defined of the household and not the extended family. Although given differing names, a number of programs share the goals of settle pastoralists and encouraging responsible rangeland husbandry by clarifying tenure of pastureland tenure on a family basis, subsidizing construction of permanent winter homes, fences and livestock shelters, and providing plots for growing supplemental winter fodder. Government outlays for these programs (Wu & Yan, 2002) have been substantial; during 2003–2006, the central government reported investing some 1$ billion for fencing alone (SEPA, 2007). Despite the enthusiasm with which they have been promoted by government sources, the long-term ecological and economic viability of these programs remains uncertain (Miller, 2002; Wu & Yan, 2002; Yan et al., 2005; Richard et al., 2006; Davidson et al., 2008).

In the early 1980s, the HCRS (Household Contract Responsibility System) was created. It’s the central mechanism of the new Chinese policy for the course, a kindof pivot around which will articulate various support measures and incentives. For example, the HCRS is a contract negotiated between the household, on the one hand, and the community and local government, on the other hand. The management of the rangeland (which the right of use) has been attributed to the household, particularly the maximum number of cattle that can withstand the land. The HCRS was a watershed in the pastoral society to the extent that, while maintaining the collective ownership of land, it requires the family, as a couple, as the managing entity and therefore responsible for the flock(Wang et al., 2010). Other policies implemented in the future will go in the direction of strengthening the CSH by introducing specific to a particular sector mechanism.

This is particularly the case law on grassland (Grassland Law) of 1985, which protects obviously punishing those who put it in culture or destroy trees. Then comes the law protecting forest cover (Natural Forest Protection Program) due to flood damage of the Yellow River and the Yangtze in the middle of the 1990s (Liu et al, 2001 & World Bank, 2001). This is also the case of the development program of the Great West (Great West Development Program).Which from the mid -1990s, Convention set up in the heart of Chinese politics notions of rural development and poverty reduction through the incentives for local initiatives in the economic field and for the protection of ecosystems.

However, Wang et al., (2010) note that the HCRS was not very effective since its implementation, particularly because of its top-down nature copied from cropimplemented throughout China agricultural. These authors consider that its effectiveness is proved in the early 2000s, when another mode of governance, also based on a negotiated agreement between the household, community and local government contract, was able to instead. This alternative mode of governance implied more bargaining, notably with greater consideration of the realities of the local context and expectations of households. It has been developedand applied for aid programs, such as for building houses but also stables and greenhouse that greatly improve the comfort of the animals during the nights of winter and spring. This also reduce the working family labor as we shall see further.

Parallel policy measures pastoral land management, the central government is, at least since the end of the Cultural Revolution (1966-1976), to improve living conditions in rural communities with special attention to maintenance road infrastructure, rural electrification and social services such as primary education, health, mail, etc.

2.6 CAN YUANPEI Program

2.6.1 Scientific Objectives

In the Qilian Mountains, due to the cold climatic conditions and the high altitude, rural activity is based on animal husbandry, especially the herds of yaks and sheep. The first results of French-Chinese research project (called QILIAN MOUNTAINS1 and financed by Cai Yuanpei program) show an important diversity of the herd productivity associated to several factors (Kammiliet al., 2011; Bonaudoet al., 2013; Ding et al., 2014). One of them is the land access, mainly pastures and forage crops during the winter. This access depends on the land allocation decided at the community scale according to the land demand, for example for young and/or new farmers.

Another factor is the available labor in the family to manage the farm, mainly the presence or lack of the kids (usually two in the minorities) and one or two grandparents. Another factor is the partnership with the local government through the HRCS (House Contract Responsibility System). This contract between each household, its own community and the local administrative governance aims to control the environmental impacts of each household's herd, especially the size of the herds and the stocking rate according to the quality and the quantity of the household’s pastures. In return, the household receives subsidies according to the surface of the pastures and the fields of forage crops.This project aims to implement a monitoring of the herds in order to assess their performances and their diversity according to the skill of the breeders, land access, family labor and subsidies received through the HCRS.

At the same time, as an efficient tool to follow-up the performances, the herd monitoring enables to test alternatives of techniques and management, and assess their impacts at farm level and on the families’ livelihood. Moreover, the herd monitoring enables implementing an analysis of the milk quality, which will be necessary to include some dairy alternatives in the scenarios at farm and local level. As dairy alternatives, we are thinking to specific yak cheeses and dry dairy products based on yak milk.

2.6.2 Main concept use in the project and hypothesis

The objective of this study is to have an overview of the economic system of herding families. This involves a long process of collecting data which will then be combined with data obtained in previous studies, in order to establish a sustainable monitoring work with farmers engaged. Thus allow farmers to improve their performance and livelihood.

The main questions are:

- What about the livelihood in the Qilian Mountains?
  - Is there a single model of farming system or different management strategies?
  - Current public policies do they influence the choice of farmers through the subsidies?
  - What are the main economic flows that households are subject?

Figure 1: Localisation of Gansu Province, and main cities in China, the grey area represent Gansuprovince. Source: www.chinatoday.com

Google Earth representation of the two study areas.
(The red line is the Silk Road and the green area the limits of the Qilian Mountains)

Chapter 3

Rangeland Management by Households, Communities and Local Governance in the Qilian Mountains, Tibetan Plateau, China

3.1 Introduction

The Qilian Mountains are located in the North-Eastern Qinghai-Tibet Plateau, along the ancient Silk Road. The average elevation is around 3-4,000 meters with the main peak at 5,500 meters above sea level. At this altitude, the rangeland is the only land use and just some crops could be cultivated in the lowlands of the valleys. In the past, due to their location, the Qilian Mountains have been crossed by several ethnic groups, many of whom settled and are still represented nowadays, especially the Tibetans, the Yugu, Hui, Mongols and Hans. Until the middle of the 20th Century, the rangeland management was defined through a complex set of partnerships between the tribes of herders and the monasteries which were the landowners (Zhang et al., 2007; Brown et al., 2008; Squires et al., 2009).

The Chinese Revolution in 1949, then the ten years of the Cultural Revolution in 1966 strongly impacted the traditional society and the management of the rangeland, mainly the collectivization of the land and the herds. In a few years, probably because the lack of control on the rangeland management, serious degradations appeared, particularly near the new urban areas and the watering points for people and herds. At the beginning of the 80s, considering the major role of the Chinese rangeland in the national water supply, specific public policies have been implemented in order to reduce their degradation and consequently avoid the stronger soil erosion with severe consequences downstream on the flows and inundations. Thirty years after the challenge is not won yet. However, many things have changed at different scales, from the pasture plot until the collective rangeland, from the herder household until the global governance. In this context, this paper aims to describe the main trends of the animal husbandry along these last decades

and presents some future scenarios as they are formulated by the local stakeholders in the way of sustainable development.

After the materials and methods used in this research, the socio-ecological system will be presented in the first session of the results, from the use of the rangeland as the major source of feed for the herds. The second session will focus on the implementation and the effects of the HCRS (Household Contract Responsibility System) on the livelihoods in the rural area. The HCRS is the main policy which led the local development since the beginning of the 80s and until nowadays. It still defined the partnership among the different components of the rural society: the herder households, the local governance and the national policymakers. The third session describes the two main weaknesses of the local development in the Qilian Mountains: the lack of sustainable rangeland management and the low interest of the young people for the breeders life. In the last session, scenarios about the future of animal husbandry will be presented. This research has been developed in partnership with the MOUVE Project4 and in the LIFLOD network5.

3.2 Materials & Methods

According to the review of the literature confirmed by the knowledge of the local research team, two contrasted research sites have been selected in order to have a better overview of the livestock diversity in the Qilian Mountains.
Fig. 2. Location of the two research sites

[4] The MOUVE Project: "*Interactions élevage et territoires dans la mise en mouvement de l'intensification écologique*", financed by ANR (French National Agency for Research), SYSTERA Program.
[5] LIFLOD: Livestock Farming Systems & Local Development, www.liflod.org

The two research sites are the villages of the towns of An Yuan and Huang Cheng, respectively in Thianzhu county and Sunan county (cf. map2). The contrasts concern four relevant factors for livestock production: (i) their location, respectively on the Eastern and Western versants of the Qilian Mountains, and directly (ii) their distances to Lanzhou, capital of the Gansu Province and main urban area to trade the products and provide inputs, even some other cities along the Silk Road offer significant local markets, such as Wuvei and Yong Chang, (iii) the quantity of rainfall, respectively around 400-500mm in Tianzhu and 700-800 in Huang Cheng, which determines the rangeland productivity, (iv) the settlement with a majority of Tibetans and Hans breeders in Tianzhu and Yugu herders in Huang Cheng.

The research sample has been built selecting 35 key-informants, 17 in Tianzhu and 18 Sunan, from the diverse sectors of the livestock supply chain, from the farm to the fork, including breeders (12) and local stakeholders (5), providers of inputs and traders (4), development and funding agencies and scientists (8) and local policymakers (4), and others (2). The interviews were mainly individual, by groups of 2, 3 or 4 stakeholders (XX), especially with the traders, and two workshops with local development agencies gathering the technicians. The interviews were focused on the responses and complementary information on the six following questions: perceptions on the past, the current situation and the future of livestock in the zone; the hopes and fears of local people working in livestock sector; the main debates and conflicts regarding the animal production; the new projects linked to animal husbandry in the zone.

The average time for one interview was around two hours according to the quantity and the details of the information given by the informants. Moreover, the time was longer with farmers and agribusiness managers, due to the visit of the farm or the enterprise. After each interview, a small report of 2-3 pages has been written by the research team gathering the main data collected during the interview, firstly regarding the six questions, but also all the relevant and complementary information given par the informant.

The data analysis has been done through two complementary ways. Firstly, an overview of the mental model about livestock activity has been explained for each key-informant and each group of key-informants and are drafted in the interviews reports. Secondly, a table has been built comparing the points of view of the different key-informants about the six main questions which structured the interviews.

3.3 Results and Discussion

The three main following results are presented in this paper: (i) the rangeland provides the main part of the feed for the herds, even some alternatives are developed; (ii) the livelihoods of the herders improve a lot due to the strong support of public policies, especially the implementation of HCRS (Household Contract Responsibility System as a partnership between the farmers, the community and the local governance; (iii) the weak rangeland management and the low attractiveness of animal husbandry for young people are the two main challenges for the future.

Before, it is important to mention the very few information given by the key-informants on the past, before the Chinese Revolution, as if that period was in the past with no consequence on the current situation and future. It is surprising due to the very significant change in the landownership, land access and land management during the first years of the Chinese Revolution in the 50s, then along the decade of the Cultural Revolution from 1966 to 1976. May be the lack of historic references is partially linked to the young age of the stakeholders at that period or they were born after. Just one key-informant, member of a recognized breeder family before the revolution, gave some information about the change at that time, especially the collectivization of the land and the herds, and consequently the new land access, the new relationship between the breeders and the local communities, including the migration of some of them. In an opposite side, the literature describes the rangeland management before the Revolution as a great harmony in the socio-ecosystem (Zhang et al., 2007; Wang et al., 2010), and the efficiency of breeders practices to manage the rangeland which the monasteries had the landownership … as if it was a paradise before the Revolution.

3.3.1 The rangeland, as the main feed provider, is the pillar of the animal husbandry

Usually in the Qilian Mountains, each household manages his herds of sheep and yaks which are the only or main source of the income. Frequently, just the couple (husband and wife) is working in the farm. Sometimes, the grand-parents helps when they are living in the household and when they are valid. The children also helps when they are not at the school and the weekends, or only during the vacations for those going to the university. The sheep are Merinos breed, locally called fine wool sheep, and Tibetan sheep. The household select one or the other according to his objectives, strategies and practices. The yaks are Tibetan breed, black or white. Goats are only present in a few herds. The size of the herds is usually around 150-200 ewes and 25-40 yaks, but some herds are smaller and others are bigger, until 300-400 ewes and 80-100 yaks. And some households have only sheep, mainly due to the lack of labor.

The figure 4 shows the seasonal mobility of the herds and the households for the villages of Huang Cheng town during the regular year according to the feed availability in the rangeland. It is a classic seasonal mobility in the mountains areas with alpine meadows. In Huang Cheng, stakeholders notice some small differences exist between the households and the villages. They are linked to the location of the farm and the pastures, the distance and the size of the pastures. In Tianzhu county, many pastures are common, but the seasonal mobility is more and less the same because depending of the weather conditions.

At the end of the spring - end of May and June according to the growing of the grass - the herds and the herders move to the summer pastures. They stay there around two months. Each household has his tent with basic equipment as this will described more forward. Due to the cold and the snow, people and animals cannot survive there during the winter. So, at the end of the summer, the sheep and the people move to the autumn pastures where the weather conditions are better and the feed is still available. The yaks usually stay in the summer pasture, due to their better resistance to the cold. However, every day or every two days, one person per family is going to see them to check if all is correct. From the middle of the autumn, usually just before the first

freezing, the sheep and the herders families come back to the villages. The sheep are feed on the winter pastures. In the same period, the herds of yaks move to the autumn pastures where they substitute the sheep herds. According to the weather conditions, the productivity of the rangeland and the farm, the yaks stay there all the winter or they move to the winter pasture where are the sheep herds. During winter and spring, the weakest animals are supplemented with oat forage cultivated in the lowland during spring and summer. The four pictures of the Figure 5 synthesize the feeding system of the herd along the year.

In the Qilian Mountains, the grazing is the feed of the herds, more than 80-85% et more 95%, respectively for the sheep and for the yaks, according to the evaluation of the local stakeholders of the counties of Tianzhu and Sunan. Even the cultivated forage represents a small part of the feeding system, it is essential because it helps the weak animals to survive. This justifies the strong interest of all the herders to have cropping areas. Moreover, a family who has more forage than necessary, can easily to sell it, in the local market or for other regions, and have a significant additional income.

Due to the low number of family members working in the farm, all the labor is focused on the herd management with daily tasks: quick checking of all the animals every day, and if possible two or three times a day, early in the morning, in the evening and during the daytime; several checking a day during the lambing and the calving period to eventually help the females and care the newborns; caring the weak animals or sick, mainly the females and the young calves and lambs; feeding with forage during winter and spring; … Other activities are more flexible in term of time, such as the treatment of the animals, the maintenance of the equipments, the marketing and the purchasing of inputs, …and they have to be integrate in the schedule of the daily tasks.

As mentioned by some stakeholders, it is interesting to notice that the herders spend the major part of their working time to manage the herd and do not have time to manage the rangeland, which is nevertheless the pillar of their livestock activity.

3.3.2 The public policies strongly support the breeders society in the Qilian Mountains

The Household Contract Responsibility System (HCRS) has been implemented in the pastoral China at the end of the 70s and the earlier 80s, as a set of policies aiming to improve the animal husbandry productivity, derived from the successful experience in the cropping areas. From an environmental point of view, the result was an increasing of the rangeland degradation (Banks, 2001; Han et al. 2008) due to the difference of the contexts between the cropping and breeding areas which have been ignored (Williams, 2002). However, according to the talks of almost all the local stakeholders during the interviews, the implementation of HCRS is a success in the Qilian Mountains due to the significant support given to the breeders to adapt their farming system to the different factors of the global change, including micro and macroeconomic changes, but also social.

The allocation among the households of the crop land for forage production and the winter pasture seems to have been the more significant policy. Directly manager of his feeding resource for winter and spring, the household can decide to reduce or increase his herd according to the requirement of his herd. The household can also decide to rent more land to increase his feed or to produce forage to be sold. The land allocation has been decided according to the size of the household. It is function of the zone and can change according to the demand of the new households and the retirement of the old farmers. It is just only a land allocation and not a landownership. The household cannot sell the land to another household. However, the land can be rent, case of some old farmers to complete their pensions.

In the villages of Huang Cheng town, Sunan county, the average of pasture per household is around 170ha, 220ha and 3ha respectively for winter pasture, both summer and autumn pasture and crop land. To highlight the importance of the winter pasture allocation, the first demand of the farmers without individual winter pasture allocation and who access just to the common winter pastures, is precisely the land allocation at the household level for, at least, the winter pasture. And the first reason to justify this demand is to better manage the rangeland at the household level according to his herd requirement.

The land allocation of summer and autumn pastures seems less significant due to the bigger availability of the pastoral resource at these seasons. However, several breeders consider the relevancy of the contracts for summer and autumn pasture which avoid the concentration of the herds in the same best places and offer to all the households the opportunity to manage his summer and autumn pasture according to his objectives, his strategy and his knowledge.

Moreover the land allocation, the households received financial subsidies according to their pasture area. The subsidies are fixed and per unit of land, around , 60€/ha (¥30/mu) respectively for the crop land, the winter pastures and the summer-autumn pastures. The subsidies for the land and per household in the villages of Huang Cheng town is are which have to be compare to the budget which is around corresponding at the sales of lambs, yak bulls, cluded ewes and yaks.

Beside the land allocation and the subsidies for the land, another significant policy is the financial support received by the household to invest to improve their farms or for better livelihoods. For the investment in the farm, the household access to funds to finance the greenhouse/stable for the herds during the winter and spring, and the tents to live in the summer and autumn pastures. According to the situation, the part of the subsidies for the tents is around 30-50%, approximately 200€ for a total price of 450€ (¥1700/¥4000). Nowadays, the tents in the alpine meadows are more comfortable with better equipment, such as a bed, a small table and a few stools, one or two small chests or shelves for storage, a stove for cooking and heating, sometimes one or two solar panels for energy, especially for satellite TV and mobile phone charging.

The contribution is lower for the building of the new house, but it is significant, around 15-20%. Moreover, the households can access to apartments built in the town near of their village, where they can live immediately or when they will decide to retire. About the equipment, the households also access to interesting loans to buy motorcycles and 3-wheels trucks. Furthermore, several other infrastructure policies interact with the local development. For example, the building and the maintenance of the roads facilitate the access to the market and the inputs. Particularly, the

maintenance of the trails is very important, due to the long distance between the villages and the alpine meadows where are the summer pastures, usually around 15-40km, but sometimes 60, 70 until 100km. Mobile phones work in the Qilian Mountains. For that, many antennas have been built. Furthermore, from 2004/05, the elementary school is free when before only the primary school was free.

3.3.3 The new challenges: effective rangeland management and better attractiveness for youth

The two main weaknesses of the local development system implemented in the Qilian Mountains over the three last decades are the low rangeland management and the poor attractiveness for the new generation. The HCRS policy aimed to reduce the rangeland degradation by a control of the animal stocking rate in order to better adapt it to the productivity of the rangeland. According to the talks of the local stakeholders, until now the strategies of the breeders have never really integrated the control of the animal stocking rate on their pastures. Two main reasons explain this disturbance. Firstly, the rangeland degradation is a real constraint for the breeders because it reduces the production of feed and consequently the productivity of the herd. However, the reduction of the rangeland degradation is a complex medium or long term process based on specific strategy and several friendly practices of use and protection of the vegetation. In contrast, the HCRS subsidies allow to maintain more easily the productivity of the herds with low interaction with the rangeland management. So, the breeders have logically selected the easier strategy based on subsidies and until now did not adopt sustainable practices of rangeland management. The second reason of the no-application of stocking rate control. Moreover, the adoption of sustainable rangeland management practices would be resolved the tow following constraints: the apparently poor knowledge at the local scale about the set of right practices and the important investment in infrastructures, equipments, inputs and labor.

Additionally, sustainable practices of rangeland management are usually more difficult to implement in common pastures due to the higher complexity of the collective governance compared to the household ones. But in contrast, the easier

implementation at individual level does not mean automatically a better efficiency. Particularly as in the Qilian Mountains, the rangeland management currently integrate common practices such as the coordination and the mutual aid to move to the summer pasture and to face the winter period, the common works to build the fences, greenhouses, etc. More, the mutual assistance between the households is not only in the same family, but also between friends and in the same village. In conclusion, the complexity of collective level offers some relevant opportunities and it has not to be only seen as a constraint.

The second weakness of the system developed in the Qilian Mountains is the low interest of the new generation to become herders as their parents. More serious, almost all the parents consider that animal husbandry is not a good option for their children. For them, the future of their children is in the urban area. For that they want qualification for their children and finance the university which an annual cost for one student (2,000€ # ¥17,000) is around one third of the family income (6,000€ # ¥50,000). Furthermore, many breeders are from minorities. They hope a better integration of their children if they be qualified, the go to high school then university and live the urban area. Logically, in this context, almost all the young people do not want to become breeders and do that their parents are doing. They use the same arguments than their parents, such as the painfulness of the labor, especially the drudgeries during the calving and the lambing period, and also the seasonal migration in the alpine meadow which is also perceived as an arduous labor.

To face the low interest of the young people for the pastoral system, a new policy has recently been implemented in order both to improve the efficiency of livestock farming system and to offer rural jobs in urban areas, especially for the new generation. This policy supports the breeders who decide to join their competences and means of production to fatten lambs and bulls in feed-lots based on irrigated forages in the villages, small towns or in the suburbs of the cities. The parents care the breeding through their pastoral system in the countryside and some children care the fattening in feed-lots located in peri-urban areas. To force breeders to join themselves and build significant animal husbandry units, this policy is available only for herds of more than 500 bulls or 3,000 lambs to be fatten. Some breeders are thinking to implement dairy farms based on the similar integration with the milking

in periurban area and the heifers production or the cows the months before the calving in the countryside.

2.4 Discussion: What about the future in the Qilian Mountains?

The discussion focuses on the future scenarios for animal husbandry in the Qilian Mountains. In their long-term analysis of the public policies in the Chinese rangeland, Wang et al., (2010) show the strong and strategic commitment of the national governance, from the beginning of the 80s, in order to reduce the rangeland degradation by better caring of the natural resources and, in the same time, to improve the livelihoods of the pastoral society which are using these resources to feed their herds. Logically, the same policy is expected to continue in the next years linked to the major role of the rangeland in the water supply of China. Meanwhile, our results show a significant improvement of the livelihoods in the rural area of the Qilian Mountains, mainly due to the direct and indirect subsidies received by the breeders households. In consequence, a contribution of these households can be expected for the effective implementation of a sustainable rangeland management. Moreover, reducing the stocking rate is not the unique way to avoid the rangeland degradation. Other efficient practices of sustainable rangeland management exist, especially the control of the pasture area daily or weekly and the time of growth of the grass between two pasturing.

The three following scenarios have been imagined

Current Trend: Progressive oldness of the farming population due to the lack of transmission to the new generation because to their preference for the urban jobs and the urban life. The short and medium term impact is an increase the land size of the farms due to the availability of land by reallocation or renting to the retired farmers. However, a serious problem of labor could appear considering the current high workload of the households and the lack of workers due to the concurrence with urban jobs. At medium and long term, the lack of farmers and workers will be a serious challenge.

“Rangeland Management”: Reallocation of the land in order to define the most sensitive or degraded rangeland areas to recuperate them, including with common

pasture management based on the awareness of the breeders and a strict control. This scenario needs to qualify at large scale the rangeland degradation and the impacts of rangeland management practices. According to the point of view of the farmers using common pasture, it will not easy to define and implement a collective rangeland management. But maybe it is the greater challenge in terms of research and extension.

"Intensification": Add-value, eventually with subsidies, to practices reducing the stocking rate, as for example the current double system based on lambing and calving on the rangeland and fattening in feed-lots with irrigated forage. Interest for young people is an advantage of this scenario.

3.5 Conclusion

After the destroying of traditional system by the land and herd collectivization during the Chinese Revolution from the 50s, following until the 80s by complex period for the breeders families which sped up the rangeland degradation, especially around the villages, the HCRS implementation has progressively in three decades led a significant improvement of the livelihoods in the rural area. However, the great challenge of the rangeland degradation still exists. The scenario based on the sustainable rangeland management could be the next step of the local development in the Qilian Mountains. This way needs an efficient set of sustainable practices in terms of technologies, but also in human dimension domains, mainly participative methods to debate, test and assess adapted innovations. Policymakers are ready to finance and incentive due to the strategic function of the Chinese rangeland in the national economy.

Chapter 4

Household Budged, Livelihoods and Rural Work in the Qilian Mountains, Tibetan Plateau, China

4.1 Introduction

This study was preceded by a thorough literature search in order to get a first overview of the study area, but also to understand the mode of functioning of the breeder's families and the productions present in the Qilian Mountains.This multi-disciplinary study involved a wide range of knowledge (animal husbandry, pastoralism, social and cultural sciences), although livestock and the economy are the heart of the research. It is for this reason that the household survey is largely based on socio-economic, in order to make sense out to the practices and strategies of farmers, taking into account their environment.

4.1.1 Choice of the study area

The choice of study area covers two counties: Sunan and Tianzhu (Figure 8), which are both, located in Gansu province. This choice is justified by the many investigations already undertaken in these two counties and the involvement and motivation of farmers participating in the program.

4.1.2 First survey

Our research is based on interviews. We created a global questionnaire (Appendix 1) with 140 main questions to investigate the several topics of interest in our case. The survey is very comprehensive and covers many topics not detailed in this report because it is common to several work-study. For a well organization on the field and in order to not ask several times the same general questions to breeders, we chose to conduct fieldwork together. The field team was composed of 6 people: Xiao Jing Qi will works on the benefit performance and quality of the livestock products (PhD), Ting Ting Yang about the diversity of farming systems and livelihoods (Master degree), GaelleBosuette on the analysis of supply chain management at household scale (Master degree) me to household budget analysis.Pr Ding &Tourrand

supervised the work and shared their experiences and knowledge during investigations.This complete questionnaire provides a good overview of the management practices of the family, even though it may be noted that sometimes very specific nature of certain issues does not allow obtaining reliable answers. We can divide it into 5 parts:

Family general considerations (Composition of the family, education level, housing...). Land management (during different season). Crop production. Animal production.

Representation of the main constraints and future of their activity (particularly with respect to possible constraints due to public policy). Within those several topics, we try to have a global understanding of the farming system of each family, by collecting qualitative and quantitative data based on the farmer's perception. The questionnaire was translated into Chinese to enableour two interpreters to ask the questions easily in order to limit the misunderstandings due to translations. Moreover, it has been tested and modified after a first test round with 4 farmers.

We also noted the GPS-point oneach farm for several reasons. Firstly it is important to remember farms already visited for the second phase of field.Secondarily, this was done in order to establish a subsequent monitoring study, with the most motivated farmers in the project.We can complete a precise mapping of all the farms included in the study (Appendix 2). During the first phase on the field (from 27 March to 9 April 2014), we interviewed 32 farmers. In both counties (Sunan and Thianzu) 4 villages were selected based on previous work and contacts already established with the leader of the village. Then, after making contact with the leader, he indicated 4 farmers with whom we could submit the questionnaire.

Village in Sunan county: Hedong / Beiji / Xiangyang / Xicheng

Village in Thianzu county: Nanni wan / Nan Ni Gou / Hong Ge Da / Dai Qian

Thus we choose to use the "snowball sampling" technique (Goodman, 1960). This technique of sampling is mostly used for exploratory investigation or "hidden population". It's based on social network of the subject that will guide the researcher to his next subject. In our cases, the only way to meet our interlocutor was to be introduced by some resource people well known by the farmers of the area. After we

were introduced to 1 or 2 breeders and when they understand our goals they often accept to give us the contact of some other farmers of the area and so on, until we can found 16 breeders for each area.

A picture with each family was taken after each interview to keep a memory of our passage and to find breeders easily when we will return for the second phase of survey on the field.

4.2 Creation of the matrix

Once completed questionnaires and transcribed from Chinese into English, we took the results obtained in a matrix in excel spreadsheet software. During the counting of the first questionnaire, we identify some errors or to clarify points in the second maintains, which enableus to validate a posteriori the responses obtained during the first investigation.

Second survey

In order to refine our economic study on the inputs and outputs of family farmers, a second questionnaire was created and conducted among 13 families (6 in Sunan and 7 in Tianzhu).

It is based on a participatory approach, which enablesthe farmer to complete a circle graph, showing his principals inputs and outputs of money and a work schedule to better understand the distribution of work and intensity during the year. For this part, we wanted to focus on farmers who seemed to be motivated to continue this working.We also tried to choose the breeders of the second phase as a function of felt from the first survey (before analysis of the results) because we could observe practices and choice of different management. So we have proposed them a second interview to learn more about their practices and budget. It was also important to create a climate of trust for the continuation in the project interest.

During this phase we particularly appreciated the presence of their wife, who seem more manage the economic part of the family budget.

Second matrix and graphics

After translation into English, a second database was created the same day, to reduce errors and omissions in the excel spreadsheet, to list the data before analysis. Analysis of the database. Data were analyzed with the Excel spreadsheet. The first part of the treatment was to highlight the major trends in order to identify discriminating variables. We have used graphics method to understand the correlations that explain some ways of managing breeders.

The most significant variables have been created through the Bertin method (Appendix3). According to Jacques Bertin graphic semiology is "the set of rules of a graphic sign system for the transmission of information."(Aschenbrenner,2000-2001). It is a system of signs, rigorous and simple that anyone can learn to use and provides a better understanding of the cards or tables. It uses a color code or texture of the data to show the relations of resemblance, order or proportionality between given sets.

Thus, a color code has been defined arbitrarily for each variable appeared to be (after graphic study) significantly (green = good, yellow = neutral Red = very poor). This now enableus to see the major trends of practices that emerge in the function assigned colors. The method is generally based on a qualitative approach, in our case we can talk about “method Bertin improved" because we kept the numbers inside the table, enableus a double overlap of data (qualitative and quantitative) for more great accuracy in the interpretation.

In a second step, an analysis principalcomponent was first realized to confirm or refute the major trends described by the method Bertin (more based on an interpretation related to perceived practices in the field) and secondly to determine whether the selected variables were relevant and well discriminating.

During this first phase of exploratory surveys, we have less farmers (32) than variables (140 terms), for this reason it wasn’t appropriate to establish multivariate analysis. These can be used in a future explanatory study with a more important sampling breeders and pre-selected variables for the purpose of a more detailed analysis.

4.3 Results

In this study, 32 farmers were interviewed during the first survey to draft an overview of the farming systems in the Qilian Mountains and thus define a typology of farms. In a second step, the research focused on 13 farmers to better understand the management and economic flows that occur within families. We finally see what factors influence these flows and the flexibility that farmer to cope.

