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Changing Food Systems and Their Resilience in the Karakoram Mountains of Northern Pakistan: A Case Study of Nagar

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Mountain communities are considered particularly vulnerable to food insecurity, and their vulnerability is sometimes assumed to be increasing because of a loss of food self-sufficiency. Based on a case study of Nagar District in the Karakoram of northern Pakistan, the present article challenges this assumption by taking a broader perspective on food systems and their changes in recent decades. Defining food security as the outcome of a resilient food system, it investigates how major transformations of livelihoods and farming systems since the 1970s have increased or decreased the resilience of food systems in Nagar in various ways. Based on empirical field research conducted between 2014 and 2016, the study finds that local food systems have transformed from largely subsistence-oriented systems of food production and consumption to increasingly complex, multilocal networks in which off-farm livelihoods, external markets, and government-subsidized food supplies play central roles. This process of diversification of food systems has generally improved communities' resilience to food crises, despite the emergence of various new risks. The article argues that rather than overemphasizing local food self-sufficiency, research and policy related to food security in mountains must address the multidynamic and multifaceted character of food systems, as local production constitutes only one of several interrelated elements.

Keywords: *Food systems; food security; resilience; complexity; agricultural change; Gilgit-Baltistan; Pakistan.*

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Introduction

Mountain regions are gaining increased attention in international debates on food security and food systems in the global South. People living in mountain areas are considered particularly vulnerable to food insecurity because of difficult conditions for agricultural production, social and political marginalization, and negative impacts of climate change, among other reasons (Akramov et al 2010; Dame and Nüsser 2011; Tiwari and Joshi 2012; Rasul and Hussain 2015). In a global study by the Food and Agriculture Organization of the United Nations (FAO), 39% of mountain populations in the global South were found vulnerable to food insecurity in 2012—a 30% increase compared to the year 2000 (FAO 2015; Manuelli et al 2017). However, the FAO study applies a very narrow understanding of food security, as the underlying model considers only local sources of food production and neglects the role of off-farm incomes for food consumption of households (FAO 2015: 28). Many empirical studies have pointed out that food systems in mountains are dynamic and multifaceted, relying on diverse farm and off-farm sources of livelihood while being subject to manifold social, economic, political, and ecological changes. Thus, the assumption of a general increase of mountain peoples' vulnerability to food insecurity needs further scrutiny, as other factors may have had more pronounced effects than the local production limits on which the FAO study relies.

The present article attempts to challenge this general assumption based on a case study in the high mountain region of Gilgit-Baltistan, northern Pakistan. Taking a broader perspective on food systems, it investigates how various developments have reshaped local production and consumption patterns in recent decades and how this has affected food security, defined as the outcome of a resilient food system. Compared to other parts of the Hindu Kush–Himalayan region (eg Tiwari and Joshi 2012; Dame 2015; Hussain et al 2016; Gautam 2017), few empirical studies on food systems in northern Pakistan exist (Dittrich 1997, 1998; Herbers 1998), making it a particularly relevant study region.

In Gilgit-Baltistan, 2 historic events have been critical for subsequent changes in local food systems: the

integration of the various mountain communities into the political system of Pakistan in 1972, and the completion of the Karakoram Highway in 1978—connecting the formerly remote region to downcountry Pakistan and China (Kreutzmann 1991; Sökefeld 2005). Since then, there has been a considerable shift from subsistence agriculture to the commercial production of cash crops, while new income opportunities have led to a diversification of livelihoods. Moreover, access to new markets has significantly improved food supply. On the other hand, a loss of food self-sufficiency of local communities has also created new risks related to market dependencies, political dynamics, and environmental hazards such as the catastrophic Attabad landslide in 2010 that cut off a large populated area from access to downcountry Pakistan (Sökefeld 2012; Cook and Butz 2013). This raises the question of whether the far-reaching developments since the 1970s have improved or reduced the capacities of local food systems to cope with emerging economic, political, and environmental risks and challenges. Put succinctly: In what way have recent transformations of food systems in Gilgit-Baltistan altered their resilience?

