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The evolving interface between pastoralism and uncertainty: reflecting on cases from three continents

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Abstract

This paper explores how pastoral systems have changed over time, drawing on six cases from across the world that are the focus of the PASTRES research programme: southern Tunisia, Sardinians in central Italy, Isiolo in northern Kenya, Kutch in India, Borana in Ethiopia, and Amdo Tibet in China. The paper builds on an earlier analysis that identified five principles underpinning pastoral systems, drawing from the wider literature. These were: adaptive herd management, livelihood mosaics, persisting mobility, reticular territories, and articulated social networks. The paper asks whether these principles endure today, even if the form of pastoralism has changed. The paper finds that to assure reliability of production and livelihoods, in each case pastoralists' practices, strategies, and relations have been altered to respond to new conditions of uncertainty arising from changing environmental, market, and socio-political contexts. While the approaches to responding to uncertainty have transformed – including through expanding livelihood activities beyond local territories – in most cases the previously identified core principles of pastoralism persist. However, there are limits to this adaptability and, in some instances, new responses have been insufficient. A big challenge for development policy therefore is to provide support for the successful operation of the core pastoral principles, so that reliable livelihoods can be assured for pastoralists across the world.

Keywords

Pastoralism, uncertainty, risk, drylands, resilience, reliability, adaptability.

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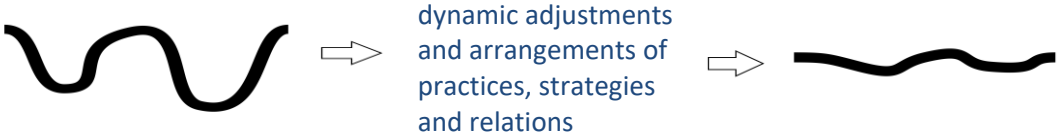
1. Reliable pastoral livelihoods: principles and strategies*

This paper explores how pastoral systems have changed over time, drawing on six cases from across the world that are the focus of the PASTRES research programme. This paper builds on two previous papers that identified five principles underpinning pastoral systems from the broader literature, much of it based on studies in the past (Nori 2019 a, b). These were adaptive herd management, livelihood mosaics, persisting mobility, reticular territories, and articulated social networks. The question for this new paper is whether these principles persist today, even if the form of pastoralism in the six case study sites has changed.

Resource management, livelihood patterns, and social organisation in rangeland ecosystems are characterised by a specific set of production principles, strategies, and practices. According to Roe et al., (1998:1) to operate under such unpredictable conditions, pastoralism is associated to a high-reliability system, *'in the search and attainment of reliable peak performance through the use and management of a highly complex range and livestock technology'.* The mandate of pastoralism is to generate a stable and reliable output supply (or low output variance) from a high input variance (i.e. highly variable and unpredictable conditions), through dynamic adjustments and arrangements in the process variance (refer to Table 1).

In more practical terms this translates into articulating livestock, labour and land resources to provide for stable and reliable livelihood levels under uncertain conditions; an example is provided by Figure 11 with reference to the seasonal supply of household milk amongst Borana. Pastoralism's overall objective is thus different from the 'productivity optimisation' that characterises other systems, as it aims instead at ensuring a constant system output under volatile and variable conditions (Krätli and Schareika, 2010).

Table 1 – High reliability management

High input variance *variable and unpredictable conditions*	***Process variance***	***Low output variance*** *stable and reliable output supply*
		

Source: own elaboration on Roe, 2019.

* This work as part of the PASTRES (*Pastoralism, Uncertainty and Resilience: Global Lessons from the Margins*) project has been made possible by the generous funding provided by the European Research Council. Further funding to PASTRES fieldwork activities has been provided by the International Livestock Research Institute and the UK Economic and Social Research Council.

We would like to thank the staff from the European University Institute, Global Governance Programme and the ESRC STEPS (Social, Technological and Environmental Pathways to Sustainability) Centre at the Institute for Development Studies. A special thank to the whole PASTRES colleagues undertaking fieldwork activities in the study areas: Tahira Shariff Mohamed, Giulia Simula, Palden Tsering, Natasha Maru, Linda Pappagallo, Masresha Taye.

Governance systems and institutional structures respond to these production objectives and livelihood rationales as adapted to particular cultural and geographical settings. These include forms of community organisation as well as decision-making systems and institutions for land access, dispute resolution, risk sharing, wealth redistribution, territorial control, and security, among others. Such arrangements were mediated through the clan, the monastery, the extended family, or other social configurations. Communities were often neither closed nor exclusive; individuals and households from other (even ethnic) groups were associated and integrated within such a socio-political perimeter. In many cases the incorporation of other groups/communities/individuals was also incentivised, so as to diversify the capacities and skills in support of the system. Table 2 therefore lists the principles and strategies informing pastoral livelihood systems identified in the earlier reviews of the literature (Nori 2019a, b).

Table 2 – The principles and strategies informing pastoral livelihood systems

Principles	***Strategies***
Adaptive herd management	Herd remains central in the pastoral economy and as a main asset for diversifying it.
	Herd structure, composition, and management dynamically adapt to conditions and opportunities, including integration with farming, relationships with markets, and the wider policy frame.
Livelihood mosaics	Multiple livelihood systems and dynamic portfolio management occur through the continuous reconfiguration of land, labour, and livestock.
	Market integration of pastoral economies is critical in this process and varies widely according to existing opportunities.
Persisting mobility	Livelihoods are constantly engaged with mobility that enables exploiting the variability and diversity characterising environments, relationships, and economies.
	Pastoralists have bet on transport infrastructure and technological innovations to significantly enhance their mobility at different levels.
Reticular territories	Rangelands' patchy use is organised through a reticulum of different but functionally interconnected landscape and social units.
	The expansion of territories and extension of networks evolves in this same reticular fashion to facilitate option-tracking and opportunity-seizing.
Articulated social networks	Pastoral institutions are typically tailored to control, manage, and govern a limited, variable, and unpredictable resource base through vast territories.
	Social networks and institutional arrangements evolve accordingly with a view to track and seize resources, relations, and opportunities in the larger societal arena.

The question posed by this paper is whether these principles – emergent from a well-established international literature on pastoralism – persist today, and if they do, what form they take. While principles may persist – pastoralists must still generate reliability and sustain production and livelihoods in a highly variable environment – their practice may have changed. A pastoral household in the same settings as some classical studies may look very different today and follow very different strategies and tactics, but are their livelihoods steered by the same principles? Furthermore, do these principles respond to the same high-reliability rationale?

The differences might in fact be significant, as important changes and transformations have taken place over the last decades. It may be that the herd is tended by a non-family member, watering livestock may require payment, the herd milk may be mostly commercialised by women through complex value chains, young calves may be sent to nearby fattening areas or faraway export markets, herd composition

and structure may have changed, and movements for grazing and water may be very different. During difficult times the animals may be fed with purchased forage paid for with remittances from emigrated relatives might be used, managed through mobile phone systems.

Pastoral systems have indeed been intensively remoulded by population growth, rangeland encroachment and grabbing, urbanisation, sedentarisation, and other environmental changes, including the climate. In turn, these processes are linked to the wider incorporation of pastoral territories in market-driven and institutionally-controlled dynamics and their growing interdependencies with other regions and systems, resulting in processes of commoditisation, privatisation, individualisation, migration, and social differentiation as well as new forms of accumulation, investment, and exploitation (Scoones, 2019; Nori, 2019b).

All these are important in shaping pastoral regions. Dramatic changes in the environmental, market and governance domains have reconfigured, widened, and diversified the uncertainties embedding local livelihoods and the related stresses and shocks, with new risks and challenges, but also chances and opportunities. Accordingly, pastoral practices and strategies have also transformed with a view to sustaining production and livelihoods reliably in such altered contexts and conditions.

To explore these questions, the paper is organised as follows. Section 2 addresses the question of which practices and strategies inform resource management and livelihood patterns for pastoralists in the PASTRES areas. Section 3 goes on to explore the core norms and principles underpinning and inspiring these practices and strategies. Section 4 then concludes by distilling the key features informing pastoral livelihoods in dealing with risk and uncertainty across time.

2. Pastoral livelihoods: transformations and practices

Taking the six PASTRES research areas (Table 3), the chapter addresses the processes that reshaped livelihoods on rangelands, and analyses the practices and strategies that local pastoral communities adopt to respond to uncertainties. In comparing different pastoral settings, the chapter assesses whether the principles identified in previous literature reviews (Nori 2019a, b) are reflected in the current reality on the ground. Each case explores one of the core principles (see Table 2), drawing on the intensive fieldwork undertaken by the PASTRES team.

Table 3 – The PASTRES case studies analysed in the paper

	Principles	***Areas***	***PASTRES case***	***PASTRES team***
2.1	Adaptive herd management	Tataouine Governorate, Tunisia	Reconfiguring the *khlata* contractual system	Linda Pappagallo
2.2	Strategic interfacing with farming and markets	Sardinia and central Italy	Sardinian dairy and emigrations	Giulia Simula
2.3	Livelihood mosaics	Isiolo County, Kenya	Camels and milk marketing in Isiolo	Tahira Shariff Mohamed
2.4	Persisting mobility	Kutch, Gujarat, India	Mobility reloaded in Gujarat	Natasha Maru
2.5	Reticular territories	Yabelo and Dire woredas, Ethiopia	Landscape reconfiguration amongst Borana	Masresha Taye
2.6	Articulated social networks	Amdo Tibet, China	Institutionalising Tibetan pastoralists	Palden Tsering

2.1 Adaptive reorganisation of land, livestock and labour in Tataouine, Tunisia[1]

This section explores the principle of adaptive herd management, and the dynamic reconfiguration of land, labour, and livestock in southern Tunisia. Positioned at the strategic crossroads between the Maghreb, the Sahara, and Europe, rangeland territories in southern Tunisia have been recently reshuffled by important economic and socio-demographic processes. Pastoral communities have gone through an intense rearticulation of household and community resources, including through migration. The revival and adaptation of customary contractual arrangements such as the *khlata* critically account for changes in land use patterns and labour regimes, evolving social relationships as well as market and political engagements, which altogether widen and diversify the local uncertainty setting.

Tataouine governorate, in southern Tunisia, stretches over one quarter of the country's territory. Together with Médenine, it is home to about 80 per cent of rangelands in Tunisia, where average annual rainfall is about 100 mm per year (Nori et al., 2009); lands are mostly common-accessed under collective management, although processes of fragmentation, privatisation, and accumulation (with plots between 10 and 20 Ha) are widespread, particularly in the plains (*El Ouara and Jeffara*). Bordering Algeria on the west and Libya on the east, Tataouine is at a critical crossing point between the Maghreb and the Sahara and therefore historically characterised by important patterns of cross-border mobility, trade, migrations, and military presence. The region is traditionally inhabited by Berber and Arab communities.

Reliance on agro-pastoral activities in Tataouine is higher than elsewhere in the country; extensive animal husbandry is the economic driver, providing almost one-third of the region's value of agricultural production (ODS, 2018). The region is traditionally affected by intense dry seasons and drought periods, main features of local climatic patterns. The impacts of these events are closely associated to the capacity to move animals to other areas, market prices for pastoral inputs (i.e., forage and water) and the terms of trade for their products, as well as alternative revenue opportunities (Nori et al., 2009). Like in much of the rest of the country, since the 1950s non-farming income has become increasingly popular as a way to reduce the extreme livelihood dependence on climatic hazards (ODS, 2018).

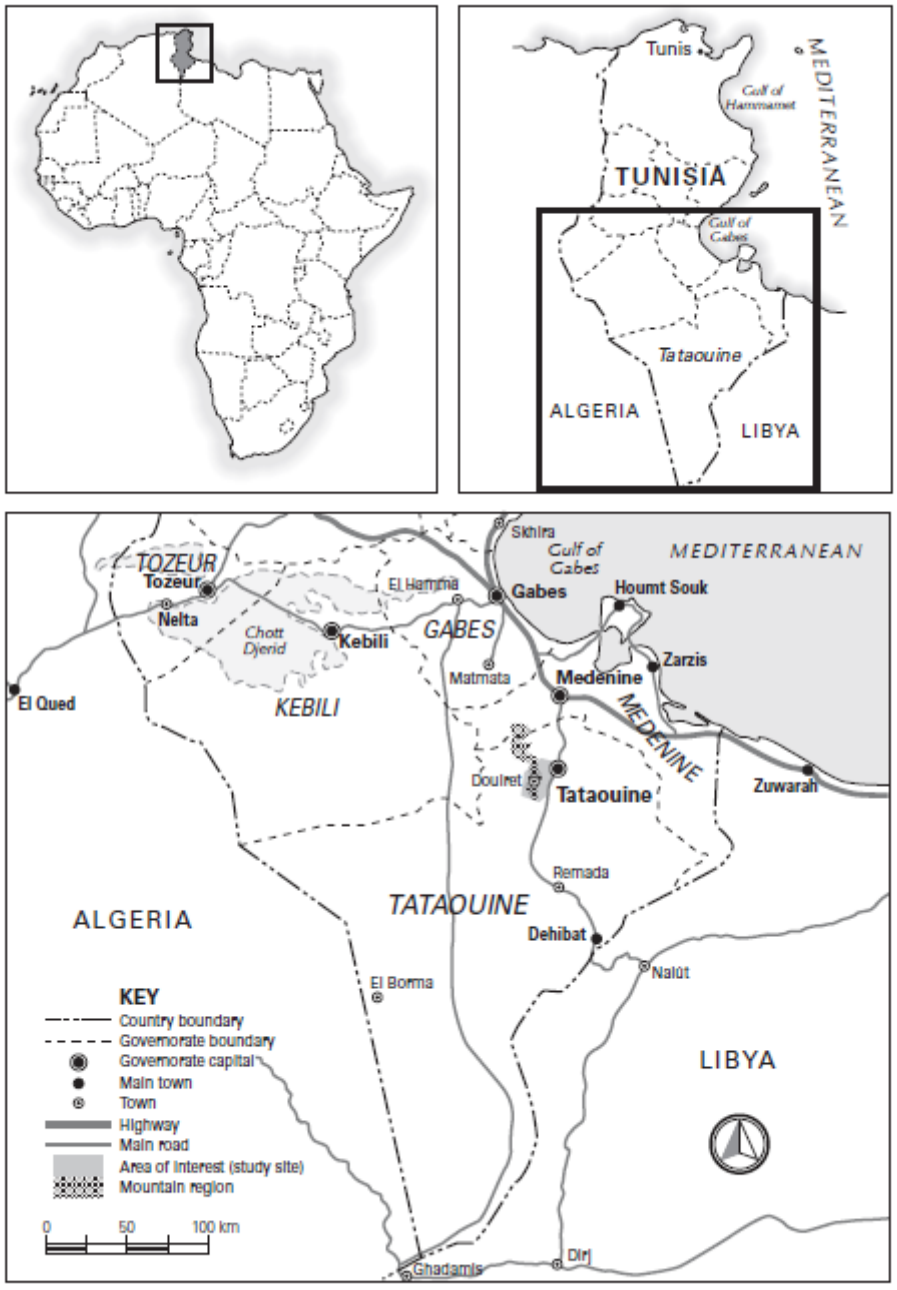
In the mountainous areas of the governorate, extensive livestock breeding is typically complemented with external income from migrating to urban centres and production, largely for subsistence, from dryland farming in the mountains, while more extensive livestock keeping and arboriculture of olive and fig is typical in the plains. Agricultural practices are often a way to secure individual land rights in the shifting local context, while livestock keeping remains for many a complementary, strategic component of a wider livelihood package as it is a liquid form of capital that allows for quick accumulation, savings, and investment.

Table 4 – Flock composition and distribution in Tataouine, 2018 (CRDA)

Cattle	*Sheep*	*Goat*	*Camels*
342	314,015	79,020	12,293

[1] This chapter has been elaborated with the collaboration of Linda Pappagallo, PASTRES PhD researcher on the Tataouine case, through funding from ESRC.

Figure 1 – Map of Tataouine governorate

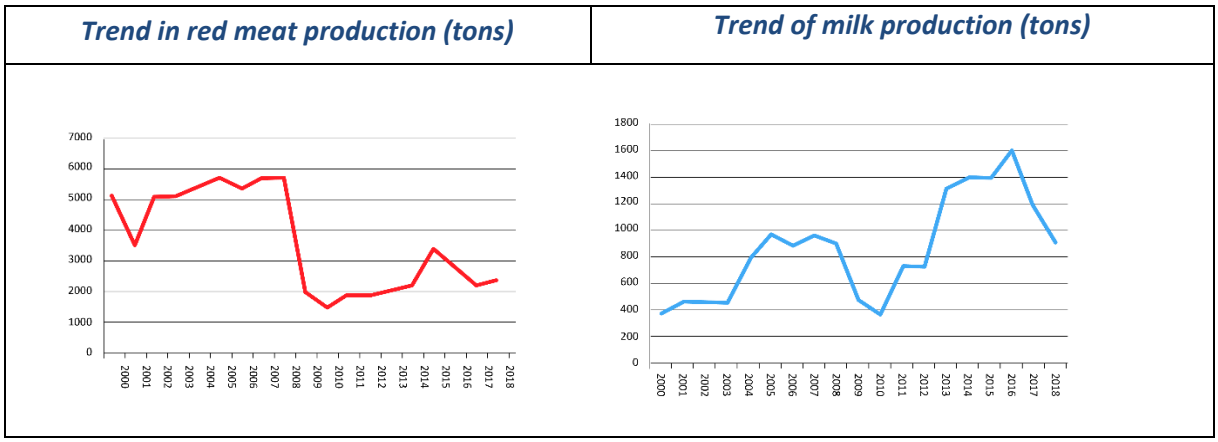


Source: PASTRES

Whereas large herds of more than 500 heads were quite common in the past, today these are becoming rare. Instead, a higher proportion of livestock owners have fewer than 50 heads. The increasingly high costs of maintaining livestock, inflation, and climatic challenges mean that only those who have revolving capital – either in the form of remittances or other kinds of investments and assets such as land or waged labour – are able to consistently cover expenses and overcome fluctuating terms of trade (price of meat/barley). Livestock thus remains an important, albeit volatile, income-generating opportunity for those able to overcome variations in market prices and climatic challenges. The shift in local livestock products from meat to milk observed in the past two decades (Figure 2) provides

interesting indications on the adaptations to changing conditions, and possibly indicates as well the development of more intensive systems in the governorate.