4.3.1 Farming systems strongly defined by bio-geo-climatic factors

Harsh climate: low rainfall and very low temperature

The Qilian Mountains area is characterized by a cold and dry climate enjoying limited rainfall ranging from 300 to 450mm per year. Thus, we can observe for the zone of Sunan county an average accumulation of 330 mm per year and 455 mm per year for the area of Tianzhu. In this part of China, winters can be very long and cold with temperatures, -30°C nearby, sometimes less if there is a "Zud"6. We still notice that in Tianzhu area they enjoys a slightly higher temperatures, which reveals different opportunities for farmers in these two areas. Based on these biophysical characters, now we could see if differences take place, depending on the area in terms of herd management.

4.3.2 Pasture management

We note that animals spend more time in winter pasture (near houses) in Tianzhu, where the herd graze can start a month earlier, than in Sunan. Indeed, temperatures and grass growth does not allow farmers to leave the herd in the summer or autumn pastures. Therefore, the transhumance in the summer pasture lasts an average of 2.5 months and 3.5 months, respectively at Sunan and at Tianzhu. Then animals return near homes where they are sheltered at night and complement.

Feeding the flock

[6]This Mongolian word means a particularly snowy winter in which livestock are unable to feed them alone, and many animals die of hunger and cold.

Animals need to be supplemented with forages and concentrates to help them to face low weak pasture and cold climate. Again, depending on the area, farmers must meet their needs over a longer period. Thus, at Sunan, they distribute forage from mid-September to late May, while at Tianzhu it is just necessary from November to late March. Concentrates more expensive are distributed over a period of three months in both areas but staggered (March to May at Sunan and January-March at Tianzhu).

The farrowing and lactation

At Sunan, lambing happens in February and April, depending on the breed, and calving are in March and April. At Tianzhu, the lambing and calving period are respectively in March and May. The milking period of yak cows is usually 2 months (June and July) and the production is largely self-consumed by the family during the time because they are in transhumance in the summer pastures.

4.3.3 Livestock sales of related products

The period of sale of animals is almost the same in the both study areas, in September and October. Traders come at the same time directly to the winter pastures near of the villages, where the herds were just returning. The price fluctuates so little because all sell at the same period and same people. The wool is sold in June at Tianzhu and July at Sunan county.

Crop management

Cultures are mainly composed of Tibetan barley and wheat, used for family consumption and also to feed the herds. Plantations are in June and May, to be harvested in the fall.

Settlement and organization of space

Settlement of pastoral area

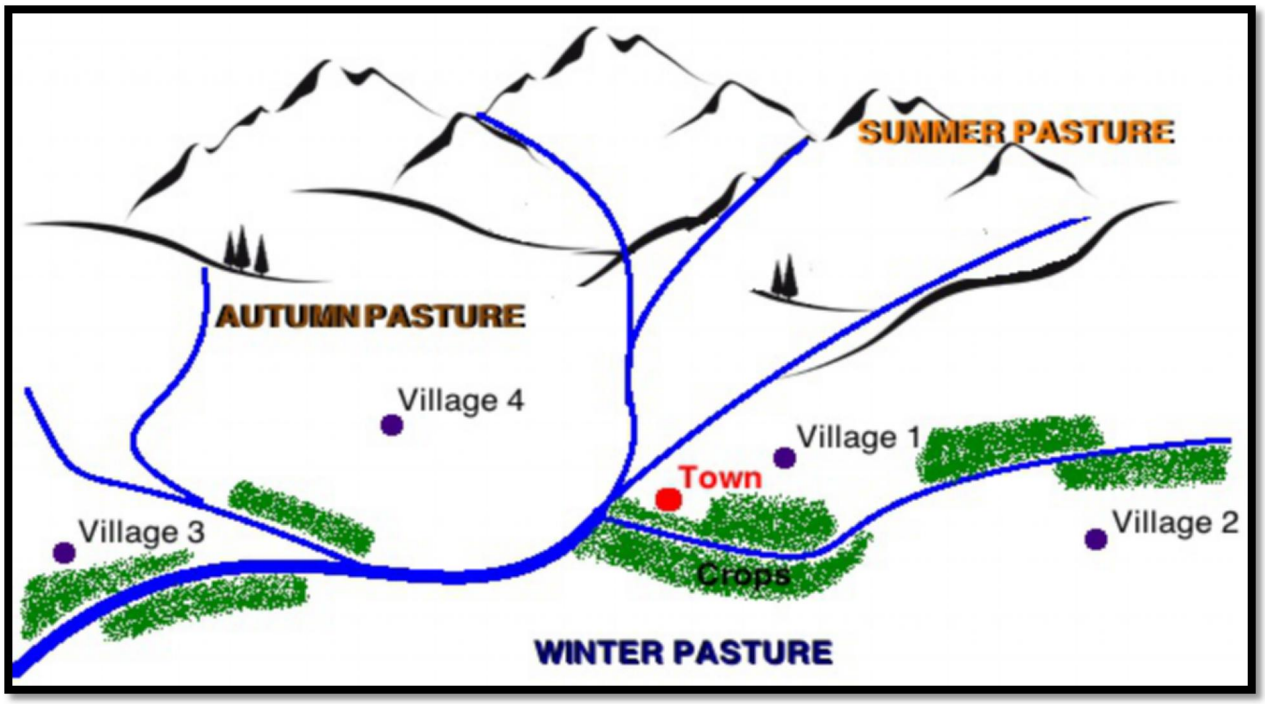


Figure 13: Schematic description of famer's habitat

The habitat in the Qilian Mountains is organized according to Figure 13. Summer pastures are located from 3200m to 4500 m (depending on the area) and go up to the limit of the rock bars. Autumn pastures are located in the intermediate zone between 2300m and 3200 m; finally, the winter pastures are located lower (from 2000-2500): at the bottom of the mountains and in the valleys near the farms and the villages.

Each farm has one or two greenhouses where are parked a part of the animals during the winter and spring nights, especially the new-borns and their mothers.Every village is linked to a town where are concentrated the main social, economic and administrative services. However, all the villages don’tbenefit the same infrastructures and opportunities of development due to the different access to crop land, pasture and water, the distance to the town, regional cities and market, and also schools, health centers, etc.

In winter, the families live in their houses located in the villages,in the valley and near the roads (Figure 14). Some of them are choosing to live in apartments located in the town during the hardest months. The home is usually equipped with a single room where the family lives and where is the stove. This works thanks to yak'sdung (they use 15kg/day). In order to not increase the environmental challenge, the government bans to cut trees and wood consumption for heating and cooking. A large wooden board can accommodate all family members to sleep. The newer homes are equipped with several parts. There are greenhouses for livestock next to the homes (easily recognizable by their transparent roofs to let in light).During the summer months, farmers set up their tents in the pastures. The tents are also equipped usually with a double bed, a small table, some chairs and one or two stores. Many families used solar energy. Government offers significant subsidies to provide special tents very similar to the army tents.

Example of household functioning

After describing the settlement of the study area and habitat characteristics of households, we will now describe a typical case (average) farming system.

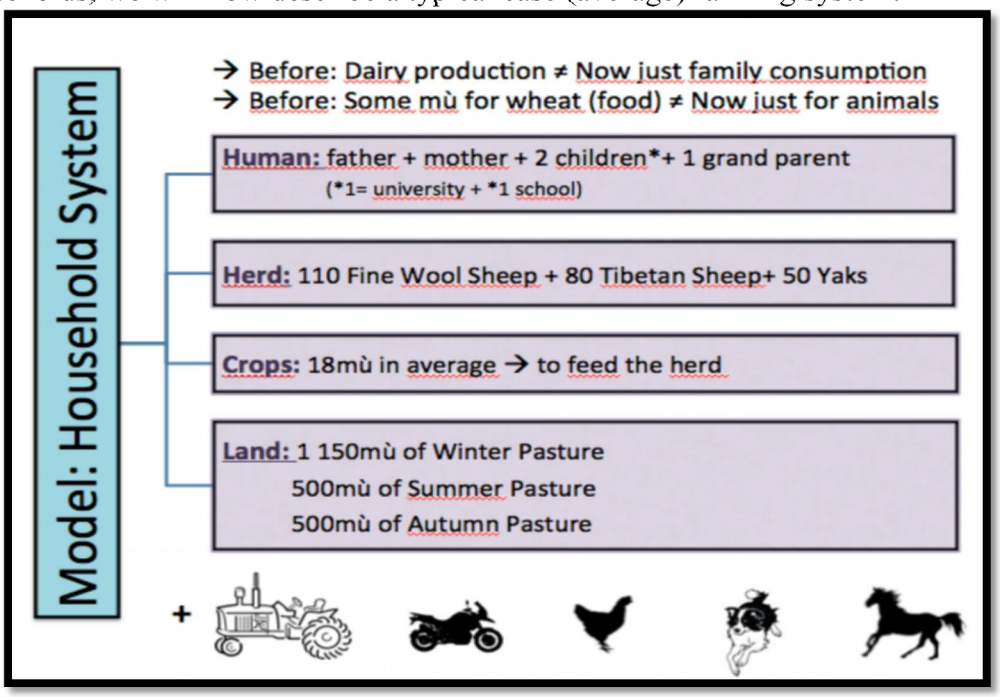


Figure 15: Model of an average household system

The Figure 15 presents a typical farming system, taking into account family, flock, cropland and the different pastures (summer, autumn, winter and spring). This basic model is added buildings (house, greenhouses, barns) and equipment for transport: usually a motorcycle, frequently a horse and sometimes a 3-wheels truck. There are also dogs to keep watch the farm; and poultry for home consumption in eggs and proteins. The area measure is the “mù”, 1 mù is around 0.065ha.The average of the cropland is 18 mù for our sample of 32 farmers.

Distribution of the activities over the year

Here, there is typical work calendar for a breeder family, which is modeled, as previously mentioned, on weather conditions, especially the temperature and the rainfall (Figure 16).

Figure 16: Typical work calendar (example of Sunan area)

Thus, the work organization is the same for all the farms because it is distributed over the year according to the management of the herdshighly dependent on the productivity of pastures and indirectly on climate conditions (see Appendix 5 for Tianzhu calendar).However, the workload differs a lot among the farms due to the herds’ size, the breed for the sheep, the distance and the size of the different pastures and different cropland. Moreover, some activities lead to specific peak of work as the milking, the harvest period, the lambing and the calving.

4.4 Analysis of main economic flows

Main expense of the households

Food

Costs related to the purchase of food vary greatly from one household to another, ranging from 225 yuan to 20,000 yuan / person / year. These large differences are primarily related to the geographical area, which enablesnot growing vegetables and grain for the family. Some families live near autarky and only buy flour or condiments.This is especially the case atNanni Wan village, where farmers buy less than 500 yuan of food per year. Others one, located further away from the altitude where streams must provide vegetables, cereals, fruits that significantly increase their budget. Apart from these extremes casesare considered food represents an average budget of 9000 yuan / person / year.

Children education

Raising children can be a major expense by level of study, around up to 30% of the total budget for a child going to college. Thus, some families must spend up to 15,000 yuan per year per child power enable them to attend school in the city.

Housing, Clothing & Tobacco

Current expenditures for the home are estimated at 900 yuan per year (after adjusting for outliers due to exceptional circumstances as an extension of the house). This includes costs related to everyday life (water, electricity, heating, etc.). Again we see significant differences in the extent they are not all in the same situation (Example: some farmers do not have running water, others heat through yak dung).Expenditure on clothing amounted on average 3,600 yuan per year, again with large disparities. Finally, smoking is common and represents an annual budget of about 1000 yuan per smoker and per year.

Loan

Farmers have access to credit, an average loan rate of about 9% currently (?). Most of the time, the money is put to use to improve their living conditions, for building a new house, or to buy animals. It can also be used to have enough cash in case of exceptional events, example marriage. It is common for farmers to have a loan from someone in their community rather than the bank. (Example farmers Number 10 & 14)

Health & Insurance

The values for the medical expenses are extremes from a family to another because they either have health concerns (example: farmers 28 & 29) or they do not, or inexpensive. In case of accident or blow, and we have seen farmers sell their entire herd of yaks to enable them to adjust care. The same extent, have some significant costs on their insurance (houses, cars), which represent an average budget of 1,000 yuan per year (not including the breeder # 5 which has very substantial insurance costs). Some (like the farmer 5) have a city apartment in addition to their accommodation in winter pasture, which greatly increased the insurance budget compared to those (example: farmers 17-32), which have not.

Transport

Similarly, farmers who have an apartment in the city have transport costs more importantly, due to daily went back to see the herd. Those yaks as primary or unique production and who do not practice trafficking have lower transportation costs because it will see the herd once a week or every 10 days.

Herd

Costs related to livestock are also very heterogeneous (500 yuan to 60,000). This is explained partly by the herd production and the herd size, as well as the various hazards susceptible weaken livestock (disease capitalization to meet a specific need). Thus, we see that Fine Wool Sheep breeders have generally higher costs than Tibetan sheep or yak breeders due the strong resistance of yak and Tibetan sheep to the harsh conditions. The Fine Wool Sheep breed, near from Australian Merinos breed, need more attention, more feed and concentrates, more cares and veterinary drugs, especially during the lambing period.

Crops

The arable land is rented from 100 to 300 yuan / mu / year depending on the area. Expenses related to crops are about 4,000 yuan per year. The differences among the breeders are the cropland area, the irrigation or not, use of own equipment to work the land or not, and also the quantity of inputs.

Salary

Some breeders are choosing to take a worker, usually a shepherd to manage herd to pasture because it's not easy to manage the yaks and the sheep at the same time, especially if there is cropland that still monopolize workforce. The cost of an employee is about 10,000 yuan per year. Presumably the breeder who has payroll costs 4,000 yuan employees the shepherd just a part of the year.

Main income of the households

Sell of animals& part time job

Sale of animals is the main source of income of farmers (60% to 100% of the budget). Some have a part time job in addition to their breeder's job, representing up to 30% of profits. We note that the good economic results related to sale of animals are not related with the species of the main production, but the number of animals and the secondary production.

Subsidies

We note that the subsidies constitute a significant proportion of household income, up to 15% of profits. These are calculated on the number of mù owned by the breeder (and not the number of rented mù) this is why we are large differences (from 0 to 16,000 yuan / year over the sample 13 breeders and 0 to 23,000 yuan / year on the sample of 32 farmers).

Wool

All farmers sell wool / skin of animals. Fine Wool Sheep that of earn 20 yuan / kg against 7 yuan / kg for Tibetan sheep. The skinof yak is sold 190 yuan per unit. This second income may still report up to 25% of total revenues.

Dairy product

The milking period of yaks lasts about 3 months anda yak female produces around 1kg of milk per day, mainly intended for home consumption. Those who sell can remove up to 20% of their income. The milk is sold 4 yuan / kg (skim) and butter 280 yuan / kg on average. Only 2 breeders / 32 turn milk into yogurt but it was not possible to know the price / kg because they are sold in pots do not we do not know the exact content.

Example of two different household budget

The Figures 11 and 12 show the principal's spending money and inputs of two households accumulate the same amount of total expenditures (59,175 yuan). The first farm has 55 yaks and 6 Tibetan sheep and the second has 120 Tibetan sheep, 25 Fine Wool Sheep and 30 yaks. It is found that the distribution of expenditure and outputs is extremely heterogeneous. Spending on food accounts for 8% of the budget for the first breeder against 20% for the second. Both households use an employee but all expenses related to the employee are not identical because the first must hire the year while the other part-time work. Land rent is also a major expense for the second breeder. We also note significant differences in terms of revenue for the second breeder part-time work outside which represents 23% of annual revenue.

Such disparities between households show a diversity of strategies specific to each that breeders choose to experiment over time. It is now boring to see if major trends and if groups are formed around these strategies.

Typology of farming systems

Bertin method

Table made allows us to identify groups of farmers with similar strategies themselves are divided into two or three separate groups (Appendix 3). Of course, sampling on a larger number of farmers would confirm this trend. Thus we can see that 3 groups differ:

Yaks Cattleman

The first subgroup (Pure Yak Breeders) has large numbers of yaks (average of 100), but little or no sheep. They have instead of arable land above the average (24mù) and receive little or no subsidies.

The second subgroup (Breeders) hasa significant numbers of yaks (≈110) with second production with sheep without distinction of breed, area of agricultural land slightly bellows the average (15.4 mùagainst 18mù) and relatively large amounts in terms of subsidies.

Mixed breeders

The same way as the previous group, we can note two subgroups.

We find in this subgroup shepherds, who mostly have Tibetan sheep and yaks in secondary production (40 on average), with arable land of 14mù average and grants of about 5 500yuan/an.

This group amounted Fine Wool Sheep only and has the same average concerning the number of yaks. They have the same arable land than the previous shepherds but have, however, two times more in subsidies than the latter (11,000 yuan per year on average).

Farmers / breeders

This group does not raise yaks and can be divided into 3 subgroups.

Some raise both breeds of sheep at the same time and we can see that thesubsidies are higher when they breed Fine Wool Sheep (30,000 yuan per yearagainst9000 for others). This is not related to the number of mù because we notice that the firstbreeder has 30mù and the secondhas only 5mù.

Others raise only Fine Wool Sheep. Subsidies are higher than the average (18,200 yuan per year). We note also large disparities in terms of arable land (from 3 to 60 mù).

People in the last sub-group chose to have only Tibetan sheep. The subsidies turn around 10,800 yuan per year and arable lands are moderately important (14mù).

Discussion

About the methods: Biases and possible improvement of the study:

Limits of the methods and observed biases:

Several biases having an influence on the collected data and the quality of the results can be pointed:

Snowball sampling biases:

Due to the lack ofdata bases of farmers for, our sample is a non-random sample technique with a major influence of the first interlocutor. This first person meet in an area is determinant to meet farmers. Indeed he introduces us to the other. We try to orientate towards a higher diversity during the sampling to be as much as possible representative of the several systems of the Qilian Mountains.

Biases of interviewer: Like every process that requiring interviewing, the interviewer includes some disturbance and influence the quality of the answer of the interviewed. The questionnaire and the data have undergone many successive translations:

(French → English → Chinese → Interview in Chinese → English...).

Sometimes between the two interpretations of the questions interviewers might differ, it is for this reason that we have retranslated all the questionnaires (for the second phase on the field, the same dayafter the interviews) to reduce biases associated with translations and omissions.

Biases from farmers (consequences of sociological aspects):

As in any interview must take into account the sometimes approximate characters of some answers. In contrast, farmers who have agreed to receive us, showed no discomfort in front of our questions, even those more personal on their household budget (witch is often better knew by women).

Quantity assessment: Data quality is directly influenced by the sampling technique and by the time spends for this part of work. It would be very interesting in a future study to examine more farmers to verify the data obtained in the first 32 breeders.Finally, do not forget that this work directly fits in a global study, that reveals additional information and also re-cross those obtained for this analysis.

Areas of improvement

The applying of questionnaires was easier than it was planned, mainly due to the efficiency of Chinese team. However, if the study were to be repeated, we could set a longer phase field to query some thirty families per county. This would enableus to have larger samples and thus to interpret a larger scale of different strategies and groups of farmers observed in the field. Another phase of field is being prepared for September to submit the questionnaire to other farmers in the province of Qin Ghai for comparison.

In addition, it should be noted that this study was difficult because we had a limited human resource and budget. But also have uncertainties to being able to conduct our interviews unhindered (because of the political context).

The first set of survey was very broad to allow data collection for each study subject. This has monopolized breeders just once time; reduce expenses and logistical problems but also creating a positive synergy withinthe group. However, the information was not specific for every studies and it’s easy to be lost under a quantities of interesting information, but too much wide.Then, it’s difficult to concentrate the work on the initial question. The same work, more focused and performed with a larger number of families would have a more refined approach.

Furthermore, it is important to mention the total freedom to visit any farms and apply questionnaires with any farmer.

Management of the rangeland and resources

Mobility as an adaptation to resource scarcity

From a number of head of livestock transhumance between winter and spring pastures (near villages) and summer pastures is necessary to receive sufficient food resources. Few uncommon breeders don't practice transhumance (this can happen if the number of animals is very small and the available resource is sufficient near homes). The staging and the seasonality of the resource implies a summer transhumance to alpine meadows, as can be seen in almost all the mountains of the temperate zone.

This is particularly the case in the European Alps, the Atlas in North Africa, the Patagonian Andes and the Rocky Mountains in North America. Mobility for better resource management is an essential element of pastoral systems (IUCN, 2011). All is based on it and in particular on the ability of farmers to find adequate feed for the heard during the winter months.However, we are now witnessing a rapid degradation of pastures and forage resource available, including an excessive load of cattle on rangelands, which endangered the present farming systems. This lack of fodder obliges farmers to always buy more feed for livestock, which is currently the largest source of expense for families.

The alarming degradation of pastures

A glance on pasture enableus to confirm the environmental trend and the plight those farmers in our discussions. We can clearly see the difference between some pastures being defended and those who are overgrazed.

Faced with the evidence of the emergency state tries to intervene by allowing farmers to install fences, which despite its high cost, can temporarily solve some problems, but it also raises other which are considerable (disputes over good pasture and water, debt, etc.) and can in no way be the only solution to the current problems of pasture degradation (TashiGongbo&Foggin, 2012, Yan et al, 2011).

However, that herd size is the sole cause of this situation is probably a bit simplistic and these are not always easy to disentangle (Harris, 2010). Considerable debates have developed since the 1980s in the scientific community specialists' course about the causes of their degradation and ways to address them (Bedunah&Angerer, 2012, Chen & Tang, 2005). This is particularly apparent that the animal loading grassland could not be the only parameter to be considered in these analyses. Thus do we emerged later the "new ecology ranks" (Behnke&Scoones, 1993) and taking into account models of "non-equilibrium systems". It is clear that the causes of rangeland degradation of the Tibetan plateau are numerous and complex and it appears that the significant loss of mobility of farmers during the recent period there has helped.

This leads us to believe that the responsibility for some inappropriate policies that have been implemented (Kreutzmann, 2013) still on the wrong track by promoting even today the intensification of livestock production.

The "zud": only way to control livestock

Today, large cold waves appear as the only regulatory element of the pastoral system (which can destroy as 2001 or 2010 over 60% of the herd). Many families have then lost their entire herd and about a quarter of them had to leave the area to try to find a job in the city. As impressive as these losses, their impact is uneven: they do not hit all breeders in the same way and the resilience of the latter is not the same, which increases the inequality over time. Farmers with large herds are better equipped to deal with the crisis and the loss of more than half of their livestock does not threaten their survival as a breeder or even the resumption of increased herd.

In addition, other officials or observers admit the inadequacy of this productivistvision and the end of the intention to increase meat production on the Tibetan plateau (PemaTsering, 2007). Some promote ecological migration policy for farmers and setting aside certain territories. But remember, this policy (which, moreover, breaks the "contract" by the state with farmers) also puts severe constraints on many families.

To summarize, the fact that only a dramatic climatic event regulates the pressure made on the environment and slow the degradation process to the detriment of the standard of living of its households appears unsatisfactory.

The role of public policies in response of the rangeland degradation

Since 2000, the priority issue is environmental (Jianguo& Diamond, 2005) and has taken over the initial problem of Livestock Development (Yeh, 2005; 2009a, b, 2010; Chinese Academy of Science, 2007). Protection of pastoral resource Qilian Mountains as many others, is now in urgent and radical ecological protection mode of excluding pastoral uses and users. This undoubtedly leads to a contradiction between the needs of government policies to develop farming in a good economy to breeder's families present on the board.

Pastoral policy has partly solved the "tragedy of the commons" by giving each family usufruct of the resource, without privatization. However, "Rangeland Law" promulgated in 1985 and amended in 2002, provides gradually prominence to environmental conservation grazing. An aid program in 4 parts supposed to allow each family gradually accompanied this policy:

• Close a part of winter pasture (about 20 to 50 hectares in general)
• Build a house
• Build a stable/greenhouse
• Set up small plots of forage closed to harvest a stock of hay

This policy of "household responsibility" was applied to a twenty years considered by some as approaching more or less traditional nomadism (Manderscheid, 2001a). But at the same time this action marked the beginning of not only the deregulation of rangeland management (with a significant increase in livestock), but also mostly a fundamental breakdown in the functioning of pastoralism. The establishment of fences is often seen as a "contractual privatization" of some grassland.

Then spoke the TuimuHuancao program "reduce livestock to restore steppe" initiated in 2003 (Yeh, 2005). This resulted in a set permanent or temporary grazing (less than ten years) areas degraded steppes, and rotational use of others; all often completed by a regulatory limitation on the size and the presence of cattle. Actually, it is a unilateral breach resulted by the public authorities 'contracts' award grazing rights, which only served to increase the already high ambiguity surrounding since the early distribution of these "rights"; confidence in public policies is found strongly undermined. While financial compensations were made available to farmers led to abandon all, or part of their breeding. But these proved insufficient to cope with the new situation, especially as these changes were accompanied by significant disruption of lifestyle due to the massive relocation process and sedentary farmers.

To summarize the effects of public policies, it is probably important to qualify the statement. They have encountered significant failures in recent decades (especially translated by unusual increases in livestock), as farmers are pushing to increase their livestock to try to secure their system (more debt, more feed costs and rangeland degradation). This is the direct result of too much government control on the management of herds and pastures under its ownership. The workings of traditional nomadic systems were undoubtedly complex, but driven and controlled by actors breeders deeply accustomed to these complex mechanisms. We can qualify this observation in the sense that other policies aim to get out and open up farmer's lifestyle often seen as precarious.

The planning policies, progress in terms of communication, willingness to organize institutions around the farm, grants allowing them to invest in a home in the city, are all favorable to the improvement efforts living conditions of farmers.

Economic consequences for farmers

Given the inequalities, multiple strategies are developed

Over time and schematically, one can observe that the political and economic objectives were initially focused on the maximization of plant and animal production.

In a second time on the implementation defends territories protected any pastoral use for regeneration and / or their protection (Foggin, 2008). These two extremes appear as a failure to take account of the whole system (dynamic steppe systems / cattle / livestock producers) as well as capabilities that communities have to know how to organize. On several occasions, various authors have also asked about the difficulties caused by this situation. Ostrom (2009) notes that it is common in these situations management "commons" that policies have a deleterious effect with the efforts of the users.

While some studies (including in Tibet and Mongolia) show an increase in poverty in the rural pastoral areas, it nevertheless found that families living in the Qilian Mountains see themselves improve their livelihoods in recent years and that of significantly. This improvement is more about the conditions of life on the net household income.

Even if the latter emphasized during interviews that the gap between rich and poor tends to increase in the countryside as described Goldstein et al. (2008).

Nowadays, families receive supports directly (subsidies) but also an indirect supports from the government to help improve their livelihoods. Thus, we find in recent years a marked improvement in communication channels, more efficient means of communication (mobile phone even captures at 4000m), elementary school children became free for everyone to read and write, aid shall be granted to improve housing, to build fences in pastures etc.All of this contribute to increase the living standards of farmers, but raises other long-term problems such as settlement, rural exodus, adversely pasture management.

Unequal subsidies distribution

In this study we found that farmers reacted very different face to the changes around them and this way, even when their inputs are similar. This results in a variety of strategies and a breakdown of their expenses and cash flow that is unique to each. A large inequality in the distribution of direct aid is undoubtedly one of the main causes of this diversity. Indeed, the state benefits are first allocated based on the number of acres of crops used (110yuan/mu), then the number of mù of the winter pastures (30 yuan / mu) and finally summer and autumn pastures (1.39 yuan / mu).

This significant difference pushes farmers into a system that now favors the acreage and at the same time the settlement in the longer term. We also note that additional funds are awarded to farmers who are turning to the production of Fine Wool Sheep, encouraged by the national policies through the construction of greenhouse to protect these animals less adapted to cold.

What follows is a revolution from within the herd structure that was previously dominated by raising yaks, more adapted to these highland areas. Through subsidies, the government stepped in indirectly in different breeding strategies, encouraging them to increase their livestock. During the literature review, the subsidies were generally estimated at 30% of the total amount of money inputs, whereas our study reveals close to 15%.

However, when we add the indirect subsidies paid by the government (subsidies to buy a tent to stay in the summer pastures, help to improve the housing and transport) it can be doubled.

Unequal distribution of aid largely explains the short-term strategies that take place in the Qilian Mountains (in our sample, subsidies range from 0 to 33,000 yuans / year) that helps as breeders emphasize in widen the gap between families in a same area. Then we can ask whether the land distribution was fairly in the long run.

The labour: a limiting factor in the improvement of livelihoods

Another important point raised in this study is the lack of future labor on farms, which in the short or medium term goes against the improvement of living conditions of farmers' families. Indeed, come we saw on our sample, the population is aging farmers and more and more young people move to live in the city to have more favorable conditions for educations.

This is an important part of household's income, up to 30%. Families expressed their desire to see their children follow a university background to cope with the uncertain future of the agricultural sector.

According to Ding et al. (2014), many breeders prefer not to see their children back after their studies, which is in this rather traditional and conservative environment revealing deep questions when their future. They also know as retirement, children can only help them better if they have a good job in the city.

There is already a real transformation of family compositions, where it is no longer unusual to see a couple of fifty years working alone on the farm, only supported by their children during the school holidays (which luckily is the period of transhumance). Systems adapt by focusing on productions requiring less labor to the detriment of systems (such as dairy systems), which require a significant workforce. Alongside its mutations, raising yaks for example see results decrease due to lack of manpower. In the past time, farmers spent more time to monitoring their herds. Today, some people admit that they will see them in the pasture once every 10 days or every two weeks, for lack of time, when before they will go check the herd two or three times a week.

They note more losses than in the past, due to lack of follow-up (especially during the calving period or in case of illness). This finding raises questions for the future because of all the changes (economic, political, environmental). If children don't return after their parents, we wonder what will become of these systems, which are the only ones capable of enhance the rangeland at this altitude.

Proposals and perspectives

The study of the pastoral system in the Qilian Mountains clearly highlights the need to reduce economic risks, in order to implement a joint management at the local level between farmers. Indeed, the innovation model and supported by policy development, the alarming ecological observation and the gradual erosion of knowledge and, more generally, the ability to breeders, let pose a threat to the sustainability of tracks improvements contemplated.

Extensive networks of actors Study

For starters, it appears that a detailed study of the various actors and organization of institutions, would consider alternatives by taking greater account of the interactions taking place in the field and thus, the actual opportunities available today for breeders. At first, the changes must take place at the highest level, namely by an overhaul of public policies. They then determine the feasibility of the proposed trails and only they-can allow farmers to regain control of their production and the space they depend.

What is also important is to identify the links that united the people as well as extension networks that exist. A study of common cultural and technical fund would be worth exploring, especially after the many migrations of people who multiplies ethnic intermixing.