This article deals with this question in an empirical case study of Nagar District in the Karakoram mountains of Gilgit-Baltistan. Little is known about this high mountain community, where research has been largely absent since the 1980s (Frembgen 1985a; Butz 1987). Self-sufficiency in terms of food production used to be relatively high in Nagar compared with neighboring districts (Frembgen 1985b; Kreutzmann 1989: 193), suggesting that recent transformations of food systems have been particularly profound.

Food systems and resilience

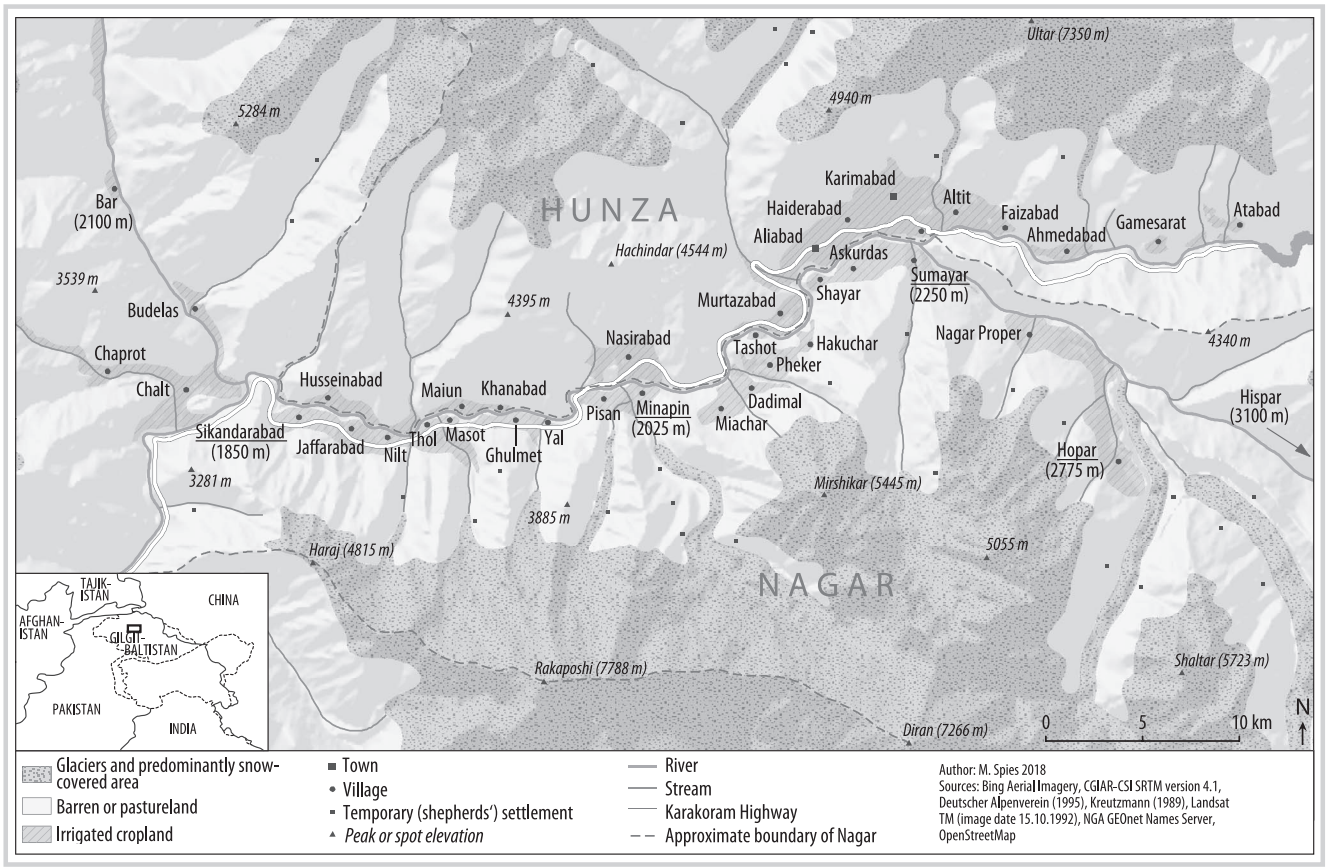
A food system is a complex network of food production, distribution, and consumption defined by its function to meet the nutrition needs of a particular group of people in a certain geographical area (Gliessman 2014: 30–31; Rist and Jacobi 2016: 5). It includes numerous actors or stakeholders (farmers, consumers, retailers, etc), but also natural resources, infrastructure, and immaterial elements such as government regulations, discourses, and food policies (Rist and Jacobi 2016; see also Cannon 2002; Bohle et al 2009; IPES 2015). These heterogeneous elements influence each other in manifold ways, sometimes with unexpected and unpredictable outcomes. Thus, change can be (co)produced by any element related to the food system, including human actors as well as new roads, degrading soils, and food subsidies, for instance. This understanding corresponds to the conceptualization of food systems as complex systems (Ericksen 2008) or assemblages (Dwiartama 2014; Dwiartama et al 2016) that are "heterogeneous over space and time" (Ericksen 2008: 237) and always characterized by nonlinear dynamics: changes are multicausal, sometimes involving complex feedback loops (see Misselhorn et al 2010; Tendall et al 2015). This conceptualization resonates with the multifaceted and dynamic character of food systems described in empirical studies in mountain regions of the global South (Dame and Nüsser 2011; Gautam and Andersen 2017; Limon et al 2017) and is thus adopted here.