Figure 2 – Evolution of livestock products in Tataouine 2000-2018



Source: own elaboration on ODS, 2018.

In the governorate of Tataouine, unemployment rates are the highest in Tunisia (32 per cent in 2017) (Zuccotti et al., 2018). Several waves of emigration that began in the late 1800s and intensified since the 1950s have considerably reshaped the local socio-demographic landscape. Particularly in the last seventy years, emigration – primarily of males and increasingly females – has contributed to the reconfiguration of households' composition. This has altered the relative value attributed to family labour versus waged labour and led to shifts in consumption and livelihood patterns. Most rural households today will have some members who have emigrated to urban Tunisia, elsewhere in the Maghreb or Mashreq, to the Arabian Peninsula, or to Europe; international emigration ranks higher in these southern regions than elsewhere in the country (ibid.).

In southern Tunisia, migration has long been an aspect of local identity and a constitutive process of agrarian change. Oftentimes members of the same family are spread in different locations and engage in diverse activities that are part of a wider livelihood package, where livestock rearing and commercialisation still hold a relevant role for employment and income-generation opportunities (ibid.). This is also the case in Douiret, the study site of the PASTRES research and one of the Berber villages in the governorate of Tataouine.

Apart from extensive rangelands, local livestock systems increasingly also rely on forage, feed, and water resources mobilised from elsewhere. Animal feeding strategies have importantly widened and diversified, with complementary sources today representing relevant options to sustain the pastoral economy and buffer seasonal risks. In Tataouine, the relevance of feed ratios and concentrates (i.e. *alfalfa*/*Medica sativa*) has been increasing in the last two decades as a result of the growing interdependencies with local farming systems and the expanding production of forage and crop by-products (Nori et al., 2009; FAO et al., 2017). This involves a broader political dimension; animal feed and rangeland management are associated with an intricate system involving diverse institutional levels that play on both public and private grounds, intertwining state subsidies (in cash or in kind), and market-based purchases. The associated institutional landscape involves the interplay amongst several producers' associations, rural syndicates, State offices, and technical agencies. The province has also been the target of overseas aid investment schemes of regional and international agencies typically concerned with agriculture-based animal feeding.

Pastoral systems in the area are typically regulated, governed, and managed through social institutions that have evolved to mediate socio-demographic and environmental changes. One such institution in the *khlata* ('mix' in Arabic) or *assesri* (in Tamazigh), which is a form of social contract

whereby different individuals pool their herds and engage in sharing livestock, land, and labour. This form of engagement could become operational at different time scales, from seasonal to multi-annual, and be present with different operational perimeters.

The *khlata* as a social institution provides an array of management patterns from which local households could draw to sustain their livelihoods. It represents a central mechanism for medium to poorer households to share costs (herding labour and feed) and resources (such as rangelands, water), as well as risks. Furthermore, while some members use the *khlata* as an investment/pension fund, for others it is more of an insurance system or contingency asset. It has thus evolved to meet the changing configuration of resource availability and accessibility, changing rainfall patterns, and as an adaptation to more sedentary lifestyle and more market-integrated livelihoods, where pluriactivity and migration are socio-economic strategy for the extended household.

By articulating new forms of alliances and cooperation, the *khlata* is just one of the local institutions aiming at mediating access to resources through a combination of strategies that relate processes of capital accumulation and social differentiation; these also include the mutualisation of labour at community level through the *twiza* , and for olive production through the *mogharsa* social contract (Pappagallo, 2020). The *khlata*'s composition is informed by social and economic variables, as different families can afford diverse options of herding labour for instance. Some can afford to hire their own herder, while others can only afford it by sharing its costs with other livestock owners. As '*a good indicator of local social and economic dynamics'* (as to Ezzedine Belfeikh, OEP, in Nori, 2020t), the *khlata* is a social institution that provides an interesting framework for analysing pastoralism and social differentiation in the southern regions of Tunisia.

Migrations, contracts and the articulation of pastoral resources

Extensive livestock rearing represents a primary economic activity for most local households; families with or without emigrated members might though sustain herd management in diverse ways (Zuccotti et al., 2018). Moving in and out from livestock rearing, and/or shifting from certain animals to other are typical strategies to respond to ever-changing options related to the environment, market, and policy settings. Herd composition, structure, and management change according to the diverse trajectories and pace of local families and individuals. '*From the species and the breeds involved, one could state the origin and the function of the herd itself, underpinning different social and economic strategies'* (as to Farhat Talbi, GDA, in Nori, 2020t).

An important part of the engagement relies on the herder, who holds responsibility for both herd and land management vis-á-vis the different partners. The herder's role and responsibility involve an in-depth understanding of the reticular territories and networked relationships that govern land access and utilisation from one period to another. Parts of the herd might be managed separately by different herders throughout the year, including some family members who might temporarily provide labour. Overall, the herder coordinates different resource options while also managing livestock within the socio-economic perimeter defined by the contracting *khlata.*

Remittances from emigrated members and money from absentee stockowners play an important part in livestock management, for instance financing the acquisition of pastoral assets or paying for livestock, land, and labour resources (M. Tarhouni, IRA, in Nori, 2020t). In this perspective *khlata* engagements are increasingly utilised in the framework of the '*substitutional herding'* pattern ('*nomadisme par bergers interposés'*). The multiple interplays between migratory projects and local livestock keeping are underpinned by different livelihood strategies – as outlined in Table 5 below).

Figure 3 – A herder hired to look after camels in El Ouara plains

Credit: Nori, PASTRES

Table 5 – Relationships between livestock rearing and migratory processes in Tataouine

Livelihood strategy	***-Household practices***
Pastoralism as a part-time activity, investment, or enterprise for out-migrants *- Stockowners reinvesting the income generated in other sectors and taking timely breaks from their job to tend their flock during strategic periods* *-Entrepreneurs who move in and off livestock rearing according to periods and conditions* *-Absent livestock keepers who maintain herd locally either through family or hired labour*	
Families with some members who have emigrated *-Migratory projects funded by money generated through livestock, such as the sale of (part of) a flock* *-Family herd assisted through remittance during times of crisis (i.e., high feed cost, drought) for purchasing animal feed or water* *-Local herding funded through remittances as a main source of employment and income for family members that remained*	

-Family herd representing an interesting investment option for migrants when (market) conditions are favourable; remittances used for hiring shepherds, rehabilitating stables *-Herding represents an economic option for those members failing in/returning from their migratory project*
Pastoralism as a resource for in-migrants *-Families and individuals originating from Libyan communities who immigrated long ago and integrated in the area through local livestock herding* *-The case might have been for Berbers migrating to Arab communities, and vice versa* *-Shepherds from other areas (Sfax, Medenine) who have recently joined the community working as hired shepherds*

Migration and remittances, and the way these processes are mediated by local social institutions and associations, seem therefore vital in supporting local pastoralism. As herding increasingly integrates into widening commercial and institutional settings, the *khlata* contractual architecture has deeply reconfigured to keep pace with the processes that are reshaping local territories and economies, with relevant implications on the access, costs and quality of land, labour, and livestock resources - as well as with the evolving socio-political dynamics within the community.

Examples in this respect include:

- While in the past the *khlata* typically involved members of the same area/community, its radius nowadays involves families from quite different communities or distant locations. This reconfiguration of the scale and engagement of social contracts overcomes the typical community boundaries, in spatial as well as in socio-political terms.
- Expanding the *khlata* operational perimeter allows access to lands, relationships and opportunities beyond the traditional community. These may include different soil qualities; seasonal pastures and other ecological features; connecting to existing associations to facilitate access to government programs and subsidy schemes; and joining further market opportunities, services or networks (including cross-border) or other domains or options that would not be available if remaining inside the merely local circle (Pappagallo, 2020).
- Different social groups can afford diverse patterns to mobilise herding labour; better-off households might hire herders, while medium and poorer groups might avail their own family pool and share labour through the *khlata*. Migration and the related processes of absentee ownership, remittances, extended social networks, and social mobility contribute to reconfiguring these patterns of herding labour.
- Due to the decreasingly available labour from local households, the proportion of hired herders is reportedly increasingly, particularly since the early 2000s. The skills and capacities that are sought in hired herders have also changed and adapted to current conditions, which involve extended and diversified resource options. As skilled herders are rare, the social relationships and economic arrangements that bind them to the *khlata* members have modified, while their contractual negotiation power has grown.

Box 1 – Freedom and control for hired herders

Moktar is a herder providing services to a local wealthy family, tending their large camel herd in Bin Leith. He belongs to the R'baya group, which is well-known for being traditionally associated with camel herding. Accordingly, he reports that access to transport, communication, and information represent key assets when looking after a herd, as these consistently improve the herder's working and living conditions. In recent times, the availability of a motorbike and the costs related to mobile phone usage have come to represent parts of the contract herders negotiate with their employees. While such items might add to the costs of contracting herders, they also enable better communications flows and forms of remote monitoring and control.

To summarize, the *khlata*'s wider configuration allows for access to different and distant soils and pastures, as well as to remote markets, or policy subsidies, with a view to offset impacts such as the increase in variability of rainfall that render rangelands around Douiret less productive throughout the year, or local markets which may provide less lucrative opportunities. The extension of pastoral territories and social networks is therefore strategic in accessing resources and options that are farther away, but increasingly needed.

The core principle of adaptive herd management, as a continuous arrangement of pastoral assets, is critical for responding to variability to generate reliable production. In addition, the articulation of household resources in a much wider geographical setting, through migration, enables responses to socio-economic variabilities with a view to sustaining local livelihoods. The intertwining of migration resources and *khlata* arrangements is crucial in tackling local uncertainties through new forms of adaptive herd management and in so enhancing the resilience of pastoralism in southern Tunisia through changing circumstances.

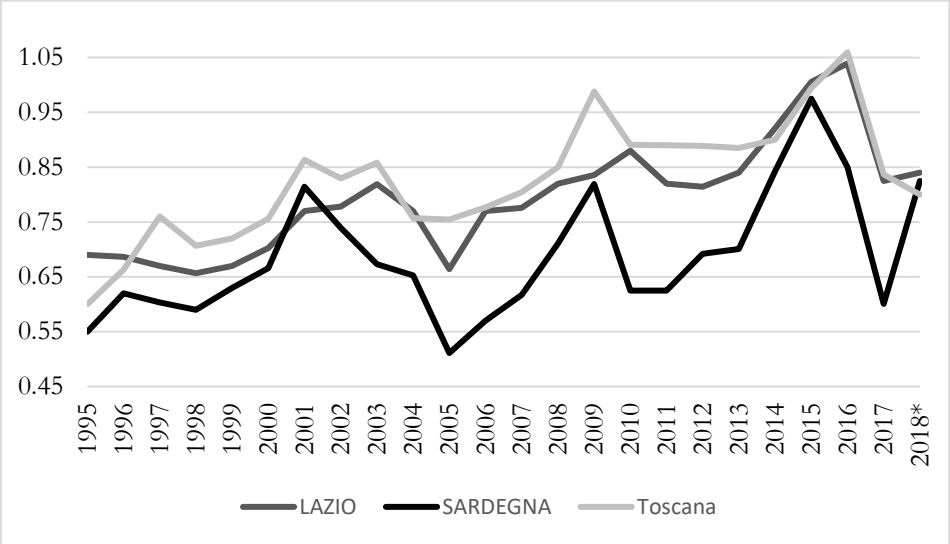
2.2 Engagement with farming, markets, and migration by Sardinian shepherds[2]

A second case relates to the principles of adaptive herd management and pastoral mobility, steered by the integration into market dynamics and farming practices. Pressured by growing commercial opportunities and increasing environmental constraints, Sardinian pastoralists migrated in thousands to mainland Italy, carrying with them their productive technology – the Sarda sheep breed. Through a process that combines tradition and innovation, Sardinian pastoralism expanded its territories and networks as a response to the uncertainties generated by important transformations triggered by market forces and piloted by policy and institutional arrangements.

Pecorino Romano (PR) had become a primary product of the island and a global commodity. Parallel to this, a new agricultural institutional frame was established in Europe through the comprehensive Common Agricultural Policy (CAP). The pastoral economy, pushed by the PR value chain and CAP policy support, increasingly represented a main source for labour and income to a significant share of Sardinia's population, providing new opportunities and challenges (see Figure 4 below). As a result of these dynamics, today the island hosts about the half the Italian sheep flock and provides for about one-third of total EU ewe milk (Simula, 2015).

[2] This chapter has been elaborated with the collaboration of Giulia Simula, PASTRES PhD researcher on the Sardinian case, through ERC funding.

Figure 4 – The volatility of PR milk pricing, a source of uncertainty



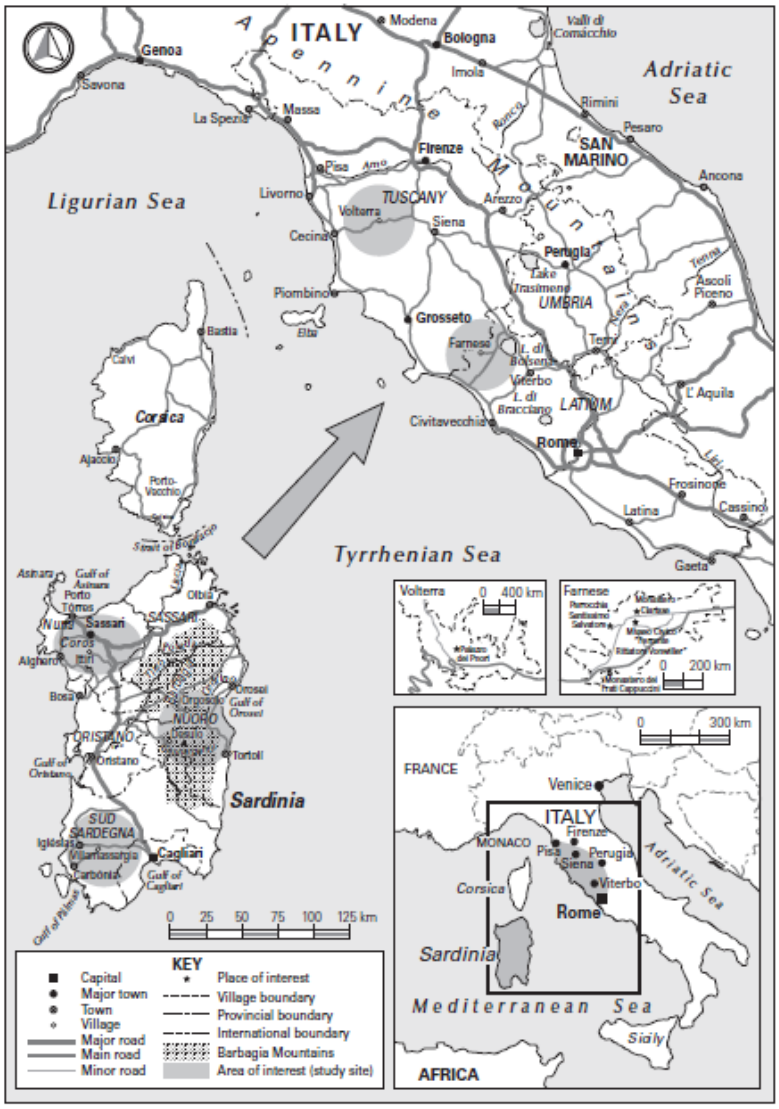
Source: Farinella, 2018, on ISMEA data

These market-led and institutionally-driven evolutions eventually reconfigured the pastoral production system and land use throughout the island. The growing interfaces with agriculture provided an important venue to reconfigure livestock production; farming systems converted to animal feed production and flock mobility readapted from seasonal transhumance to modular rotation on grazing paddocks. Once Sardinian plains and agricultural lands had been colonised by shepherding communities, a main constraint on the pastoral economy was land; the potentials of such commercial booming were squeezed by a growing population insisting on a structurally-limited territory. Migration therefore became the response for many pastoralists seeking opportunities to improve their livelihoods.

On the other side of the Tyrrenian Sea, environmental, economic, and policy processes were reshaping the local agrarian society (Solinas, 1989; Meloni and Farinella, 2015). Finalising the *bonifiche* (land reclamation) freed large parts of central Italy from malaria, thus making those territories viable for production and inhabiting alike throughout the year. In pastoral terms this meant the effective use of pasturelands with modalities that could overcome the traditional need to practise seasonal transhumance. Moreover, a series of agrarian reforms were being implemented to accompany the intense industrialisation that Italy was undergoing (Nori and Baragliu, 2021).

The *mezzadria system* (sharecropping) was ended and new forms of land institutions and contractual arrangements were being established. Paradoxically, as agricultural lands were becoming increasingly accessible and available, they were progressively deserted by local communities attracted by the alternatives proposed by a booming economy. These political and economic transformations contributed to a dramatic restructuring of the agrarian world. In central Italy (Tuscany, Umbria, Latium regions) many rural areas and villages underwent forms of abandonment, particularly in communities situated in inner settings presenting forms of agro-ecological constraints to agricultural intensification (i.e., remote, mountainous, drier areas).