Different public policies

The price of livestock products is often rewarding and can sometimes offset more expenses related to the activity, which precipitate farmers in a precarious situation and poverty. It seems inevitable that the policies put in place the systems for border protection products for the domestic market (such as meat or dairy products) to protect farmers against the price fluctuation experienced by livestock products on the world market. In an emergency situation, it happens especially for the poorest countries, that protectionist exceptions are tolerated. One might consider that this situation is obtained in the name of protection of the steppe and the fight against desertification.

This policy should focus on the marketing of livestock products in the domestic market. This involves trusting breeders and especially to believe in their abilities to meet the needs of the population while preserving the pastoral resources.

To reinforce this initiative, training seems necessary to bring up to date knowhow or productions that have now tend to get lost. Indeed, some farmers interviewed expressed a needto engage in the processing and marketing of dairy products, but lack of knowledge; they cannot turn to this production.

Finally, faced with a growing number of farmers are now working outside the operation, it becomes necessary to create good paying jobs closer to the farms in the surrounding villages.The central authority can play a positive role in facilitating and supporting the implementation of collective actions. By establishing favorable customs policies, participating in the establishment of cooperative collection and marketing, participating in the training of farmers (technical transformation of livestock products, support veterinary services, marketing).Strong weights of public policies sometimes include perverse effects. It is not unique inthe Republic of China because we can see the same things everywhere (Ref?). Terms of mediation and discussion must now be reflected with governing bodies to be in adequacy with changes currently affecting pastoral societies and the farming community in general. A good knowledge of local issues and actors interaction is necessary to consider pertinent and positives actions for farmers in the future.

Creating farmers groups

In the past, particularly during the period of collectivization, we have seen that the central authorities were in charge of regulating grazing (for who could use and how stocking). The regulation therefore came from outside and not households themselves. It was in the form of cooperatives organized rangelands. This system was quickly met its limits, to the extent that the administration requires considerable monitoring and a system of appropriate sanctions must deter farmers without generating costs putting their systems at risk.

The same situation seems difficult to reproduce at the level of family production and a market economy. However, the system of cooperative strategy appears as an interesting alternative, if applied locally between farmers and they all agree to respect the constraints to improved pasture conditions.

Farmers are better placed, because they use the term from one year to another for generations and they know the carrying capacity of rangelands. They are best able to develop conditions and limited staff to achieve the objectives of restoration.

Obviously, this organization is not easy to implement on the ground and the increase of current conflicts (due to lack of forage resources and abuse of some breeders) appear to be very conducive to negotiations.In addition, the mixing of populations, cultural diversity, large disparities in economic terms and the various strategies we have described are obstacles to a common consensus. An employer breeder's employee who has a large herd and lack of labor will not have the same strategies and concerns a farmer who is obliged to have a job off the farm to support his family. We found that farmers in the same area sold their animals at the same time private collectors. Many complain, because this method of collection is low paying but for lack of time, training and organization, do not know how to remedy this situation that does not value their work.Other deploy a considerable time and energy to escape this mode of selling and marketing their products directly in the city, with individual means of transport

We note that a group organization enableto remedy these situations by pooling their labor, their knowledge and means of transport, in order to better promote their products.

Incentive measure

As we have risen in this study, the issue of labor remains. In medium terms, it will be the main issue to be resolved to extent that it endangers all this pastoral system. Could be imagined without a strong incentive policy, aimed at young people back on the farm, the functioning of these ecosystems will soon be questioned. Currently, other countries (example of European countries) implement special measures to enable young people to resume operations.

Appropriate training, aid programs installation, technical monitoring, the creation of groups may allow those who wish to install confidence in their future that now seems too uncertain.Other solutions could be discuss as genetic improvement, encouraging public policies to promote local breeds, improved forages to find varieties that can tolerate the short growing season and the creation of fattening farms. But the greater part of these solutions may appear as unsatisfactory long-term, to the extent they again raise environmental consequences, or some impossible economic investment for farmers. Which would aggravate the current situation.

4.5 Conclusion

To conclude, we have seen that there are currently a large variety of strategies based breeders and opportunities and constraints around which evolve. We have identified 7 sub groups of farmers who seem to have very different strategies. They are in part explained by strongly public policies that apply to grants and donated to each family, widening the economic gap between households. Yet, thanks to current policies, most households saw their overall living conditions improve (city apartment, roads in better condition, equipment). Paradoxically, we noticed that many farmers have no choice but to deal with capitalization hazards of daily life (health problems, accident, harsh winter, children's education).

Address these inequalities, they do not all have the same resilience as a result of an unusual event and have no other choice but to affect their future resource to meet the needs of the present, which is well safe against sustainable development of the area. In this context, the challenges of tomorrow then appear very clearly. Firstly, therangeland, base of the feed, dangerously deteriorating and no longer allows the livelihood of families. Secondary,the problem is the lack of workforce due to the low interest of youth for breeding, which now didn’t want to engage in more risky and uncertain path.In this context, everything suggests that the future of pastoralists Qilian Mountains is in the hands of new public policies most appropriate, which would leave more room for joint initiatives and cooperation between operators.

In agreement with the literature and resource people on the field, we found that the pastoral world through the world meeting invariance at restructuring territories (North Africa, Central Asia, Africa, Europe). Population growth and public policies have important roles across the face of incessant expansion of agricultural areas (land grabbing, who reduce the rangeland).

Today, we can talk about phenomena of mutations, more than phenomena of change. In this context of metamorphosis, we understand the importance to support farmers to limit their vulnerability. The challenges of tomorrow will result in the ability of institutions to disseminate information and to support the vulnerable populations face to this rapid change. It is for this reason that China is emerging as a very good example to integrate into networks pastoral study in the future.

Chapter 5 Comprehension of the farm holdings and analysis of supply chain management from household point of view

The Qilian Mountains are located in the Qinghai-Tibetan plateau, often called the 'roof of the world', the highest large plateau on the globe (LONG, et al. 2008). More than six ethnics, including the Tibetan, the Mongols, the Yugus1 and the Hans, are living with a transhumance system based on yaks and sheep herds. Along the last decades, the ecosystem is becoming dysfunctional through adverse climate sequences, over-population and over-grazing. Several policies have recently been introduces to improve grazing management and to reduce these degradation problems. (LONG, et al. 2008) The rural society of the Qilian Mountains has faced several significant changes, particularly in landownership, rangeland management, agriculture market chains, irrigation and other water uses, social services in education and public health (Cai YuanPei 2013).

It is in this context that the Cai YuanPei program is conduced, the Chinese-French research partnership aims four following scientific objectives: (Cai YuanPei 2013)

- Increase the scientific knowledge about the adaptation strategies to global change of farming systems in the Qilian Mountains, Tibetan Plateau, China,
- Modeling the dynamics of farming systems using participatory methods, especially ABM (Agent-Based Models) with local people,
- Identify and build, then simulate using the models, new practices and alternatives aiming at improving the sustainability of farming systems, also through participatory methods,
- Training young researchers, graduate students and local extension staff to participatory methods, particularly applied to modeling.

This study has been developed with three other, XiaoJing QI on the benefit performance and quality of the livestock products (PhD), TingTing YANG on the livelihoods and the diversity of farming systems (Master degree) and Doryane BRASQUIES on the household budget analysis (Master degree). The subject of this study is the comprehension of the farm holdings and the analysis of supply chain management from household point of view. The purpose is to describe and understand the farming system, the economy and the integration in some supply chain management of families in Tianzhu and Sunan, two counties of Gansu

province.

This report is divided into four parts. The part 1 consists of a review of the context and the development of the purpose of the study and the part 2 is the description of the methodology used.

1. Actual situation (LI, LI et DAN 2011)

The economic and social disparity between East and West is firstly the result of environment inequality. So, the Eastern regions have vast plains with a propitious climate for farming: four distinct seasons, good precipitations and an access to the sea. On the contrary, the Western regions have hilly areas and few precipitations that do not allow the agriculture development. Moreover, there are some policies that have pushed the development of the East

such as the creation in the 80's of the Special Economic Zones (SEZs) in eighteen coastal towns3.

2 "Measures the extent to which the distribution of income or consumption expenditure among individuals or households within an economy deviates from a perfectly equal distribution.(…)Thus a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality." (The World Bank 2014)

3 The SEZs began in 1980 with four towns: Shenzhen, Zhuhai, Shantou, Xiamen. Then in 1984, fourteen coastal

towns also joined. (CATIN et VAN HUFFEL 2004)

The result is a large inequality between the East, open to the world economy, and the isolated West, dominated by agriculture. So, the GDP per capita varies between more than 60,000

Yuan in Shanghai and Beijing to just 10,000 Yuan in Gansu and Yunnan province (BOQUET

2009). In addition, there is an economic disparity within the provinces, an inequality between rural and urban areas. In 2009, the income of urban Chinese was, on average, three times higher than the one of rural Chinese. A part of this difference is due to the hukou4 that theoretically assigned an inhabitant to the rural or urban area.

In order to progressively reduce these disparities, the Chinese government started the

Western development strategy in 2000.

2. Gansu province: a full expansion West province

i. Geographic and historic situation

General data (2013)

Area: 452,000 km²

Capital: Lanzhou

Population: 25.8 million

GDP: 565 billion RMB

Figure 6: General data Gansu province (Ubifrance Chine -

However, this province owns important mining resources: 90% of the nickel reserve, the biggest gold mine in China (Yangshan), as well as 170 kinds of minerals. Moreover, there are also more than sixteen million hectares of pastures, one fifth of the national reserve. The grassland-livestock system is the traditional livelihood of local residents. This serves also an important function by maintaining the natural environment. Nevertheless, Gansu generally has a semi-arid, continental climate, with warm summers and cold winters. Most of the precipitations occur in the summer months with annual rainfall ranging from 600mm in the South East to less than 100mm in the North West. Thus, this climate prevents the development of intensive farming in some regions.

On the other hand, thanks to a unique geographical location that acts as a link between the Eastern / Central and the Western regions and, more specifically, to the Western Development Strategy, Gansu’s economic development has been improving these last few years.

ii. A recent dynamism

Gansu's economic development has been promoting with the implementation of China's Western Development Program. Many services have been improved, such as public facilities, communications, energy, tourism, ecology and environment. Furthermore, the province has 33 colleges and universities, and a lot of research institutions that attract every year many more student

In the first half of 2013, the growth in Gansu province was higher than the national average, with a year-on-year growth of 11.3 percent, showing the effects of a policy turned to the West (Chinadaily 2013). Moreover, Gansu province took advantage of increased tourism on the Silk Road.

iii. Localization of the two counties

1. The Qilian Mountains, an area in transition

The Qilian Mountains establish the natural frontier of the Tibetan Plateau that covers

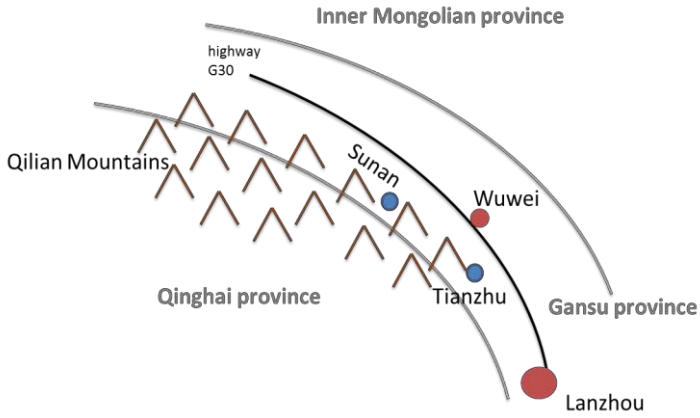
2,570,000 km² at an altitude between 4,000 - 5,000m. It comes from the collision of the Indian and the Eurasian plate and is the starting point of most of the principal Asian rivers. The total grassland has an average of 8.7 million ha equal to 51% of the area. This grassland has several ecological functions such as retention of water, maintaining biodiversity and ensuring the stability of seasonally frozen soil (SHANG, et al. 2014).

The border, between Gansu in the South-West and the Qinghai province in the North-East, represented by the Qilian Mountains, overlook the Hexi corridor. Once crossed by the Silk Road, still today, this corridor is one of the main routes for products and humans. These mountains, with some forest preservation areas, are used by the local population for pastures, between 2,000 -
4,000m. This area also attracts each year many tourists who come to enjoy these preserved mountains.

2. Tianzhu and Sunan, the study area

a. Two counties with different characteristics

Sunan and Tianzhu are two autonomous counties. Indeed, Chinese minorities can have local autonomy in the area where they are concentrated. Four administrative levels exist for these areas: province, prefecture, district and county. For instance, the province has a more independent local government with a legislative power that can take some local decisions such as education, public health, agriculture, water conservation, etc. Concerning the counties, this decision level is lower and is visible especially with the local policies regarding farmers.



Even if these two counties are in the same province and in the same area, they have different characteristics. Tianzhu is composed by a majority of Tibetans, famous for the white yaks. Many tourists come each year to eat and drink yak butter and milk, and also to discover the traditional Tibetan culture. Sunan is composed of Yugus, descendants of Mongols and Uighurs.

Tianzhu have a higher population within a lower area than Sunan, which have an effect on the total pasture areas for the farmer families studied (Table 1). Although the agricultural income is decreasing in these counties, this is still an important income for most of the small mountain villages. In these, the greatest part of the population lives on agriculture and more specifically on animal farming.

Table 1: Population and area characteristics of Sunan and Tianzhu (FAN et XIAN 2012)

Sunan (16 families)	Tianzhu (16 families)
Total population	36,600	176,200
Number of villages	101	176
Total area	20,500 km²	7,150 km²

Activities : Agriculture:17.55% Industry 60.36%

Service industry 22.09%

Agriculture:13.06% Industry 58.67%
Service industry 28.27%

Income per person 10,025 yuan/year3,842 yuan/year

b. The importance of the local policies

As previously stated, local policies are different in each county. These differences are visible especially with the subsidies given to the farmers. So, in Sunan, subsidies are given to fine wool sheep owners. To have these subsidies, certain conditions have to be respected, such as a specific number of animals per mu. Even if it is a constraint, most of them agree with this policy. And, since the beginning of this policy, they think that the grassland is in better condition. But, some of them explain that the inspections are seldom and could be better. For the grassland condition, the opinion of the Tianzhu farmers is very different. For them, the degradation of the grassland increases every year and has consequences on the weight of their animals. Indeed, there is no policy to control the number of animals on pastures. In Tianzhu, subsidies are given to white yak owners, local government wants to keep white yaks in the county because of their reputation and their touristic value.

However, some policies are common to these two counties, such as for the wolves, the greenhouses and the apartments. For instance, although many wolves (or bears) attack sheep and yak herds, these are protected animals forbidden to kill. The government offsets this loss with compensation equal to half of the market price. To obtain this money, farmers have to prove that the animal has been killed by a wolf. The common way is to take a picture of the dead animal. So when an animal is missing the farmers spend a lot of time to find the carcass in order to avoid an important loss that can reach 4,000 Yuan for a 5 years old yak.

In order to help farmers to build a “greenhouse”5 the purpose of which is to keep animals during winter, to decrease the mortality rate and to increase the production (an average of 20%), the government allocates subsidies that reach 40% of the construction price, so most of the farmers own one (TOURRAND 2013). Concerning the apartments, the government encourages farmers to have one in town. A loan with a very low rate (close to 0%) is granted to all farmers who accept to buy a flat. Most of them live in town during winter with a daily trip to the farm and leave the apartment in summer to go to the pastures.

c. An area in changing

Even if Gansu is the poorest province of China, since almost 15 years the living standards have increased and many things have progressed, particularly due to new policies and the Western development Program. These transformations are visible in town and also in the countryside, but they are more important in the villages and more especially at the families’ level. Indeed, each change that occurs at the province’s level has an impact on farmers’ lives and on their way of living. Thus, the change of consumption patterns, the access to the communication technologies, the access and the development of the market and a good education such as the university, influence the evolution of the farms and their owners. All of this, without forgetting the environment with the degradation of the pastures and also the pressure of tourism, that galvanizes the local economy but is also invasive.

In light of all these elements, farmers represent a very important actor to understand the influence of these changes in the villages of the Qilian Mountains. However, before trying to understand the evolution of these farms, firstly it is essential to understand how these farms work
and how they are integrated into the different markets.

c. Purposes of the study

In a general economic growth context, some social and economic inequalities are visible between East and West. Policies such as the Western Development Strategy have been created in order to reduce these inequalities and to allow a recent dynamism in the West as for the Gansu province, one of the poorest provinces but with an interesting geographic localization between the eastern and western regions. The Qilian Mountains and more particularly Tianzhu and Sunan counties are a precious study area. In fact, with different characteristics such as the local policies, this changing area is a good place to observe these evolutions.

So, on the basis of several studies lead by ICTPEM and CIRAD team, this study aims to deal with the comprehension of farm management. The supply chain, in which these farms are integrated, is also studied. As previously stated the study is focused on two counties of Gansu province, to have a good representation and comprehension of these systems with a limited number of families.

II. Material and method

a. Overview of the different study's stages

Thirty-two families have been surveyed, and then twelve have been selected to represent at best the system diversity. The Qilian Mountains are an interesting area to see the rural dynamics because they are under the administration of two provinces: Gansu and Qinghai. Furthermore, the choice of two counties is explained by the different policies at local level. Indeed, policies can push the farms' evolution in a certain way (as well as the subsidies given to fine wool sheep owners in Sunan). Two counties allow having a broader view of the farms' direction.

The information collected is divided in three parts: a general approach, a family's economy approach and a look into the supply chain and the actors. These surveys have been realized by questionnaires.

i. General approach

This first questionnaire (Annex 1) gathers together several types of information and is common for the four studies of the program:

Geographic and family information
Possessions (Land, Animals, commodities…)
Cropping system
Livestock management (feeding, pastures, diseases, performances

Market and animals marketing
Social capital and change in the environment

The purpose is to give an overview on the farms' management, its family structure, social capital and environment; furthermore, the bibliography that allows restoring the farms into their context. This first questionnaire has also the objective to understand the farming systems and to make hypothesis about the different systems present in this area. This phase took place with the ICTPEM team that facilitated the first contact with families and also the comprehension thanks to their knowledge of the area.

Thirty-two families, spread in eight villages6 in Sunan and Tianzhu counties, have been surveyed. It is more polite to be introduced to the families by someone, so the selection occurs in the following way:

Contact with the village secretary or with a family already in relation with the ICTPEM team.

Introduced by our first interlocutor we meet one or two families that helped us to get in contact with other families.

For all the interviews a GPS point has been collected, in order to complete a precise map of all the farms. (Annex 4)

ii. Families' economy approach

This second questionnaire (Annex 2) is mainly about the family's economy, divided into three parts:

Family's income and expense
Working of subsidies' system
Loan

Three parts have also been added: one about the common land and another one about the cropping system, two parts with still some issues to be looked into after the first questionnaire. And, a last part on animals and dairy products traders in order to prepare the third questionnaire.

So, the objective of this second survey is to understand the family's economy and the proportion of each cost and income item. Thirteen families among the thirty-two have been
surveyed in seven villages, and selected on the base of the following criteria:

Their geographic repartition

Their livestock management

Their accessibility

Their ease for answering and their welcoming

iii. The supply chain and the actors

This last questionnaire (Annex 3) is reserved for traders, meats, dairy products and wool. The purpose is to know the organization of these activities and look briefly at the destination of each product outgoing from the farms in order to trace as far as possible the different supply chains involved. In addition, some interviews have been realized with professionals of several sectors such as a CEO of a dry yak meat company or a yoghurt saleswoman.

Only seven traders have been surveyed because they are mobile and with little time between June and September, their busy period, so they can be reached with difficulty. And for this reason, half of these surveys have been done by phone.

iv. Organization and conduct of the surveys (Annex 5)

Four field phases have been realized, one each for questionnaires 1 and 3 and two for questionnaire 2; the time between two surveys is used for a quick analysis and the preparation of the next. One interview takes one to two hours and always begins by a presentation of the team and the purpose of the survey. The interview was conducted in Chinese; during the first questionnaire the translation was done simultaneously. For the other questionnaires, the translation was done at the end of the day as well as a little debriefing to go back on some farmers' answers.

b. Data analysis

The first database is analyzed by PCA7 and them by MCA8. Even if the number of farmer is low (less than 50), it's possible to use this methodology to draw the main tendencies. A first typology has been created on the comprehension of the farm management. Then, these hypotheses are compared through the PCA to obtain a better one.

For the questionnaires 2, 3 and also for the interviews, the sample is too little so it is impossible to use the PCA.

presentation of the PCA9: (ERIC 2009)

The PCA is a statistic method that project data into a lower dimensional space, by converting a set of variables into a set of linear uncorrelated variables called principal components. This statistic method has two main purposes: understand the structure of a set of variables and condense the data of this set without losing too much information.

Main steps: (Annex 6)

- Bartlett's test: this test checks if all the variables are not independent. (With $p < 0,05$)

- The choice of the factors: to choose the number of factors required, the standards usually used are the eigenvalue. The higher the eigenvalue factor the better it explain a significant part of the total variables. Usually, a factor with an eigenvalue superior to 1 is considered as significant.

The explanatory percentage can also be used; the selection has to take at least enough factors to obtain a cumulative percentage superior to 70.

- The table of factors: this table explains the variables' weight according to each factor. This weight represents the correlation between the variables and the factors. Unfortunately, this table is not very clear and a factors rotation is needed.
- The factors rotation: this step change the coordinates used in order to maximize the comprehension of each correlation. In the example (Figure 8), the variables after the rotation are better explained by the factors (axis).
- The circle of correlations: this circle is the chart representation of the table of factors.

The closer the variable is to the perimeter the

Figure 8: Representation of a factors' rotation (6 variables)

The MCA is a factor analysis approach used on qualitative variables. “The aim is to map the dataset in a reduced dimension space (usually two) which allows us to highlight the associations between the examples and the variables.” The result is two charts, one of the variables to read the second one of individuals. In order to use this approach, it is necessary to create two or three class for each variable. For instance, with the variable TLU Yak, three classes are created:

- Farmers without yak,
- Farmers with less than 70 TLU of yak,
- Farmers with more than 70 TLU of yak.

With these two analyses, the hypothesis can be checked and a new typology can be established.

III. Comprehension of the farm holdings

a. Harsh climate and a complex land management system

i. Climate, which leaves little time for the production of fodder biomass (LI, et al. 2003)

The climate is the most important factor for determining the biomass production and

growth rate in the area. Fortunately, in the Qilian Mountain area, the warmth coincides with the rainfall and favors a short intensive growing season (Annex 8). According to Li et al. (2003), following biomass feed is available in three phases to the animals of the area (Annex 9):

- Surplus of green forage from June to September,
- Relative surplus of mature and dry forage from October to January,
- Limited quantity of dry forage from February to May.

This pattern of available forage affects its utilization; consequently farmers make a rotation over space and time to maximize its use. The farmer use higher pastures during the summer when the temperature is warm with more available forage, moving then to the lower altitude pastures during autumn and finally pastures nearer to their town in winter. These three types of pastures are called; summer pastures, autumn pastures and winter pastures accordingly. Most of the time summer pastures include summer and autumn pastures. Thereafter, the term autumn pasture will not be used anymore.

ii. History of land management changes

- Pre-1953: Rangelands were privately owned but used collectively,

- 1953-1978: Rangelands and livestock were used and owned collectively,
- 1978- onward: Livestock owned and used privately and rangeland under contract (HCRS10)

Before 1953 and the collectivization, land management was “traditional”. Then, the government created the system of “three-level ownerships”; i.e.11 i) every farmer’s household belonged to a production team (the village with 100-150 families), ii) then a number of team formed a production brigade iii) and finally several brigades made up a commune. The grassland was the property of the commune while the livestock was owned by the brigade. A team having the farm implements and was responsible for the livestock production (HO 1996). At the same time, three policies were enacted to address rangeland problems: a) “General Summation of the pastoral production in pastoral areas in Inner Mongolia, Sichuan, Qinghai and Xinjiang province”,

b) “National program for agricultural development” and c) “Regulation on policies for the minority ethnic groups and people’s communes pastoral areas” (WANG, et al. 2010). These policies promoted pastoral development with an increase of livestock production including the protection of the grassland and the water resources. Resultantly, livestock production has been intensified and has doubled the livestock number. At the same time, the agricultural production didn’t in China as a whole increase, so the government created the HCRS to galvanize the production. The HCRS is a contract between the household, the community and the local government the land is owned by the community but the farmer has the rights to use the land. It is a public land with a private use, but at any time, the right of use can change according to the community decision. The effect of the new policy has been an increase in the agricultural production of the area. In 1982, this policy was applied to the whole of China and especially for pastoral area too but without accommodation. A rapid degradation of the rangeland followed and it was difficult to adjust the policy. To apply the land sharing, each village had the choice to divide the land between the farmers or leave it for common use. It is why, some differences are observed between villages, with some pastures still common such as the summer pastures in Tianzhu county
or such as in Nan Ni Wan village where all the pastures are common

b. A general overview of the system

A typical family is composed of one couple with one or two children. Sometimes, there is also one grandparent or grandchild. The couple takes care of the animals and makes all decisions concerning the farm. This is the main activity for most of these families, the main and only source of income. In this area, due to the harsh climatic conditions, just three species are bred: the yak, the Tibetan and the fine wool sheep (and some goats). The last one resulted from crossing native sheep with imported breeds and now is very common in North-West China. (MASTERS, et al.
1990) These three species can survive best in the cold harsh winter with temperatures below zero and poor pastures and today are the only one able to be promoted in this area (Box 1). The
livestock provide meat, milk, leather and manure.

Box 1: Yak and Tibetan sheep, two species adapted to a harsh climate

Yak has developed special characteristics to survive in these conditions. (LI, et al. 2003)

- Resistance to cold;

o Special fleece, which insulates the animal from cold and protects it from heat and moisture,
o Three different types of fiber, which maintain a stable air temperature,

o Sweat glands poorly developed, so the absence of sweating assists cold tolerance.

- Adaptation to low oxygen and high solar radiation;

o Blood cells and hemoglobin with a strong absorption and retention of oxygen,

o Dark fleece and skin to protect the yak against solar radiation.

- Adaptive characteristics to grazing conditions;

o Incisor teeth and lips allowed it to graze like sheep short grass and creeping stems.

- Adaptation of reproduction;

o Short gestation length and breeding season (during the start of grass growth) are the best to allow calves to improve body condition before their first winter.
- Then yaks are gregarious, so they protect each other and it’s unusual to lose an animal

from wolves attack.

Tibetan sheep are as well adapted to this condition because of their hardiness.

- Resistance to cold;

o Fleece with long and coarse fiber.

- Adaptation to high solar radiation;

o Dark skin and thick fleece which protect it.

- Ewe behavior;

o Tibetan ewes are good “mothers”, very attentive and protective, that allows a good
ratio of surviving lambs. 23

i. Animals and land holding size

On the average each family owns 80-300 sheep and 60 yaks however; the differences between Sunan and Tianzhu are obvious. In Sunan county priority is given to sheep, both fine wool and Tibetan sheep, and each family has an average of 300 sheep. Some have just fine wool sheep or Tibetan sheep and some have both. Half of the families don't have yak or just a few. In the particular case of Nan Ni Wan village families still have yak about 100 in addition to sheep. The distinctive feature of Tianzhu county is the white Yak and almost all the studied families have about 60 yaks with Tibetan sheep. In Tianzhu, these sheep are more common than in Sunan county due to their higher resistance and their hardiness. The Tropical Livestock Unit12 (TLU) can be used to make a better comparison between the two counties. In fact, with this single unit, the livestock types and sizes can be easily compared (Table 2).

Table 2: Comparison of the animals possessed between Sunan and Tianzhu

Sunan (16 families) Tianzhu (16 families)
Sheep owner
- Average number
Tibetan sheep owner
- Average number
Fine wool sheep owner
- Average number

16 families (100%)

321

7 families (44%)

253

13 families (81%)

259

14 families (88%)

83

12 families (75%)

84

4 families (25%)

36

Both owner 4 families (25%) 2 families (13%)

Yak owner

- Average number

TLU

- Sheep
- Yaks
- Total

This contrast can be explained by the difference of land management between these two counties (Table 3). Each family own two kinds of land: crop fields and pastures. Oat is the major crop of the area which is used to feed animals during winter and this forage production has been named as Summer-Forage (SHANG, et al. 2014). Hay making is a well-established method of forage production on the Tibetan plateau to supplement animals during the cold season and safe- guard animals against starvation during natural disasters (SUN, et al. 2007). The families of Sunan have more pastures than those of Tianzhu; the main explanation is the difference of total area of

these two counties (Table 1). This availability of pastures allows a higher number of animals for the Sunan families while maintaining a lower animal density than in Tianzhu.

Table 3: Comparison of land possessed between Sunan and Tianzhu

Sunan (16 families) Tianzhu (16 families)

Winter pastures

- Average per family

Summer pastures

- Average per family

Crops field

- Average per family

Private

1,760 mu

Private

1,530 mu

Private

17 mu

Private (except Nan Ni Wan)

353 mu

Common

189 mu13

Private

24 mu

The quantity of concentrate and grain, given to the animals during winter, are hardly understandable. Most of the farmers give almost nothing to the animals, with less than 10kg per TLU and per year, at the opposite some give more than 100kg per TLU and per year. So, these data seems to be too various to be used.

With this first analysis, the localization seems to be an important point of comparison for the farms. A first hypothesis to characterize the farms can be:

- Farms of Tianzhu with white yaks and Tibetan sheep, common summer pastures and few winter pastures.
- Farms of Sunan with Fine wool sheep and a lot of pastures.

To check this hypothesis the methodology of PCA14 and them MCA15 can be used, seven variables are studied:

- The TLU of fine wool sheep (TLU FWS)
- The TLU of Tibetan sheep (TLU TbS)
- The TLU of yak (TLU Yak)
- The area of winter pastures16 (WP (mu))
- The animals density (TLU/WP)
- The area of crops (Crops (mu))
- The wool income part (Wool income %)

The farmer n°1 is not use due to some extreme data. From 2 to 16 it is Sunan farmers and from 17 to 32 it is Tianzhu farmers. Three groups can be created with the PCA (Figure 9):

- A1: Farmers with mainly yaks and a few Tibetan or fine wool sheep, they have a small winter pasture area, an animal density medium to high and a crops area higher than the average. All of these farmers come from Tianzhu county.
- A3: Farmers with mainly fine wool sheep, the wool have a significant place in the family income; they have enough winter pasture area and a low animal density. All of these farmers come from Sunan county. The A3' could be separated from the A3 du to an important area of winter pasture.
- A2: Farmers with sheep and yaks, a medium to low density and enough winter pasture area.