Food systems and their constituent elements are subject to constant modifications by wider processes of change linked to regional and global trends. Moreover, with the natural environment being the basis for food production, food systems should always be understood as coupled social–ecological systems—even though "the links between the social and environmental components may be indirect in many cases" (Ericksen 2008: 237). Most food systems are multilocal, involving actors and elements that operate in sometimes very distant places. This makes it difficult to draw geographical boundaries around a food system under investigation. In this article, food systems in Nagar are defined as comprising all elements—local or distant—that make a significant contribution to ensuring the nutrition needs of households in Nagar.

This understanding of food systems as complex and dynamic systems can be linked to the concept of resilience. Resilience can be described as the capacity of a system to endure or respond to disturbance and change while maintaining its basic functions. Originally developed in the field of ecology (Holling 1973), the concept has been widely applied to investigate the responses of social–ecological or other types of complex systems to internal or external disruption (see eg Janssen and Ostrom 2006; Holdschlag and Ratter 2013; Brown 2014; Cameron et al 2015). The resilience concept rejects the mechanistic notion of a universal equilibrium and argues that systems can always have multiple stable states (Hatt 2013; Holdschlag and Ratter 2013). In other words, there is no ideal state of a food system, as resilience can take many forms that historically emerge from the particular constellation and interactions of the elements involved.

The resilience approach has also been subject to debate. In particular, social scientists have criticized the unmodified application of this concept to society that often leads to a neglect of normative factors and power relations (see Cannon and Müller-Mahn 2010; Brown 2014). Bohle et al (2009) argue that prominent resilience approaches fail to properly address individual agency, and recommend shifting from a systems-oriented to a people-centered perspective. Hatt (2013) finds that resilience approaches often adopt a mechanistic, functionalist understanding of social systems that actually contradicts the theorizations of multiple stable states and nonlinear dynamics on which the resilience concept is based (see also Kirchhoff et al 2010).

FIGURE 1 Map of Nagar District and lower Hunza. (Map by M. Spies)



Based on the above conceptualization of food systems, this article adopts a systems-oriented perspective. Nevertheless, individual agents, discursive formulations, and power relations may well play important roles in the resilience of food systems, as they are considered constituent elements or characteristics of these food systems in the first place. To operationalize the resilience concept for this empirical study, the definition by Keck and Sakdapolrak (2013) is found particularly helpful and is adopted here:

> … *a system's capacity to* persist *in its current state of functioning while facing disturbance and change, to* adapt *to future challenges, and to* transform *in ways that enhance its functioning.*
>
> (Keck and Sakdapolrak 2013: 8)

Thus, the resilience of food systems is conceptualized in terms of 3 different dimensions: their capacities to persist, their adaptive capacities, and their transformative capacities. While Keck and Sakdapolrak (2013) apply this differentiation mainly for their concept of "social resilience," it can also be used to investigate the resilience of food systems or any other type of social–ecological system. "Capacities to persist" describe the capability of food systems to endure disturbances or stress without significant change in the systems' properties. "Adaptive capacities" refers to the abilities of a food system to reorganize itself in order to cope with more severe disturbances or changing circumstances that may emerge. Finally, "transformative capacities" describe a food system's abilities to undergo more fundamental changes in its constituent elements and their relationships—not only to adapt to disturbances and change, but also to improve its overall functioning (Keck and Sakdapolrak 2013: 6–8, 10–11). In Nagar in recent decades, these capacities of food systems have been subject to manifold changes.