Figure 5 – Map of central Italy indicating migratory flows of Sardinian shepherds in mid-1900



Source: PASTRES

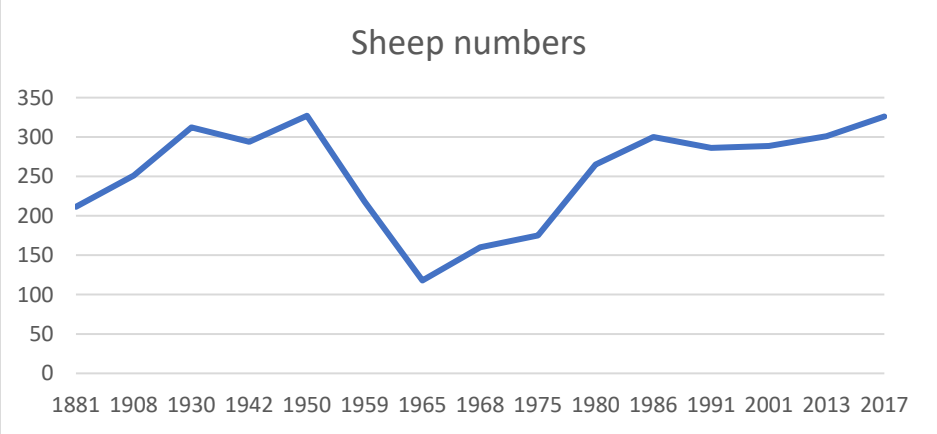
Dairy evolutions and migration patterns

As a response to important structural limitations, Sardinian pastoralists benefited from their expanding economy driven by the booming Pecorino Romano value chain. In the mid-twentieth century hundreds of pastoral households emigrated from the western, mountainous portions of the island (basically *Barbagia* and *Ogliastra*) to the hilly regions of mainland Italy, as these were being vacated and abandoned by local populations.

This 'long transhumance' was part of the wider emigration process that characterised Sardinia in that period and the restructuring of the rural world throughout Europe (Meloni, 1996; Nori and Farinella, 2020). Sardinian men migrated to mines and factories in northern Europe, while migratory patterns for girls were mostly to work as domestic help in capital cities. The migration of Sardinian shepherds, though, presents specific features as it is located at the interface of three intertwined and complementary processes: the collapse of the sharecropping system in central Italy; the imbalances of the agro-pastoral

economy in Sardinia; and the evolving favourable conditions of milk marketing (Cianferoni, 1969; Furati, 1973). Figure 6 below shows how sheep numbers increased in northern Latium following the arrival of Sardinians.

Figure 6 - Changes in sheep numbers, Viterbo province, 1881-2017 (in 000s)



Source: Chamber of Commerce, Viterbo

The Sardinian form of pastoralism differed from the mainland one, which was centred on the production of wool and the multi-functionality of sheep breeding. Production and use of ewe milk in central Italy were devoted mostly to local consumption as market outlets and infrastructure were quite limited until the mid-twentieth century. Milk productivity emerged as a main entrepreneurial objective within the newly imported paradigm; land use was reorganised, household resources relocated, and labour patterns and farming practices were adjusted accordingly through different and evolving ecological, institutional, and market-related dimensions (Meloni, 2006; van der Ploeg, 2008).

Migrant Sardinian shepherds reached Italian mainland rural areas with a specific project, which interfaced pastoral production with a strategic articulation of farming systems and market forces. A clear indication of such an attitude is a peculiar feature of this migratory process, whereby the incoming communities carried their core production technology in the transfer. Thousands of Sarda sheep were loaded onto boats and ferries to accompany the migrating families.

Table 6 – People and sheep that (officially) landed from Sardinia to Civitavecchia, Latium

Year	*People*	*Sheep heads*
1961	*134*	*44,274*
1962	*295*	*57,693*
1963	*268*	*33,770*
1964	*603*	*65,507*
1965	*341*	*36,207*
1966	*373*	*42,052*

Source: Cianferoni, 1969

Box 2 – Boosting provincial flocks in Siena and Viterbo

By the late 1970s, sheep from Sarda breed exceeded 100,000s heads in both the provinces of Siena and Viterbo, over half of the total local flocks. While it is difficult to quantify this fluid phenomenon, indications from previous research (Solinas, 1989; Meloni, 2006) report that by the 1980s, 1,256 people originating from Sardinia had immigrated and settled in the province of Siena: 340 pastoral families

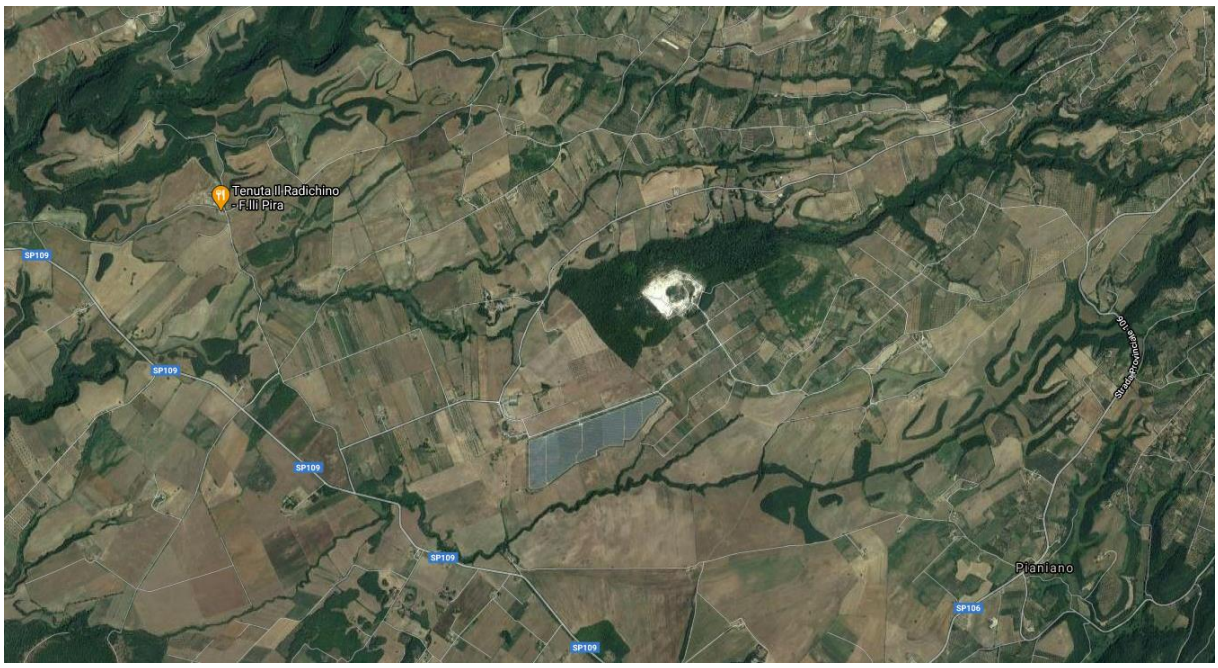
who, by that time, owned a total of 16,000 hectares and about 100,000 sheep, with an average of about 300 heads per farm. The situation and figures are similar for the neighbouring province of Viterbo, with 350 families and over 80,000 sheep of Sardinian origin by the late 1980s; thanks to the Sardinians contributions, between 1970 and 1990 the provincial sheep flock almost doubled (Felli, 1987; Menna, 1990) (see Figure 6 above)..

The Sarda breed represents the technology most suited for this milk-oriented agro-pastoral system. While in Sardinia the continuous swapping between sheep, goats, cattle, and pigs represents an important economic strategy, mainland Sardinians initially bet on just their sheep. Known for its hardiness, the Sarda sheep has a specific devotion to milk production, compared to the typical local breeds (Sopravvissana, Maremmana), which were known for the quality of their wool and production versatility (i.e., used for meat and milk as well as wool). The Sarda breed requires specific labour regimes, with tailored animal feeding and more intense milking patterns. Accordingly, Sardinian husbandry practices had to be readapted to the specific ecological features of mainland Italy such as different soil nature and the presence of predators.

As milk production became the primary objective, the production system reconfigured accordingly around the Sarda breed, with the related articulation of land and labour resources (Cianferoni, 1969). Apart from the composition, the size and the structure of the flock were also reshaped accordingly, as were land management and mobility patterns. Transhumance was initially replicated on the mainland, taking advantage of the local railway system and road networks. The train connecting Orvieto and Spoleto was initially used to carry the flocks to summer Apennine pastures, and then eventually replaced with trucks. Transhumance reduced consistently through time as the agro-pastoral land use and production patterns evolving in Sardinia started taking over even in mainland Italy; animal feeding was increasingly acquired or produced on the farm.

The increasing reliance on agricultural products to satisfy the feeding requirements of a growing flock became a strategic choice for most agro-pastoral farms, which in turn contributed to diverting pastoral labour and income. '*We are nowadays spending much time with tractors and working the land; especially the new generations, they tend to overlook their animals'* (as to Ms. Murgia, in Nori, 2020v).

Figure 7 – Land use patterns in Farnese area, renamed 'little Sardinia'



Source: Google maps

To manage these processes, Sardinian migrant communities have skilfully reconfigured their institutional setting. Associative forms and cooperative systems have been established, capitalising on their tight and intense social networks; the acquisition of new lands and farms relied on effective information system, trusts relationships and credit schemes. The pioneer migrants that first landed in Civitavecchia in the early 1950s started scouting the local countryside in search of land and opportunities. They eventually set up operational networks that served to assist the incoming community members, either logistically or financially, helping them through '*fare spazio' ('making room*'). In certain areas, for example, the acquisition of bars was instrumental to facilitating the local flows of information and money. These connections and networks have been strategic for weaving interpersonal relationships, which have transformed into flows of relevant information on the availability of land, farms, finances, and markets

The networks informing and feeding the agro-pastoral economy have eventually evolved and expanded with a view to strengthening pastoralists representation vis-á-vis landowners and dairy industrialists as well as in empowering them in political negotiations at regional and national levels, including for the allocation of the EU CAP resources (Solinas, 1989; Meloni, 1996). Nowadays household labour in several families engage in a diverse set of activities, from farm production to local dairy processing and from tourism services to bars and restaurants. Members of the Sardinian community also engage importantly in the policy dimensions through local cooperatives and national parties, as well as in other social and cultural domains.

The system has though opened to an international dimensions. On the one hand, many dairy factories today in central Italy have a Sardinian name; traditional local cheeses and landscapes that attract international tourism are preserved and reproduced through the Sarda flock and Sardinian shepherds. On the other hand, the agro-pastoral labour force is increasingly drawn from migrant communities, mostly from eastern European countries. Meanwhile, Sardinian entrepreneurs have moved to Romania to establish farms and dairy factories.

Sardinian pastoral communities thus reinvented themselves by projecting their labour, skills, and technologies into new territories with a view to tackling the opportunities and risks provided by evolving institutional and market domains. As happened in the late twentieth century with the establishment of the Pecorino Romano technology and its commercialisation, Sardinian pastoralists showed their capacities in opportunistically reorganising their pastoral assets, adjusting their strategies, and adapting their skills.

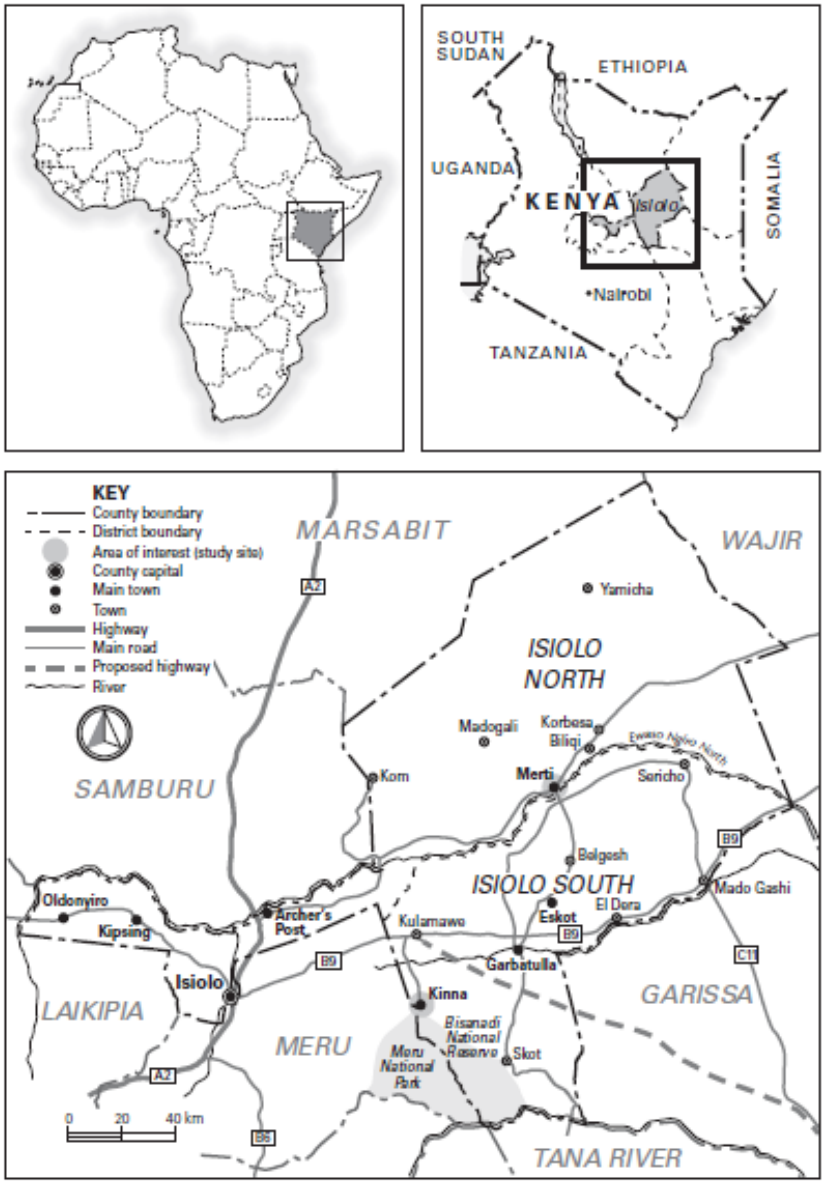
Through many changes and transformations, the principles informing herd adaptive management and inspiring pastoral livelihoods and mobility are still visible. Land, labour, and livestock have been rearticulated through innovative and evolving relationships with agricultural production and market opportunities. Territories and networks have been expanded and reorganised in a reticular manner to serve patterns of production specialisation and livelihood diversification, while all the time extending and rearranging their room for manoeuvre amidst widening uncertainties.

2.3 Reconfigured livelihood mosaics: milk marketing networks in Isiolo, Kenya[3]

The case from Isiolo County in northern Kenya, traditionally home to the Waso Borana pastoralists, focuses on the principle of reorganising livelihoods in the form of mosaics through shifts in herd composition and management in response to uncertainty. The growing presence of camels underpins the evolution of different types of livelihoods interacting within and across households, including through the engagement of markets.

[3] This chapter has been elaborated with the collaboration of Tahira Shariff Mohamed, PASTRES PhD researcher on the Isiolo case, through ERC funding.

Figure 8 – Isiolo county in Northern Kenya



Source: PASTRES

Isiolo County is increasingly central to a series of dynamics and processes reshaping local livelihoods. Local Borana pastoralists feel encircled and encroached by neighbouring regions, Somali herders, farmers from Meru, and Nairobi investors, as well as by the expansion of natural conservancy schemes, the interventions of development aid projects, and ongoing dramatic infrastructure development programmes. Over 80 per cent of Isiolo County's inhabitants rely on livestock for their livelihoods and about one-third practice agro-pastoralism (MoALF, 2017). Food poverty rates are alarmingly high, which has led to the population's high dependency on relief food. Short-term indications attest to a shift in local ecological conditions towards a rise in average temperatures with more frequent rainfall failure events. Figure 9 below shows the recurrence and degree of vegetational stress in the area in the last two decades.

Figure 9 – Vegetation Conditions Index for Isiolo during the last two decades

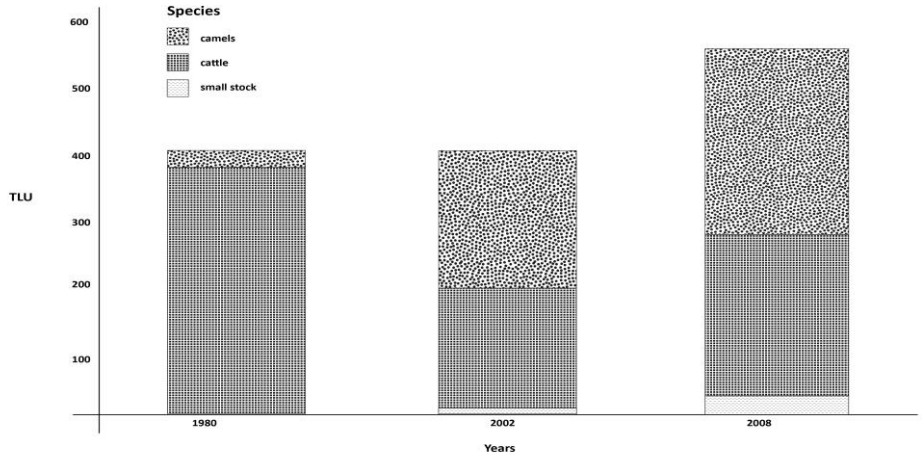
Source: own elaboration on National Drought Management Authority, 2020

Local herd composition and management are shifting to adapt to changing conditions; on the one hand, cattle breeds have diversified, and the *geleba* breed has been introduced in Borana areas to increase the drought survival capacity of the local *qortii* (Abebe, 2016); on the other hand there are greater proportions of camels in areas typically grazed by cattle. Indications from PASTRES fieldwork reflect what was also found in neighbouring Laikipia, under comparable ecological conditions (Unks et al., 2019; Volpato and King, 2018; see Box 3). Camels perform better as they feed by browsing on existing vegetation, and produce milk continuously even during dry spells. Their milk has a longer shelf life than cow's milk, facilitating its storage and management. Due to these features, and a recognised value in nutritional and medicinal terms, camel milk is increasingly demanded in the market, making camel production even more valuable. The proportional growth of camels in the county is furthermore also ascribed to the encroachment of Somali camel herding communities in these territories traditionally associated to Waso Borana cattle herders.