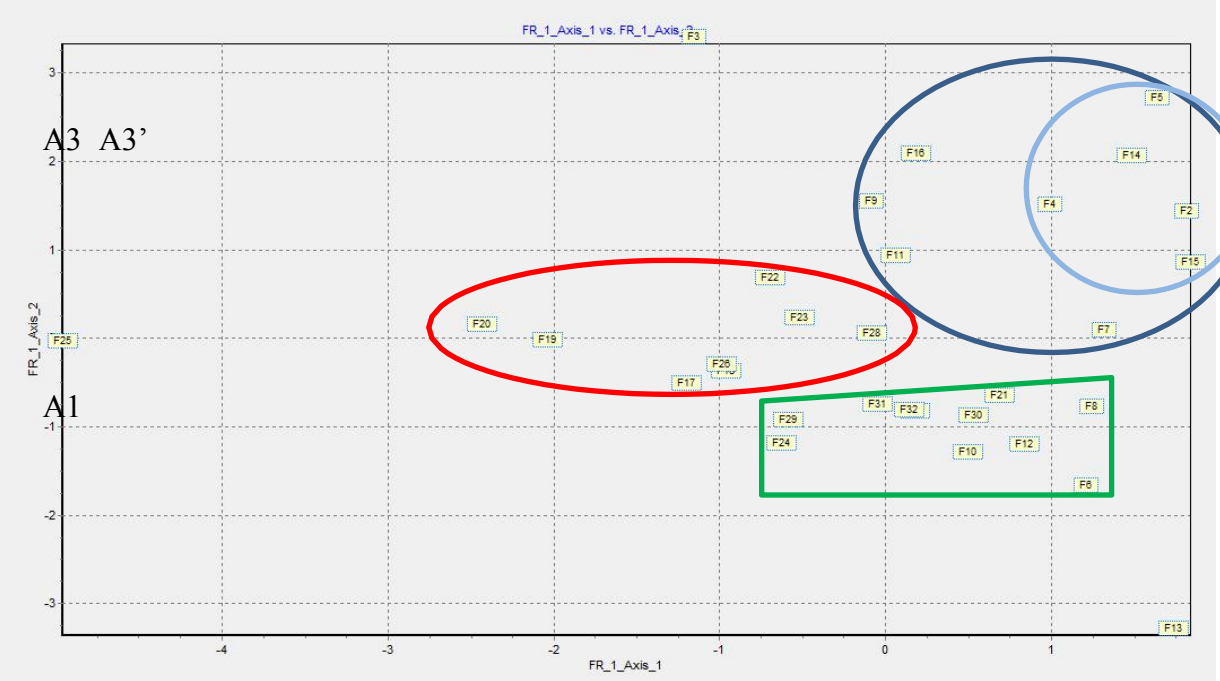


Figure 9: Result of the PCA

Them, with the MCA, it is possible to try to see if the farmers are specialize in their productions, meat, dairy products and wool. Here, seven variables are studied:

- The TLU of fine wool sheep (TLU FWS)
- The TLU of Tibetan sheep (TLU TbS)
- The TLU of yak (TLU Yak)
- The animals density (TLU/WP)
- The wool income part (Wool income %)
- The production of dairy products (Dairy products)
- The yak meat income part (Sheep meat income %)
- The sheep meat income part (Yak meat income %)

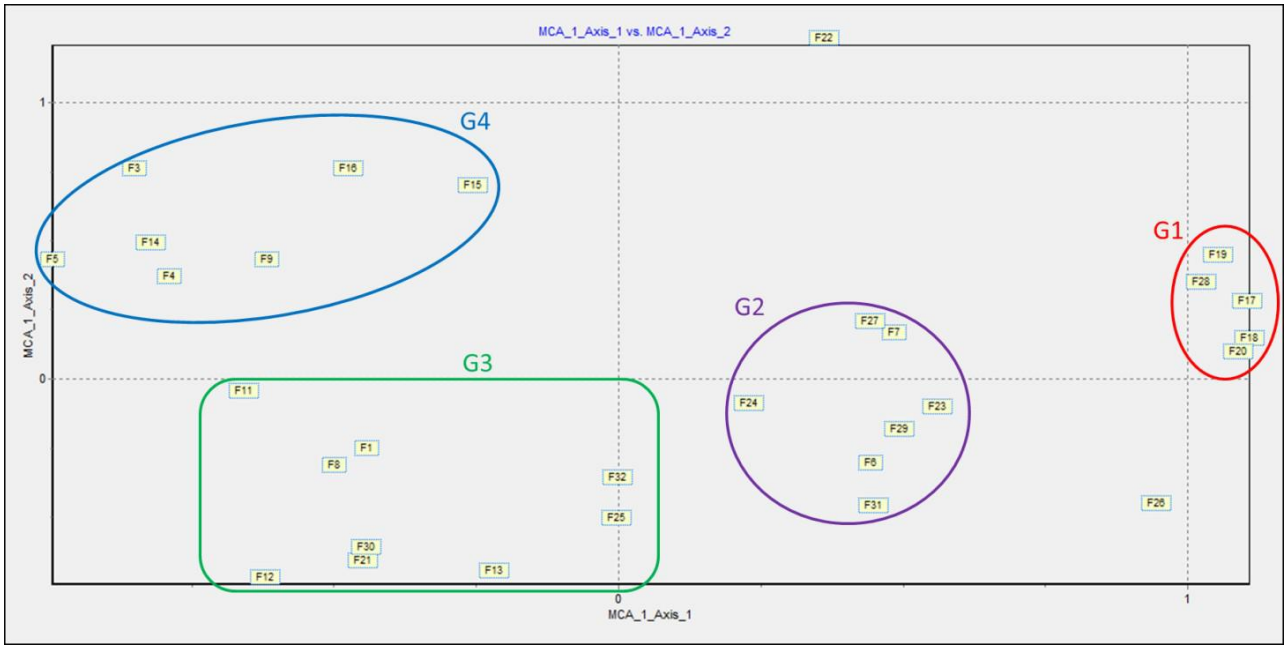


Figure 10: Result of the MCA

Finally, four farmers groups can be created, two are specialist group (Figure 10);

- G1: Farmers specialize in sale of dairy products. They have a lot of yaks, very few sheep, and high animal density on the pasture. All of them come from Tianzhu county.
- G4: Farmers specialize in sale of wool. They have a lot of fine wool sheep some Tibetan and few or no Yaks. They have enough winter pasture and a low density. All of them come from Sunan county.

G2 and G3: Farmers without specialization, who mixed Yaks and sheep. They have a medium density on the pasture.

- G2: Farmers with more yak than sheep, some Tibetan and very few or no Fine wool sheep.

Most of them come from Tianzhu.

- G3: Farmers with Tibetan, some Fine wool sheep and few yaks. They come from the two counties.

The contrast between Tianzhu and Sunan county are visible with three groups (G1, G2 and G4) composing almost exclusively of one county. The creation of these four groups confirms that due to the difference of local polities, the farmers choose the herd composition in order to receive the subsidies and to maximize the income with the different products. However, with a herd composition different, the activity calendar and the livestock management is almost similar for both Tianzhu and Sunan.

ii. Activity calendar

In order to reveal the year round seasonality of the work a circle calendar is used (Figure

11). The year is divided in two main periods, the winter and the summer. These two periods are separated in time and also in space, the winter near the town in the "winter-house" or in the apartment from October to May-June and the summer in the pastures.

The winter period is characterized by the rest time, from November to February due to the difficult weather, and followed by the peak workload, from March to May-June. Apart from this, there are also some delicate times like the lambing and calving period and the winter feeding. During this period, the breeders have to take care of newborns each day in order to avoid a high mortality rate. For instance, they have to take care of the umbilical cord, put cold protection and check breast feeding.

The short summer is the most important period. During these months farmers have to make sure animals take on sufficient weight for being sold or for surviving the next cold season. They have also to produce enough forage for the next winter. It's also the milk production and shearing season, two important income sources unavoidable for some families.

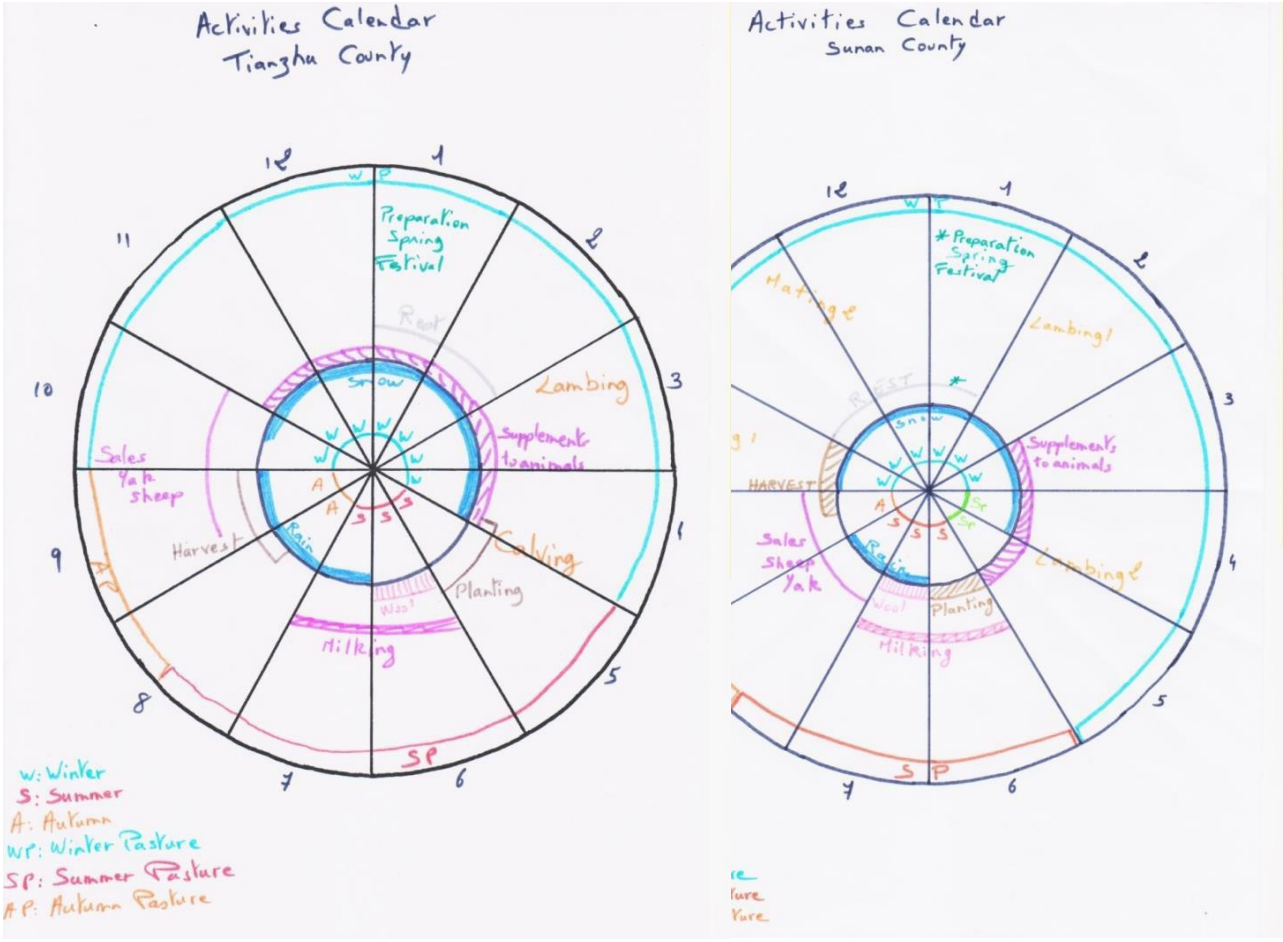


Figure 11: Activities calendar: Tianzhu and Sunan

iii. Livestock management (Annex 11)

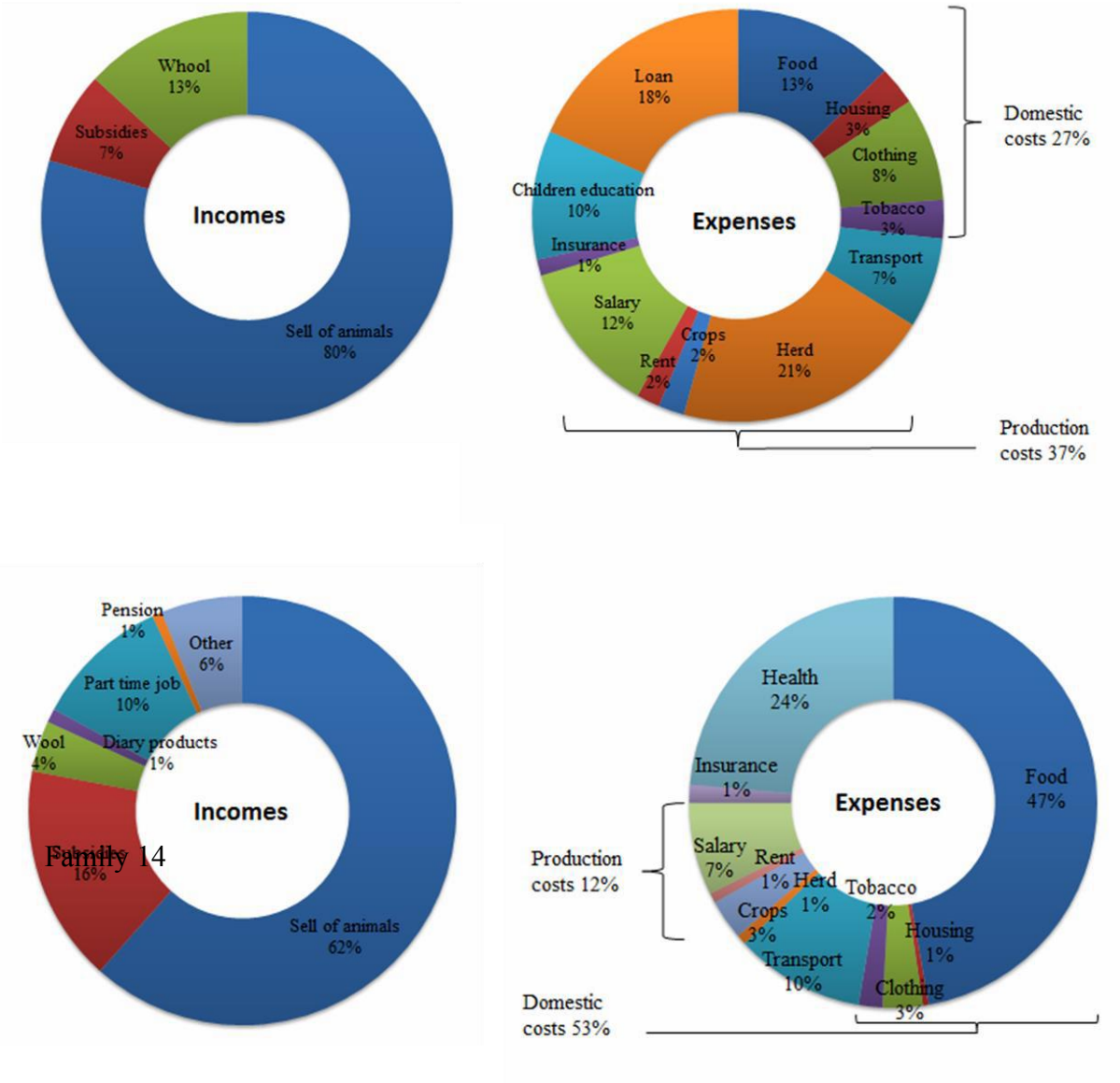
Even if the composition of the herd and the land possession are different, the livestock management is very similar for the two counties (Annex 11). In a farm, Tibetan and fine wool sheep are lead together without distinction. Same care and same supplements are given, the difference between the lambing and the mortality rate are explained by the hardiness of the Tibetan sheep. Indeed, these are more adapted to the climate than the fine wool sheep. Moreover, Tibetan ewes have are more protective towards lambs than fine wool ewes. The mortality rate can change a lot between two farms; it is often explained by the difference in the care delivered to the lambs just after the lambing.

The replacement rate seems high and there is an important variation among farms; some capitalize their herd in order to establish a live saving, at the opposite some sell more animal than newborns. In this case, some additional questions point out a particular event such as accident, health trouble, education costs… These events oblige the family to sell more animal than usual to cover the costs. This element focuses on a specific purpose of the animal farming, the saving / risk management.

c. A family's economy based on livestock

To understand the families' economy, a list of the main expense and income has been realized with thirteen farmers during the second survey. The expenses can be separate in seven categories and the income in seven too. The repartition is really different between each family, the presence of a child, a shepherd, a part time job and of course the kinds of products sold, influence this repartition. (Figure 12) The choice of these categories is based on the comprehension of the families' lives after the first questionnaire.

Figure 12: Example of two families' economy



Family 14

However, all these data have to be relativized and to be considered like a qualitative data. Indeed, the farmers have given us an average by memory of their expenses and incomes. Furthermore, for most of the questionnaire, only one member of the couple was present, well, with both of the couple, there was a lot of discussion about the answer. The points of view of both of them look to be more exhaustive and more precise. So a return on these economies could be interesting especially if it could be realized each month, to have the evolution and a comparison
with the activities realized.

- Incomes

i. Description of the categories

o Sell of animals

Incomes coming from the sale of calves, lambs and also old animals for the culling, it is the main income of the families that can reach 90%.

o Subsidies

Given by the local government, the subsidies can be obtained due to the possession of fine wool sheep, white yaks or winter pasture. Around 7%, the subsidies have an important place to balance the family's budget.

o Wool

Coming from the sale of the wool of the animals, yaks and sheep, this income can reach more than 20% of the total income depending of the quantity and the type of sheep possessed by the farmers.

o Dairy products

Most of the farmers self-consume the milk of their yaks, for the farmers specialize in the dairy products production this income reach between 15 and 30%. This activity requires a lot of work and none of them have a part time job.

o Part time job

Half of the thirteen farmers have a part time job, mainly during slack periods they are hired like workers for houses construction.

o Pension

It is given by the local government to the old people, around 60 Yuan per month and per person.

o Other

In this category, there is all the gift and money send by neighbors, family and

friend for special occasion such as weeding, new year

- Expenses

o Domestic costs (Food, Housing, Clothing and Tobacco)

Costs relativize to the family support, it is between 30% and 60% of the total expenses. The food is the main expense and can reach alone 50%, but there is an important variability between the families and also according to who give this data, the wife or the husband. It can be to 200 to 20,000 per person per year; this difference is also due to the geographical area and the production or not of vegetable self-consumed.

o Transport

All the farmers have motorbike and some also have little trunk, used to go in town.

o Production costs (Herd, Crops, Rent and Salary)

These costs are relativized to the crops production and also to the cares to the animals. However without an exhaustive list some could be forgotten, for instance some farmers look to integrate the rent of equipment in “crops” and some no. The herd is an important expense that easily reaches 25% and 30% when there is a shepherd.

o Insurance & Health

Most of the farmers have a health insurance (50 yuan per year per person) and one for the pension (100 yuan per year per person). The health costs are mainly due to accident and farmers need to sell more animals to cover them. If the health issue is too important and one of the couple cannot work, the family will have difficulties to maintain the activities.

o Children education

Very important expense for some family, the children education is one of the main raison, with the heal issue, of a diminution of the herd size. A couple used to increase the herd size to cover the education cost for the future children.

o Loan

Some farmers have a loan to the bank; it is mainly for the apartment or for a greenhouse.

o Other

It is the same category than in the incomes.

ii. Discussion

After analyze of the data, half of the families have a negative balance and for them, one or two expenses are really important in comparison with the others. Some farmers explain that if they really need money they sell another animal, but they try to do it not often. Indeed, they have to bring the animal to traders by them-self or ask him to come for few animals and the price will not be the same than usual.

In all these budgets, the sale of animals is the main income and sometime the only one that mean that families are dependent of their herd and also weak. If a problem appears one year, it is all the families of these counties who are touched without any way to protected them-self. So a winter colder or a summer without enough rain could be a disaster to these families.

IV. Analysis of supply chain management from household point of view

The purpose of this part is to make an explicative model of the matters organization, based on the households, with their relations to the other actors such as their interdependence or the regulation modes. The analysis of the supply chain management is not focused to one specific product but on the households. It is the starting point then; the supply chain management of each product is studied as much as possible, the whole in the limit of the Gansu province. Due to not enough information a quantitative analyze is not possible, so the study is based on a good supply chains and actors' strategy description.

a. Sectors' organization and involved actors

i. The farms' point of view (Figure 13)

With an activity centered on animal farming, three products are sold by the farms: wool, young animals and dairy products. The last one can be milk, yogurt or butter; this depends of the family but the nature of the product doesn't change the organization of the supply chain. Thereafter, only the term dairy products will be used. The farms are one of the first actors of the supply chain, only two elements can be considered such as an entry: the medicines and the supplements (concentrate, grain, and forage). In short, there are a lot of farms who mainly buy from two actors, vet services and supplement companies, and sell to traders. It is worth noting that traders come directly to the farms to buy the products and most of the farms have just one or two traders' phone number. Finally, this position doesn't really allow farmers to choose and to discuss the price. Before the creation of the supplement company, farmers bought forage to other farmers located lower in the valley and producing only cereals and vegetables.

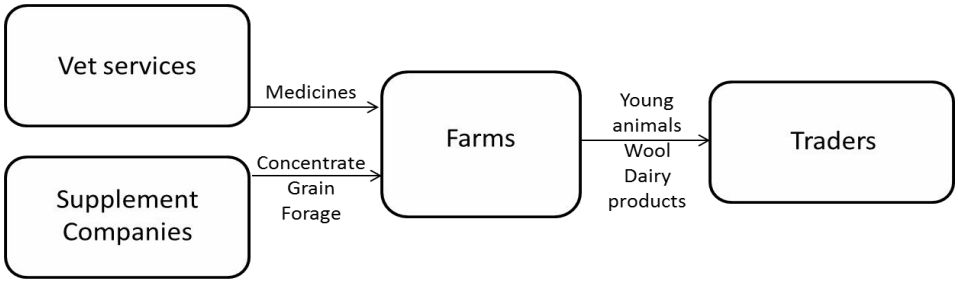


Figure 13: Input-output of the farms

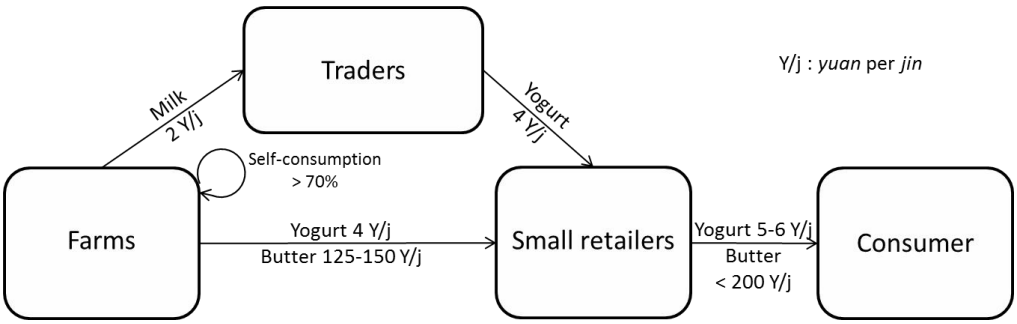
ii. The actors and the products (Annex 12)

Only four supply chains are described in this study, the yak meat, sheep meat, wool and dairy products; the supplements and vet medicines are not studied due to a lack of information. Eventually, seven types of actors constitute these four supply chains. In addition to the farmers, some actors are common to two or more supply chains.

1. Dairy products supply chain (Figure 14)

This supply chain is the shortest due to the perishable nature of these products; it is also a supply chain in decline due to the decrease of farmers commercializing dairy products. Most of them self-consume these products and some don't even milk the dri. The yak milk composition is different and richer than the cow milk (Annex 13) and it is also rarer. For these two reasons, this milk has a higher price and the reputation to be healthy. Usually, farmers make butter and yoghurt directly in the summer pasture, in fact fresh milk is difficult to transport. Only farmers from Na Ni Wan village sell fresh milk because their summer pastures are close to their homes and so easy to reach for the traders. Then, the fresh milk is transformed in butter and yogurt and sold to small retailers in town. This activity is possible for only a few months a year, per consequence dairy products traders have another job. Most of them are also traders of young animals and some are farmers.

Figure 14: Dairy products supply chain



2. Wool supply chain (Figure 15)

For all the farmers of the sample, the wool is sold during summer to the traders who are also traders of young animals. There is three kind of wool: the Yak wool white or black between
25 to 40 Yuan per kilogram, the Tibetan sheep wool at 8 Yuan per kilogram and the wool of fine wool sheep at 25 Yuan per kilogram. The prices are different due to the fiber length and the color, but the supply chains at the province scale look same. These wools are destined to be transformed in carpets, clothes and other products. These transformations are realized outside of Gansu province, for instance in Tianjin with the group “Qinghai Tibetan Sheep Carpets”. So this supply chain goes out quickly of the study area and becomes complicated to follow.

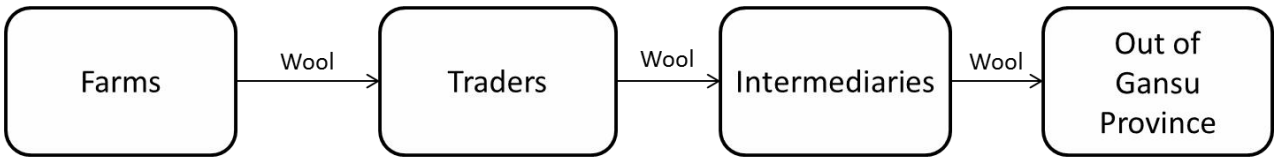


Figure 15: Wool supply chain

3. Meat supply chain (Figure 16)

Except for an urgent issue, main of the young animals are sold at the end of the summer. So, the beginning of the supply chain is seasonal and the traders concentrate theirs activities between August and October. Some of them and some retailers fatten up animals, especially sheep, between six and twelve months. The seasonality is, in this case, broken and do not appear for the following actors. However, it is worth noting that the factory of transformed yak meat has it production peak between July and November and the production is stopped in Mai and June for the equipment maintenance.

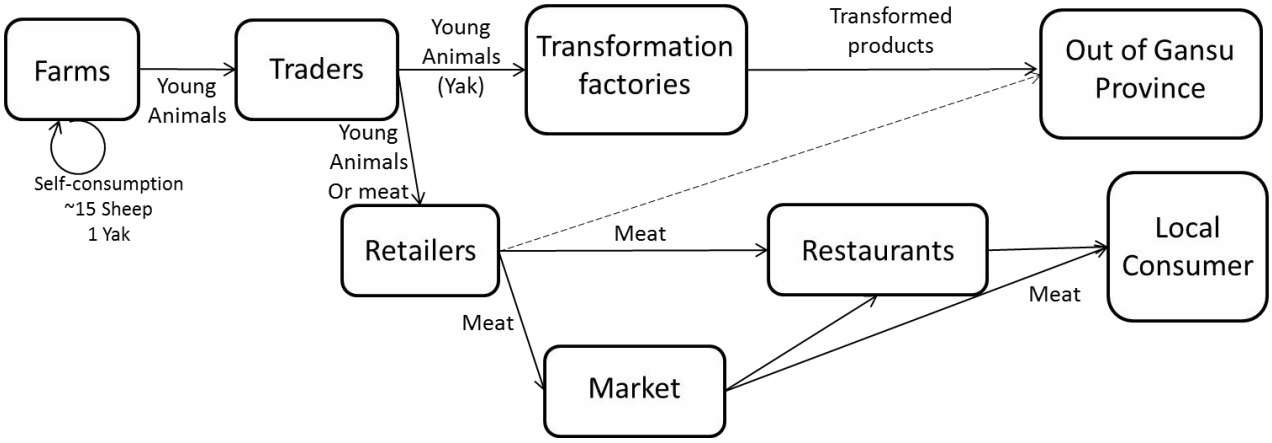


Figure 16: Meat supply chain

The slaughtering is realized by the traders or by the retailers, four slaughterhouses exist in Wuwei17 and the main is the factory who commercializes this service. There is no distinction between the Tibetan and the fine wool sheep meat, both follow the same itinerary.

The margins realized by the traders and the retailers seems high (Table 4), however these margins do not included the activities costs, such as the fuel, the trunk maintenance and the fattening (for some of them).

Table 4: Prices evolution of the meat function of the actors

Yak prices (in yuan) Sheep prices (in yuan)

Farmers 4,000 – 10,000 per animal
(= 12 – 20 per jin)

b. Discussion

For all the supply chain overview here, the farmers have access to only one actor: traders, and most on the time to just one or two traders. Farmers have not really the choice of their intermediary and the discussion of the price, even if traders said that is a stable concession, is never to the farmer advantage. Then, except for the dairy products, no transformations are realized by the farmers, the value-added and so the margins possible aren't earn by them. Inside these supply chains, margins are mainly earned by the factories, who realized most of the transformations, and by the traders, who are the unavoidable contact point between farmers and the others actors.

Since a couple of years, some farmer associations are created; unfortunately this kind of initiative is still very seldom and is not yet operational. The farmers would like, with these associations, to improve their negotiation power. For instance, some farmers want to change the
way of sell young animals, in spite of sell individually they want to create a group and sell together. A support for these initiatives could be bringing to these farmers in order to reinforce and to galvanize their activities.

The role of the local government is really important; it helps farmers with the subsidies, and also the support of the village secretaries for the daily life. This doesn't stop to the farmers and touch other actors, such as the transformation factory where the local government allow the obtaining of a certificate to export aboard the products.

The last years, the demand and the price of the meat seem to increase, farmers and traders want to produce and sell more and more. However, since June 2014 the situation changes, with a new policy the government want to reduce the administration costs and especially the costs link to the administrative meal. Indeed, the main commercial actor is the state and so the local authority. In Chinese tradition, the negotiations are mainly conduct over a meal and the sheep is a reputing dish. At the beginning of September a lot of farmers declare to have sold less sheep than usual and at a lower price; they explain that it could be the result of this policy. With an application time really short the public policies could have an important impact on the region economy and so could be a powerful lever for the area.