Study area and research methods

The district of Nagar (36.2°N, 74.5°E) is located in a semiarid mountain valley in the western part of the Karakoram, bordering Hunza to the north and Gilgit to the south (Figure 1). For centuries, Nagar constituted an agrarian "microstate" or princedom governed by an autocratic ruler (*tham*) and a small local elite. As migration was highly restricted, the population lived in relative isolation from neighboring valleys. Formal education was confined to the political and religious elite. Food systems

TABLE 1 Household composition, farm ownership, and income in selected villages of Nagar.[a)]

	Chalt	Sikanderabad	Minapin	Sumayar	Hopar	All villages
Average number of members per household						
Total (including absent)	7.7	8.0	7.2	6.4	7.8	7.4
Absent members[b)]	0.4	0.6	0.5	0.3	0.3	0.4
Members generating off-farm income	1.4	1.4	1.5	1.6	1.1	1.4
Farm-related household ownership: average and median (in parentheses)						
Farmland in *kanal*[c)]	6.9 (2)	4.6 (2.5)	10 (5)	6.9 (5)	10.6 (10)	7.8 (5)
Fruit trees	14.8 (7)	8.8 (5)	22.9 (9)	20.1 (18)	21.4 (18.5)	17.5 (10)
Cattle (incl. calves)	2.5 (2)	1.6 (2)	2.5 (2)	2.4 (25)	3.2 (3)	2.4 (2)
Goats and sheep	1.7 (0)	1 (0)	1.2 (0)	1.4 (0)	6.8 (0)	2.2 (0)
Household income in 2014 in PKR[d)]: average and median (in parentheses)						
Farm income	73,900 (32,500)	23,100 (3000)	50,200 (31,000)	24,600 (15,000)	105,900 (80,000)	54,600 (30,000)
Off-farm income	228,800 (180,000)	250,900 (228,000)	297,900 (180,000)	208,100 (144,000)	174,300 (180,000)	232,300 (180,000)
Share of household income derived from farming	25% (14%)	12% (3%)	31% (21%)	15% (12%)	40% (31%)	24% (16%)
No. of households	29	29	30	30	29	147

[a)] Data source: household survey in Nagar, 2014–2015.
[b)] Absent members: household members living in Gilgit or downcountry Pakistan who are still counted as part of the household.
[c)] 19.8 *kanal* = 1 hectare.
[d)] US$ 1 ~ PKR 105–110.

were essentially local, relying on subsistence agriculture adapted to the high mountain environment. While food was generally in short supply, most farmers had to deliver parts of their agricultural produce as a tax to the ruling class (Frembgen 1985a; Sökefeld 2005).

Local farming practices combine irrigated crop farming in the village lands with animal husbandry that makes use of high pastures during the summer months. With an average of about 0.4 ha per household (Table 1), landholdings are small and characterized by intensive cultivation. Irrigation relies on complex channel networks that utilize meltwater from glaciers and snowfields in higher areas. The main field crops are wheat, potatoes, maize, alfalfa, and buckwheat. Tree fruits, especially apricots, used to be the main source of sugar and are still an important component of local diets. Most households are self-sufficient in milk production by keeping some dairy cows close to their home. Most livestock—sheep, goats, cattle, and yaks—are sent to the pasture areas and are kept mainly for their meat. Moreover, they also provide valuable manure for crop production.

In 1972, the Pakistani government deposed the *tham* and formally integrated Nagar into its political system (Frembgen 1985a). Subsequent reforms and the completion of the Karakoram Highway paved the way for major developments and changes in livelihoods. Government and nongovernmental organizations invested in new infrastructure and initiated development projects in education and agriculture. Education and migration to other parts of Pakistan opened up new income opportunities for men, and in recent years also for women, in public and private sectors (Malik and Piracha 2006; Benz 2014). At the same time, markets in downcountry Pakistan and China became accessible, not only creating opportunities for transboundary trade and for marketing of locally produced crops, but also providing access to a variety of new food and nonfood items.