Box 3 – Cattle herders turning to camels

Several studies in neighbouring Laikipia indicate a recent camel adoption of Maa-speaking pastoralists (Kirimi et al., 2013; Unks, 2017). During the 30-year process, camels broadly shifted from few to meaningful, while inducing social and cultural change and resistance on the way (Volpato and King, 2018). Other studies in Laikipia attest that the reconfiguration of the county herd includes a consistent increase in small stock (Unks et al., 2019. See Figure 10 below). The growing presence of camels and small ruminants within the herds of pastoral societies known to be typically devoted to cattle provides the ground for various motivations and indeed carries important implications in terms of resource management.

Figure 10 - Historical changes in livestock (TLU per species) in Laikipia County



Source: own elaboration on the surveys and livestock counts in Unks et al., 2019:80.

Parallel to these changes, other important transformations have taken place in northern Kenya. Infrastructure works and advances in technologies have been instrumental in reshaping pastoral livelihoods and mobilities according to evolving market-related opportunities and political interests. Examples of such improvements in local transportation networks include the recent paving of the Isiolo-Moyale tarmac road. A local airport is also under construction, while the LAPSSET (Lamu Port-South Sudan-Ethiopia-Transport) corridor designed to transit Isiolo, connecting the Kenyan coastline to inner southern Sudanese areas, is another important initiative in the transformations experienced in the northern Kenyan drylands (Chome et al., 2020). Communication networks have expanded, through public and private investments, and cover large parts of the county. Information flows effectively through mobile phones and timely payments can be made through the *M-pesa* system.

These evolutions have in turn resulting in connecting more remote inner areas to main roads and urban facilities, and the county to broader, regional market outlets. The county is criss-crossed by motorbikes carrying camel milk, rough trucks loaded with live animals, and other pastoral products to urban areas and other commodities back again. Through newly available, cheap technologies (bikes and phones) and an improved road and communications infrastructure, there are booming opportunities for marketing, investments, credit, and economic diversification that support the evolutions of various livestock-related value chains. These important transformations are mirrored by a reconfiguration of the institutional architecture and governance systems at different levels, as the 2010 Constitution established processes of local power devolution. These different processes and pressures provide local pastoralist communities with new risks and challenges, as well as opportunities and threats for sustaining their resource management, governance mechanisms, and livelihood strategies (Nori, 2019a).

Milking opportunities

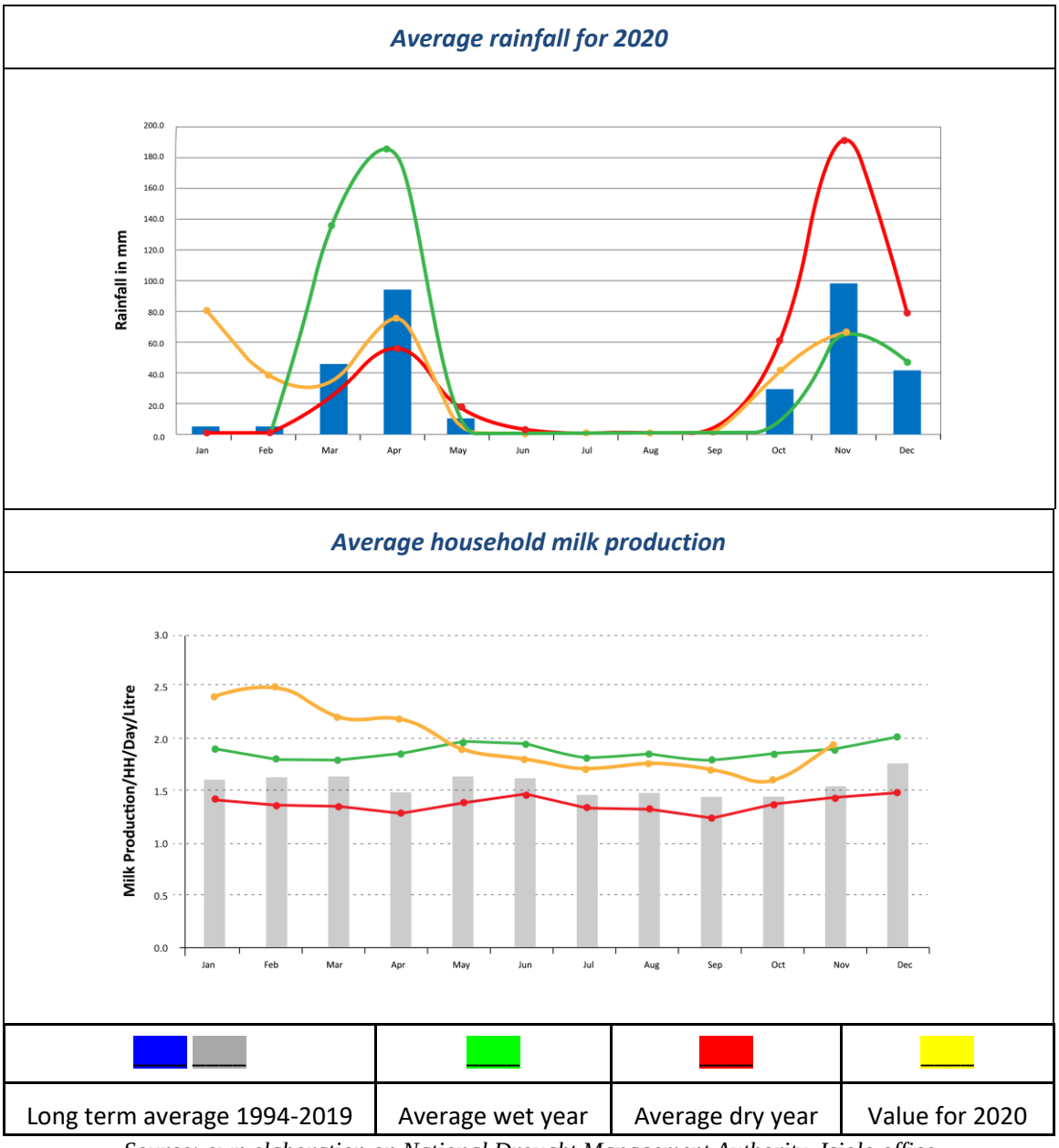
The shift in herd composition and livelihood configuration is therefore justified on the ground of the transformations affecting the local agro-ecological, economic, and socio-cultural settings. Through camels, and their milk, Isiolo pastoralists can profit from the growing market-related opportunities related to the booming demand from urban consumers, even beyond the county boundaries.

A key feature of the reorganisation of local livelihoods has in fact been a significant growth of camel milk marketing (CMM). Since the early 2000s, about 5,000 litres of camel milk are gathered from county rangelands, collected and processed in Isiolo, and sent to Nairobi daily to meet and serve the growing demand for camel milk the capital's burgeoning Eastleigh district, and beyond. This has been important

for confronting uncertainties and contributes significantly to the local economy, employment, and social support systems, as well as to national food security and regional integration. Overall, it provides direct benefits to more than 10,000 people in Isiolo, representing a strategic livelihood asset for the most vulnerable population groups, especially women (Anderson *et al.*, 2012; Elhadi and Wasonga, 2015).

Reshaping herd composition and management involves a reconfiguration of land and labour resources. Camel-owning households supplying milk to the milk Aanoley cooperative pool their animals and collectively contract herders who are tasked with taking care of the herd, enhancing its performance, and supplying milk to the value chain daily. These salaried workers could be local or originate from neighbouring Turkana and Meru groups. The important seasonal fluctuations imply herd mobility and grazing in different areas; these variations are incorporated in the milk pricing mechanisms.

Figure 11 – Seasonal supply of household milk in Isiolo. 2020 against 1994-2019 average



Source: own elaboration on National Drought Management Authority, Isiolo office

The most long-standing CMM companies in Isiolo are Aanoley, Tawakal, and Defe – all founded and managed by women. In the case of Aanoley, about two-thirds of the founding members originate from the Garre community (which draws socio-cultural elements of both surrounding Borana and Somali cultures – Anderson *et al.*, 2012; Staro, 2013). The milk collection and marketing system is organised through collection points, transport systems, processing, and storage facilities in Isiolo and connections with the Nairobi market centres.

The value chain that enables this marketing is complex and dynamic, and indeed requires skilled entrepreneurial capacities and a risk-taking attitude, as several variables can change any day. A flexible governance system is in place to continuously coordinate flows of milk, information, and money, as well as to distribute roles, responsibilities, and risks amongst the different agents. The decision-making systems underpinning CMM is informed by complex sets of intertwined factors whereby new strategies and practices are continuously tested and readapted according to conditions, such as during the recent COVID pandemic when conditions inhibited access to Nairobi markets for an extended period.

Box 4 – The challenges of Aanoley (excerpts from Yussuf, 2020).

"*Before the self-help group was formed, five women saw an opportunity within the camel value chain and started selling camel milk individually, later they came together as a group called Aanolei and registered their group as a self-help group to share ideas, attract donors and assist one another during times of crises, when the group was formed, we invited more women to join, among friends and relatives who were interested in the camel milk marketing and suddenly 5 people became 30."* Interview with Safia, Aanolei chairlady.

"I remember we had a lot of challenges especially keeping milk fresh, we incurred a lot of losses from spoilt milk. Our only means of transport to Nairobi was done via the Isiolo bus which travelled to Nairobi in the morning at 6.00 O'clock, we would put our jerry cans on the bus with our names and the name of the person receiving it in Nairobi. By 10:00 am it will be in Nairobi, and the women in Nairobi will send empty jerry can back. During this time we experienced a lot of losses, milk would easily go bad, because our only form of preservation was partial boiling and storing it in cold water overnight." Interview with Nuria, Aanolei member.

[In these COVID times] "*the main challenge we face is with the women in Eastleigh, they are untrustworthy and delay payments. Also, many of them are refugees from Somali and have no permanent residence in Kenya, there is always a big risk in the business of sudden loss of your market in Nairobi. I have never met the lady I supply milk to in person, I send her milk and we maintain contact over the phone. And there is always an expected loss due to doing business on such risky arrangements.*" Interview with Nasra, Aanolei member.

Figure 12 – Women lining up for milk collection and sales along the Moyale –Yabelo road

Credit: Taye, PASTRES

Tackling such entrepreneurial challenges has enabled the diversification of local livelihoods, with new professions related to CMM being established. Motorbike drivers (*boda boda*) and taxi services are recruited to transport the milk; even herders from other communities are hired to look after the camels. Rural women are engaged as milk collectors and milk hub managers in production areas, while urban women in Isiolo and Nairobi weave new relationships and connections that support milk supply and sale. A factory has also been established in Isiolo town to pasteurise and preserve the fresh milk. CMM women in Isiolo nowadays come from multiple groups – Garre, Somali, Borana – and are often engaged in multiple marketing activities such as marketing smallstock and the sale of dried camel meat '*nyrnyiri'* or camel yogurt *'susaa'*.

Marketing camel milk, however, is not a new phenomenon in the region as similar dynamics have evolved in parts of Ethiopia, Kenya, and Somalia (Anderson et al., 2012; Noor et al., 2013; Galma, 2015). More broadly, the growing commercialisation of milk in pastoral areas is reported across Sub-Saharan Africa (Nori et al., 2006; Sadler et al., 2009; Corniaux et al., 2012). The marketing of pastoral milk represents a further step in the commoditisation of pastoral resources and reflects the increasing need for pastoralists to generate income, expand networks, and diversify their livelihood base through activities related to livestock breeding. This process is part of a wider articulation of land, labour, and livestock resources with the view to composing livelihood mosaics to tackle changes and seize opportunities, better address uncertainty, and generate reliability.

Isiolo County has undergone dramatic structural changes, economic development, and socio-political transformation in recent decades. Local pastoralists – both women and men - are skillfully navigating such changes, expanding and diversifying risks and uncertainties and shaping new herd management and production patterns accordingly. New 'livelihood mosaics' are emerging, with widening portfolios of activities, integration into markets, and new labour and income options generating diversified local livelihoods.

2.4 Persisting yet evolving mobilities in Kutch, Gujarat, India[4]

The Gujarat case shows how north-western India's herding communities, who are deeply attached to livestock and its keeping, retain patterns of reconfigured mobility to intersect and cast their livelihoods in an increasingly fragmented and diversified landscape. Through various strategies, mobility remains a core pillar sustaining local livelihoods amidst unpredictable conditions and deep ecological, political, and socio-economic transformations.

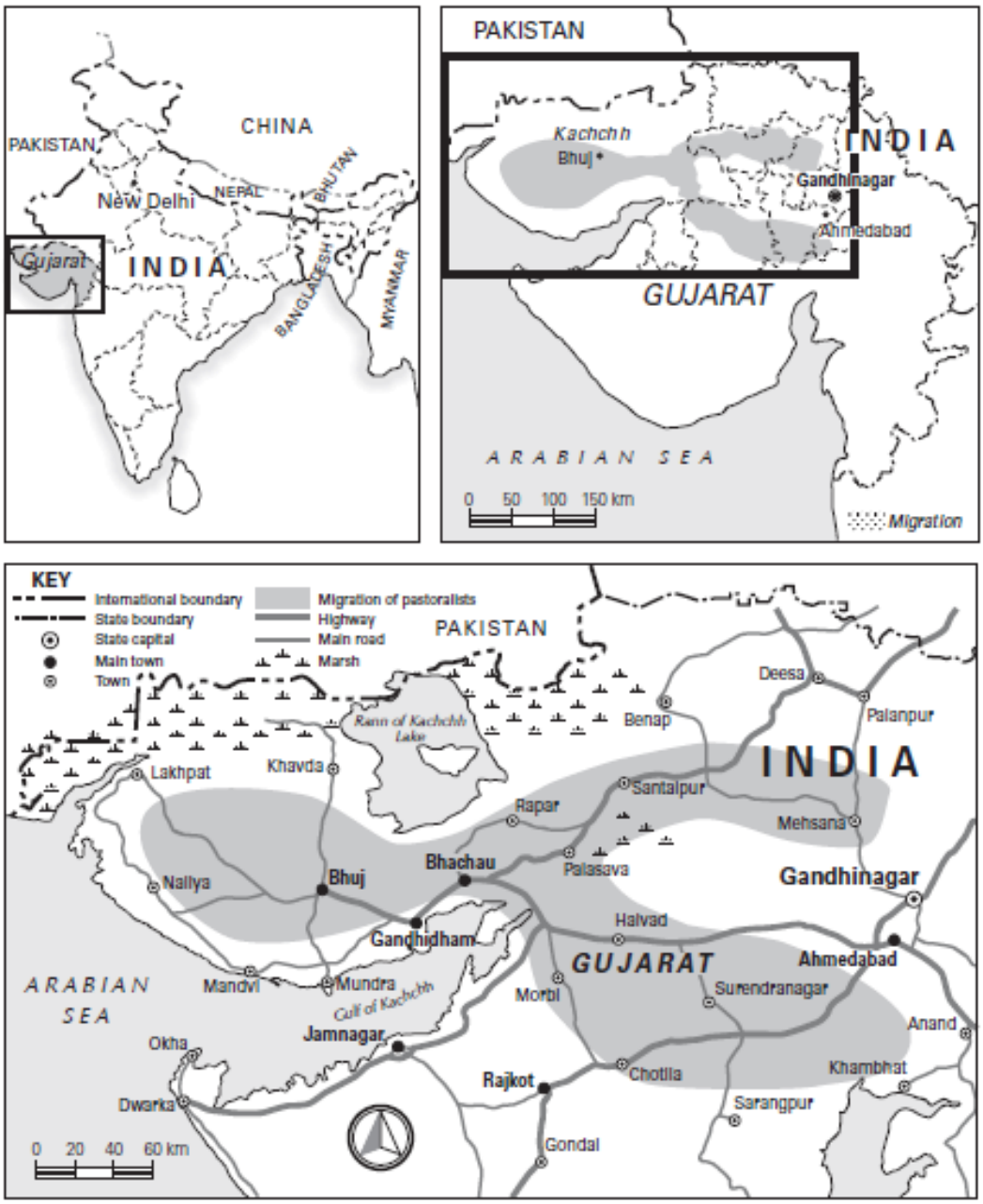
In the aftermath of the 2001 earthquake, the district's vast stretches of sparsely populated semi-arid lands have become the target of public and private investment schemes, with the development of large-scale industries, commercial agriculture, major infrastructure projects, and tourism (Maru, 2020). Intense agricultural growth linked to the ´green revolution' process has rapidly transformed rural landscapes. Large projects, development programmes, and subsidised schemes have converted rangelands into farmland through irrigation, mechanized labour, and continuous cropping. Land reform policies led to the breakup of village common lands, the fragmentation of rangelands, and the displacement of pastoralists from primary resources. The establishment of forestry plantations, natural conservation areas, and national parks have further reduced access to grazing lands throughout Gujarat (Agrawal and Saberwal, 2004).