Concerning the milk supply chain, the decline are very explicit when farmers explain that milking dri is a difficult activity taking a lot of time and giving too few income. Indeed, only farmers who are “specialized” and with summer pasture near their home, really earn a substantial income with the dairy products. In comparison, in Sang Ke village near the town of Labrang19, farmers produce a lot of dairy products. One of them has a small transformation unit (Annex 14) to make several kinds of dairy products which are sold in the village but also in the town. The
proximity of the touristic town offers to these farmers an outlet for their products and so incites this production. Finally, the presence of a sure outlet could be an important point to re-galvanize the supply chain in Tianzhu and Sunan. Indeed, the loss of an income, like the yak dairy products while it is a product very popular for urban residents and tourists with an increasing demand, can
be avoid with the structuration of the supply chain management.

Conclusion and perspectives

This study allows glimpsing the organization of the systems and it place in the supply chain; however, a lot of questions are still incomplete. All of the data coming from actors' point of view are valid for a short time scale and have been subject to a bias of translation. Even if the knowledge of the area has been improving, the comprehension could be deeper and better, such as the common management of the pasture and it cycle of organic matter, the crops and supplement management and the supply chain management which are here just an overview.

The farming system of the Qilian Mountains is changing in order to adapt to the global change of the province. The farmers are created several strategies of herd management to increase their life condition and to face the over-grazing of the pastures. In the same time, the government with the public polities tries to slow down this degradation and also to galvanize the local economy. The overview of the supply chain management of some products, such as the meat, the wool and the milk, allows glimpsing some amelioration way. The organization of these supply chain and the livestock farming future are linked and have to be thought together.

The addition of a third field such as Sang Ke village could enrich the study. Indeed, with a difference market access the farming systems have evolved to an interesting way that could offer a good comparison to Sunan and Tianzhu.

Chapter 6

The analysis on treatment of MODIS image of the dynamic range in pasture biomass at the region of the Qilian Mountains, China

The Cai yuanpei project in the Qilian Mountains focused on the social-ecosystems on the rangeland. Qilian mountain was located in the north of the Tibetan plateau. Because of the conditions of a cold climate and high altitude, rural activities are based on animal husbandry, especially yaks and sheep flocks.Therefore the pastoral activities and qualities were essential in this semi-arid region, which had changed considerably over the past few years.The aim of this study was to better identify the dynamics of rangeland, and develop a diagnostic tools that in the "average size" (in the range of "l", "l" <10,000 square kilometers). Because Modis satellite has the advantage of obtaining time series information on the average surface, Modis images are selected to track rangeland on the Qilian mountains.
.

5.1 Introduction

The pasture was meaning a land or a field that was covered with grass, which corresponded to a prairie in French. The pasture was used for extensive grazing in many parts of the world. This area was vulnerable caused by the fragility of vegetation, and human pressure is increasing. Because of their breadth and vulnerability, the pasture was a high-risk space,especially in the carbon and water cycles. So, understanding the space and their development information is critical for the public sector and space users, especially for farmers, in order to better guide animal husbandry and conservation measures for pasture.

The knowledge of environmental conditions arised on different scales: plots, farms, and landscapes. We were interested in the development of a suitable method for the diagnosis in pasture status. This method was suitable for the range of large surface (thousands of square kilometers), but it can provide enough resolution, with the activities of herds together. The aim of the tool was to better guide management patterns and dialogue with herdsmen, so that it should temporarily track degradation and productivity of pasture. In order to establish a method that fits this problem, a test in a space was needed. Therefore, Qilian mountain was choosen as this space.

The methods was based on calculations from MODIS sensors and NDVI, which provide a powerful time resolution to tracking rangeland dynamics. Low spatial resolution (250 m) is not really harmful in such landscapes. To describe rangeland's

photosynthesis, the phenolic metric calculation software derived from the NDVI curve. According to the metric system of measurement results, the MODIS (Base, amplitude) data should be measured whether to allow the evolution and mapping of the productivity of grazing. If the measure and technology (management mode) were corresponding, and useful for mapping, the method was fit for the system.

5.2 Objective

The problems of ranching degradation and income decreasing were closely related and mutually reinforcing. Low income forced farmers to increase the number of animals, leading to overgrazing and ranching degradation (Waldron, Brown and Longworth, 2010). The management of ranches must be analysed before a solution can be found to deal with the degradation of ranches. The aim is to better understand the strategies of different farmers and communities, and the impact of those strategies on mid-range and long-term farm productivity.

The goal of the research was to adapt and implement a method to assess changes in vegetation cover on the pastures of Qilian mountains. One approach was developed in different geographical environments (the amazon area) to monitor and map the ecological efficiency of pastures , which means their capacity to produce biomass during the dry season. It's an agira, from a MODIS image to a high time frequency (one image every eight days):

L‟objectif consiste à l‟adaptation et à la mise en œuvre d‟une méthode d‟évaluation de l‟évolution du couvert végétal sur les rangeland des Monts Qilian. Une méthode a en effet été mise au point dans un contexte géographique différent (en Amazonie) pour suivre et cartographier l‟éco-efficience en eau des pâturages (leur capacité à produire de la biomasse en saison sèche). Il s‟agira, à partir d‟images MODIS disponibles à une haute fréquence temporelle (une image tous les 8 jours) :

de classifier l‟occupation du sol afin d‟en extraire les rangeland,

de calculer des indices biométriques annuels (à l‟aide de l‟outil Timesat),

de suivre et de cartographier l‟évolution des indices sur les dix dernières années,

d‟associer ces valeurs d‟indices et leur évolution à des pratiques de gestion des parcours

au moyen de données de terrain, à acquérir par des enquêtes.

De croiser les indicateurs jugés pertinents pour la qualité des pâturages avec des variables

topographiques afin d‟évaluer le rôle de la topographie.

IV. Climat et géomorphologie des Monts Qilian

La Chine a la deuxième plus grande superficie de rangeland dans le monde. Les rangeland sont principalement distribuées dans le Nord de la Chine, ont de nombreuses fonctions écologiques importantes. Dans le Nord de la Chine, le climat typique des plateaux passe de l‟aride au semi-aride d'ouest en est, les résultats des différences évidentes de la température et les conditions de l'eau, et un climat plus chaud et sec, notamment dans les dernières décennies a été observée (Ma et al, 2010).

Les Monts Qilian sont un massif montagneux, situé en bordure nord du plateau du Tibet. Leur altitude varie de 2500 à 5000m. Les saison aux Monts Qilian sont bien marquées. Les hivers sont froids et secs, avec une température moyenne négative de novembre à mars, des minimas nocturnes pouvant aller jusqu‟à -30°C, pour une pluviométrie cumulée inférieure à

20mm. Les étés sont frais et plus humides, avec des moyennes mensuelles de maximas diurnes autour de 15-20°C, pour une pluviométrie totale de l‟ordre de 150-250mm, jusqu‟à

500-600mm en fonction de la zone (Tabouret et al, 2009). La quantité de précipitations sur le zone d‟étude, respectivement autour de 400-500mm à Tianzhu county et de 700-800mm à Sunan courty, qui détermine la productivité des parcours.

V. Révolution de mode de gestion des pâturages

Les steppes herbeuses couvrent des surfaces considérables dans le monde sous différentes latitudes. Ces milieux sont fréquemment utilisés en pâturage extensif mais ils sont soumis dans de nombreuses régions à une dégradation du fait des pratiques d‟élevage. Ces parcours d‟élevage sont désignés sous le terme de « rangeland » dans la littérature internationale.

En Chine, les rangeland occupent le centre ouest et le nord du pays. Outre leur importance socio-économique, ces terres d‟altitude sont le véritable château d‟eau du continent asiatique, leur équilibre affecte l‟écoulement des grands fleuves qui traversent ces régions, l‟érosion des sols et les flux de carbone. La connaissance de l‟évolution de la biomasse sur de grandes étendues est essentielle pour identifier l‟ampleur de leur dégradation et fournir une compréhension des phénomènes pour les politiques de préservation. La Chine a adopté une stratégie concertée majeure pour réduire la dégradation des rangeland et améliorer

les conditions de vie des éleveurs dans la région pastorale de l'Ouest.

VI. Zone d‟étude

La zone d'étude englobe deux county dans la province de Gansu : Tianzhu et Sunan. Elle est comprise entre les longitudes 101,32_E et 103,25_E et les latitudes 38,03_N et 37,02

_N. Elle se trouve dans les Monts Qilian, et est proche du bord du plateau tibétain (Figure 2). Les climats des montagnes et du plateau prévalent dans la région, et les précipitations annuelles sont généralement en dessous de 600 mm, sauf sur le plateau tibétain. La zone d'étude comprend des types très différents de pâturages qu‟on retrouve en Chine. Les pâturages de la zone d‟étude sont de quatre types : steppe désertique, forêt pâturages mixte, pâturages d‟altitude et pâturages des plaines.

La surface de Tianzhu county est 7149 km². La population est de 221 000 habitants et comprend 16 ethnies différentes (principalement des tibétains). Le county est au croisement du plateau tibétain, du plateau de Loess et de celui de Mongolie intérieure. Il est situé à l‟est des Monts Qilian. L‟altitude de cette région très montagneuse varie de 2040 à 4874 m. La température moyenne annuelle varie de -8 à 4 °C.

La surface de Sunan county est 22 100 km². 80,31% de son territoire sont occupés par des pâturages. Il est situé au nord des Monts Qilian. Le climat de cette région est différent en

fonction de l‟altitude qui varie de 1327 à 5564 m. Elle est parcourue par de nombreuses cours d‟eau. La température moyenne annuelle varie de 8 à 16.7 °C.

1. Données MODIS

Le satellite américain Terra a été lancé le 18 décembre 1999 et est toujours en activité aujourd‟hui. Il culmine à 705 km d‟altitude et a une fauchée de 2 330* 2 330 kilomètres carrés (au nadir seulement 10 km). Il produit des images brutes sur l‟ensemble du globe tous les jours à tous les 2 jours. Le satellite Aqua a les mêmes caractéristiques et complète le précédent . Leur résolution radiométrique est élevée : ils comptent chacun 36 bandes spectrales mais nous n‟utiliserons que les 7 premières, qui servent à la caractérisation des sols, des nuages, des aérosols principalement.

Les données sont acquises à 36 bandes spectrales et trois résolutions spatiales sont: 250 m (bandes 1-2), 500 m (bandes 3-7), et 1000 m (8-36) Bands. Nous avons utilisé les ensembles de données MODIS NDVI qui sont incorporés dans le produit de MOD13Q1. Ces ensembles de données ont été acquis à partir de Janvier 2002 à Décembre 2014 et obtenus sans frais auprès de NASA Land Processes Distributed Active Archive Center. Néanmoins, la série chronologique de ces données contiennent inévitablement des perturbations causées par le bruit résiduel lorsque la perturbation atmosphérique ne peut être enlevée efficacement par l'algorithme MODIS VI. Par conséquent, la réduction du bruit ou ajustement d'un modèle de données d'observation est nécessaire avant la dynamique de la végétation ainsi les stades phénologiques peuvent être déterminés (Sakamoto et al, 2005; Lu et al, 2007).

NDVI

$$\mathrm{NDVI} = \frac{\rho_{\mathrm{NIR}} - \rho_{\mathrm{red}}}{\rho_{\mathrm{NIR}} + \rho_{\mathrm{red}}}$$

Bandes spectrales MODIS :

Band 1 (0.62–0.70 μm)
Band 2 (0.84–0.876 μm)
Band 3 (0.46–0.48 μm)
Band 4 (0.545–0.565 μm)
Band 6 (1.63–1.65 μm)
Band 7 (2.105–2.155 μm)

2. Données MNT

La première mission Shuttle Radar Topography (SRTM) a été transportée à bord de la navette spatiale Endeavour Février du 11 au 22 février 2000. Le Aeronautics and Space Administration nationale (NASA) et l'Agence nationale de renseignement géospatial (NGA) ont participé à un projet international visant à acquérir des données radar qui ont été utilisés pour créer le premier jeu quasi mondial des élévations de terrain. Initialement ces données était à 90 m de résolution spatiale (3-arc-seconde).
SRTM 1 offrent une couverture dans le monde entier des données à une résolution de 1 seconde d'arc (30 mètres) et assure une distribution ouverte à cette haute résolution sur
l‟ensemble du globe (bien que certains carreaux peuvent encore contenir des vides).
Le SRTM 1 seconde d'arc mondial (30 mètres) est publié à partir du 24 Septembre, 2014. Les utilisateurs devraient vérifier la carte de couverture dans EarthExplorer de vérifier si leur domaine d'intérêt est disponible.
Georeferenced Tagged Image File Format (GeoTIFF) est un fichier TIFF avec l'information géographique intégrée. Ceci est un format d'image standard pour les applications SIG. La taille du fichier est d'environ 25 Mo pour les fichiers de données à 1 seconde d'arc et environ 3 Mo pour les fichiers 3-arc-seconde.

METHODOLOGIE

I. Prétraitements des images

1. Série temporelle et filtrages

Une série temporelle est une suite de valeurs numériques représentant l‟évolution d‟une quantité au cours du temps. Dans notre cas, nous pouvons ajouter les mesures des produits M*D13Q1 pour représenter l‟évolution de l‟NDVI d‟un pixel. Chacun des deux satellites Terra et Aqua fournissent une image de synthèse tous les 16 jours, mais les deux satellites sont "décalés" de 8 jours, nous permettant d'obtenir une image tous les 8 jours. Ainsi, nous obtiendrons l‟évolution de la production végétale de chaque pixel, avec un pas de 8 jours en moyenne, sur près de 13 ans. Les images sont codées en 16 bits.

La série temporelle telle quelle, n‟est pas vraiment exploitable car elle doit être filtrée. L‟avantage du filtrage est de pouvoir lisser la courbe afin de la rendre plus représentative de l‟évolution de l‟NDVI réel en diminuant le bruit. Diverses méthodes de filtrage existent.

Après divers essais et documentations, le filtrage Whittaker a été utilisé (Figure 3) (Atkinson et al. 2012). Ce filtrage propose un lissage très fidèle à la courbe d‟origine, tout en utilisant les divers paramètres tels que le vi_quality (en donnant un poids moindre à un point dont la qualité est faible) ou le composite_day_of_year (deux pixels distants de deux jours ou de huit jours seront attribués d‟un poids différent).

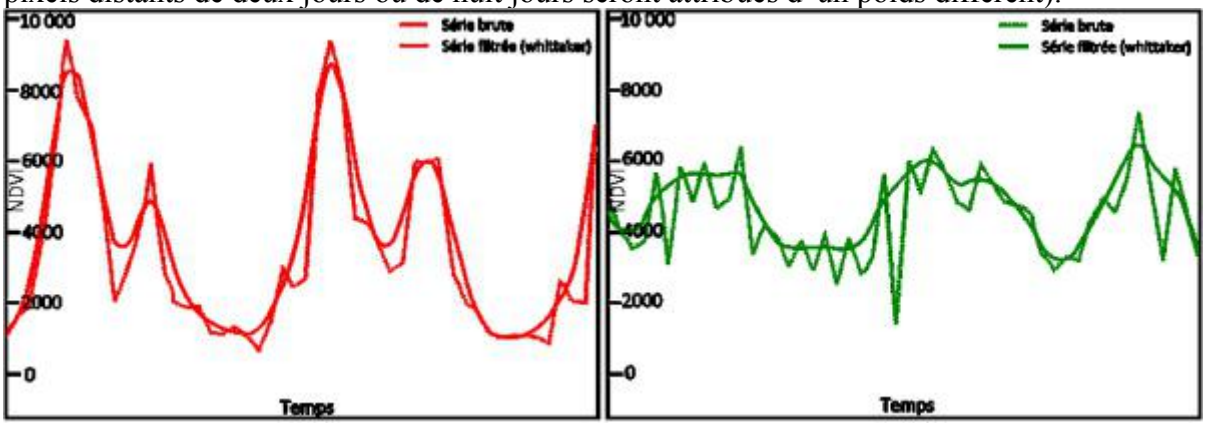


Figure 3 Effet du filtrage Whittaker (courbe de culture et de pâturage)

L‟ensemble des images filtrées par la méthode de Whittaker ont été commandées sur la plateforme en ligne http://ivfl-info.boku.ac.at/. Les images ont été commandées du 1er janvier

2002 jusqu'à la fin de décembre 2014. La zone choisie englobe une grande partie du territoire de Tianzhu county et Sunan county. En quelques heures, après, les images MODIS filtrées sont téléchargées. Les images MODIS Terra sont disponibles du 1er Janvier 2002 au 19

Décembre 2014 et les images MODIS Aqua, du 4 Juillet 2002 au 27 Décembre 2014. Nous disposons donc de 299 images MODIS issues du satellite Terra et de 288 images issues du satellite Aqua. Les fichiers sont au format .tif.

Nous utilisons TIMESAT (http://www.nateko.lu.se/TIMESAT/), un logiciel qui analyse les séries temporelles (NDVI, EVI ou autre) et utilise les courbes pour produire diverses métriques phénologiques, c‟est-à-dire de métriques représentant le cycle végétal sur une durée annuelle. Le logiciel TIMESAT nécessite une période minimale de 3 ans afin de calculer les indices phénologiques de la deuxième année, avec un nombre d'images identique chaque année. Pour répondre à cette restriction, nous avons donc copié les images depuis le 1er Janvier 2014 jusqu‟au 27 Décembre 2014 et les avons utilisés en tant qu'images de l'année
2015. De ce fait nous simulons une année 2015 complète.

2. Listage des fichiers

Le logiciel R Studio nous permet de "stacker" (= faire une pile) de tous les fichiers tif. Ensuite nous pouvons exporter ce stack en tant que fichier unique, exploitable sous le logiciel ENVI (un seul ficher avec une bande par image MODIS téléchargée). Ensuite, TIMESAT nécessitant une liste d'images au format binaire (donc pas en .tif), nous pouvons "déstacker" (= défaire la pile) la pile précédemment réalisée et enregistrer chaque image MODIS en image binaire (16 bits, Entier signé). Enfin, nous établissons une liste de tous les fichiers ainsi créés, la liste de fichiers étant le paramètre entrant dans TIMESAT. Une liste des images des années
2003 à 2005 est produite, afin de calculer les métriques phénologiques de l'année 2004 en vue de les exploiter pour une classification. Chaque année est traitée ainsi.

II. Calcul des métriques phénologiques sous TIMESAT

La phénologie est l‟étude de l‟apparition d‟évènements périodiques dans le monde vivant. Par exemple, dans le cas de végétaux, la date d‟apparition des feuilles, des premières fleurs ou encore de changement de couleur des feuilles sont trois phases phénologiques. La phénologie de la végétation contrôle fortement l'activité photosynthétique et la fonction de l'écosystème, ainsi elle est essentielle pour le suivi de la réponse de la végétation au changement climatique et à la variabilité des actions anthropiques sur la végétation (Xin, Brioich, Zhu, & Gong, 2015). Ici, nous avons employé le logiciel TIMESAT afin de produire des images de mesure de certains de ces évènements. Ces mesures sont appelées métriques phénologiques (Figure 4).

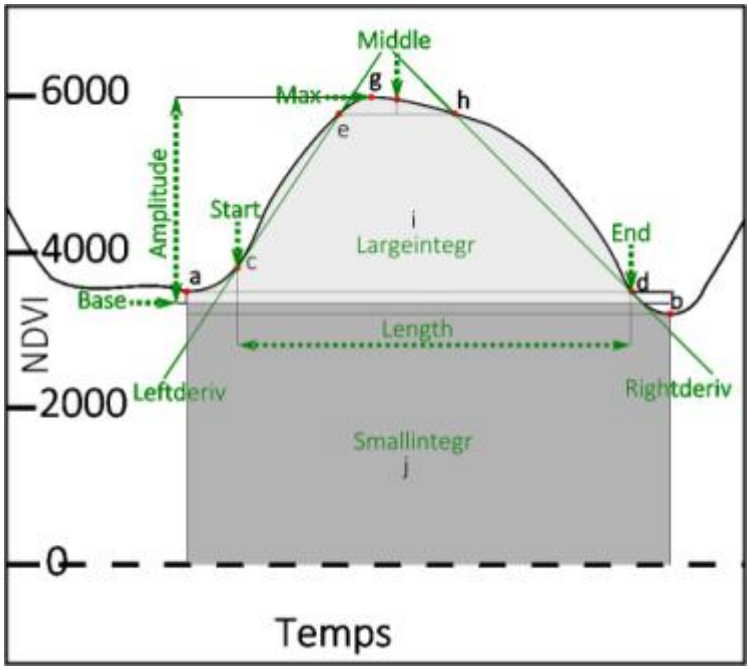


Figure 4 Schémas des métriques calculées par Timesat Source : http://www.nateko.lu.se/TIMESAT

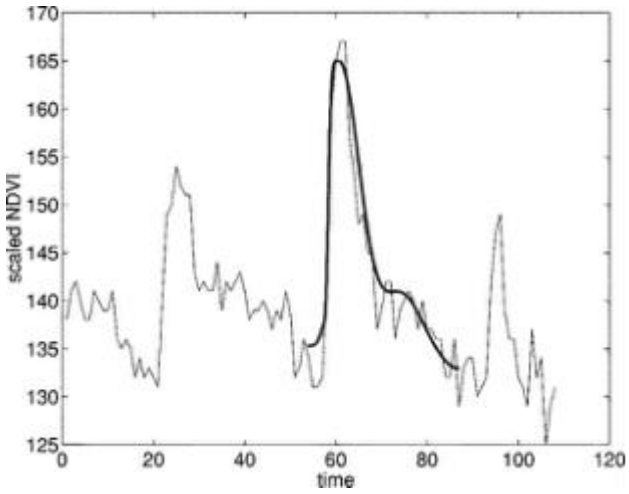
3. Filtrage obligatoire

D‟abord nous importons dans le logiciel la liste des fichiers sur une période de trois ans.

Par exemple pour l‟année 2004, la liste des fichiers indique le chemin des images depuis le

1er Janvier 2003 au 27 Décembre 2005. Il faut aussi spécifier la taille de l‟image (notre scène mesure 865*896px) et renseigner le codage (16 bits entier signé). Ensuite le logiciel affiche la série temporelle sur trois ans, mais nécessite l‟application d‟un filtre de lissage afin de calculer les métriques. Divers filtres sont proposés : asymétrique gaussien, double logistique ou encore Savitzky-Golay. Puisque notre série est déjà filtrée avec Whittaker, nous n‟avons pas besoin d‟appliquer ce filtre. C‟est ici une limitation de TIMESAT : nous n‟avons pas pu indiquer au logiciel que notre série était déjà filtrée et ce dernier doit absolument appliquer un de ces filtrages à nos données. Divers tests ont alors été effectués afin de trouver un filtrage déformant le moins possible notre série. Il s‟avère que Savitzky-Golay est le filtre permettant le plus de réglages possibles : taille de la fenêtre de S-G, Force d‟adaptation et nombre d‟itérations. Avec les paramètres de fenêtre de S-G=4, on obtient un filtrage Savitzky-Golay collant au plus près de notre courbe déjà filtrée par Whittaker. Le filtrage S-G est considéré comme sans impact sur nos données. Ainsi nous minimisons ce petit souci de TIMESAT et nous pouvons continuer d‟utiliser le logiciel.
Propriétés du Filtrage : Filtrage Savitzky-Golay, Taille de la fenêtre de S-G= 4, Force d'adaptation= 2, Nombre d'itérations= 1.

4. Paramètres de saisonnalité



TIMESAT considère qu‟une saison est

une période de forte activité végétale (Jönsson,

& Eklundh, 2004). Elle est détectée lorsqu‟un minimum est suivi d‟un maximum sur la courbe, avec une amplitude importante; puis à nouveau un minimum, tout cela dans la même année. L‟amplitude doit être significative afin d‟éviter d‟avoir une saison détectée dans des vaguelettes (Figure 5).

Figure 5 Fonction globale montrant une série temporelle avec un pic distinct suivie d'un palier de décomposition

Ensuite selon des infos, la période de croissance des pâturages sur la région des Monts Qilian est du mois de mai au mois d'octobre chaque année. Nous réglons donc les paramètres de début et de fin de saison à 0.25 de l‟amplitude, le paramètre saisonnier sur 1 (soit le nombre de cycle végétal complet par an sur notre zone d‟étude) et démarrons le processus de calcul de saisonnalités. Pour chaque ligne de l‟image, chaque pixel voit ses métriques calculées et ce pour chaque saison. TIMESAT a besoin d‟au minimum trois saisons pour travailler (donc trois ans de données) et ne peut travailler sur la première saison (Jönsson, & Eklundh, 2004). Ainsi, pour 2004 par exemple, chaque pixel voit ses métriques calculées pour 2004 et 2005, mais pas 2003, première des trois années. TIMESAT crée alors un fichier de saisonnalité, recensant tous les pixels et chacune des valeurs des métriques pour deux saisons.

Options de saisonnalité : Début et fin de saison à 0.25 de l'amplitude, Paramètre saisonnier à 1 (pas de double saison).

5. Export des métriques en format image

Enfin, un dernier traitement, le plus important est effectué : la sortie en fichier image des métriques (cf annexe 7). À partir du fichier de saisonnalité, nous pouvons sortir des images des métriques (Figure 6). TIMESAT reconstitue l‟image pixel par pixel et attribue à chacun de ces pixels la valeur de la métrique souhaitée. Les images sont produites en entier signé, TIMESAT recherche une « saison » entre la période des images 1 et 138 (il ne peut en trouver que deux, et seule la première nous intéresse et sera conservée).

Les rangeland aux Monts Qilian commençont habituellement tournant vert de mai de chaque année, jusqu'à octobre de chaque année, la feuille du pâturage est devenue jaune. En hiver, le pâturage d‟altitude sera couvert avec de la neige.

Option d‟écriture des métriques : Entier signé, Période spécifiée entre 40 et 100 (vert à jaune), Code 0 si aucune saison n'est détectée entre la période spécifiée, Code 1 si absence de données ou autre erreur.

Finalement, nous obtenons, pour chaque année observée (de 2004 à 2014) 4 fichiers. Par exemple, pour la métrique base_2004 (Minimum de végétation sur la saison 2004) :

Deux fichiers images: Base_2004 _s1, Base_2004 _s2

Un fichier indiquant le nombre de saisons trouvées: Base_2004 _nseas

Un fichier d'erreurs éventuelles : Base_2004 _errors

Le fichier d‟erreurs a toujours été vide, toujours deux saisons trouvées, mais uniquement le fichier _s1 conservé pour chaque année (puisque le fichier _s1 est celui de
l‟année concernée). Si il n‟existe pas la deuxième saison dans l‟année concernée, le fichier
_s2 est vide aussi.

Base

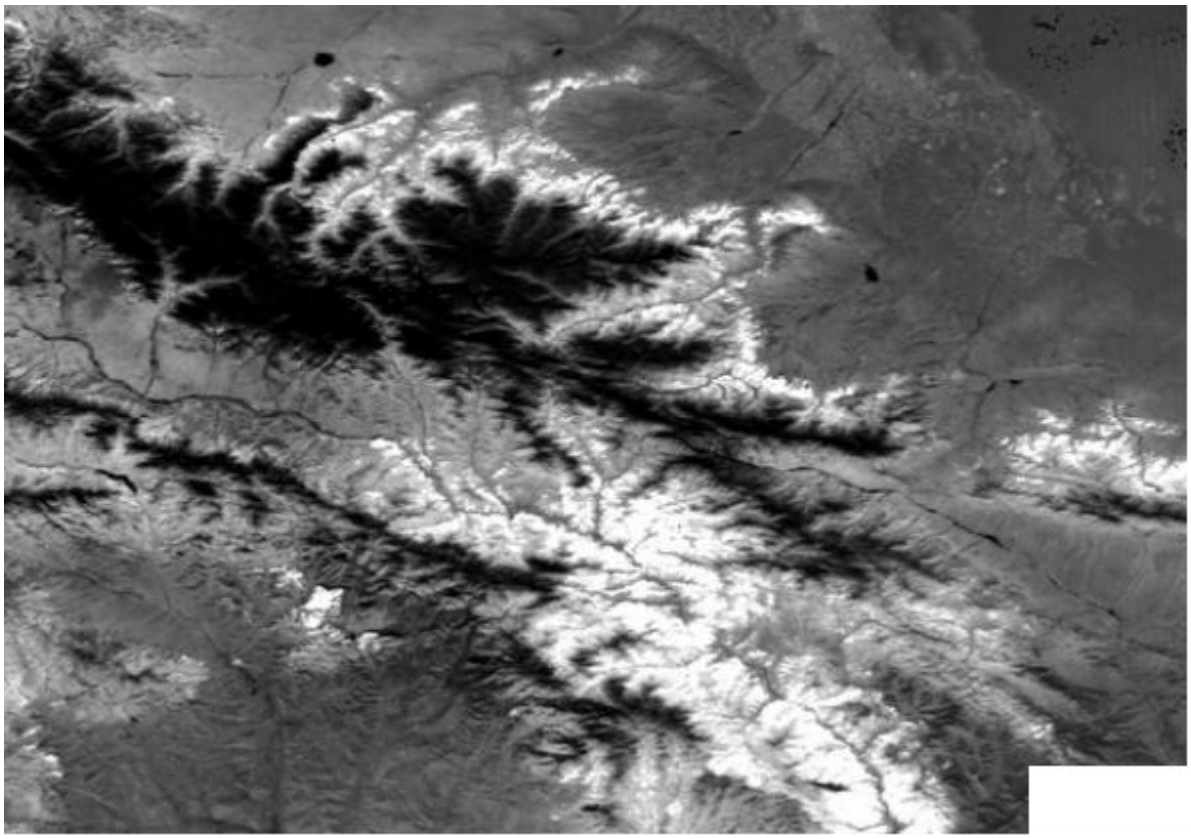


Figure 6 Exemple d'image de métrique. Métrique "Base" en 2004.

Source : Produit MODIS traité avec TIMESAT

6. Vérifications sous le logiciel ENVI

Pour chaque année, toutes les métriques sont importées sous le logiciel ENVI afin de contrôler le taux de valeurs inutilisables (valeurs 0). Les valeurs 0 peuvent arriver si le logiciel TIMESAT ne détecte pas de saison au cours d‟une année (courbe plate ou difforme…). Ces valeurs 0 correspondent à des pixels qui ne posséderont pas de métriques calculées par la suite. Ce taux variait selon les années entre 0 et 0.44% des pixels de l‟image des métriques, soit une part minime des 775 040 px qui la composent.