To study the implications of these developments for local farming and food systems, empirical data were collected during 11 months of field research as part of a larger study on agricultural change in Nagar between 2014

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and 2016. Four settlements were selected as focus villages (Figure 1): Sikanderabad, Minapin, Sumayar, and Hopar. The main research methods informing this article were explorative and focused interviews and informal discussions with more than 100 farmers, village elders, and community activists, mostly in cooperation with local research assistants. Other research methods were repeat photography, field observations, and mappings. Local customs prevented us from interviewing women, resulting in a strict male bias among interview partners that was partly mitigated by a quantitative household survey with female respondents. A local female research assistant conducted a total of 147 standardized interviews in the villages of Chalt, Sikanderabad, Minapin, Sumayar, and Hopar. Unless otherwise indicated, quantitative figures provided in the following are based on this household survey.

During the qualitative and quantitative interviews, issues related to food system resilience were addressed from 2 perspectives: first, from a household perspective via questions on household economy, food production and consumption, sources of livelihood, and related challenges; second, from a more historical, community-based perspective via questions on broader transformation processes. The findings presented in this article are based primarily on the perceptions of the interviewees, but are contextualized through observations, secondary data, and various literature sources.

Changing food systems in Nagar

The political, infrastructural, and socioeconomic developments in Nagar since the 1970s have affected local food systems in manifold ways. The most profound changes can be summarized in terms of 2 interrelated dimensions: livelihood diversification and agricultural change.

Diversification of livelihoods

When asked about important changes during their lifetime, elders from all parts of Nagar report substantial improvements of living conditions. They remember times of starvation in the past due to crop failures, extended winters, and heavy taxation, while today, by contrast, "it is easy to find food, like Basmati rice from the Punjab" (interview in Chaprot, 4 September 2016). They emphasize the role of new income opportunities for these improvements—primarily in the off-farm sector, but also through marketing of cash crops. Today, about two thirds of the male and 7% of the female workforce aged 25–65 years are primarily engaged in the off-farm sector. About 36% of them are employed in the state sector (including the army), 32% work as skilled or unskilled laborers, 19% work for private enterprises, and 12% have their own business, such as a tearoom, shop, or trade enterprise. Today, the average share of off-farm income of the total household income is over 75% (Table 1). Although most households still produce much of their consumed food themselves—such as vegetables, fruits, and milk—the larger share of food is now purchased, in particular wheat, the local staple food.

While wheat used to dominate the cropland of Nagar, the survey shows that today, households produce wheat on only about 0.06 ha on average—that is, on about 15% of their total farmland (about 0.4 ha; see Table 1). Local yields vary strongly, but on this area of land a household can typically produce about 100–300 kg of wheat per year. Interviewees report average annual wheat consumption of about 100–150 kg per person. Thus, with an average household size of 7 permanent members (Table 1), only around 10–40% of the annual demand for wheat is met by individual household production. However, this figure varies strongly between households because of uneven distribution of land. As reflected in the difference between median and average values in Table 1, inequalities in land ownership are particularly high in the villages of Chalt, Sikanderabad, and Minapin, where families of the former political elite reside. Despite a high government subsidy on wheat imported from downcountry Pakistan, daily consumption items—mostly food items like wheat, cooking oil, sugar, rice, lentils, and tea—form the biggest household expenditure: households spend an average of about 50% of their income on daily consumption items, followed by education (26%), periodic investments (11%), health (10%), and other expenses (3%). Hence, most households rely on off-farm incomes as the main source of food security today.