Gujarat is one of India's most industrialised states; important portions of its territory are nonetheless still devoted to agricultural production. Western Gujarat is a traditional pastoral zone as dryland terrain and variable rainfall patterns limit the feasibility for crop farming. Large grasslands provide enough forage for various livestock breeds in different ecological zones within these regions, including cattle, sheep, goats, camels, buffaloes, horses, and donkeys. In the absence of any official survey or census of the pastoralists in Gujarat, it is difficult to know their total population. However, various estimates put it between two and five per cent of the State population (Bharwada and Mahajan, 2012).

As elsewhere in India (Nori, 2019b; Kavoori, 2007), recent changes in the economic infrastructure have remoulded the ecological, socio-economic, and political landscapes on which Indian pastoralists rely. The growth of industrial activities has further affected water availability, as contamination and salinity have increased throughout the region with the spread of *Prosopis juliflora* imposing further constraints on animal production patterns. This resource reconfiguration has affected the composition of herds, their management, their feeding, and their productivity, with relevant implications for pastoral livelihoods. The dryland ecology of Kutch, *Kachchh* on the map above, the semi-arid north-west district, provides for a highly diversified and variable landscape, more suitable for pastoralism than agriculture (Bharwada and Mahajan, 2012). The district hosts the highly biodiverse *Banni* grasslands, amongst the largest in Asia, and includes other environmental hotspots such as the *Chhari Dand* wetland areas, salt deserts, and wildlife conservation zones.

[4] This chapter has been elaborated with the collaboration of Natasha Maru, PASTRES PhD researcher on the Kutch case, through IDS and PASTRES funding.

Figure 13 – Gujarat and Kutch (Kachchh in the map)



Source: PASTRES

Livestock raised in Kutch consists of a large variety of animal species and indigenous breeds. Different animals fit diverse ecological niches and satisfy specific socio-economic capacities and needs. These have changed through time, as livestock are nowadays more appreciated in local markets for their protein rather than their fibres. Official animal husbandry statistics (DAHD, 2020) indicate that the number of cattle and buffaloes are on the rise given incentives for dairying, while small ruminants are growing at a declining rate. Livestock census data in Kutch normally accounts for about one-third of Gujarat sheep.

Table 7 – Livestock census data in Kutch, 2019

	Cattle	***Sheep***	***Goat***	***Buffalo***
Indigenous	553,303	610,533	439,258	466,341
Exotic	21,534	96		

Source: Department of Animal Husbandry and Dairying, 2020

Such variety underpins the different patterns of pastoralist mobility. Mobility of pastoral livestock in the area is mostly associated with camel, sheep, and goats, while cattle and buffaloes are typically tended at the village level, also as a result of evolving dairy production and commercialisation. Apart from the main herd/flock, other animals – from lactating cows to pack animals – often accompany the household moves. When the household decides to move with the herd, camels or donkeys are strategic for loading the household's items for the camp. This role nowadays could also be fulfilled by a pick-up, truck, tractor, or jeep.

Kutch dryland ecology typically induces herding communities to undertake extensive transhumance through seasonal winter-summer migration to mainland Gujarat where they graze on farm residues before moving back to their home district to graze in the monsoon months (Maru, 2020). Two different herding communities inhabiting the Kutch district are analysed here, the Banni herders and the Vagad Rabari, with a view to exploring how pastoral mobility endures and reconfigures between continuity and change.

Transhumance on different scales remains though a viable and extensively practiced strategy throughout the country to make effective use of biomass variability and diversity in space and time scales (Krätli and Schareika, 2010). In Rajasthan, the number of people and flocks undertaking nomadic migration has increased, and Gujjar pastoralists from Himachal Pradesh today move over longer distances and for greater durations than in the past (Axelby, 2007). Specific forms of further mobility are perpetrated when extreme conditions apply, such as the long dry spells or drought events in the 1980s; today, however, forage could be stocked and mobilised for emergency animal feeding. The perimeter and purpose of such movements have widened and diversified, from enabling the exploitation of ecologically diverse settings and natural grazing to accessing irrigated plots and farm by-products as well as services and markets.

Sindhi-Muslim Banni pastoralists live and produce on the local grasslands. For Banni communities, local movement in a radius of kilometres within and through neighbouring villages is a daily practice in each season, hinging on landscape geo-morphology, with highlands providing for grazing in monsoon times and low-lying areas during winter and summer. Apart from enabling optimised animal feed utilisation, these moves are also strategic in preventing overexploitation of resources in one area. These moves, though, increasingly serve and interweave with constant connections with nearby towns like Bhuj, Mundra, Mandvi, Anjar, and Nakhtrana. This also allows for wider socio-political connections and more complex relationships with local and national institutional levels (Bharwada and Mahajan, 2012).

Box 5 – Milk and mobility in the Banni

A survey conducted between 2009 and 2011 (n=300) with pastoralists in different parts of the Banni area revealed that livestock-based income accounts for 70.3 per cent of the revenue of Banni pastoralists, of which milk sales alone constitutes 63.6 per cent. These values have greatly increased since the establishment of dairies in Banni in 2010 and have further risen exponentially by now, following the recent development of technology that facilitates the storage and transport of milk over time and distance.Despite limited public transport, pastoralists of Banni are highly mobile and remain well

connected: 29 per cent had bicycles and 18 per cent had motorbikes; 63 per cent of surveyed pastoralists had a mobile phone, especially in more remote villages where this is a necessity for linking to the outside world.

Table 8 - Asset ownership amongst surveyed Banni families (in %, N=300)

Asset details	West Banni	Central Banni	East Banni	Total – average %
N	90	90	120	300
Families with traditional house	93.3	92.9	93.0	93.0
Productive assets				
Agricultural enclosures	74.4	45.6	52.5	57.0
Bullock or camel cart	1.1	1.1	1.7	1.3
Jeep or three-wheel motorbike for milk	10.0	0	8.3	6.3
Consumer asset				
Bicycle	22.2	38.9	26.7	29.0
Radio	11.1	16.7	18.3	15.66
Mobile phone	50.0	65.6	71.7	63.3
Motorbike	12.2	16.7	22.5	17.7
TV	0	0	0	0
Refrigerator	0	0	0.8	0.3

Source: own elaboration on primary survey in Bharwada and Mahajan, 2012

The Rabari/Raika constitute India's largest nomadic community with a population of over 500,000. They trace their origin to a religious myth where they were "created" by the Hindu god, Lord Shiva, to be his wife Parvati's camel keepers (Choksi and Dyer, 1996). This myth still resonates strongly among the Rabari, who today not only keep camels, but also cattle and small ruminants such as sheep and goats (Maru, 2019). The Vagad Rabari analysed here have a strong ethic of mobility, migrating up to eight months a year and moving frequently even if within a smaller region. They are deeply engaged with farming communities through traditional reciprocal arrangements, and relationships built over generations are mobilized for grazing access (ibid.).

Several Rabari groups maintain long-distance transhumance to Gujarat, (and some even to other parts of central India) through a complex migratory dynamic that is embedded in a constantly-changing social and environmental landscape. When moving to Gujarat, the Rabari usually select agricultural 'hotspots' and rely on local farming communities to obtain animal feed resources and also earn cash or grain in exchange for their valuable manure (Choksi and Dyer, 1996). Factors such as rainfall and agrarian cycles as well as the availability of government subsidies, irrigation infrastructure, negotiations with farmers, religion, caste, and so on, determine when and where pastoralists can migrate. In the end, though, the power balance is tipped in favour of the farmer who ultimately controls the resource (Maru, 2020).

The main income of the Rabari comes from live animal sales; the Rabari do not have to take their animals to market, as traders come to the camp and buy directly from the flock owners. Their other source of income is manure, which is sold to farm owners. In the past, wool was a source of income but is not any longer – and Rabaris nowadays have to pay shearers for their services. Coordination with traders, farmers, and shearers, is conducted via mobile phones. Traditionally Rabari women are in charge of all transactions – they keep the money, and do the household shopping as well as the spending for social customs, rituals, exchanges, etc. They also attend to the new-born lambs who are unable to go grazing with the mature sheep. Men amongst Rabari milk the animals, the milk is mostly used for household consumption either fresh or converted into buttermilk and ghee; some quantities may be sold to the market (ibid.).

Box 6 – An insight into a Vagad household and livelihood

Maru's (2020) description of a Vagad Rabari family shows distinctly the different ways, pace, and trajectories of mobility that accompany everyday life of a contemporary transhumant family.

The father, Nathubhai, serves as the *mukhi* or head of their group. He spends the day 'scouting' (*niharu*) the surrounding area to see which farms were being harvested and which they could use later for grazing. He goes to the village to speak with the farmers and obtain their permission. He also goes to the local government office to submit forms for compensation for damages to his farm from the late rains. He visits other pastoral camps in the area that invited him to a *jaatar* (religious feast) that night. He then spends some time at the village tea shop catching up on local news and gossip. During the day, he makes a couple of trips to the camp where he helps with chores such as taking the camel to graze, eventually returning before the flock comes back in the evening. In his youth, Nathubhai himself migrated to Mumbai to work in a factory along with other migrants from non-pastoral backgrounds from his village and other parts of the country. He also owns farmland that he leases to landless peasants to sow. Moreover, Nathubhai pays a specialised Jat pastoralist to keep his few camels as an absentee livestock owner.

Pabiben, the mother, is often in charge of the flock, while she also performs other critical chores such as cooking for the family and fetching water. She is in charge of building and breaking the mobile camp as well as taking care of its structure and pieces such as bedding, cooking utensils, and all kinds of cooking material. She also undertakes social activities and events, such as participating in religious gatherings and attending to markets.

Two of the family sons, Vibho and Valo, provide their support in looking after the flock, at times complementing or substituting the parents in tending the animals, and supporting the household economy. As an example, Vibho takes care of the animals browsing on millet residues over a radius of five to seven kilometres to the camp, when Pabiben spends the day at an annual festival at a faraway temple. Valo would support his brother during the day at the camp and then take a lift and return to the village to spend some time with his wife and new-born child; he would then return to the camp every morning when the dairy van goes on its morning rounds. When the family and flock move to Gujarat a few weeks later, Valo would remain back trying to start a dairy franchise of his own; he would call on his uncle to take his place instead – mobilising someone who had not been on migration for a few years (Maru, 2020: 217). A third son is a hired tractor driver for another Rabari who has given up shepherding but capitalised on his farmer connections in Gujarat to take up jobs such as harvesting, ploughing, and trenching with a tractor, migrating with his machines just as shepherds do with their flocks. A fourth son is continuing his college education and would probably migrate to town in search of employment (Maru, 2020: 220).

Figure 14 - Pabiben and Nathubhai on the move

Credit: Maru, 2020:224

Overall, this pastoral family sketches the centrality of livestock in the livelihood of Rabaris, while also displaying significant capacities in drawing from multiple resource systems and degrees of constant multi-siting of its members. These are nested into forms and practices of mobility, which connect and intersect patterns of moving and settled dimensions, herding, and farming practices, along a continuum that provides for complementary, alternative, and substitutable resources and options, according to different social, geographic, and temporal scales.

Shifting routes and pace

For both the Banni and the Vagad Rabari pastoralists, migration remains necessary to sustain herds; amidst important landscape and societal transformations, mobility is retained to pursue effective livestock production in such variable setting – or maybe as a response to these changes. Some groups have expanded transhumance to access more pastures and new markets, while others have reconfigured livestock movements to include seasonal permanence and more settled systems, at least for part of the household. Accordingly, they have also adapted their herd composition and labour regimes, with more mixed and diverse patterns.

Departing from past practices, herders adopt new compasses, maps, and agendas to steer their migrations. Along their migration, pastoralists navigate through new realms of uncertainty – encountering the fruits of the developmentalism that has had a deep impact on the area – as much as following traditional routes, customs, and rituals (Maru, 2020). Infrastructure development often cuts across and confines rangelands and landscapes, but also serves to connect them, thus widening the capacity of livestock producers to benefit from the evolving opportunities these dynamics generate (Singh *et al*., 2015; Nori, 2019b). The expansion of irrigation agriculture is an important factor that sustained the outstanding growth in the dairy industry and related cooperative systems. Road grids constrain pre-existing tracks and trails, but also offers opportunities for motorised transport and commercial outlets otherwise inaccessible, including primary ports, special economic zones, and major cities like Mumbai and Delhi. Communication and transport technology developments enable access to evolving opportunities and services, including education, health, and veterinary care (Maru, 2016).

Market networks also impinge on pastoral mobilities, as herders are increasingly enticed by the commercial opportunities for milk and meat to meet urban consumers' ever-expanding demand. While wool's commercial value has declined, Indians' turn to animal protein has generated important venues for the herding economy. In 2015 pastoral producers supplied roughly 50 per cent of the milk production and 75 per cent of the national meat consumption, while animal fibres were traded through regional networks (Nori, 2019b). Many pastoralists have connected to more intense, peri-urban dairy systems to which they continuously provide livestock services and replacement stock (Sharma *et al*., 2003), and cash income provides chances to procuring feed for the animals during critical times. Market engagements eventually trigger new tensions, dependencies, and inequalities. The commoditisation of animal products, especially meat, in India is in fact the subject of deep controversies and religious conflicts. Pastoralists must thus often perform through side-line and subtle strategies to market their products through trusted middlemen.

New mobility patterns, itineraries, and pace are mediated and informed by relationships and arrangements with other societal actors and economic opportunities. While, on the one hand, access to common, open grasslands is constrained, on the other, opportunities arise for feeding animals from irrigated farms. Engaging with urban settings, commercial networks, and traders provides important opportunities to expand local livelihoods through either milk provision or less-formal livestock sale, the purchase of forage and animal feed, or other income-generation and alternative labour market options. Religious festivals, pilgrimage routes, social events, and temples are also relevant in setting migration trajectories. Mobility endures as a strategic asset in the interplay of these different dimensions in enabling the flexibility and engaging with the variabilities in the shifting economic, ecological, social, and political contexts that embed and permeate pastoralists livelihoods as they seek to manage and achieve various goals (Maru, 2020). These strategies and the underlying mobility patterns are embedded in and underpinned by new and evolving networks of relationships and related socio-political manoeuvring. Synergies and connections with farming, urban communities, and market agents are critical in exploring and engaging with landscapes deeply transformed by agricultural encroachment, infrastructure development, and industrial schemes.

As Bharwada and Mahajan (2012:75) note, pastoral communities in Kutch "*have persisted, struggled and kept going";* indeed, they demonstrate outstanding skills in navigating through changing landscapes, adverse policies, evolving challenges, constraining factors, and volatile opportunities. The principle of mobility is central to this, however, given the challenges it must be combined with other strategies to address uncertainties, including changing livestock composition or herd size, shifting their products for sale, establishing alliances with other societal actors, and changing dependence on outside markets (Bharwada and Mahajan, 2012).

The multiplicity of contemporary movements shows that pastoral mobility is not simply the search for fodder and water for livestock, but a tapestry of intersecting social, economic, cultural, and other mobilities that have a bearing on each other (Maru, 2020: 223). Differently practised but persisting and evolving at different scales, forms of overlapping and nested mobility are deployed and adapted,

interconnecting new webs of resources and relationships that are critical in responding to an ever-changing context. Mobility is still so embedded in their livelihoods that, according to Sharma et al. (2003), most pastoral groups in India cannot be easily identified with one specific territory as most are spatially integrated and interdependent with other land use systems.

2.5 Reorganising Borana rangelands in southern Ethiopia[5]

This section explores the principle of reticular territories through the case of Borana in southern Ethiopia, where pastoralists live with rapid changes in the landscapes that traditionally support their livelihoods. Rangelands are fragmenting, being converted into farm plots and turned to more intense use as new markets, urban economies, commercial channels, and regional flows provide for fresh resources and opportunities. To manage these uncertainties, new social and economic reconfigurations are needed; pastoralists reorganise their communities and rearticulate territories accordingly.