III. Classification de l‟occupation du sol

1. La scène autour de Monts Qilian

Le logiciel ENVI permet d‟afficher une composition colorée de trois bandes (trois images à trois dates différentes). La composition choisie pour travailler est toujours la même. Par exemple, ici en 2013 (Figure 7) :

Rouge : 12 Juillet 2013

Vert : 17 Janvier 2013

Bleu : 24 Octobre 2013

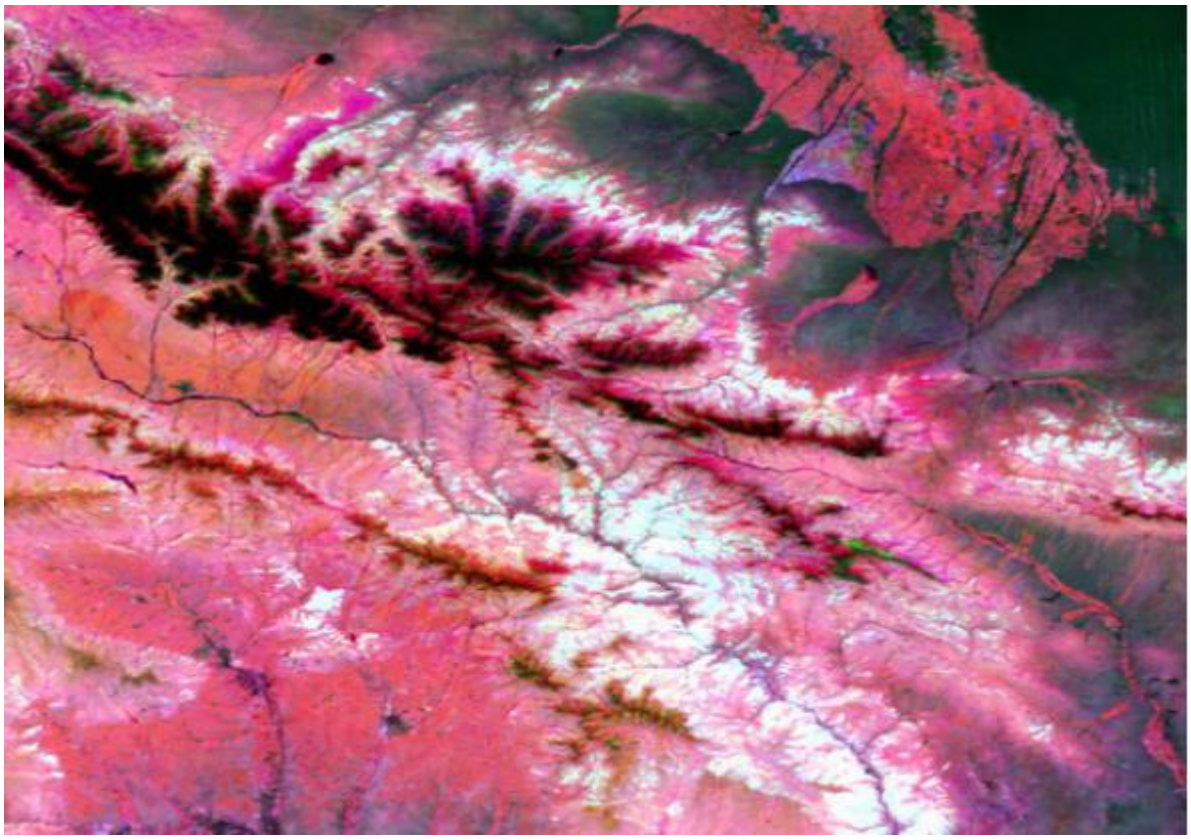


Figure 7 Composition colorée de la scène de Monts Qilian Source : Produit MODIS

Ce type de composition a la particularité de couvrir une large durée Janvier -> Juillet, mais aussi de fournir deux bandes V et R au maximum et minimum d'NDVI de la végétation (Figure 8). Les cultures annuelles reviennent régulièrement en rouge vif (pic de végétation vers mi-Juillet) voire violet très vif (cultures légèrement en deux saisons par année) :

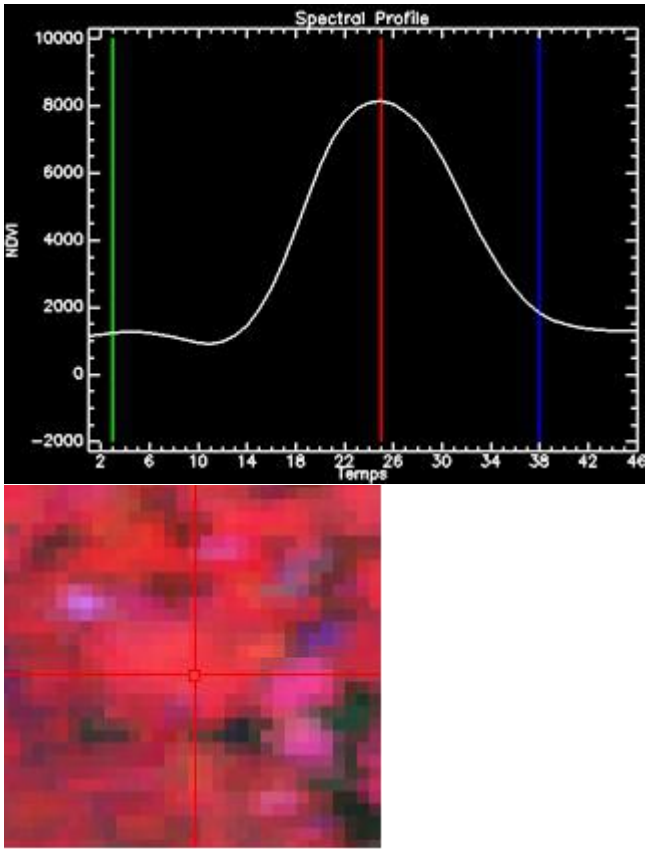
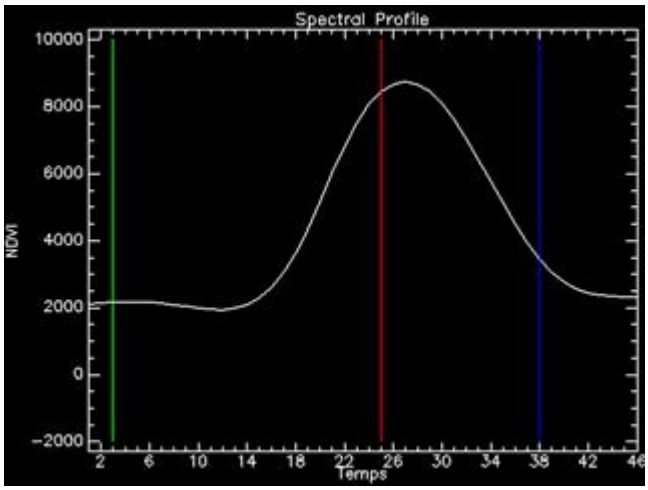


Figure 8 Valeur de l'NDVI en fonction du temps (en jours) et zoom sur la composition



Sur ce type de composition (Figure 9), les pâturages reviennent régulièrement en rose clair (pic de végétation vers début Août); et le neige et le glacier en noir (NDVI faible toute l'année).

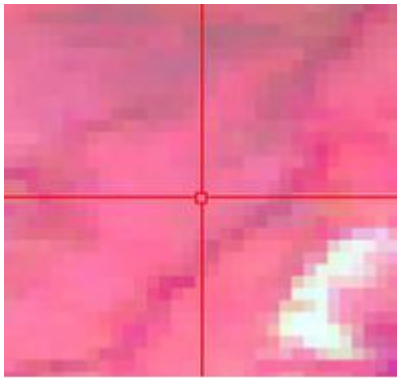
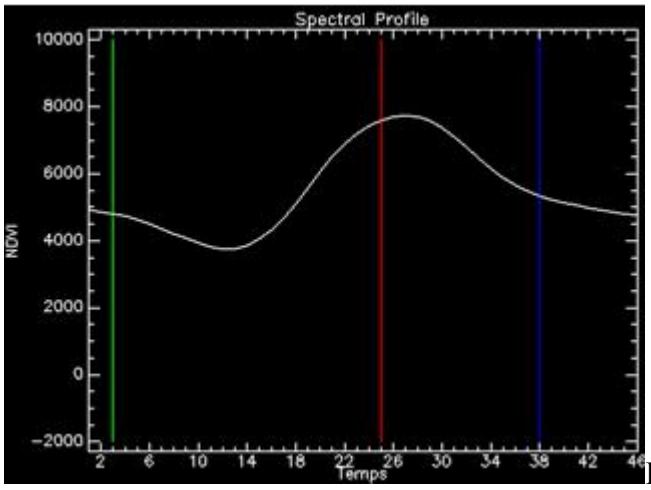


Figure 9 Valeur de l'NDVI en fonction du temps (en jours) et zoom sur la composition



Enfin, la forêt et la forêt d‟arbustes apparaissent dans les blancs puisque mélange à parts égales de R V et B (NDVI haut, variant peu toute l'année) (Figure 10).

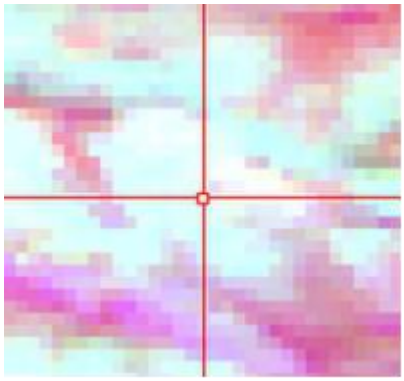


Figure 10 Valeur de l’NDVI en fonction du temps (en jours) et zoom sur la composition

Ainsi, cette composition permet d'avoir rapidement pour chaque année, un aperçu des différentes utilisations du sol qui nous intéressent.

2. Préparation des zones d'apprentissages

Les ROIs, Region of Interest, sont des zones dessinées sous ENVI correspondant à une classe bien définie. Les ROIs servent à la phase d‟apprentissage de la classification. La nature de chaque classe est déterminée par lecture de la courbe NDVI directement, avec l‟appui des images de Google Earth. Les classes des ROIs sont: cultures1, cultures2, cultures3, désert, eau, neige_glacier, steppe_désertique, forêt d‟arbustes, forêt_pâturages_mixte, pâturages_altitude, pâturages.
Ces ROIs sont ensuite exportées en tant qu‟image. Cette image fait la même taille que l‟image de base (865*896px) mais possède des valeurs codées : 0 - (vide), 1 - cultures1, 2 - cultures2, 3 - cultures3, 4 - désert, 5 - eau, 6 - neige_glacier, 7 - steppe_désertique, 8 - forêt d‟arbustes, 9 - forêt_pâturages_mixte, 10 - pâturages_altitude, 11 - pâturages.

3. Résolution réechantillonnage avec données d’altitude

Les MNT sont une représentation numérique spatialisée de l‟altitude. Étant facilement manipulables par les logiciels de traitement d‟image, les MNT ont une grande faculté à être transformés en de multiples documents associés relevant de la morphologie (Puech et al.
2009). La richesse potentielle des MNT pour les études environnementales vient de la possibilité de transformer le plan initial des altitudes (Z) en de multiples plans associés. Ceci met en œuvre des dérivations (pentes, orientation, courbures), des analyses de topographie et géomorphologie locales, etc pour une introduction dans des modèles mathématiques qui utilisent l‟altitude ou ses transformées (Dietrich et Perron, 2006 ; Roering et al., 2007).

4. Classification sous R Studio (cf annexe 3)

Avec un raster de ROIs d'apprentissage

Utilisation des commandes Stack pour empiler :

Le raster des ROIs en 20xx

L‟image du MNT

Les 46 images du NDVI (Janvier 20xx - Decembre 20xx)

Les 11 métriques phénologiques correspondant à la saison en question

Nous utilisons les métriques en données d‟entrée de classification, car elles sont susceptibles d‟augmenter la qualité de cette dernière (Vuolo et al. 2011). Puis on renomme chaque couche du stack pour savoir à quoi elle correspond.

On extrait ensuite les valeurs et les coordonnées des pixels composant les ROIs d'apprentissage puis on sélectionne (aléatoirement) 70% des pixels pour l'apprentissage. Ensuite on renomme les classes (par défaut 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11) vers cultures1, cultures2, cultures3, désert, eau, neige_glacier, steppe_désertique, forêt d‟arbustes, forêt_pâturages_ mixte, pâturages_altitude, pâturages afin d'aider à la compréhension de la matrice de confusion, qui est établie avec les 30% des points restants.

Vient ensuite l'étape de classification et de vérification des réglages. On y remarque notamment que certaines métriques phénologiques et les données d‟altitude font quasiment systématiquement partie des 20 variables les plus importantes, ce qui confirme bien leur apport lors de la classification.

Classification Random forest

La classification Random forest est une classification similaire à une classification par arbre de décision, sauf que cette dernière emploie plusieurs modèles d‟arbres de décision (500, par défaut). La classification Random forest n‟emploie toujours que les deux tiers du jeu d‟apprentissage, et réserve le troisième tiers pour estimer les erreurs et l‟importance des variables. L‟assignation à une classe est faite par nombre de « votes » dans tous les arbres produits, soit la classe finale qui ressort le plus parmi les résultats des 500 arbres de décision.

En même temps que l‟export de l‟image de la classification, un raster est créé contenant les probabilités d‟affectation de chaque pixel pour chaque classe. C‟est un des avantages de la classification random forest : on possède pour chaque pixel sa probabilité d‟affectation à la classe.

Par exemple :

un pixel ayant eu une probabilité de 0.92 dans la classe désert, 0.06 en steppe_désertique, 0.01 en pâturages_altitude, 0.01 en neige_glacier, 0 en culture, 0 en eau, 0 en forêt d‟arbustes, 0 en forêt_pâturages_ mixte et 0 en pâturages est un pixel très fiable et pur.

alors qu‟un pixel aux probabilités de 0.45 en culture, 0.40 en pâturage et

0.15 en forêt_pâturages_ mixte, 0 en désert, 0 en eau, 0 en neige_glacier, 0 en steppe_

désertique, 0 en forêt d"arbustes et 0 en pâturages_altitude, représente un pixel moins fiable. Ce dernier peut être un pixel mixte culture/pâturage, ou alors est un pixel de culture dont les caractéristiques spectrales sont très proches de celles d"un pâturage.

IV. Post-traitements

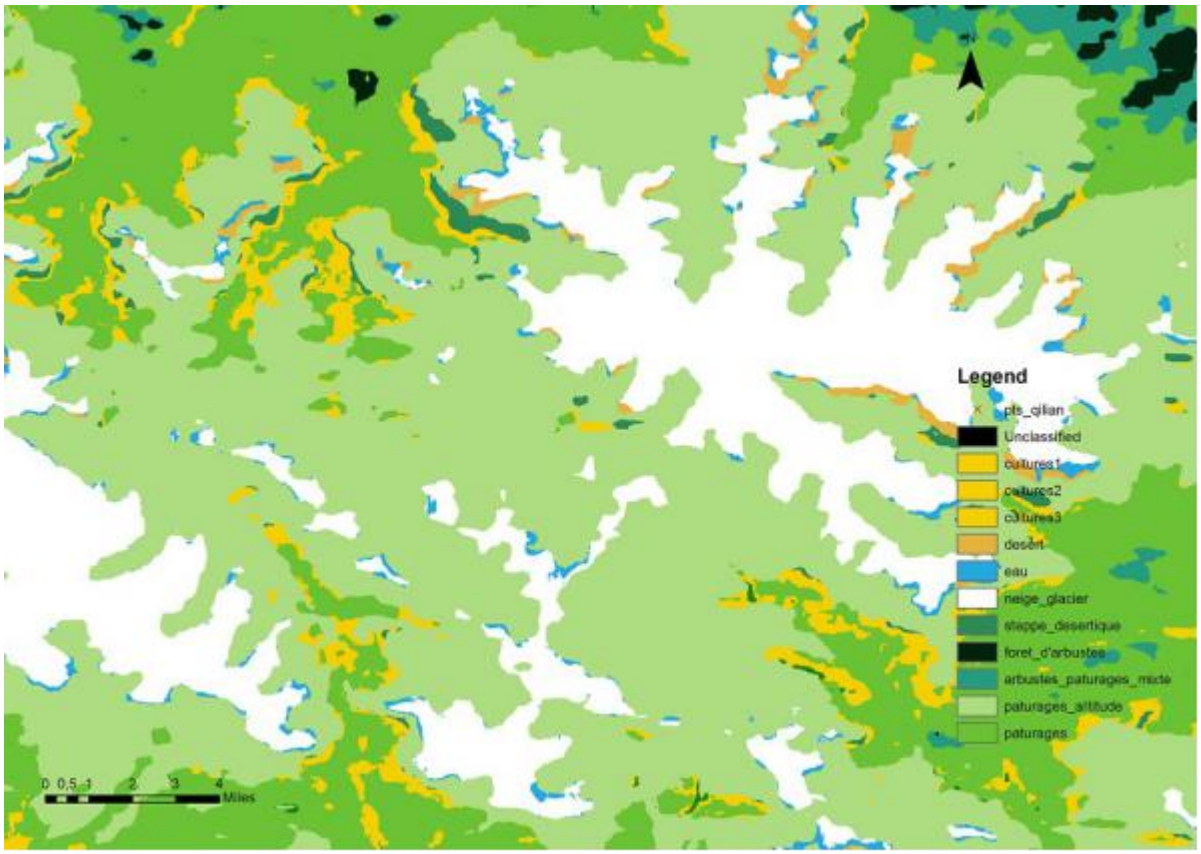


Figure 11 Cartographie d'occupation du sol sans post-traitements

Les images des classifications sont ensuite sujettes à des post-traitements afin de corriger certaines erreurs ou effets indésirables.

La (Figure 11) montre qu‟aux alentours des montagnes enneigées, les zones sont divisées en zones désertiques et zones en eau. La première raison est que les pâturages d‟altitude comprennent peu de végétation, à la limite des zones enneigées. Par conséquent il y a une similitude avec les indices NDVI des déserts. La deuxième raison résulte d‟un problème inhérent à l‟utilisation des images MODIS. En effet ces images sont constituées de pixels mixtes, qui sont des pixels sur lesquels se situent deux occupations différentes de sol. Aux limites des zones de pâturage, certaines zones sont considérées comme des champs, parce que la quantité d‟organismes vivants dans ces pâturages d‟altitude est relativement faible. Les

indices NDVI maximales sont autour de 6000, ce qui est très proches des indices NDVI des champs. On peut difficilement les distinguer.

1. Filtrage selon des expériences

Utilisation des commandes Decision Tree et Band Math sous le logiciel ENVI pour filtrage . Par exemple, la fonction pour les cultures : (b1 ge 3300 AND b2 eq 5)
(b1 eq 1)*11 + (b1 ne 1)*b2

Paramètres du Filtrage : Culture≥3300m, Desert≥3000m, Eau≥3000m, Forêt

d‟arbuste≥3300m.

2. Masque des pâturages dans la zone d’étude (cf annexe 8)

Selon l‟image de la classification, un masque des formations de rangeland assimilées à des pâturages est créé sous le logiciel ENVI contenant quatre classes : steppe_désertique, forêt_pâturages_mixte, pâturages_altitude et pâturages.
En raison de changement d‟occupation du sol pendant dix ans, pour améliorer la précision du masque, ce masque est la superposition de celui des pâturages en 2004 et celui des pâturages en 2014.

V. Analyse géostatistique par des observations GPS

Enquête sur le terrain (cf annexe 9)

Les données GPS sont réunies au sein d'un fichier Shape géoréférencé dans la même projection que les images et les métriques. Les points de pâturage repérés sur le terrain sont au nombre de 46. Ces données, enregistrées en Mai et Juin 2015 et commentées (altitude, type sol et 4 critères de qualité du pâturage : pourcentage de sol couvert par la végétation, pourcentage d‟arbustes dans le couvert végétal, présence de formes d‟érosion, vigueur de la végétation herbacée) afin d‟évaluer la qualité du pâturage et de comparer les critères de qualité avec les métriques phénologiques issues de Modis.

Dans le même temps, nous faisions des entretiens réalisés avec les éleveurs pour connaître leurs pratiques, leur perception de l‟évolution du milieu, leur perception de la qualité des pâturages.

RESULTATS

I. Evolution de l‟occupation du sol

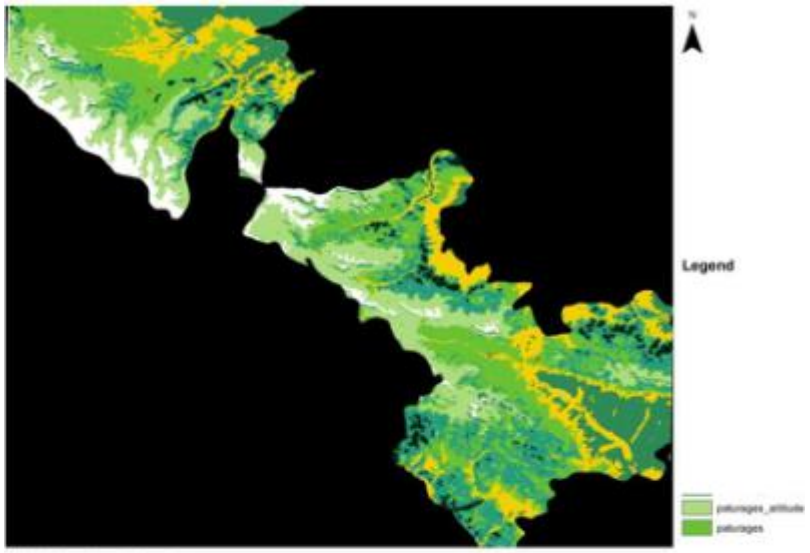
1. Évolution générale des surfaces

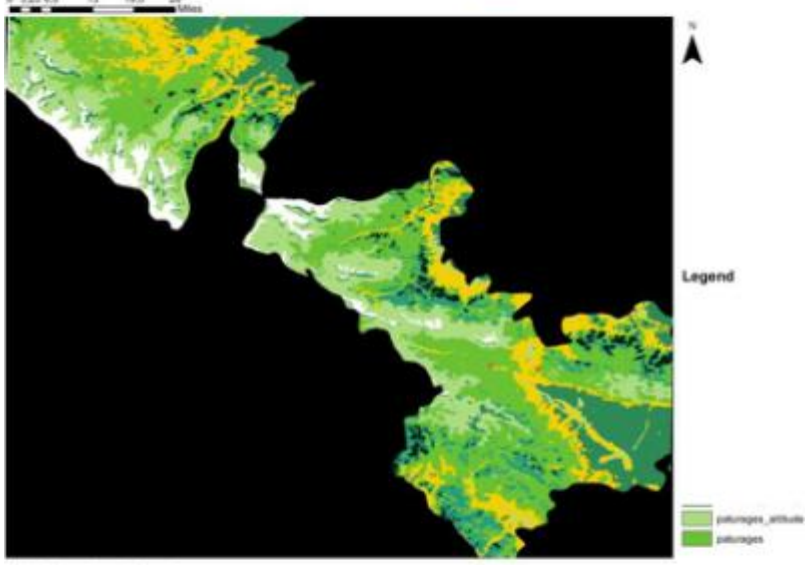
Au total, 3 années ont pu être traitées par la classification de l‟usage du sol. Mais l‟image contenant la scène entière, nous devons découper la scène pour extraire les données uniquement sur les zones d‟étude (Figure 12). De plus, le reste de la scène sera aussi important lors des analyses, car il permettra de rechercher s‟il existe des différences entre l‟évolution de l‟occupation du sol du territoire de Tianzhu county et Sunan county.

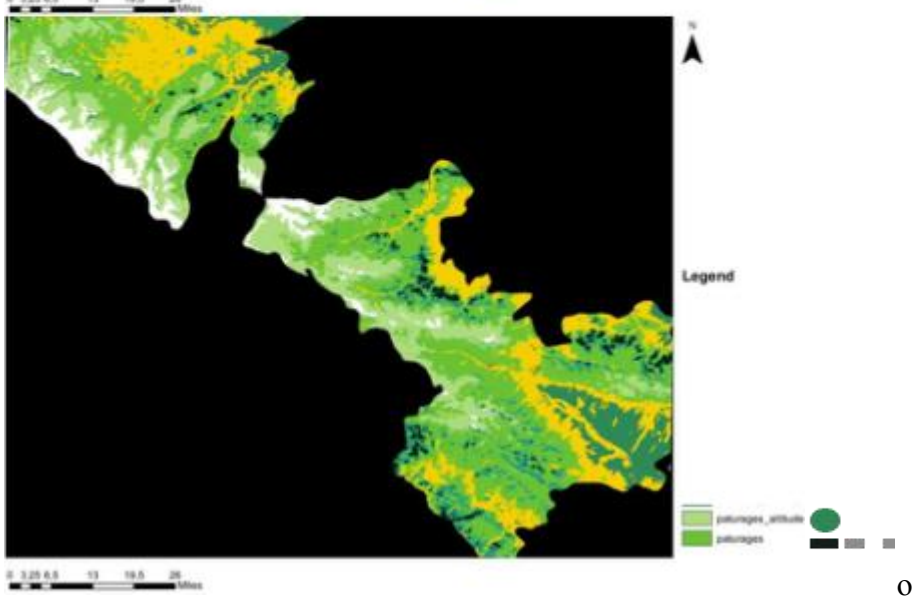
Pour obtenir les surfaces de chaque classe, un simple comptage de pixels multipliés par la résolution de l‟image suffit à obtenir la surface (Tableau 1). Rappelons qu‟un pixel représente 0.09 ha au sol, , les images étant re-échantillonnées à la résolution du MNT de
30 m.

	2004	2009	2014
Cultures 1, 2, 3	106412 ha	114219 ha	152052 ha
Désert	0 ha	0 ha	93 ha
Eau	257 ha	255 ha	277 ha
Neige_glacier	43881 ha	41218 ha	38384 ha
Steppe_désertique	84865 ha	92012 ha	58378 ha
Forêt d'arbustes	22510 ha	19289 ha	17996 ha
Forêt_pâturages_mixte	132234 ha	60209 ha	44800 ha
Pâturages_altitude	141077 ha	156591 ha	138450 ha
Pâturages	207108 ha	254573 ha	287953 ha
Total	738344 ha	738366 ha	738383 ha

Tableau 1 Tableau de l'occupation du sol sur les zones d’étude en 2004, 2009 et 2014


N
Legend
pâturages_attribute
pâturages
0 3.25 6.5 13 19.5 26
Miles


N
Legend
pâturages_attribute
pâturages
0 3.25 6.5 13 19.5 26
Miles


N
Legend
pâturages_attribute
pâturages
0 3.25 6.5 13 19.5 26
Miles

o

--_,...._ -

Figure 12 Cartographie d'occupation du sol sur /es zones d'etude en 2004, 2009 et 2014

Ce qui saute aux yeux, en 11 ans, c‟est la surface vouée à l‟agriculture qui a été multipliée par 1.5 à Tianzhu county et Sunan county. La hausse est, de plus très nette après

2009, date du développement de l‟avoine dans la région. La surface de pâturage, elle a augmenté, dans le même ordre que la baisse de forêt_pâturages_mixte. Ainsi, à la forte baisse de forêt_ pâturages_mixte entre 2004 et 2009 correspond une forte hausse des pâturages sur la même période. On en conclu que principalement, la déforestation a eu lieu pour produire de nouveaux pâturages. Ceci est lié au fait que d‟une part, des pâturages sont plus facilement abandonnés que des terres de culture (la rentabilité d‟un ha de pâturages est inférieure à un ha d‟avoine), mais aussi à la dégradation des pâturages par envahissement des rongeurs (Myospalax aspalax Pallas) et la forte croissance du bétail (cf annexe 11).

Cependant la baisse des surfaces de steppe_désertique : 26 487 ha entre 2004 et 2014,

33 634 ha entre 2009 et 2014. Cette différence s‟explique par le fait de l'appui de la politique de mise en valeur des steppes par le gouvernement, le phénomène de la désertification a été effectivement freiné entre 2009 et 2014.

Enfin, la faible baisse de la surface de neige_glacier et de forêt d‟arbustes peut être expliquée principalement par un phénomène : le réchauffement climatique.

Method	Overall accuracy (%)	Kappa coefficient
Random forest	65.83	0.926

II. Métriques phénologiques les plus importantes

1. Leur calcul

Maintenant que la classification du sol est faite pour chaque année, nous avons la localisation des pâturages. Une des manières d‟évaluer l‟éco-efficience des pâturages est d‟utiliser les métriques phénologiques calculées précédemment avec Timesat (cf annexe 6).

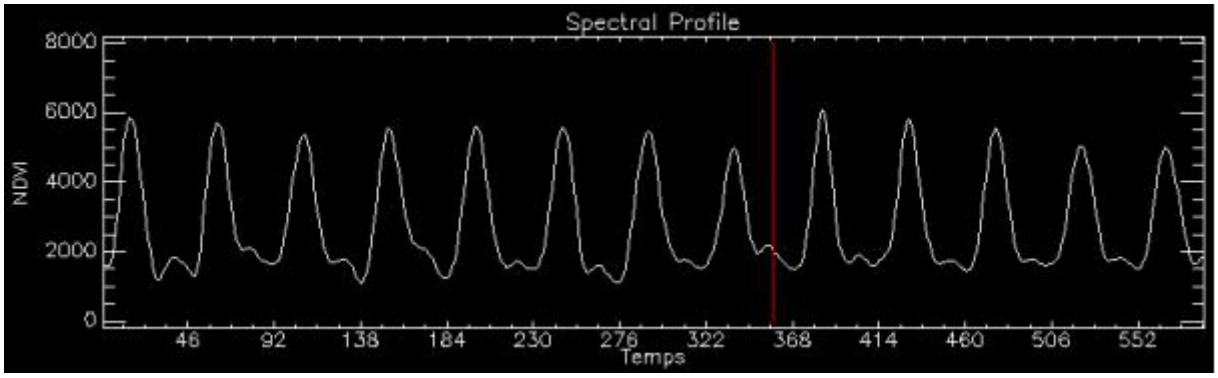
2. Leur utilité pour l’appréhension de l’éco-efficience des pâturages

Les quatre métriques les plus discriminantes lors de la classification furent le left, la

base, le max et l‟amplitude. En effet ces métriques possèdent une large gamme de valeurs.

Afin d‟étudier plus précisément les pâturages, nous réalisons un masque des pâturages. Ainsi nous pouvons étudier uniquement les pâturages sans être dérangé par les autres classes de pixels. Les autres classes sont toutes affectées de la valeur 0.