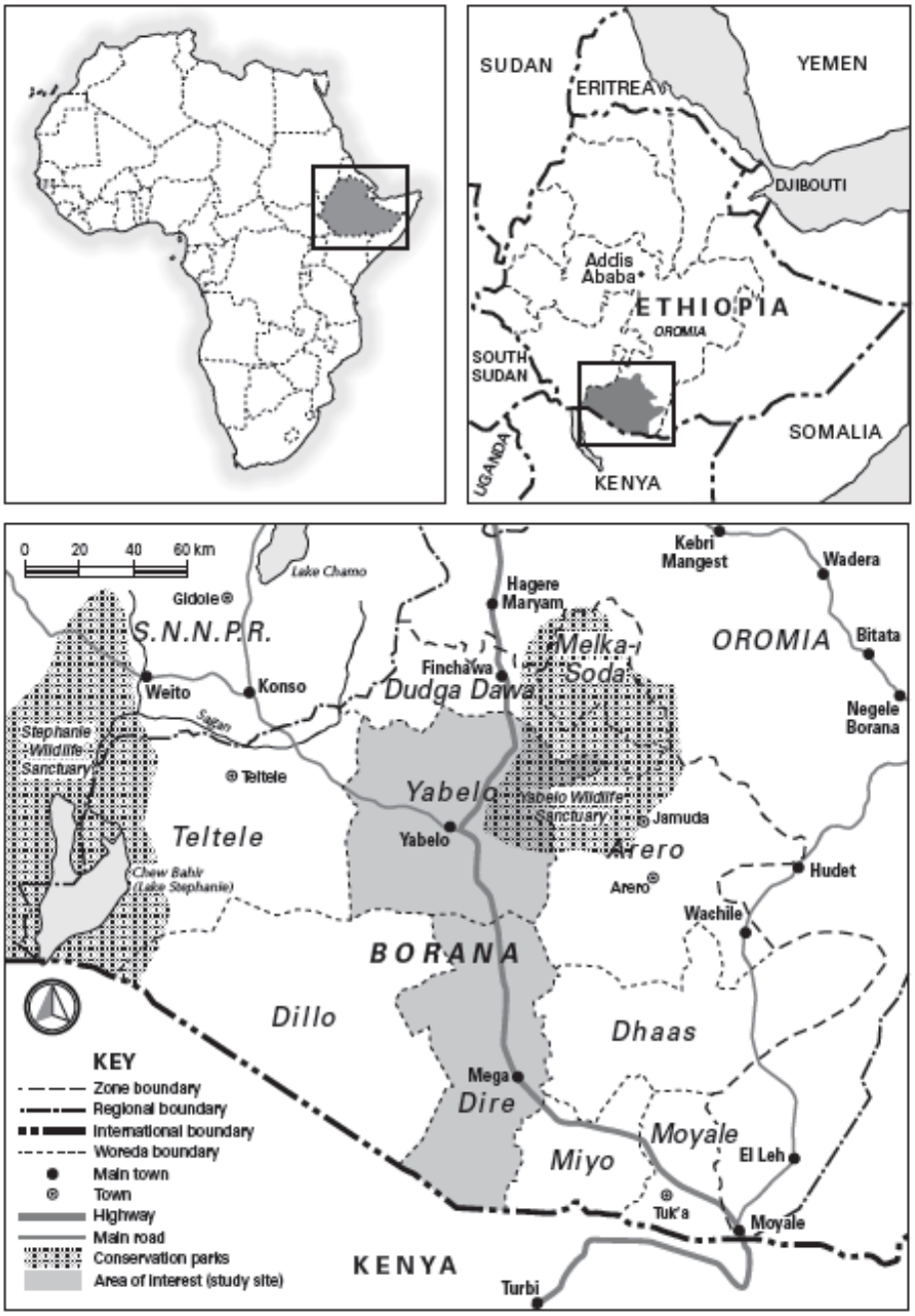
Yabelo and Dire are main centres for the Borana, a sub-group of the Oromo, one of the largest ethnic group of pastoralists in Sub-Saharan Africa. The Borana drylands of southern Ethiopia – like much of those in northern Kenya – have recently witnessed important changes in land use, with relevant implications for livestock management, household configuration, social organisation, and local livelihoods. Throughout these processes Borana territories are reorganised in reticular patterns, mosaics of different but functionally interconnected landscape and social units that allow for exploiting variable and volatile opportunities, including climate and soil patchiness due to seasonal rainfall, market pricing, export trade or localized subsidy schemes – with a view to responding proactively to uncertainties.

Environmental change in the region has been intense, with local rangelands coming under immense pressure (BZPEDO, 2011). Figures from the area attest to a significant increase in human and livestock population, with the former more than doubled in the last two decades; the latter has been growing as well, although at a slower rate (Abebe, 2016). Borana are typically cattle raisers, though things have been changing recently. Livestock population swings consistently, according to rainfall patterns and the related forage availability. Cattle population is sensitive to drought events, which particularly affect cows and calves, with critical implications for the economy of pastoral households, in terms of milk production and herd growth dynamics. According to Coppock (et al., 2008) cattle density peaked at about 85 heads per household in 1982. This number was reduced by 35 per cent to 55 cattle per household following the 1983-1985 drought; it then increased again to 80 by 1991 only to decline to 42 following the 1991-1993 drought. Numbers rose again until 1998 and then crashed by over 60 per cent in the 1998-1999 droughts. Similarly, high mortality occurred in 2005-2006 when about 50 per cent of the cattle died, which was again followed by many livestock deaths in the drought of 2008-2009 (Degen, 2011).

Changes in climatic patterns and environmental uncertainties are also commonly reported, accelerating from the lengthy droughts that hit the area as from the 1970s. Altogether these environmental changes have triggered important societal transformations, and the related reconfiguration in land use and livelihood patterns. As a result of these processes, per capita livestock holdings have declined over a long period and continue to diminish, falling short of subsistence requirements for a large proportion of the pastoralist population. Herd composition and management have been subject to dynamic change, while local households have as well resorted to other livelihood sources (Homann et al., 2008; Flintan, 2010; Lind et al., 2020).

[5] This chapter has been elaborated with the collaboration of Masresha Taye, PASTRES PhD researcher on the Borana case, through ILRI and IDS funding.

Figure 15 – Yabelo and Dire woredas



Source: PASTRES

Livestock rearing remains central in these woredas, although with an extended and varied role, as it is now the source for income-generating activities; provides services and products to growing settlements and towns; generates the capital to start new businesses and projects; and, contributes to more broadly diversify local livelihoods. A large variety of animals populate local rangelands, each one with different capacities and functions; from more traditional cattle to increasing numbers of goat and sheep, which serve the economy of poorer strata, to camels and donkeys, which are increasingly relevant for milk and transport respectively (Lind et al., 2020).

Box 7 - Livestock and livelihoods

The story of Malich, 42, in Harboro *Kebele*, is indicative of the relevance of livestock for local livelihoods, though in articulated and continuously readapting ways. When he married 14 years ago, his primary source of cash and livelihood was brokering – linking pastoralists with traders and reselling livestock to other regional traders outside Borana. '*When I start to accumulate cash, I started to retain goats and cows for my household'*, he explains. Getting involved in livestock production is Malich's form of accumulating wealth and diversifying risk, but also to enhance sustainable consumption for his children and increasing social status in the community (Taye, 2019). For most households, the reasons and livelihood assets associated to livestock are many and multi-folded.

Livestock assets are highly differentiated, influenced by the household capacities to control land and provide labour, their socio-economic level, and their integration into farming, market and government networks (Lind et al., 2020). Different arrangements support diverse livelihood strategies, household practices and labour regimes; some specialise in specific breeds and value chains, some diversify their herd to serve different purposes, and others integrate livestock with farming (Aklilu and Catley, 2010). Diversified herd composition and management imply a reconfiguration of mobility patterns: traditional transhumance remains in place for larger herds, while shorter distances are covered by small ruminants and attached to agro-pastoral schemes.

Expanding and evolving territories

These livelihood transformations have been underpinned by the reorganization of territories and landscapes. Settling and farming have become popular in the area in the aftermath of severe drought events, when many impoverished households settled in areas around deep wells (Tache, 2013). With water availed through pumps, forage production is complemented with grazing on crop residues, and livestock rearing increasingly linked to dryland farming, either for human food, animal feed, or market cash.

Extended rangelands use has been reorganised through a complex mosaic of interconnected patches with different characteristics, functions, and access rights, through which people, livestock, commodities, farm inputs, water, and other resources flow and are mobilised. Wetter areas, farmlands, peri-urban agricultural plots, quality grasslands, irrigated perimeters, communal range enclosures, and forest resources came to provide important nodes in such a web through which livestock are moved according to the season and rainfall. Moreover, the development of water points and rural markets have contributed to sedentarisation and new settlement patterns across the region, which have evolved into new nodes, in turn providing rural dwellers with important market outlets and related options to diversify their livelihoods and seek alternative sources of food, feed, and income.

These transformations did not happen in a vacuum, but rather casted in and steered by a complex and dynamic socio-political landscape. The norms and structures ruling on the governance of these resources emanate from the wider institutional dimension informing land access and utilisation amongst the Borana. The *Gadda* (an eight-year-based administration system) and *Luba* (age-set for all Borana, identifying oneself with a certain age-mate) are important social structures that inform the relationships amongst people, their networks, and with local resources. These systems are still in place in rural and urban settings alike (Taye, 2019).

Borana rangelands (*Dheed*) are traditionally divided into five major classes according to specific features and resources (including agro-climate, soil type, morphology, groundwater, flooding risk, etc). These clusters are *Gomole, Wayama, Dire, Golbo and Malbe* - each one with a distinctive landscape and vegetative cover (see Figure 16 below). Local administration, settlement patterns, migration, and all livelihood-related issues are linked with these clusters (ibid.).

Figure 16 – Diversity of Borana rangelands (Dheed)

Gomole	
Malbe	
Dire	

Credit: Taye, 2019

Many previously open rangelands have been converted to community grazing (*kaalo*), or individual farmlands (*oburuu*) or both. These changes in land uses, the related access rights, negotiations and arrangements are mediated by institutional structures that have adapted to evolving ecological, demographic, and socio-political circumstances, including different perspectives along social and generational divides. The widening social stratification does not enable all community members to benefit equally from public and common resources ("*you need livestock to benefit from kaalo*"), and each generation has a different appreciation of land potentials, with elders valuing *kaalo* more than other land types and younger participants expressing preference for *oburuu,* as they may be more interested in undertaking farming activities (Nori, 2020y).

Local perception of opportunities for off-farm, urban-based and alternative livelihoods is also changing. Many pastoralists have converted part of the household labour to petty trading or other forms of income generation. As in northern Kenya, here too, in the last decade women-led milk commercialisation advanced. Milk flows to urban areas and markets in turn connect inland ranges to sources of cereals and commodities, credit and services, information and opportunities. Together with

milk, trading smallstock as well as hides and skins provide important sources of income for women, including female-headed households. These processes also have an impact on the appreciation for education; as commented in Ya´karayu "*We want our children to get schooling; and especially girls, as they are better performing and more reliable in sending back remittance*" (Nori, 2020y).

Moreover, the transformation of dryland landscapes in Ethiopia has also coincided with important political changes. The Derg regime since the 1970s promoted settled agriculture schemes in pastoral areas, while also supporting ranch-style livestock production for export – a pattern pursued after 1991 under the successor EPDRF government. The wars with Somalia and Eritrea in the 1970s and 1990s, as well as more localised conflicts. contributed disrupting dryland livelihoods. The ethnic federalism paradigm promoted since 1991 significantly influences the relationships and patterns of rule amongst different communities, along with the underlying natural resource base. Skirmishes between different ethnic factions have become recurrent, particularly with neighbouring communities.

Borana value chains supply cattle and camel to domestic and international markets, including to the Arabian Peninsula, providing income-generating opportunities for a range of involved agents, from the livestock owners to small-scale collectors/traders, brokers, larger traders, transporters, hotels, and restaurants (Lind et al., 2020). Trade corridors invert their flows opportunistically according to prevailing political and market conditions. The informal trade that moves animals into Kenya and Somalia during certain periods reverts to official trade within Ethiopia, depending on existing bans, prices, bands, security, controls, taxation, and market incentives on either side of the borders – and beyond (Aklilu and Catley, 2010). The expansion of local cattle marketing into regional and international trade has been greatly incentivised by the Ethiopian government and supported with foreign aid funds for investments in quarantine facilities, feedlots, and modern market yards, as well as with trade agreements with importing countries (Lind et al., 2020).

These also open possibilities to other livelihood options: in 2015 about eight per cent of households reported receiving remittances as a source of cash income, largely from family members who have permanently migrated or are employed by the government and NGOs. Such support provides a critical buffer against food insecurity and vulnerability, including during droughts (Abebe, 2016). As in other pastoral areas, mobile phones provide effective ways to maintain contact, share information, generate trust, and enable remote control – all critical features when trading livestock, hiring a herder, or demanding a loan. Today, some pastoral households hold a bank account, and live on credit during those months when they are unable to sell their products (Nori, 2020y).

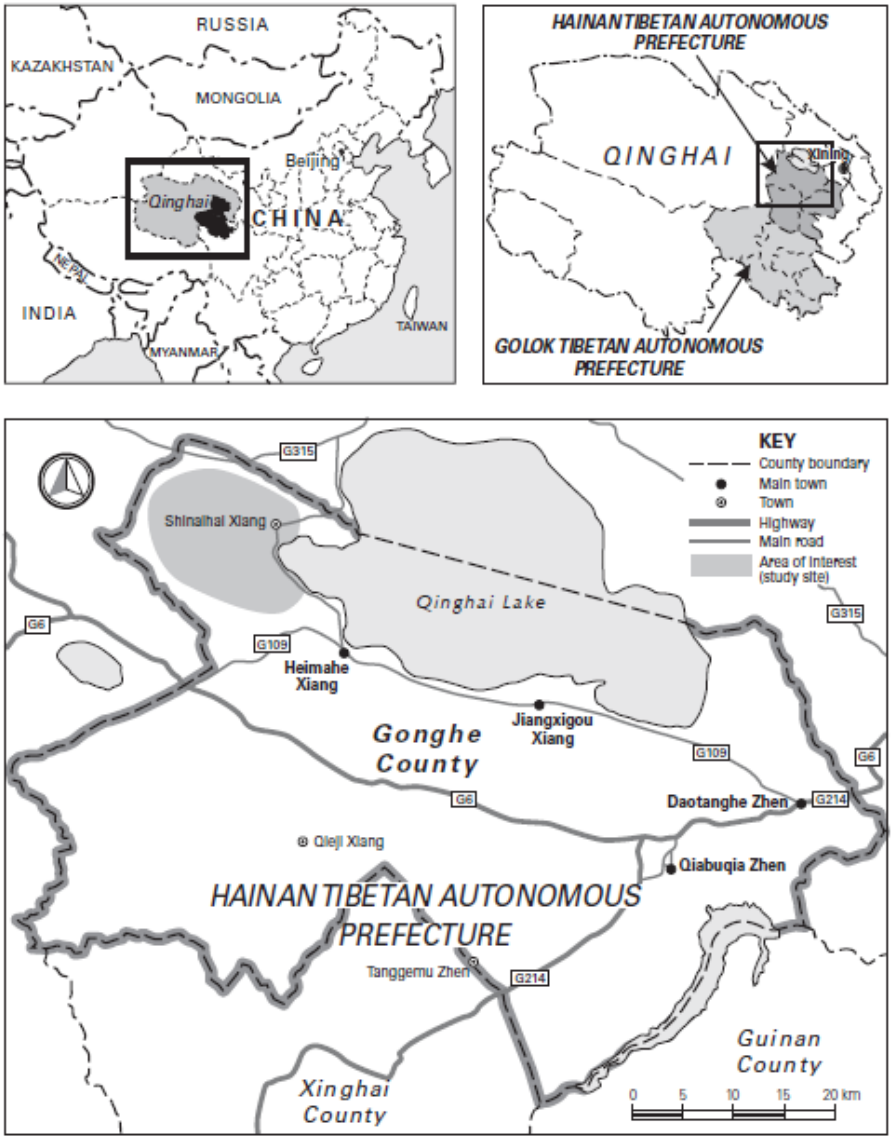
Borana rangelands are becoming increasingly bound to processes of state territorialisation, large-scale infrastructure and resource development, and regional trade and investment. New nodes and links contribute to reconfiguring local territories, livelihoods, and economies. These further contribute to connecting and integrating Yabelo and Dire into the wider national and regional settings, market outlets, trade hubs, political centres, and the global diaspora (Lind et al., 2020). Networks of roads, communication, and transportation services strengthen such flows and exchanges. The reshaped local mobility brings opportunities for the utilisation of motorbikes, donkeys, buses, and Bajaj.

Borana pastoralists diversify land use and livelihood patterns and reorganise resources and territories to respond to growing market opportunities, environmental pressures, and processes of political incorporation. Territories are arranged in a reticular fashion, through different but functionally interconnected landscape and social units to enable mobilities and flows, tracking options and seizing opportunities. These reticula evolve at different scales; those across large areas are facilitated by traditional transhumance of large stock, alongside with those more localised associated with more intensive production patterns. In turn, the pastoral system today is connected to a larger regional and international arena through flows of people, information, commodities and finances. New mobility and economic arrangements, social networks, and institutional structures underpin these territorial reconfigurations and their articulations with the evolving farming systems, urban settlements, and market value chains.

2.6 Navigating institutional dimensions in Amdo Tibet, China[6]

A core principle of pastoralism uncovered in the earlier review was the articulation of social networks and institutional arrangements with a view to tracking and seizing resources, relations, and opportunities in the larger societal arena. The Tibetan case shows how pastoralists juggle within the dynamic institutional and policy framework characterising their plateau rangelands. While the operational setting has changed dramatically, the core principles enabling the much-needed flexibility and adaptability underpinning pastoral livelihoods adjust to current conditions, and herding communities evolve their social networking capacities and political capital to sustain their livelihoods in the face of uncertainties.

Figure 17 – Golok and Hainan Tibetan autonomous prefectures and the Qinghai lake



Credit: PASTRES

[6] This chapter has been elaborated with the collaboration of Palden Tsering, PASTRES PhD researcher on the Amdo Tibet case, through ERC funding.

The Tibetan Plateau is home to some of the world's largest alpine steppes – and the majority of China's pastoralists. Set at the centre of evolving and contrasting dynamics, the plateau is busy and connected, as it is increasingly integrated into the national and regional settings, as well as international markets. Tibetan rangelands are massively reorganised in intense reticular fashion. The Belt and Road Initiative is reshaping the plateau's skyline, and infrastructure works – wind farms, railways, electricity grids, road networks – are underway across the highlands. Fencing systems cut through vast steppes and pasturelands, separating seasonal uses, community holdings, and individual rights.

As it hosts a large segment of the communities targeted by the government's poverty alleviation programmes, policy frameworks and public investments are particularly relevant to this territorial reorganisation, with great emphasis on infrastructure and services as well as expanding markets and development. The latter two have been a primary concern for the Chinese government since the end of collectivisation and the shift to a market economy in the 1980s.

The region is characterised by environmental variability and a high frequency of natural disasters with direct implications for rangeland management and pastoral livelihoods (Gongbuzeren, 2020). Particularly exposed to climate change, the regional herd composition is continuously remoulded; sheep and yak consistency shifts according to the dynamics of the ecological as well as the policy and economic domains (Nori, 2019b). As the plateau represents a strategic environmental asset for China's primary rivers and the entire regional economy, it has recently become the target of intense policies aimed at forms of ecological re-engineering, with significant impacts on local livelihoods (Nori, 2004; Li *et al*., 2014; Chies, 2018; Zhang *et al*., 2018).

Box 8 - The expanding concerns over the Qinghai Lake

The area of Qinghai Lake is simultaneously subject to quite diverse and diverging forces and pressures. On the one hand, climate dynamics are expanding the lake surface and redefining the perimeters of surrounding lands; on the other, it is increasingly attracting massive investment from the State as well as from private businesses due to its potential for tourism and markets.

The lake area is also rich in natural resources. Its ecological importance thus further contributes to the escalation of land acquisition for designed conservation projects and tourist sites alike. Since the early 2000s, the area has been the target of important State environmental policies. These included the *Three River Heads* (*Sanjiangyuan)* and the *Stop cultivating and restore grass and forest lands* (*Tuigeneghuanlinhuancao*) programmes that basically aim at reducing human and livestock pressures on the plateau hence inhibiting the access to local herders.

During the last decade, the *Eco-Conservation Based Provincial Development Plan* (*Shengtai Jiansheng*) and the *Sanjiang Yuan* and the *Qilian Mountain* National Parks have also been established, while the *Qinghai Lake* one is being planned, within the three-year *National Park Modelled Provincial Development Plan* (*Guojia Gongyuan Jiansheng 2020-2022*). A Qinghai Lake Management Bureau exists since 2007, tasked with the implementation of unified conservation, programming, tourism works, and overall use of the lake and its precincts (Tsering, 2019).

As in the case for other pastoral settings in the region (cf. Nori, 2019b), gradual State integration has opened the Tibetan plateau to the influence of a wide array of policies directed at modernising the region. This may be through either a development or a conservation perspective – and more often a mix of the two, as environmental schemes and national parks are accompanied by programmes aimed at developing tourism and supporting market expansion. Whatever the inspiring narrative, state-led policy reforms and market-driven transformations may challenge the principles underpinning traditional pastoral management (Li *et al*., 2018; Zhang *et al*., 2018). Evolving policy frames and economic shifts have contributed to reconfiguring access to and use of the rangeland resources, with relevant implications on land governance, mobility patterns, and the overall transformation of pastoral livelihoods (Gongbuzeren et al., 2016; 2018).

Figure 18 – Busy landscapes on the plateau

Credit: Nori

Since the establishment of the People's Republic of China in 1949, the institutional systems governing natural resource access and use have changed drastically, from the initial collectivisation policies to the household responsibility system to more recent trends toward increasing individualisation and marketisation. The transformation of land governance regimes has been quite fuzzy; the pace and trajectory of these reforms have varied widely amongst different areas and communities (Yu and Farrell, 2016; Li *et al*., 2018; Nori, 2019b). The capacities displayed and practiced by pastoralists throughout these processes have been critical in combining central rules and local implementation with communities' interests. These are explored through cases from two faraway settings in Qinghai and Sichuan Provinces, which show similar dynamics.

Box 9 - Land regime patchwork in Zoigê County

Gongbuzeren (2020) illustrate how in Zoigê County, south-east Golok, different rangeland management institutions and arrangements were established and evolved in three neighbouring villages with similar ecological and social characteristics that were also subject to the same policy environment.

Village A has gone for a community-based grazing quota system that maintains collective use of rangelands and seasonal livestock mobility. In 2009, individual grazing quotas were defined so that the total number of livestock that each family could own in the village was brought under control and land rights among herders within the village could be traded. Decisions are made by the whole village and change annually based on rangeland conditions.

Village B decided to contract its rangelands to individual household units in the late 1990s, when the government promoted the *Household Land Contract Period*. At the same time, however, its herders realised that contracting rangelands into individual units would limit livestock mobility. Thus, they implemented collective use of rangelands based on voluntary group organisation (ranging from 5 to 50 households), which eventually enabled maintaining seasonal livestock mobility.

Village C implemented a very different rangeland management system. In 2009, the collective use of rangeland was contracted to individual households, with wire fencing demarcating individual parcel

boundaries. Restricted mobility and the land leasing system were gradually applied, with some families now renting grazing parcels from households with fewer animals to gain access to more extensive pastures.

As reported by Tsering (2019, 2020), the situation is even more complex in Golok due to the presence of the Caterpillar fungus *(mbu*), a traditional medicinal plant that grows in certain settings under specific ecological circumstances. *Mbu* harvesting and marketing importantly sustain local livelihoods; its collection and sale normally takes place by late spring and early summer, and for some households it represents a major source of income (Nori, 2004). *Mbu*'s commercialisation has gained importance, and value, in recent decades; its trade has specifically been growing since the 1990s, within the wider liberalisation frame. Its marketing is mostly in the hands of Han and Hui dealers, while consumers are mostly Chinese living on the eastern coast. Control and access to market information and mechanisms is therefore quite remote from Tibetan herders.

Even in Golok the processes underpinning local negotiations and provisions concerning land use rights are articulated through multiple factors, interests, and actors, and result in a variegated and dynamic picture. This is further reconfigured at sub-village levels down to locally-combed arrangements. Features such as household demography, herd size, land topography and exposure as well as pastures' seasonal quality are taken into account since they impact the utilisation of resources and the redistribution of benefits.

Amongst other features, the potential for *mbu* production is also taken into account, given its economic relevance; as the value of the fungus varies, so do land access arrangements. *"The price of mbu boomed after 2005 and had its peak during the Beijing Olympic Games in 2008; (…) the booming of the mbu economy had shattered and reshaped the existing relationship of the land and the people here"* (quoted in Tsering, 2020).

The revenues generated through the sale of harvested fungus represent a family asset; in cases where land leasing rights remain collective, income must be equally distributed amongst all families within the encampment. *"This winter pasture is a common property for the encampment, and we all have a say on what happens to this piece of land. The lease of our winter pasture was the compromise of all families here, so we must share the income from the land leasing"* (quoted in Tsering, 2020).

As this income-generation activity is attracting a growing number of people, mechanisms, and structures to govern the land while also ensuring the reproduction of the fungus also evolve accordingly. Moreover, *mbu*'s intense commoditisation and the privatisation of land rights have in certain areas reportedly destabilised community cohesion, triggering disputes and enhancing forms of economic differentiation and social tensions (Tsering, 2020). Monasteries, which have regained official recognition since their reopening in the 1970s, as well as local authorities may become involved in local land-related negotiations, at times exhibiting vested interests (Tsering, 2019; Gongbuzeren, 2020).

In some villages, community leaders and family representatives gather each year to define the specific institutional structure and governance strategies. Each area displays particular sets of access restrictions and regulations, sanctions, and indemnities – often on a case by case basis – mediated by cultural and religious rules. Social networks and ICT technologies (mobile phones, WeChat) are used to monitor infringements. As to the situation in Zoigê County, diverse forms of land governance strategy overlap and intertwine, exhibiting mixes of individual, household, group, and more collective strategies for seasonal pasturelands (Tsering, 2020; see Table 9 below).

Table 9 - Types of land governance strategies and access rights in Golok

Land Governance Strategies			
Pasture / Type	***Type 1***	***Type 2***	***Type 3***
Winter pasture	Private use	Collective use	Private use
Summer pasture	Collective use	Collective use	Private use
Land Access Right			
Access / Type	***Type 1***	***Type 2***	***Type 3***
Access right to winter pasture	Contracted family	Encampment	Contracted family
Access right to summer pasture	Village members	Village members	Contracted family
Access right	Access to summer pasture limited during *mbu*	Access to summer pasture limited during *mbu*	Access to land is flexible

Source: own elaboration on Tsering, 2020:8-10.

Networked arrangements

Multiple institutions and actors participate in land governance and negotiations; these include state agencies, local authorities, monasteries, traditional organisations, community networks, and kin-based organisations. Accordingly, tribal leaders, government cadres, county officers, religious incarnates, traders, and investors display different agendas, social networks, and power gradients in this interplay (Gongbuzeren, 2020). Overall, the resulting institutional architecture produces complex mosaic forms that dynamically account for the area's specific biophysical features and the community's socio-economic characteristics.

State programmes aiming at regional economic development, at alleviating poverty for its communities and/or at protecting the environment, contribute to reconfiguring local landscapes, with shifting policy paradigms, swinging tenure regimes, and appealing financial services (Li *et al*., 2018; Zhang et al., 2018; Nori, 2019b). State plans and policies are translated into local contexts and rules are always negotiable on the ground: '*they [the government] have their policies, and we have our own on the ground*' (in Tsering, 2020). The outcome is a multi-layered mosaic of tenure regimes and institutional arrangements that include formal or informal, official or unofficial, state or customary, traditional or modern dimensions (Robinson, 2019).

Rural-urban relationships are transformed, both those associating the plateau with the rest of China and those linking Tibetans with other groups. Enhanced connections and encroachments challenge the pillars of pastoral economies, with emerging opportunities to access market-driven transformations, basic services, and alternative livelihoods. Markets and financial services increasingly provide a parallel, complementary landscape that herders are exploring, with or against their will. Herders' ability to respond to ecological variability has shifted, and their tightening engagement with market and policy dynamics has significantly affected pastoralists' ability to respond to uncertainty (Gongbuzeren et al., 2018; 2020).

For the two cases analysed, Tibetan pastoral communities have responded by reorganising communities, lands, relationships, and agendas in a reticular fashion with a view to retaining the mobility, autonomy, and flexibility patterns that traditionally inform their livelihoods. These cases illustrate how social networks and institutional arrangements evolve dynamically to track and seize resources, relations, and opportunities in the larger societal arena – a strategic asset for responding to

uncertainty. However, the consequence of territorial reorganisation means there are winners and losers as interests and capacities diverge within and amongst communities, resulting in processes of social differentiation and divergent economic strategies along social, gender, and generational cleavages. However, livestock, in different ways, remains central to the local economy, although livelihoods are now diversified into and integrated with a multiplicity of alternative options, all carrying different risks and challenges.

Rangeland control on the Tibetan plateau has become an arena for different interests that encroach and compete at different scales. On-going land grabbing, commoditisation, privatisation, sedentarisation, and territorialisation contribute to reshaping pastoralists' rights and ability to access rangeland resources. Adaptive responses suggest a wide range of coping strategies, proactive interactions, and innovative approaches. Locally-nested institutional arrangements emerge and evolve, taking into account seasonal management, individual and collective capacities, market dynamics, and mobility patterns, as well as opportunities for income and provision of state support, including basic services, development programmes, and rural finance. By navigating through the existing interstices in the diverse institutional and territorial levels, herding communities exhibit considerable social networking skills, adaptive political capital, and community governance capacities (Bauer and Gyal, 2015; Gongbuzeren et al., 2018). While these may be very different from the past, again, the principles persist in new forms, as new networks and institutional arrangements emerge to respond to contemporary settings.

3. Exploring pastoral adaptability

The changes taking place amongst pastoralists across the PASTRES case studies point to diverse dynamics and trajectories, but they equally indicate some common configurations. As this paper has shown, across cases, while reconfiguring their livelihood systems, pastoralists adapt their socio-technical infrastructure to ensure reliable provision of products and services for sustaining livelihoods amidst new forms of variability and uncertainty.

These transformations, in turn, generate new uncertainties, challenges, and opportunities that pastoralists constantly face in juggling with wider and diversifying territorial and societal frameworks. Having explored six PASTRES cases in relation to the principles identified in the earlier literature reviews, this section now brings the analysis together and examines each principle in turn, in relation to its relevance to the way pastoralism functions today and whether there are changes and challenges to pastoral systems as we know them.

Across the case study sites, the first principle - **adaptive herd management** – is maintained, though within a wider and diversified livelihood setting. While livestock's direct role as primary food provider for the family has declined because self-subsistence is practised less than in the past, livestock represents a main source of income for pastoralists and a main contributor to socio-economic diversification and livelihood transition. The integration of the livestock economy with other sectors and domains (i.e., farming, urban economy, trade) provides the necessary resources, connections, and revenues to financing off-herd, activities, either through its products (dairy sales, livestock markets, petty trading, agro-tourism), or through the income these generate (schooling, waged occupations, migratory projects) (see Table 10 below).

Table 10 – The diverse ways livestock supports household diversification

Case Study	***Livestock supporting household diversification***
Tataouine, Tunisia	Livestock funding emigration Remittance invested in herd and *khlata* Livestock funding education Hiring of herders
Central Italy	Pastoralism as the migration driver Interface with farming Livestock funding education and income diversification Hiring of herders
Isiolo, Kenya	Camel milk enabling access to market Livestock products supporting women's income generation and resourceless pastoralist petty trading Hiring of herders
Kutch, India	Interface with farming Market access through dairies and meat Sale of services to other land users Livestock income financing alternative livelihoods Hiring of herders
Borana areas, Ethiopia	Processing and sale of livestock products supporting women's income generation and resource poor pastoralists Interface with agriculture Income from livestock sustaining local credit schemes
Amdo Tibet, PRC	Market access through dairy and meat Livestock funding education Rights for *mbu* collection related to access to pasturelands Income from livestock sustaining local credit schemes

The herd also remains an option for reinvesting resources generated elsewhere; savings, revenues, and remittances from other sources are often fed into the herd, directly or indirectly. Two core patterns prevail whereby livestock keeping receives direct funding from other economic dimensions: a) when the herd is in dire need, and the livestock economy suffers resource deficits (either due to climate or market dynamics) and thus requires external support; b) to reinvest family surplus generated in other domains, for accumulating wealth, diversifying risk and/or supporting the livelihood of certain members. Cases from Borana areas, central Italy, and southern Tunisia attest to these dimensions.

Regardless whether livestock is a readily rentable asset, keeping a herd provides some benefit to the overall pastoral economy and plays a strategic role in navigating uncertainties. In the Sardinian, Ethiopian, and Tunisian cases, livelihoods often resulted in stepping in and out from pastoral production; depending on prevailing market and policy conditions, family labour could be allocated to extensive livestock breeding after acquisition of animals, grazing lands, and shepherding labour.

Income from some animals might support the economics of others. In northern Kenya, the role of smallstock as a source of cash to support cattle keeping was emphasized, while in Sardinia the reverse occurs. Livestock, though, is also relevant in socio-cultural terms as pastoralists across the sites stressed that their identity is associated with the rearing of animals. Furthermore, pastoral communities articulate relationships, bonds, and institutions that are centred on livestock, as this provides their reference system.

Herd management is constantly reshaped, together with its size, configuration, and movements. The herd itself is not such a stable and uniform asset, but rather a dynamic enterprise, as its versatility is a key prerogative to enable adaptation to prevailing conditions, capacities, and needs – a critical resilience feature. Sarda breeds were strategic to colonise hilly areas of central Italy; camels are essential in exploiting ecological and socio-economic dynamics in Isiolo; smallstock provides specific labour and market options in north-western India and southern Tunisia. Herd diversity is strategic for multi-purpose and diversified use of land and labour, as cases from Ethiopia and India indicate. Environmental and market-related domains are most influential but shifting policy and legislative settings can also be relevant in informing herding configuration patterns, as attested by the restrictions issued by the Chinese government, power decentralisation in Borana areas, and subsidy schemes of the EU's Common Agricultural Policy.

Herd management materialises in modular ways, with different portions undergoing different patterns that combined provide for the process variance needed to stabilise its overall performance in face of a shifting input variance. These include forms of intensification to serve given markets, tighter integration with crop farming, forms of enhanced extensification (including through the encroachment onto new lands), and diversification into more mixed herds, products or services or specialisation into specific ones.

Reorganising herd management and diversifying the pastoral economic base imply a reconfiguration of resource management and livelihoods patterns through a dynamic articulation of livestock, land, and labour. This continuous and adaptive process accounts for significant interactions with environmental changes, other actors and land uses, policy frames, economic options and labour markets. Accordingly, herd management is constantly reshaped, together with its size, composition, structure and moves; herd versatility is a key prerogative of pastoral livestock breeding, as it enables adapting to prevailing conditions, capacities, and needs – a critical resilience feature. In Borana areas some families have switched from cattle to camels, thus expanding grazing and trading opportunities, while others from cattle to cropping, thus converting to more intense land use and different market opportunities; some families have gone both ways.

Accordingly, access and use of land resources is submitted to a constant reconfiguration - as new territories get colonised, some are over-utilised and degraded, others are abandoned, switched or lost to other land uses, including forestry, farming, infrastructure, and protected areas. The growing integration between herding and farming systems is a primary process underpinning land transformation. On the one hand farmers increasingly raise livestock, while on the other, seasonal crop farming is spreading to more marginal lands.

These convergences generate opportunities for complementarity and synergy – as well as for competition and conflict. The latter characterises certain regions, such as parts of the Sahel. In southern Ethiopia and Tunisia, farmed plots could easily convert to grazing areas or fodder resources if rainfall is insufficient for cereal grains; in Sardinian systems, crop farmlands have been converted to animal feeding. Farm products – primary as well as by-products – often provide a main interface between different land use systems and communities. In central Italy, north-western India, and southern Tunisia, forage and fodder represent strategic assets for pastoralists to profit from market opportunities, while in Sub-Saharan Africa and on the Tibetan plateau these are essential for herds to survive climatic extremes.