III. Dégradation des pâturages



En analysant la courbe NDVI des pixels présents dans la tâche bleue on obtient bien un profil NDVI de type de pâturage, mais on constate en 2010 une chute d‟NDVI puis un retour, sur plusieurs années, à un profil de pâturage (Figures 13).

Nous pouvons observer en ce pixel exemple, une diminution progressive du maximum annuel de 2010 à 2014 ce qui montre une dégradation des la productivité en fourrage en été, puis une hausse du maximum, ce qui montre une amélioration. L‟‟interprétation peut être soit climatique (série d‟‟années aux étés secs par exemple, puis série d‟‟années aux étés humides), soit liée aux actions anthropiques (surpâturage lors de la première période, puis baisse de la pression animale par exemple).

IV. Evolution de la métrique „Left‟‟ en série temporelle

Très bon pâturage Bon pâturage Moyen pâturage Mauvais pâturage
Steppe/pâturage altitude

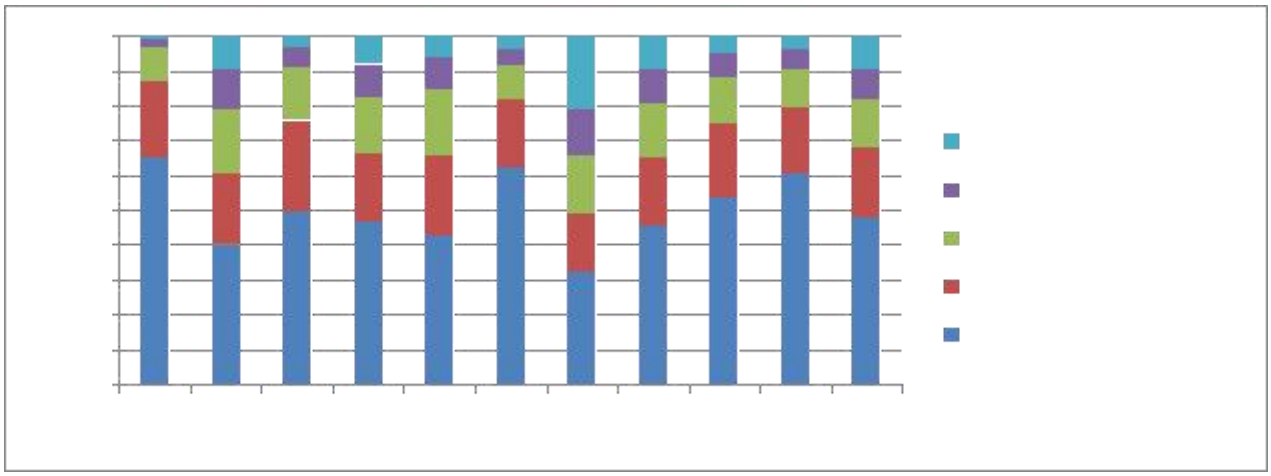
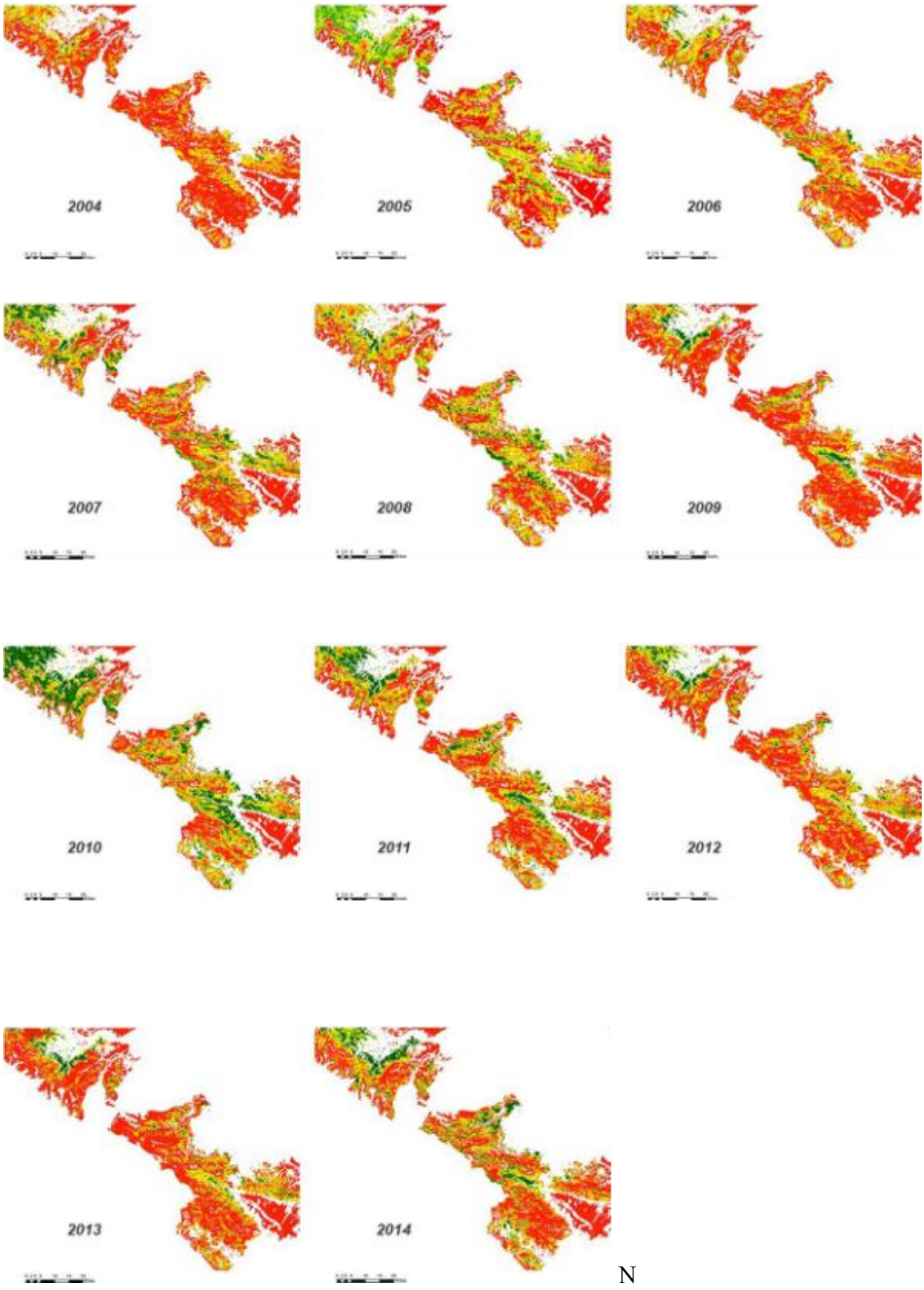


Tableau 2 Dynamique de qualité du pâturage en série temporelle



1. Classement des métriques (Figures 14)

Pour chaque année, de la même manière que cela a été fait pour les classifications de l‟occupation du sol, nous avons classé les pâturages en créant plusieurs classes au sein des métriques Left, Amplitude, Max et Base. Chacune de ces classes est supposée être sensible au
type de pâturage.

Sol couvert	Niveau
0%～20%	1
20%～40%	2
40%～60%	3
60%～80%	4
80%～100%	5
Erosion	
Sol exposé et Chemins d'animaux	1
Sol exposé ou Chemins d'animaux	2
Rien	3
Vigueur de la pâture	
Très faible	1
Moyennement faible/ Faible	2
Normale/ Vigoureuse	3
Totale	11

Fonction de		
y = 24,974x + 336,3	R^2=0,5699	
	x(qualité	y(left)
Très bon pâturage	11---10	≥585
Bon pâturage	9---8	585-
Moyen pâturage	7---6	535-
Mauvais pâturage	5---4	485-
Steppe/Paturage	3	≤435

V. Limites

Les pasteurs des Monts Qilian ont connu successivement trois phases de changements au cours du dernier demi-siècle, respectivement en 1970, en 1980 et en 2000. Cependant, à cause des limites du potentiel de MODIS (produit utilisé depuis 2002), les images satellites datant d‟avant 2002 ne peuvent être exploitées, ce qui cause l‟impossibilité d‟évaluer les évolutions anciennes des modes de gestion des pâturages sur les Monts Qilian.

La première limite due à la faible résolution concerne les pixels mixtes en occupation du

sol. Si la résolution de 250m permet un faible taux de pixels mixtes dans une zone présentant de grands ensembles d‟occupation du sol, ce taux va considérablement augmenter dans une zone ou les paysages sont plus variés et les ensembles plus fins.

La produite de NDVI est unique, Sans assez temps pour faire l‟analyse d‟autres produites, comme WDRVI, MSAVI.

Trop de pixels mixes à cause des erreurs et approximations.

Le différent dimension d‟image MODIS et MNT.

Absence de prise en compte du climat.

DISCUSSION

I. Comparaison des 4 métriques phénologique avec 4 propriétés du

pâturage

	Sol.couvert	Arbuste.couvert	Erosion	Vigueur.de.la.p.ture
Ampli	0.25144030	0.11470874	0.3143691	0.49970696
Base	0.39484263	-0.16166870	0.2007358	0.10433242
Left	0.31455274	0.24232530	0.4253483	0.37282926
Max	0.41887530	-0.02807148	0.3497734	0.40249568

Tableau 3 le coefficient de corrélation entre les métriques phénologique et les propriétés du pâturage

Evaluation des métriques phénologiques “Left” en série temporelle

II. Evaluation des métriques phénologiques relatives à la pente et à

l‟orientation des versants de pâturage

Left

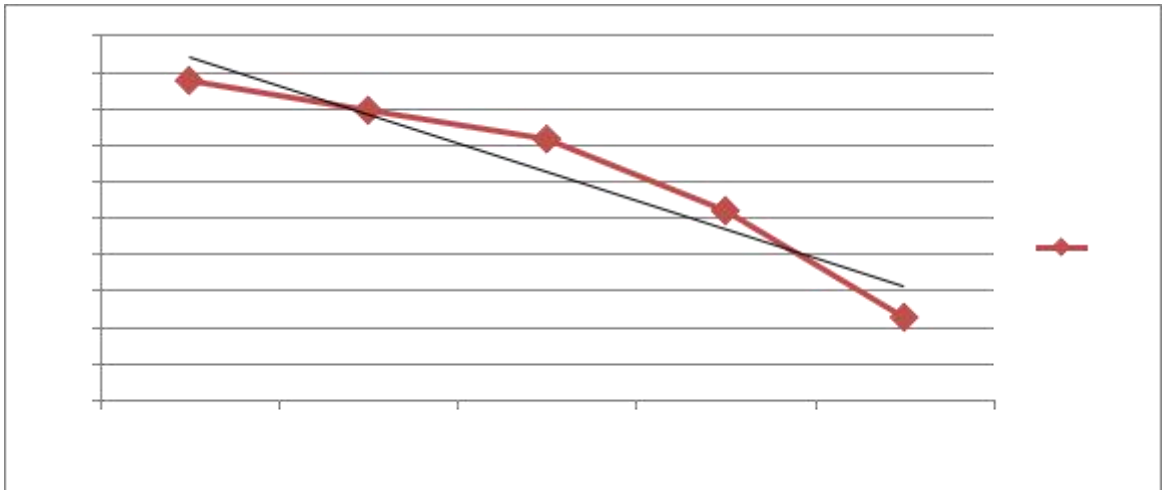


Tableau 4 Evolution de la moyenne de “Left” sur différent types de pentes

La moyenne des indices Left des pixels du pâturage de chaque niveau de pente topographique calculée à partir du MNT 30 m a été obtenue dans le logiciel Arcgis (Figure
16). On remarque que l‟indice Left diminue lorsque la pente croît. De plus lorsque la pente dépasse 45 °, la diminution de LEFT est encore plus accentuée. L‟indice Left décline de façon systématique, ce qui peut correspondre à une baisse de la productivité en fonction de la pente.

La correspondance entre l‟indice Left et la qualité du pâturage a été démontrée plus haut. A partir de cette observation, on peut en conclure que : la qualité du pâturage est la meilleure en plateau (0 ° - 15 °). L‟augmentation de la pente a un effet inhibiteur sur la qualité du pâturage. Lorsque la pente dépasse 45 °, l‟effet inhibiteur devient plus apparent. Ceci peut être lié à des processus accrus d‟érosion et à la qualité des sols nécessairement plus caillouteux sur les pentes que sur les zones aplanies.

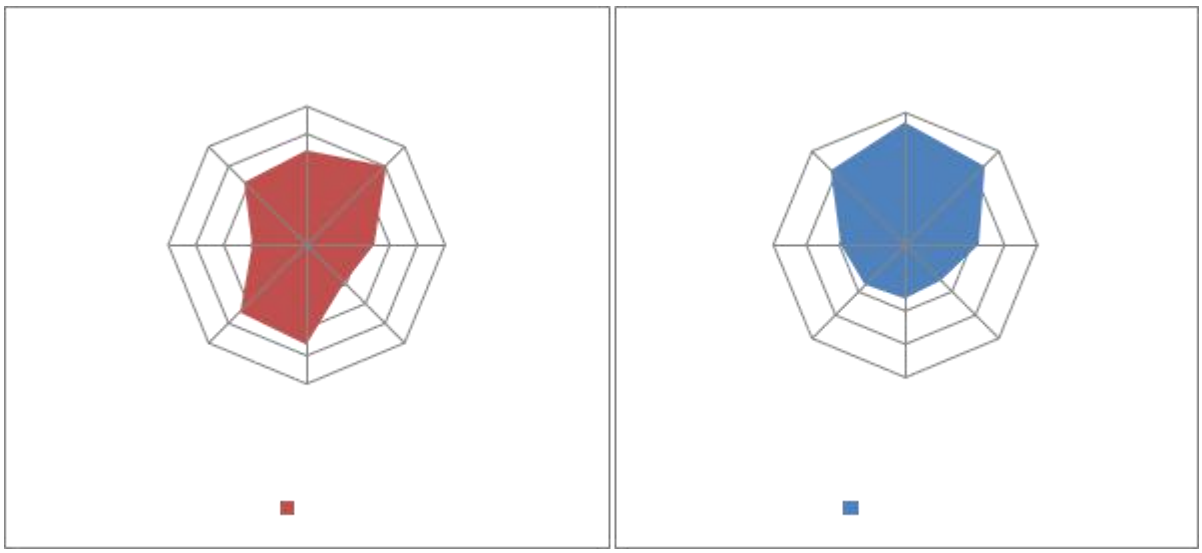


Tableau 5 Comparaison de la moyenne de “Left” et “Amplitude” selon différentes orientations

Les moyennes des indices Left et Amplitude des pixels du pâturage de 8 orientations du versant ont été calculées avec Arcgis (Figure 15). L‟indice Left de 4 orientations (440~446) - Nord-Est, Nord, Sud-Ouest et Sud – est nettement plus grande que celle des 3 directions Est, Ouest et Sud-Est (440~433). L‟indice Amplitude des 3 directions Nord-Est, Nord et Nord- Ouest (5 200~ 5 000) est nettement plus grande que celle des 3 directions (4 600~ 4 400) Sud- Est, Sud et Sud-Ouest.

La corrélation entre l‟indice Left et la qualité du pâturage a été démontrée plus haut. L‟indicateur Left est proportionnel à la rapidité de la croissance de l‟activité photosynthétique au printemps. Les travaux de terrain réalisés avec des agronomes, zootechniciens et géographes chinois et français en juin 2015, nous ont permis d‟émettre comme hypothèse d‟interprétation la combinaison de deux phénomènes : les faces exposée au sud se réchauffent plus vite au printemps ce qui produit un Left plus important, les faces exposées au nord sont généralement plus envahies d‟arbustes à feuilles caduques montrant une croissance plus rapide que le couvert herbacé au printemps. Cette interprétation à « dire d‟experts » mériterait d‟être étayée dans la suite des travaux par des observations au sol.

La corrélation entre l‟indice Amplitude et la production de biomasse du pâturage a été démontrée plus haut. A partir de cette observation, et la direction du lever du soleil dans les Monts Qilian au Sud et Sud-Est, on peut conclure que : la production de biomasse du versant sombre et humide est supérieure à celle du versant ensoleillé. Ceci peut s‟interpréter comme une meilleure disponibilité en eau du versant nord, plus ombragé, favorisant l‟activité

photosynthétique estivale. Mais ce phénomène peut également s‟expliquer par la présence plus importante d‟arbustes dans le versant sombre, arbustes à feuilles caduques donc montrant une forte différence d‟activité photosynthétique entre l‟hiver et l‟été.

Finalement, les résultats montrent bien que les métriques phénologiques sont contrôlées par l'orientation des versants et la pente.

III. Signification des résultats obtenus par ACP

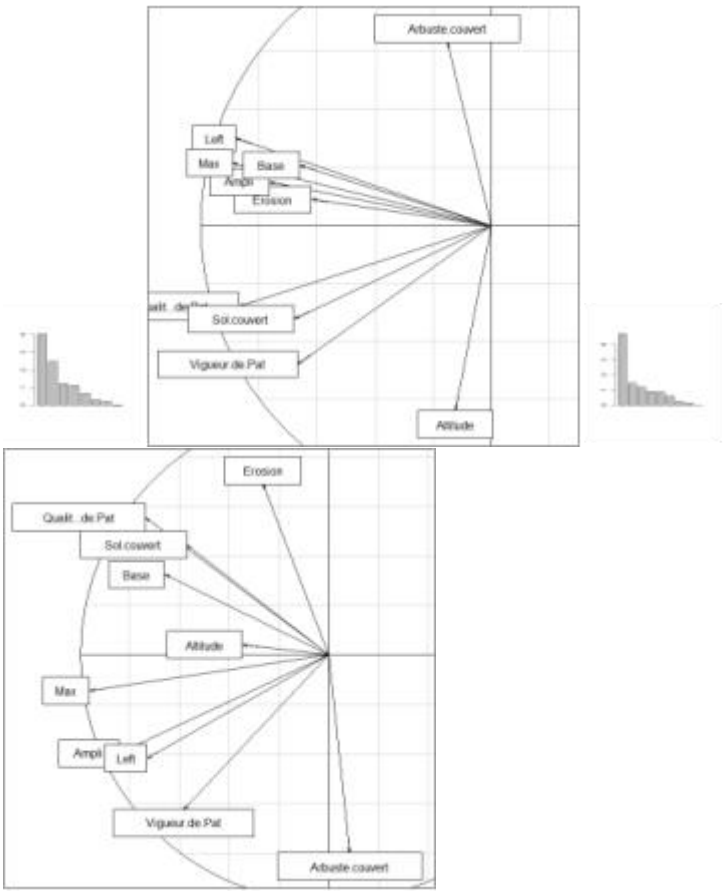


Figure 15 Résultat de l’ACP pour Sunan County (à gauche) et Tianzhu County (à droite)

Les résultats obtenus par ACP pour Sunan County et Tianzhu County (Figure 15) ont été comparés. On peut remarquer que les métriques phénologiques et le degré d‟érosion ont des composantes similaires à Tianzhu county. Mais ils diffèrent beaucoup par l‟altitude. A l‟inverse, les métriques phénologiques et l‟altitude ont des composantes similaires à Sunan county.

Figure 16 Distribution des repères GPS des pâturages par la méthode ACP source : H. Lingzi, 2015

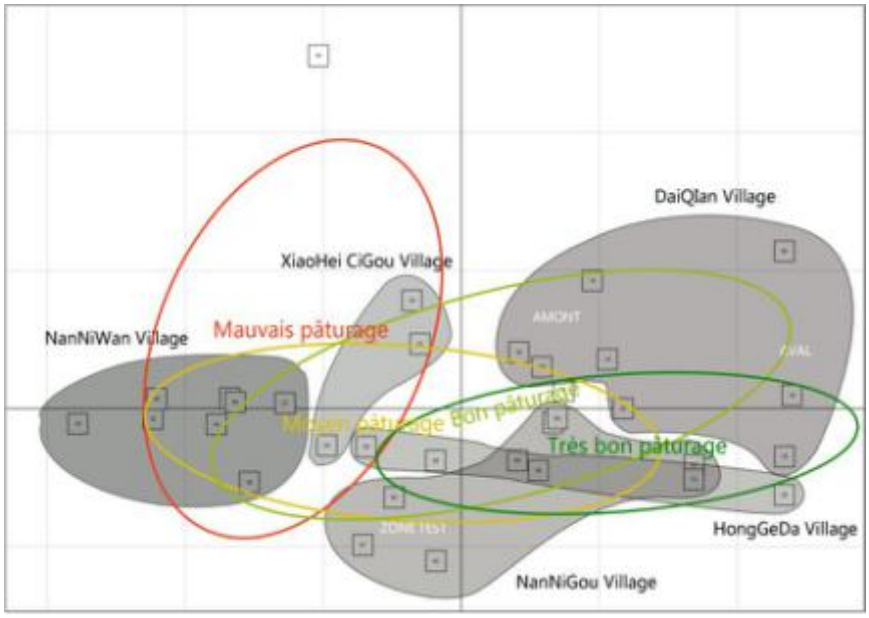


Figure 17 Schéma qualitative des pâturages à Tianzhu County source : H. Lingzi, 2015

Chaque carré représente un point d‟observation GPS, il englobe les propriétés suivantes dans une zone de 250m x 250 m : l‟altitude, le pourcentage de sol couvert par la végétation, le pourcentage d‟arbustes dans le couvert végétal, la présnece de formes d‟érosion, la vigueur de la végétation herbacée, l‟Amplitude, la Base, le Left et le Max (Figure 16). On remarque que les repères GPS d‟un même village comportent des propriétés similaires. A partir de la méthode ACP et les résultats obtenus de la qualité des pâturages sur le terrain, la carte de la répartition de la qualité des pâturages du Tianzhu county peut être obtenue. Par exemple, le village DaiQian a de très bons et bons pâturages ; le village NanNiWan a de mauvais et moyens pâturages (Figure 17).

CONCLUSION

Comme ce rapport l‟a montré, la télédétection offre des possibilités importantes pour l‟approfondissement des connaissances sur les rangeland aux Monts Qilian. Pour la classification des occupations du sol, la richesse temporelle des images permet une meilleure distinction entre des classes très opposées (pâturage / neige) mais parfois la similarité des courbes de culture et de pâturage est très proche. De même, nous avons observé les limites de la classification sur des environnements hybrides tels que la forêt, la forêt d‟arbuste ou forêt_pâturages_mixte.

Cependant, l‟analyse visuelle des courbes NDVI est riche d‟apprentissage. En effet cette courbe se lisant comme « l‟historique » de la parcelle permet d‟identifier des changements brutaux, mais aussi des changements plus progressifs comme l‟invasion des arbustes, ou encore des changements plus ponctuels liés aux pratiques de gestion des pâturages pour le futur (il n‟existe pas de grand changement de la mode de gestion des pâturages aux Monts Qilian depuis 2000). La richesse temporelle qui fut efficace, cela un avantage du capteur Modis, car aucun autre capteur ne permet jusqu‟alors la reconstitution de plus de dix années d‟observation de l‟environnement.

Enfin, en considérant la longue période 2004 – 2014, on remarque des résultats différents dans la zone d‟étude :

Au pâturage en saison d‟hiver, la pâturage est encore plutôt préservée,

Au pâturage en saison d‟été /printemps, la dégradation du pâturage est flagrante.

Concernant le futur du programme de recherche sur les Monts Qilian. L‟étude de la corrélation entre les métriques phénologiques et l‟intensité de chargement animal /les indices climatiques est faisable, bien que les défis seront grands. La méthode détaillée dans ce rapport sera offerte une stratégie pour les autorités locales pour le développement durable.

Reference

Gale, F., Somwaru, A., Diao X. 2000. Economic Research Service/USDA.; China's Food and Agriculture: Issues for the 21st Century / AIB 775.www.ers.usda.gov (accessed: 22 April 2014).

Longworth, J. W., & Williamson, G. J. 1993. China's Pastoral Region: Sheep and wool, Minority Nationalities, Rangeland Degradation and Sustainable Development. CABI International Ed., Oxford, England, 368p.

Brown, C., Waldron, S., Longworth, J. 2008.Sustainabledevelopment in Western China: Managing people, livestock and grassland in pastoral areas. Edward Elgar Publishing, Cheltenham.

Dong, S. K., L. Wen, L. Zhu and X. Y. Li, 2010. Implication of coupled natural and human systems in sustainable rangeland ecosystem management in HKH region. Frontier of Earth Science in China. Vol. 4. pp. 42-50.

Dong, S., Kassam, K.A.S, Tourrand, J.F., Boone, R.B. (Eds) 2014. Building Resilience of CoupledHuman-Natural Systems of Pastoralism in the Developing World. SPRINGER (in press)

Gu, A.L., 2000. Biodiversity of Tibet's rangeland resources and their protection. In: Wu, N., Miller, D.J., Lu, Z., Springer, J. (Eds.), Tibet's Biodiversity: Conservation and Management. China Forestry Press Publishing House, Beijing, pp. 94-100.

Kammili T., Hubert B. &Tourrand J.F. (Eds) 2011. A paradigm shift in livestock management: from resource sufficiency to functional integrity. Cardère Editor Lirac, France, 272p.pp 9-70.

Lobsang, 1998. The development of animal husbandry on the Qinghai-Tibetan Plateau. In: Clarke, G.E. (Ed.), Development, Society and Environment in Tibet, Proceedings of the Seventh Seminar of the International Association for Tibetan Studies, Graz 1995. Verlag der O sterreichischenAkademie der Wissenchasften, Vienna, pp. 77–78.

Michel, G. & Chevalier, B. 2011. Les nouvelles ressources en minerais stratégiques : l'exemple des terres rares, Géoéconomie 59, pp. 87-97.

Squires, V., Lu, X., Lu, Q., Wang, T., Yang, Y. 2009. Rangelanddegradation and recovery in China's pastoral lands. In. Squires, V. (Ed) RangelandStewardship in Central Asia: BalancingImprovedLivelihoods, Biodiversity Conservation and Land Protection, CABI Publishing: Oxford, pp: 219-234.

Bedunah, D. J. &Angerer, J. P. 2012. Rangeland degradation, poverty and conflict: how can rangeland scientists contribute to effective responses and solutions, Rangeland Ecology & Management 65(6), pp. 606-612.

Behnke, R. H. &Scoones, I. 1993. Rethinking range ecology: implications for rangeland management in Africa, in R.H. Behnke et al. (eds.) Range ecology at disequilibrium (London, Overseas Development Institute), pp. 1-30.

Chen, Y. & Tang, H. 2005. Desertification in north China: background, anthropogenic impacts and failures in combating it, Land Degradation and Development 16(4), pp. 367-376.

Chinese Academy of Sciences. 2007. Research Group for China Modernization Strategies / Ecological modernization report 2007.

Davidson, G., Behnke, R.H., Kerven, C., 2008. Implications of rangeland enclosure policy on the Tibetan plateau. UPDATE Magazine No.2, October 2008. International Human Dimensions Programme on Global Environmental Change, pp. 59–62.

Dedieu, B., Hubert, B., Ickowicz, A., Tourrand, J-F. 2011. Livestock farming embedded in local development: a functional perspective to alleviate vulnerability of farming communities. Presented at IX International Rangeland Congress, Rosario, ARG.

Ding, L., Long, R., Tourrand, J.F. 2014. Rangeland Management by Households, Communities

and Local Governance in the Qilian Mountains, Tibetan Plateau, China.*Rev.Elv.Med.Vet.Pays Trop.*(Submitted).

Dong, S. K., Long, R. J. and Kang, Y. M. (2003). Milking and milk processing: Traditional technologies in the yak farming system of the Qinghai-Tibetan Plateau, China. Int. J. Dairy Technol. 56, pp. 86–93.

Dougill, A. J., E.D.G. Fraser and M.S. Reed. 2010. Anticipating vulnerability to climate change in dryland pastoral systems: using dynamic systems models for the Kalahari. Ecology and Society (in press).

Foggin, J. M. 2008. Depopulating the Tibetan grasslands. National policies and perspectives for the future of Tibetan herders in Qinghai Province, China, Mountain Research and Development 28(1), pp. 26-31.

Fraser, E. D. G. 2007. Travelling in antique lands: studying past famines to understand present vulnerabilities to climate change. Climate Change83, pp. 495-514.

Hardin, G. J. 1968. The tragedy of the commons. Science 162 (3859), pp. 1243–1248.

Harris, R. B. 2010. Rangeland Degradation on the Qinghai-Tibet Plateau; a review of the evidence of its magnitude and causes, Journal of Arid Environments 74, pp. 1-12.

Hu, Z.Z., Zhang, D.G., 2003. China's pasture resources. In: Suttie, J.M., Reynolds, S.B. (Eds.), Transhumant Grazing Systems in Temperate Asia. Plant Production and Protection Series 31. Food and Agriculture Organization of the United Nations, Rome, pp. 81–133.

IUCN. 2011. Supporting Sustainable Pastoral Livelihoods: A Global Perspective on Minimum Standarts and Good Practices. Second Edition March 2012. Publish for review and consultation through global learning fora. Nairobi, Kenya: IUCN ESARO office. Vi + 34p.

Jianguo Liu & Diamond, J. 2005. China's environment in a globalizing world, Nature 435, pp. 1179-1186.

Johnson, D.G. 2000. "Agricultural Adjustment in China: Problems and Prospects," *Population and Development Review*, Vol. 26, pp. 319-334.

Kreutzmann, H. 2013. The tragedy of responsibility in high Asia: modernizing traditional pastoral practices and preserving modernist worldviews, Pastoralism: Research, Policy and Practice 3(7), pp. 11.

Long, R. J., Ding, L. M., Shang, Z. H., Guo, X. H. 2008. The yak grazing system in the Qinghai-Tibetan plateau and its status.The rangeland Journal30, pp 241-246.

Luosan, L., 1996. Development and Environment of the Qinghai-Tibet Plateau. China Tibetan Studies Publishing, Beijing (in Chinese).

Manderscheid A. 2001a. Decline and re-emergence of nomadism: Tibetan pastoralists revive a way of life and production, Geojournal 53(2), pp. 173-182.

Miller, D.J., 2002. The importance of China's nomads. Rangelands 24, pp. 22–24.

Ostrom, E. 2009. A general framework for analyzing sustainability of social-ecological systems, Science 325, pp. 419-422.

PemaTsering .2007. Tibet : A human development and environment report, Central Tibetan Administration Publ. (Environment Development Desk, Dept of Informations and International Relations), (Dharamshala, Narthang Press), pp. 267.

Rawski, T.G., and R.W. Mead. **1998.** "On the Trail of China's Phantom Farmers," *World Development*, Vol. 26, pp. 767-781.

Richard, C., Yan, Z.L., Du, G.Z., 2006. The Paradox of the Individual Household Responsibility System in the Grasslands of the Tibetan Plateau, China.USDA Forest Service Proceedings RMPS-P-39. USDA Forest Service, Fort Collins, CO.

TashiGongbo&Foggin, M. 2012. Resettlement as development and progress ? Eight years on: review of emerging social and development impacts of an 'Ecological Resettlement' Project in

Tibet Autonomous Region, China, Nomadic Peoples 16(1), pp. 134-151.
Wang, G.X., Li, Y.S., Wu, Q.B., Wang, Y.B., 2006a. Relationships between permafrost area on the Qinghai-Tibetan plateau and vegetation, and influence on high, cold ecosystems. China Science D: Earth Sciences 36, pp. 743–754 (in Chinese).
Wang, W.Y., Wang, Q.J., Wang, H.C., 2006b. The effect of land management on plant community composition, species diversity, and productivity of alpine Kobresia meadow. Ecological Research 21, pp. 181–187.
Wang, M. P., Zhao, C. Z., Long, R. J., Yang, Y. H. 2010. Rangeland governance in China: overview, impacts on Sunan County in Gansu Province and future options. *The Rangeland Journal*, 2010, 32, pp. 155-163.
Wu, N., Yan, Z.L., 2002. Climate variability and social vulnerability on the Tibetan Plateau: Dilemmas on the road to pastoral reform. Erdkunde 56, pp. 2–14.
Yan Jianzhong, Wu Yingying& Zhang Yili . 2011. Adaptation strategies to pasture degradation : gap between government and local nomads in the eastern Tibetan Plateau,Journal of Geographical Sciences 21(6), pp. 1112-1122.
Zhao, X.Q., Zhang, Y.S., Zhou, X.M., 2000. Theory and practice for sustainable development of animal husbandry on the alpine meadow pasture. Resources Science 22, pp. 50–61 (in Chinese).
Zhao, X.Q., Zhou, H.K., 2005. Eco-environmental degradation, vegetation regeneration and sustainable development in the headwaters of the three rivers on the Tibetan plateau. S&T and Society 20, pp. 471–476 (in Chinese).
Yeh, E. T.2009a. Greening western China: a critical view, Geoforum 40(5), pp. 884-894. **2005.** Green governmentality and pastoralism in western China: 'Converting pastures to grasslands', Nomadic Peoples 9(1&2), pp. 9-30. **2010.**Restoring the grasslands?

Conference communication

Bonaudo, T., Ding, L., Long, R.J., Tourrand J.F., 2013. Politiques publiques : moteur de changement en élevage dans les Montagnes du Qilian, et le Plateau Tibétain, Chine. 6ièmes Journées. Rech. Sci. Soc., 13- 14/12/2012, Toulouse.

Thesis / Report

Liu, Y., Baas, S., and Ni, H. (2001)."Strengthening Pastoral institution in North-West China Pastoram area to access improved extension services for risk management and poverty alleviation." Study reports FAO/MOA/CIAD. (United Nations Food and Agriculture Organisation: Rome.)
Tabouret, S. 2009. Les montagnes du Qilian : un élevage pastoral et agropastoral contraint par l'accès aux ressources fourragères locales. *DiplômeIngénieurAgronome, IRC*, Montpellier, France, 130p.
Yan, Z.L., Wu, N., Dorji, Yeshi, Ru, J., 2005.A review of rangeland privatization and its implications in the Tibetan Plateau, China. Nomadic Peoples 9 (1), 31–51.

Web site

Aschenbrenner C., 2000-2001. Paris. *Les visionnaires de l'information : Jacques Bertin et la «graphique».*
Caraway, W., 2010. China: the Middle Kingdom, Climate. www.koreanhystoryproject.org (accessed : 12th June 2014).
Goodman L.A., 1960. Snowball sampling. *The Annals of Mathematical Statistics*, 32 (1): 148-170. http://projecteuclid.org/euclid.aoms/1177705148
World Bank. 2001. China-air, land, and water: Environment priorities for a new millennium. Available at: www.worldbank.org (accessed: 16th may 2014).

www.statistiquesmondiale.com
http://countrymeters.info/fr/China
http://www.asianinfo.org/asianinfo/china/pro-history.htm

Bibliography consulted but not cited in the text

Davidson, G., Behnke, R.H., Kerven, C. 2008. Implication of rangeland enclosure policy on Tibetan Plateau.Mountainous Regions: Laboratories for Adaptation (pp. 59–62). Bonn, Germay: Human, International Programme, Dimensions Change, Global Environmental.

Harris, R.B. 2010. Rangeland degradation on the Qinghai-Tibetan plateau: A review of the evidence of its magnitude and causes. Journal of Arid Environments, 74(1), 1–12.

Tashi, N., Partap, T. 2000. Livestock based livelihoods in Tibet, China and sustainability concern. In P.M. Tulachan, M.A.M. Saleem, J. Maki-Hokkonen, & T. Partap (Eds.), Contribution of livestock to mountain livelihoods: R&D Issues (pp. 171–182), Pokhara, Nepal.

Yi, S., Ning, W., Peng, L., Qian, W., Sli, F., Zhang, Q., Ma, J. 2008. Agricultural heritage in disintegration: Trends of agropastoral transhumance. International Journal of sustainable Development & world Ecology, 15(3), 273–282.

Zhang, L., Zhang, Y., Yan, J., Wu, Y. 2008. Livelihood diversification and cropland use pattern in agro-pastoral mountainous region of eastern Tibetan Plateau. Journal of Geographical Sciences, 18(4), 499–509.

Zhao, Y.Z., Zou, X.Y., Cheng, H., Jia, H.K., Wu, Y.Q., Wang, G.Y., Zhang, C.L., et al. 2006. Assessing the ecological security of the Tibetan plateau: methodology and a case study for Lhaze County. Journal of environmental management, 80(2), 120–31.

Banks, T. 2001. Property rights and environment in pastoral China: evidence from the field. *Development and Change* **32**, 717-740

Brown, C., Waldron, S., Longworth, J. 2008. Sustainable development in Western China: Managing people, livestock and grassland in pastoral areas. Edward Elgar Publishing, Cheltenham.

Han, J. G., Zhang, Y. J., Wang, C. J., Bai, W. M., Wang, Y. R., Han, G. D., Li, L. H. 2008. Rangeland degradation and restoration management in China. *The Rangeland Journal* **30**, 233-239.

Squires, V., Lu, X., Lu, Q., Wang, T., Yang, Y. 2009. Rangeland degradation and recovery in China's pastoral lands. *In. Squires, V. (Ed) Rangeland Stewardship in Central Asia: Balancing Improved Livelihoods, Biodiversity Conservation and Land Protection*, CABI Publishing: Oxford, pp: 219-234.

Wang, M.P., Zhao, C.Z., Long, R.J., Yang, Y.H. 2010 . Rangeland governance in China: overview, impacts on Sunan county, Gansu Province and future options. *The Rangeland Journal*, 2010, 32, 155-163.

Williams, D. M. 2002. Beyond Great Walls: Environmental, Identity and Development on the Chinese grassland of Inner Mongolia. Stanford University Press, Stanford

Zhang, M. D.., Borjigin, E., Zhang, H. 2007. Mongolian nomadic culture and ecological culture: on the ecological reconstruction in the agropastoral mosaic zone in Northern China. Ecological Economics 62, pp19-26.

AUBERT, Claude. «Le devenir de l'économie paysanne en Chine.» *Revue Tiers Monde*, n° 183 (2005): 491-

515.

BOCHUAN, He. «La crise agraire en Chine, Données et réflexions.» *Etudes rurales*, n° 179

(2007): 117-132. BOQUET, Yves. «Dynamiques de développement et inégalités régionales

en Chine.» *Espaces populations sociétés*, 2009.

BRASQUIES, Doryane. «Household budget and livelihoods in the Qilian Mountains, Tibetan plateau, China.» Rapport of second year, Master Ecologie-biodiversité spécialité ecologie et developpement durable, parcours EPSED, Montpellier, 2014.

Cai YuanPei. «Sustainability of Farming Systems in the Qilian Mountains,Tibetan Plateau, Facing Global Change.» Project Description & Synthesis, 2013.

CATIN, Maurice, et Christophe VAN HUFFEL. «Ouverture économique et inégalité régionales de développement en Chine : Le rôle des institutions.» *Mondes en développement*, n° 128 (2004): 7-23.

CHAN , K. W. *Despite China's Modernization, the Inequable Hukou System Remains.* February 2010. http://www.artsci.washington.edu/newsletter/Feb10/Hukou.asp (accès le July 2014).

—. *Despite China's Modernization, the Inequable Hukou System Remains.* February 2010. http://www.artsci.washington.edu/newsletter/Feb10/Hukou.asp .

Chinadaily. *Economic overview of Gansu province.* February 2013.http://www.chinadaily.com.cn/m/gansu/2013-11/02/content_17076120.htm (accès le July 2014).

DABURON, Annabelle. «Urban and peri-urban milk producers of El Cairon City an efficiency focus.» Rapport de stage de seconde année pour le master EPSED, 2013.

DREYFUS, Fabrice. «Politiques pastorales et transformations de l'élevage des yaks sur le plateau

http://eric.univ-lyon2.fr/~ricco/tanagra/fichiers/en_Tanagra_Pca_Varimax.pdf (accès le July 2014).

FAIVRE-DUPAIGRE, B, Y LASSICA, L LIAGRE, et D NEU. «Les filières agricoles et agroalimentaires.» Dans *Memento de l'Agronome*, de Collectf, 135-154. QUAE, 2009.

FAN, Huaiyu, et Liqun XIAN. «General situation of prefectures and counties.» *Gansu development yearbook*, 2012: 180-223.

FAO. *Tropical Livestock Units (TLU) .* April 2002. http://www.fao.org/ag/againfo/programmes/en/lead/toolbox/Mixed1/TLU.htm (accès le August 2014).

—. *Dairy production and products: Milk composition.* 2012. http://www.fao.org/agriculture/dairy-gateway/milk-and-milk-products/milk-composition/en/ (accès le September 2014).

FERRATON, Nicolas, et Isabelle TOUZARD. *Comprendre l'agriculture familiale. Diagnostic des systèmes de production.* Pays-Bas: CTA, Edition Quae and Presse agronomique de Gembloux, 2009.

FLOQUET, Anne. «Concepts de systèmes de production et de filières.» 2005.

HO, Peter. «Ownership and control in chinese rangeland managemenr since Mao: the case of free-ridiing in ningxia.» *Pastoral Develpment Network, Series 39*, 1996.

LA GRA, Jerry. «Introduction aux filières agro-alimentaires.» Dans *Une méthode d'évaluation des filières agro-alimentaires pour l'identification des problèmes et des projets*. Moscow: University of Idaho, 1990.

LI, Cai, Gerald WIENER, Han JIANLIN, et R.J LONG. *THE YAK SECOND EDITION.* FAO, 2003.

LI, Jun, Yujing LI, et Wenhong DAN. «Disparité régionale de la Chine.» *Les cahiers d'Outre-Mer*, n° 253-254 (2011): 83-100.

LING, Zhu. «Agricultural policy reform and food security in China.» *Rural21*, 2013: 24-26.

LONG, R.J, L.M DING, Z.H SHANG, et X.H GUO. «The yak grazing system in the Qinghai-Tibetan plateau and tis status.» *The rangeland journal* 30 (2008): 241-246.

LOWDER, Sarah. K, Jacob SKOET, et Saumya SINGH. «What do we really know about the number and distribution of farms and family farms in the world ? Background paper for The State of Food and Agriculture 2014.» *ESA Working Paper No. 14-02.* Rome: FAO, 2014.

MASTERS, D. G, et al. «Production from fine wool sheep in three areas in northern China.» *AJAS* Vol.3, n° 4 (1990): 305-312.

MERCOIRET, M.R. «Les organisations paysannes et rurales.» Dans *Memento de l'Agronome*, de Collectifs, 111-134. QUAE, 2009.

NOLAN, Sharna, Murray UNKOVICH, Yuying SHEN, Lingling LI, et William BELLOTTI. «Farming systems of the Loess Plateau, Gansu Province, China.» *Agriculture, Ecosystems and Environment*, n° 124 (2008): 13-23.

SHANG, Z.H, et al. «The sustainable developement of grassland-livestock systems ont he Tibetan plateau: problems, strategies and prospects.» *The Rangeland Journal*, 2014: 267-296.

SOURISSEAU et al. *Les modèles familiaux de production agricole en question. Comprendre leur diversité et leur fonctionnement.* paris, 2012.

SUN, L, G.L WU, X.H WEI, et D.J SIQUE. «Study on adaptability and evaluation of grass sowing in sheep pen in Nagchoe prefecture, Tibetan autonomaus region.» *Grassland and Turf*, 2007: 64-67.

TABOURET, Sophie. «Les montagnes du Qilian : Un élevage pastoral et agro-pastoral, contraint pas l'accès aux ressources fourragères locales.» Mémoire d'ingénieur agronome de l'ENSAIA (Montpellier SupAgro / Institut des régions chaudes), 2009.

The World Bank. *Date country China.* 26 June 2014. http://data.worldbank.org/country/china.

TOURRAND, Jean-François. «Les pasteurs du toit du monde face au changement, Les monts du Qilian du Plateau Tibétain, Chine.» 2013.

TOURRAND, Jean-François. «Politiques publiques : moteur de changement en élevage dans les Montagnes du Qilian, Plateau Tibétain, Chine.» 2013.

Ubifrance Chine - Bureau de Pékin. «La province du Gansu.» *Ubifrance - Fiche province*, 2013.

WANG, M. P, C. Z ZHAO, R. J LONG, et Y. H YANG. «Rangeland governance in China: overviem, impacts on

Sunan County in Gansu Province and future options.» *The Rangeland Journal*, n° 32 (2010): 155-

163.

Annexes

Annex 1: Questionnaire 1; General approach

Guide interview household the Qilian Mountain

First survey 2014

Introduction: some words or sentences about the history of the household/family until now

1. Name of interviewer:_____
2. date of survey: _____
3. Locality/district: _____/_____/
4. Name of the **head of family/household**: /_____/
5. Age of the head of the family/household: /____ _/
6. Name of the community: /_____/
7. Name of the village: /_____/
8. Name of the town: /_____/

9. Name of the county: /_____/
10. Name of the social group/ethnic: _____
11. Name of the head of the village:_____
12. Link with the administrative contact person: near – medium - far – no link
13. Are you member of local associations? (Y/N) /____/
14. If yes, what is the name of the association: _____
15. Precise the benefit from this association: _____

DIRECT FAMILY

16. How many direct member in your family/household behind/dependant you? : /___ _/
17. Wife: /____/
18. Adult Son: /___/

20. Unmarried sons: _____

21. Married sons:_____

19. 22. Adult Daughter: /____ _/

23. Unmarried daughters: _____

24. Married daughters:_____

25. Children under 16 years old: _____

26. female: _____

27. Male: _____

28. How many schooled children: /___/

29. in primary:___

30. pre-school:____

31. secondary:___

32. University/faculty: ____

33. technical: _____

34. How many children are involved in the work? /_____/

35. Type of work: _____

36. Level of education of the head of family: /____ /

(1.Illiterated 2. Read and write 3.Primary 4.Secondary 5.Faculty 6.Technical)

EXTENDED FAMILY

37. Name of the head of family: _____

38. Relation with the breeder/household: _____

39. Extended family is still economically dependant: Y/N /_____/

40. Brothers:/____/

41. Unmarried brothers: _____

42. Married brothers:_____

43. Other members (wife+children): ____

44. Sisters:/____/

45. Unmarried sisters: _____

46. Married sisters:_____

47. Other members (men+children): ____

48. Cousin from father side: /____/

49. Male cousins: Unmarried: ___

50. male cousin: Married: _____

51. Male cousin: other members (wife+children)____

52. Female cousin : Unmarried: ___

53. Female cousin : married: ___

54. Female cousin : Other members (men+children): ___

55. How many total members in your family dependent on you? _____

56. how many men are working or able to work: /____/

57. How many children (under 16 years old):/___/

58. Male: /_____/

59. female: /____/

<u>In your household/family, HOW MANY MEMBERS WORK AS:</u>

60. State employee: /____ _/

61. comment: _____

62. Private sector permanent worker: /____ _/

63. comment: _____

64. temporary worker: /____ _/

65. comment: _____

66. Ag. Worker: /___/

67. comment: _____

68. Self-employed (business):/___/

69. precise the sector:_____

70. Touristic activities: /____ /

71. comment: _____

72. Business /_____/

73. comment: _____

74. Shepherd: /____ _/

75. comment: _____

76. Other sources of income: _____

77. remittances (LE/year): /_____/

78. comment: _____

79. How many sons have completely left the family (monetary independent): /____/

80. comment: _____

LEVEL OF EDUCATION OF THE FAMILY/household:

Estimation of the level of education: How many persons in your family:

81. Illiterated (*omi*): /____ _/
82. Preschool: /_____/
83. Primary school: /___/
84. Secondary/high school: /____ _/
85. Faculty: /___/
86. Technical: /___/

HOUSING (*If yes, check the box*):

87. Type of housing: Y/N Concrete? /____ _/
88. Area of the house: ____
89. How many other houses: /_____/
90. Mobile tent: Y/N /___/

91. Electricity: Y/N /___/
92. source of electricity: _____

93. Source of drinking water for the family: Y/N /___/
94. Source of drinking water: _____
95. Source of drinking water for animals: Y/N /____ _/
96. source of drinking water for animals: _____
97. System to get rid of water; Y/N: /_____/

98. TV+satellite: Y/N /____ _/
99. Mobile phone: Y/N /____ _/
100. transport: Y/N /____ _/
101. precise the type of transport: _____ (1. 4*4, 2. Car, 3. Motorbike, 4. Other)

102. If other transport precise

103. Refrigerator: /____ _/

IN YOUR FAMILY, COULD YOU PRECISE WHO MANAGE (TAKE THE DECISION) (*IF YES, CHECK THE BOX*):

Livestock marketing:

104. head of family :Y/N /__/
105. Household: Y/N /____ /
106. common: Y/N /____ /

Livestock grazing/keeping: _____

107. head of family :Y/N /__/
108. Household: Y/N /____ /
109. comm

on: Y/N /____ /

Livestock daily

management: _____

110. head of family :Y/N /__/
111. Household: Y/N /____ /
112. co

mmon: Y/N /____

/ Land/

agricultural work:

113. head of family :Y/N /__/
114. Household: Y/N /____ /
115. co

mmon: Y/N /____

/ Get loan: _____

116. head of family :Y/N /__/
117. Household: Y/N /____ /
118. common: Y/N /____ /

Contact with the government and subsidies: _____

119. head of family :Y/N /__/
120. Household: Y/N /____ /
121. co

mmon: Y/N /____

/ Sharing activities

concerning:

122. Livestock grazing: Y/N / ____ _/
123. Comment on livestock grazing: _____
124. Livestock marketing: Y/N / ___/
125. Comment on livestock marketing: _____
126. Livestock feeding/purchase of inputs: Y/N / ____ _/
127. Comment on feeding/purchase of inputs : _____
128. Nature of social link in the family: _____ Are your chi

Land ownership:

Type of land (1.winter pastures, 2.Summer pastures, 3.Autumn pastures 4.fields for crops, 5.Other land	Area (mu)	Type of holding (1 land attribution. 2. Inheritance; 3. In rent; 4. Common land; 5. Other. precise)	Since when do you use this land?	Cost for access to land (cost of renting or in kind)	Irrigation facilities (precise the type) 1. Rainfall 2. Reservoir 3. other	If other type of irrigation, precise	Cost of irrigation (equipment)

Cropping system including fruit crops (2013 and 2014):

Crop	Winter (W) or Summer (S) crop	Total area (Mu)	Productive costs in inputs (CNY/Mu)	Labor cost (CNY/Mu)	cost for mechanization (CNY/Mu)	Cost of irrigation (CNY/Mu)	Total production (use the unit of the farmer)*	% sale *	Price (/kg Or / cut fo 1 Mu)

If not harvest: give the expected production and the % that he wants to sell

What equipment do you have for cropping: _____

Livestock asset/ Livestock structure in March-April 2014:

Sheep (main breed: _____): Ewe: /____ _/ Rams: /_____ / fem. kids: /___/ male kids: /____/ G

Yak (main breed: _____): Cow: /____ _/ Bull: /____ _/ Calves:/__/

Heifers: :/____ _/ Young Bulls:/____ _/ Camel (main breed: ____): Total

camel: /____ _/

Cattle (main breed: _____): Cow: /___/ Bull: /___/ Calves:/___/ Heifers: :/_

_____/ Young Bulls:/____ _/ Poultry/Chicken: /_____ / Rabbits: / /

Other: /____/ Horse: /_____/ Dogs: /____ _/

How many animals 5 years ago:

Sheep : /___/ Goat : /__/ Yak: /___/ Camel : /_ / Poultry: /____ _/ How many animals 20 years ag

Sheep : /___/ Goat : /__/ Yak: /___/ Camel : /_ / Poultry: /____ _/ How many animals 40 years ag

Sheep : /___/ Goat : /__/ Yak: /___/ Camel : /___/ Poultry: /____ _/

Pastoral system (only rangeland):

	Good year (____/_____)			Bad year (____/____)		
Specie	Range period (from… to…)	Distance from house	Status of ranges (1. Good, 2. Medium, 3. Weak, 4. Very weak)	Range period (from… to…)	Distance from house	Status of ranges (1. Good, 2. Medium, 3. Weak, 4. Very weak)
Sheep						
Goat						
Yak						

Who keeps the animal in the rangeland: family member (Y/N): /_____/ shepherd (Y/N): /_____/ If shepherd with salary, precise the monthly wage: _____ RMB/ average flock size: /_____/ Mode of watering in pastoral area: 1. Undergournd 2. Rainfall 3. River 4. Others / /

Comment_____

Type of supplementation during grazing period: _____ _____ _____Forages: Y/N /___/ q

Concentrates: Y/N /_____/ quantity: ____

Grain: Y/N /___

/ quantity: ___ Straw: Y/N /__/ quantity: _____

Crop residue: Y/N /__/ quantity: _____

Other Y/N /_____/ precise : ___quantity: _____

Does one part of the herd/flock go to other places: (Y/N) /___/

If yes: since when? /_____/ from …… to…… (month)

How many Mu do you rent: _____, how much do you

_____

pay: _____ Have you some direct links with the

Do you keep some animals around your house all

the year? Y/N /_____ / If yes, precise the species:

Sheep Y/N/____/ Physiological stade: _____

Goat Y/N/____/

Physiological stade: _____ __ Yak Y/N/____/ Physiological stade: ___

Feeding system: _____ _____

_____

Are you some damage on crops due to animals: Y/N /___/

How do you solve the potential risk of damage of cropped areas (included tree) by animals?

_____ ____ _____

Feeding system:

	Sheep	Goat	Camel	Cattle
Forages				
Concentrates				
Grains: barley/wheat…				
Straw				
Hay				
crop residues				

Feeding cost (year 2013/2014) by kg:

	Quantity bought in 2013	Where and who do you buy it? (precise if trader, private shop, cooperative, …)	Price in good/bad year (Mu/kg)
Forages			
Concentrates			____ /____
Barley and wheat grain			____ /____
Hay			____ /____
Dry clover and crop residues			____ /____

Animal performances

Specie	Precise the main months of lambing/calving ?	Av. Number of born kids over the period?	Av number of born female?	Number of died kids over the period?	How many young animals do you fatten?	Period of fattening (in month)	Number of culled female
Sheep							

Goat							
Yak							
Other							

Describe the main changes in the animal management during the last years in:

129. mating period? Y/N /___/ If yes what change: _____

130. lambing? Y/N /__/ If yes what change: _____

131. rangeland grazing,? Y/N /___/ If yes what change: _____ _____ What did

Animal marketing for **female adult** in 2013/2014:

Specie	Number of animals sold to other breeders/traders?	Number of animals sold to market?	Av. Price/ animal	Av. Age per animal	'Av.' Weight Per animal
Ewe					
Doe					
Yak					
Other					

Animal marketing **for young animals** in 2013/2014:

Specie	Number of animals sold to other breeders/traders?	Number of animals sold to market?	Av. Price/ animal (CNY)	Av. Age per animal (month or year)	'Av.' Weight Per animal
Sheep					
Goat					
Yak					
Other					

When you sell in market, which market (localization): _____

Have you observed a change on the demand in the market during the

last years? Y/N /____ / Which change: _____

_____

Have you changed your way of marketing? _____ _____ How many animals do you

What is approximately your consume of manure for heating

during one year? (maybe the average is #15kg/family/day)

Number of milking animals

Milk production rank:

- main economic activity
- Security for family income
- Security for family consumption
- Tradition
- Other

Duration of lactation period.

Average of daily milk production per animal (from… to …)

- The First month
- Peak period
- Production the day of visit
- Last month

During the last week: Average total production of milk (per day)

- Self-consumption of milk (per day)
- Process the milk on the farm? Y / N
- Transformation for better (per day or week)
- Transformation for cheese

(per day or week) Sell of milk: Y / N

- If yes how many this week? (Average kg/day)
- Where and to whom?
- Price

Sell butter: Y / N

- If yes how many this week? (Average kg/day)
- Where and to whom?
- Price

Sell Cheese: Y / N

- If yes how many this week? (Average kg/day)
- Where and to whom?
- Price

Have you changer of trader or collector since the

last 5 years? Y / N Why?

Have you changed the transformation activity in the farm since the last 5 years? Y / N

W
h
y
?

Age of culling of dairy animals

<u>Other Animal products :</u>

Specie	Quantity sold in the neighborhood In 2013/14	Quantity sold in Market in 2013/14	Price/ unit	Have you 1. Increased or 2. Decreased the Qt?
Milk				

Skin/leather				
Wool				
Manure				
Other				

Animal Disease/health change

Do you apply regular vaccination: Y/No

If yes: which specie: sheep: /____ / goat: /_____ / yak: /_____/cattle: /____/ Type of vaccine :__

What are the more frequent animal health diseases/pathologiess:

Specie (Sheep, Goat, Yak, Other)	Treatments	How often do it occur? (frequency)	What proportion of herds or flock is affected? (%)	Main symptoms / or loss of productivity	What is the impact in affected flock? (1)	Type of treatments +costs of treatment	Evolution since the last 10 years? (1. high increase; 2. Medium; 3. Low, 4. Non increase) (2)
	Internal parasites						
	External parasites						
	…						
	…						

(1) Impact: 0. Negligible, 1. Moderate reduction in livestock productivity, 2. Chronic reduction in livestock productivity, 3.

Occasional deaths, 4. Mortality + serious reduction in livestock productivity, 5. High mortality

(2) If high increase try to quantity the % of the head that it is affected before and now.

Can you give the main events that have affected your farm/flock/herd/work/family in the 5 last year?

Events	When	Consequences	From who did you receive the main support to face to this event?

Can you give the main events that have contributed to improve your

farm/flock/work/family in the 5 last years?

Events	When	Consequences	From who did you receive the main support to benefit it?

Have you accessed to credit
or loan among :

132. Trader (Y/N) /___/
133. Relative (Y/N) /___/
134. Community (Y/N) /___/
135. Friend (Y/N) /____ _/
136. Other? (Y/N) /___/

If yes precise who and for what occasion? _____

During the last years, who give you the most efficient support/help? _____

Explain: _____

What have been the main changes in the family life during the last drought?

_____ _____ _____ _____

Give details about the subsidies received for farming activities: Total value

in 2013: /_____/ Value/rangeland: /_____/, Value/forage crops: /_ _/, Value/livestock:/ /

Social capital

Social network	County leaders	Town leaders	Village or community leaders	Neighborhood	Ag. extension service/ agricultural association	Other…
Distance						
Freq. of contacts (1.Rare 2. Seasonal 3. Continuous, 4 other)						
Reasons of contact						
Roles during the events or disasters						
Support of gift/loan.						
Degree of trust: strong, Middle, low						
Is there a change of the intensity of link since the last years?						

What are the impacts of past research or development projects on your farm _____ (livestock management…), _____ _____your livelihood (family organization), ____ social life? _____

Did you know some conflict on land access for cultivation or rangeland access for grazing? If yes explain? Y/N /___/

If yes explain: _____

When you decided for your daughters or your sons to get married, do you try to reinforce some social links? Y/N /___/

If yes explain ? _____

How do you see the development of the zone in the next 20 years: the main evolution

In the cropping systems? _____ _____ In the livestock system? ____

In the family/village organization?_____

According to you livestock is mainly: /___/ + /___/ + /___/ + /__/ …

(1. Cash income, 2. Special security, 3. Family prestige, 4. A drought coping mechanism, 5. Other) Give comments: _____

HAVE YOU

OBSERVE/PERCEIVE A

CHANGE ON: Soil quality: Y/N

/_____/

1. Comment on soil quality: _____

Water quality: Y/N /____/

1. Comment on water quality: _____

Drought rhythm or cycle: Y/N /____/

1. Comment on drought rhythm: _____ Rainfall rhythm or cycle and quantity: Y

1. Comment on Rainfall rhythm: _____

Temperature change: Y/N /____/

1. Comment on temperature change: _____ Shrubs population in rangeland: Y/

1. Comment on Shrubs population in rangeland : _____

Palatable plants in rangeland: Y/N /____/

1. Comment on palatable plants in rangeland : _____

Animal productivity: Y/N /____/

1. Comment on animal productivity : _____

Family relationships: Y/N /____/

1. Comment on family relationships : _____ Between rich and poor families: Y/

1. Comment on relation between rich and poor families : _____

Guide interview household second survey 2014 The Qilian Mountain

Bossuette G.,
Brasquies D., Yang
T.

Name of interviewer:

_____ __ Date of survey: _____

Questionnaire number in phase 1_____

Name of the head of family/household: /_____/

Schedule of activities

Place on the schema:

- Climate (Winter / Summer)
- Months with rain
- Farm work (seeding, harvest …)
- Home-Works (cooking, cleaning, time for kids…)
- Months with supplement give to animals
- Month of lambing and calving
- Months of milking
- Months in Summer pastures
- Months in Autumn pastures
- Months in Winter pastures
- Month of sale:

Money:

Amount borrowed

- Lambs / calves
- Wool
- Other (manure, leather…)

Duration

Interest rate

Saving

Amount