Table 11 – Patterns of evolving interactions between crop farming and livestock herding

Case Study	***Herd-farm interaction patterns***
Tataouine, Tunisia	Land individualisation and farming encroachment in rangelands Animal feed increasingly sourced through farm production Forage and fodder drivers of market integration Forage and hay provision essential in times of drought Patterns of agro-pastoralism, including with olive trees Agricultural intensification as a way to secure land rights
Central Italy	Sardinian transferring labour and livestock into new lands in mainland Italy Animal feed increasingly sourced through farm production Seasonal patterns of agro-pastoralism
Isiolo, Kenya	Forage and fodder relevant to enhance pastoralists access to markets Peri-urban camel milk production and small ruminants trade supported through farm-produced animal feed Forage and hay provision essential in times of drought Patterns of agro-pastoralism Farming as an option for herd-less groups
Kutch, India	Green Revolution investments contributed to fragmenting grazing lands Seasonal migration to mainland Gujarat to graze on farm residues Forage and fodder relevant to enhance pastoralists access to markets Relevance of forage and hay in climatic crises
Borana areas, Ethiopia	Rangelands plotted into patchy lands uses Processes of land fragmentation Land individualisation and farming encroachment in rangelands (i.e., land right shifts to *kaalo* and *oburuu*) Peri-urban agriculture supporting urban development tin pastoral areas Relevance of forage and hay in climatic crises
Amdo Tibet, PRC	State-led investments in farming in lowland areas Animal feed relevant to enhance milk production and animal fattening Peri-urban agriculture supporting urban development tin pastoral areas Relevance of forage and hay in climatic crises

Across the cases assessed, farming can also represent a way to secure rights to land within insecure institutional settings aimed at avoiding dispossession or to accumulate and reinvest wealth – or both. Agricultural intensification in pastoral territories could in fact be the outcome of social differentiation which, in turn, triggers patterns of exclusion, inequality, and social tensions. In PASTRES cases from Tunisia, Ethiopia, and India, wealthier groups invest in more suitable lands, while poorer ones might turn to rainfed cropping either because they do not hold enough livestock to sustain their livelihood or to expand and diversify production and risks accordingly.

Household labour is also reorganised through patterns that diversify herd and land production, profit from expanding trade, and enjoy alternative livelihoods or other labour markets, with family members migrating elsewhere. Demography, family cycles, gender aspects, and generational change play relevant roles in such decision-making. All contribute to redistributing wealth and risks while also expanding social networks. Encouraging farm and economic diversity is strategic in maintaining stable livelihood output from an increasingly unpredictable setting.

Where pastoral labour is allocated elsewhere, patterns of wage labour for herding often apply, whereby herders are supplied through flows of migrant workers issued from other communities, through networks and arrangements that importantly expand pastoral capacities. The cases of Libyan shepherds

in Tataouine, Romanians in Italy, and Turkana and Meru looking after herds in Isiolo are all indicative in these respects.

This reconfiguration of land, labour, and livestock and the related integration of pastoral economies within market-driven dynamics is deeply informed by the second principle, **diversification into livelihood mosaics.** This represents a process complementary to ongoing transformations – and, in part, triggers them. Urban development, settling populations, and the associated rising demand for livestock products provide important venues for reconfiguring pastoralists' herds, mobility, and livelihoods. The commercialisation of fresh milk and dairy, live animals, dry meat, fibres and other non-food products and services is a growing phenomenon that pastoralists enjoy as venues to differentiate their diet as much as their economy. While livestock is the technology that enables transferring resources from one season and one place to another, market exchanges permit converting livestock products into income that could be availed in other seasons and regions.

Value chains of pastoral products are growing larger and more complex: Sardinian cheeses satisfy consumers' demand in the United States; Borana cattle is in high demand in regional capital markets and Saudi Haj festivities; Tibetan Yak dairy products and *mbu* are sought by mainland Chinese clients; sheep and goats from southern Tunisia and north-western India support national food security. All these pastoral products are primary commodities whose trade structures, commercial networks and global markets, provide the backbone to evolving channels, networks, and flows connecting and integrating distant regions and communities.

These in turn generate and underpin political economy dynamics; as indicated by Lind et al. (2020:4) for the Horn of Africa 'better off pastoralists are able to maintain and sell livestock and their products as a successful business enterprise, commercialising the milk and livestock trade, selling in high export zones, creating private abattoirs and finding lucrative business opportunities along the livestock value chain'. This might not be the case for worse-off groups, who find it difficult to support their livelihood in such ways but that can still rely on market-related opportunities generated through others' livestock. Female-headed households in Borana sustain their economy through trade in milk, and small ruminants as well as processing dry meat, hides, and skins. In Sardinia dairy processing and sales provide a specialised profession. Wherever the engagement with market outlets, trade channels, commercial networks, and the associated transportation, information and credit systems have become critical pillars in pastoralists' decision-making about resource governance, social organisation, and mobility patterns.

A process parallel and complementary to the commercialisation of livestock and their products concerns the increasing commoditisation of pastoral resources. Access to grazing lands, forage and fodder, water, and animal health services is essential to overcome seasonal stresses where pastoralists are highly dependent on natural grazing. These same resources are also critical in supporting their engagement with market opportunities as these sustain livestock fattening and milk production. Land is also individualised, hired, and commoditised; herders in Amdo Tibet, southern Tunisia and Ethiopia, and central Italy must continuously navigate shifting institutional domains to secure their access. The shepherding workforce is also increasingly sought in the labour market, and new forms of contracts, arrangements, and networks support migratory flows whereby members of other communities are engaged to look after local herds, as is the case of the Sardinians in central Italy, the Jats in north-western India, and the R'baya in southern Tunisia.

The shifts towards more farming-convergent, market-integrated, and diversified livelihoods imply a **persistence of mobility patterns** – the third principle. However, today not only herds and flocks are on the move, but other pastoral resources are also mobile, such as forage and fodder, livestock products, water provisions, shepherds, and even entire families and communities. Pastoral movement has been reorganised either by readapting herd and household composition and locations or by reshaping mobility perimeters, routes, and networks. In some cases, transhumance patterns have widened, while elsewhere these have reduced livestock movements and shifted to more settled systems, often aimed at better exploiting synergic engagements with farming and urban communities.

Animal feeding and welfare remain primary objectives of pastoral moves to pursue effective livestock production in variable settings, even amidst relevant landscape and societal transformations. Fresh and changing interests, maps, agendas, and compasses inform pastoral mobility today. New navigations are taking place in a more articulated and connected world; market forces importantly expand the outreach of pastoral economies; patterns of human migration are superimposed on and complement livestock mobility. Pastoralists seek new ways to access and acquire critical resources to pursue their livelihood moving through the interstices of intensive systems, drawing from marginal contexts, harsh terrain and peripheral territories, and crossing administrative and national boundaries.

Pastoralists themselves often mobilise to engage in alternative livelihoods, as evident from all PASTRES areas. Sedentarisation often signifies a major transformation as parts of the household and herd attach to certain areas, while the rest stay on the move. This process presents new economic opportunities (access to water, peri-urban agriculture, markets, waged labour) and social advantages (access to basic services, tightening of social relationships), but also important challenges to pastoral livelihoods since movement restrictions and demarcation of land rights and family residence can undermine livestock performance.

Like local mobility, migratory dynamics are also typically informed by social and gendered features. Women's mobility in Kutch and Borana pastoral camps is often related to specific functions, different from those of their male partners (i.e., camp management, fetching water, selling milk, petty trade). Differences also exist according to family cycles and members' ages; pastoral families with children in school are likely to split, with women and children remaining close to primary service provision. In southern Ethiopia and Tunisia, central Italy, and Amdo Tibet specific mention was made about girls who migrated to urban settings looking for wage employment so their remittances could eventually support the pastoral household economy. Household structure, composition, and dislocation thus change and adapt according to circumstances and opportunities.

Overall, rangelands and pastoral populations show increasingly patchy configurations as new forms of tenure, resource allocation, labour regimes, market engagements, and mobility arrangements apply. These require adequate organisation. Community networks evolve to provide the most-needed social infrastructure that sustains pastoralists' performances through developing infrastructure, policy frames, market routes, technical devices, and institutional arrays. As suggested by the fourth principle, **territories, resources and relations are arranged and managed in a reticular way**, and constantly connected through evolving grids, mobilities, and flows that are essential to enable real-time tracking and seizing of available prospects.

As the cases seen in southern Tunisia, northern Kenya, northwest India and Amdo Tibet, urban settings have become new hubs that concentrate opportunities, from market demand to basic services and from social networks to information systems, financial services, income opportunities, and alternative livelihoods. Farming areas enable expanding the lands pastoralists draw from through engagements with seasonal crop production and with cultivating communities. Market arrangements and financial services provide new landscapes pastoralists scan in search of additional resources to sustain their livelihood. In southern Ethiopia, Amdo Tibet, and amongst Sardinians, the opportunity to avail and access credit provide an important room for manoeuvre to complement and integrate pastoralists' income-generation options.

Nodes of territorial webs link grazing areas with other lands where forage and hay are produced, and livestock products are marketed. Evolving road networks, urban settlements, commercial hubs, as well as evolutions of transport and communication technologies – mobile phones, internet connections, motorbikes, trucks, and even boats – provide new grids that enable strategic links with different communities, resources, and opportunities and facilitate ties, moves, and flows.

Recombining herds, moving and feeding them through new patterns, reconfiguring land use in diversified ways, mobilising labour force in different settings, and logging on to a variety of market options and policy frames are key practices that inform livelihood strategies across PASTRES case study

areas. As pastoralists rely on extended networks, organising landscapes, resources, and relations in this reticular fashion requires a socio-political infrastructure that governs the engagements and arrangements amongst different groups, locations, and domains to adapt to prevalent trends and conditions.

Finally, in relation to the fifth core principle, **the dynamic articulation of social networks** and institutional arrangements is increasingly critical for continuous scouting of territories, the tracking of resources, the prospecting of scenarios, and the seizing of opportunities, as well as for providing mechanisms for accumulating and redistributing roles, skills, wealth, and risks. Pastoral societies are in fact simultaneously confronted with multiple challenges: on the one hand, the relations, negotiations, and engagements with other communities, interests, and agendas are evolving; on the other, these contribute to reconfiguring pastoral constituencies from within, with progressing social disparities as well as gender and generational dynamics.

Pastoralists' growing engagement with local markets, international trade, and global value chains together with processes of land use reconfiguration, regional integration, political participation, and power devolution provide fresh room for rearranging social relations and community institutions. Cases from Amdo Tibet, Gujarat India, and Borana areas of Ethiopia attest to the growing relevance of interfacing with other societal actors and state agencies in support pastoralists' integration into wider livelihood frames, policy dimensions, and marketing domains. Everywhere, new forms of alliance and competition arise with farming communities, urban citizens, market players, local authorities, state officers – but also religious actors, diaspora members, international investors, and international development agencies. Due to longstanding exposure to frontier dynamics and cross border relations, pastoral networks often transcend local markets and administrative boundaries, often even regional perimeters. The cases from central Italy and southern Tunisia and the regional Borana constituency clearly depict how the expansion of pastoral territories has evolved hand-in-hand with an extension of their economic and political perimeters out of national boundaries.

Simultaneously, pastoral societies must manage internal dynamics as they engage in new economic configurations, mobility patterns, and labour regimes. As discussed, market integration triggers social stratification and economic winners and losers. Across the case studies, the role of women in the wider social and economic dimensions is reportedly growing – even more so for households with migrated members. Pastoral women display specific forms of social capital that enables them to entrench distinctive roles vis-á-vis market forces and political dimensions. Inter-generational dynamics are also challenged by ongoing transformations as innovative techniques and practices affect resource management, labour markets, cultural patterns, and decision-making systems.

4. Conclusions: changing contexts, persisting principles

In sum, across the six PASTRES cases, we see the core principles identified by the earlier review of literature (Nori 2019a, b) persisting but in new forms, adapted to often radically changed contexts. By reconfiguring institutions, labour arrangements, land use, mobility patterns, and social organisation, pastoralists across the sites have in most cases been able to respond to changes and the consequent new sources of uncertainty (Nori and Scoones, 2019).

Pastoralism may be conceived as a complex socio-technical system, a form of 'critical infrastructure' delivering reliable services (Roe, 2019). Herding is the skilled management of the interplay between two biological dimensions – grassland ecology and animal physiology – juggled through the capabilities and needs of the herder community. Pastoral socio-technical systems are set to balance an unpredictable input supply (biomass available for animal feeding), with the need for stable and reliable livelihood output (conversion into socio-economic products and services).

Looking at pastoralism through this 'high-reliability' lens helps frame herders' strategies for facing the diverse forms of unpredictability that typify their livelihoods. It helps explain how changes occur. The persistence of principles of pastoralism observed across the cases is achieved by adjusting the

'process variance' and 'performance modes' of the high reliability system (Roe, 2019). While the practices, strategies, and relations change and adapt from the 'traditional' modes of pastoralism to keep pace with dramatic transformations, the principles continue: each is central to high reliability pastoralism.

Pastoralists have through time expanded their livelihood base and operational perimeter; they are now part of a wider and more articulated global network. While livestock herding remains a strategic productive asset locally, most pastoralists today rely on much more than just their herds and flocks, and resources and opportunities are increasingly drawn from wider territories and networks. On the one hand, the growing presence of new actors, interests, and investments encroaching on these regions is evident. Pastoralists are faced with lessening control over rangeland resources and livelihood sources whose availability rests on wider uncertainties. On the other hand, pastoral communities maintain output stability through a mosaic of interconnected economic activities and social relations. They play simultaneously on different grounds, either through the dislocation of the herd or the distribution of household members in different time and space scales.

As the case studies in this paper have discussed, the performance of pastoral socio-technical infrastructure is determined through the continuous articulation of land, livestock, and labour with the aim of opportunistically exploiting a volatile and variable resource setting. Herd and household units are mobilised across rangelands to maximise the utilisation of forage availability while minimising the impacts of such transient supply. The control of rangelands is not so much a question of ownership, but rather the capability to gain access to resources and options when these are available, thereby providing for livelihood opportunities. These features have today extended to a wider access and mobilisation of livelihood sources: forage and water, livestock products, and even the pastoralists themselves as they engage with labour markets, migratory processes, and other sources of trade and income, scanning prices and browsing the web.

The dynamic use of patchy rangelands through skilled herd management translates into a diversified seizing of livelihood options out of complex and connected territories, networks, and domains. Thus, diversifying production strategies, maintaining forms of mobility, enhancing flexible decision-making, strengthening social networks, and retaining fluid access to resources are all central. Class dynamics, reconfigured social relations, ethnic relationships, market integration, and institutional arrangements, in turn, evolve at the interface with farming communities, urban environments, labour markets, trade agents, state structures, and other societal actors.

In other words, the 'input variance' of herding systems has extended as a result of their market integration and the commoditisation of their resources, as well as their growing incorporation into institutionalised settings and processes of globalisation, combined with environmental and climate change. Pastoral territories have expanded beyond rangelands; pastoral economies extend beyond the herd and their mobility beyond transhumance. Accordingly, pastoralists' 'process variance' – their practices, strategies, and relations that generate high reliability – has been rearranged to assure a stable and reliable set of outputs, that is, decent livelihood levels for its members from an extended and diversified setting.

The core capabilities that enable this process include a) reliance on large-scale resource networks that facilitate connections, mobilisations, flows, and exchanges; b) knowledge management and information grids aimed at constantly tracking contexts, conditions, and scenarios ; and, c) forms of governance that provide for degrees of interconnectedness within an important dimension of autonomy. All these provide the setting for operational decision-making that enables real-time seizing of opportunities.

With its built-in trust and through the reciprocity principle, the extended family provides a primary operational and coordination reference. The family architecture is arranged through different self-contained but interrelated units, nodes of webs that serve to redistribute surpluses and deficits. Pastoralists' ambiguous relationships with national statehood also significantly inform their governance

systems. Typically located near borders and away from political centres, rangelands have undergone specific economic and political patterns. On the one hand, these have evolved through intense interactions and exchanges between trans-border communities; on the other, political dynamics and institutional arrangements have been shaped by tensions with remote and centralised state structures.

However, adaptive flexibility and adjustment of core pastoral principles to fast-changing contexts is not always possible or successful. Across our cases, in certain places for certain people, situations evidently exist where the boundaries of the system have been stretched too far. The sources of variability are too great, uncertainties too challenging, and the strategies, practices, and relations usually drawn upon to respond are insufficient. For example, Borana pastoralists in Ethiopia are confronted with growing degrees of social differentiation and ethnic tensions undermining the capacity of collective responses. Herders in Amdo Tibet find themselves operating within a shrinking physical space for strategic manoeuvring as options for reticular land use across mosaics becomes more and more challenging. Sardinian pastoralists are equally challenged by generational renewal, without younger generations able to learn the skills necessary for making pastoral principles function in new contexts, including increasingly volatile markets and policies. The COVID pandemia has provided an interesting playground for assessing pastoralists' resilience in different contexts (Simula et al., 2020).

Across the PASTRES case study sites, pastoralism persists under massively reconfigured conditions; the pastoral principles identified through the review of earlier literature are still in operation, adapting to new circumstances. An embedded dynamic adaptability allows pastoralists to tackle the processes that are transforming their lives and generate reliable livelihoods amid a whole array of new uncertainties. However, there are cases influenced by economic, social, and ecological constraints, where such principles can no longer function to deliver reliability, despite deeply reconfigured strategies, practices, and relations.

A big challenge for development interventions and wider policies is to provide continued support for the successful operation of the core pastoral principles. This means facilitating mobility, flexibility, adaptation, and innovation in pastoral systems and, where constraints are confronted, to find ways of alleviating them so that the core principles that have been so successful in sustaining pastoralism over millennia are able to continue to provide reliable livelihoods for pastoralists across the world.

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