This shift towards off-farm sources of livelihood is not only the result of new opportunities, but also perceived as a necessity: as possibilities for expanding agricultural land in Nagar are limited, local informants emphasize that population growth has led to a substantial decline in landholdings per household: "The pieces of land are getting smaller, so without employment, one cannot feed his family" (interview in Sikanderabad, 20 September 2014). Since 1972, the population of Nagar has increased from about 25,000 to between 60,000 and 70,000 inhabitants (Government of Pakistan 1972, 2000; projections based on a postulated annual growth rate of 1.5%). During this time period, the local custom of partible inheritance has led to a shrinkage of average farm sizes by likely over 50%. As revealed by comparison of a map based on expeditions in 1954 and 1959 (Deutscher Alpenverein 1995) with recent Google Earth imagery, most of the cropland found in Nagar today was already used agriculturally in the 1950s. Potentials for expansion still exist, but they are limited to areas with difficult terrain or a scarcity of irrigation water (see Spies 2016). In addition, changes in the farming systems themselves have further reduced the self-sufficiency of households in terms of food production.

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FIGURE 2 Cropland of Sikanderabad, Nagar, (A) on 26 October 1985; (B) on 26 October 2014. (Photos by [A] Hermann Kreutzmann; [B] M. Spies)

Transformations of farming systems

Comparison of a photograph of Sikanderabad in 1985 (Figure 2a) with the current situation (Figure 2b) reveals considerable changes in the agricultural landscape. Many new buildings have been constructed, encroaching on farmland. Field plots have become smaller—mainly as a result of land partition, but also because of changes in cropping patterns: in the 1980s, cultivation was largely dominated by a first crop of wheat, followed by a second crop of maize. Today, most farmers cultivate potatoes as the dominant first crop, producing wheat only on a smaller share of their land.

Produced for the large markets in the Pakistani Punjab, potatoes are now the main cash crop of Nagar. Various factors contributed to this development beginning in the early 1990s: road improvements, the appearance of new traders, and improved access to chemical fertilizer and modern seed varieties introduced by development organizations, but also the above-mentioned government subsidy of wheat. Introduced in the 1970s to provide Gilgit-Baltistan with wheat at the same price as in downcountry Pakistan (Kreutzmann 1989: 189), the relative and absolute amounts of the subsidy have successively increased: in 2016, the local price of a

40-kg bag of subsidized wheat was around PKR 650 (US$ 1 = PKR 105–110), while consumers in Karachi and Islamabad had to pay as much as PKR 1300–1500 for the same amount (Pakistan Bureau of Statistics 2017). This has made it very profitable for farmers to cultivate potatoes for the markets, while using earnings to purchase wheat: for 40 kg of potatoes, the local price can be as high as PKR 1000–2000, and yields of potatoes are several times higher than those of wheat.

Further, comparison of Figure 2a and Figure 2b reveals another important agricultural change that applies to all villages in Nagar: a significant increase in the number of fruit trees, especially apricot, apple, and cherry trees. Again, these fruits are mainly produced for the markets in downcountry Pakistan. Besides improved road access and new trade networks, development organizations have played important roles by promoting the expansion of commercial fruit production and by establishing local tree nurseries since the mid-1980s. Moreover, the increase in fruit production must also be understood in relation to wider livelihood changes. Because of its lower labor demand compared to arable farming, fruit production has become increasingly attractive for households, as off-farm employment and education have led to a significant reduction of the agricultural workforce. In recent years, the production of cherries has become particularly worthwhile: prices are exceptionally high, and farmers sell the production of their whole cherry orchard for a lump sum to local traders. The traders then take care of the picking, packing, and transport of cherries by themselves. Farmers in Sikanderabad and Minapin report earnings of about PKR 75,000–100,000 from cherry trees planted on about 0.05 ha of land, which is significantly more than the highest reported earnings from potatoes produced on a similar area. Consequently, many farmers increasingly plant cherry trees on their farmland.

Apart from this apparent commercialization of crop production, other farming practices have significantly changed as well. Among them, the most pronounced change has been the decline in animal husbandry reported in all parts of Nagar. Largely because off-farm employment and education opportunities have made it difficult to find young men willing to work as shepherds, total livestock numbers have decreased considerably—this despite a rising demand for meat and milk products due to population growth, income improvements, changing food customs, and other factors. In Brushal, Hopar, for instance, a livestock census in 1985 counted 775 cattle and about 3700 sheep and goats (AKRSP 1985); according to local estimates, the village population currently owns around 300–500 cattle and 1500–2000 sheep and goats.

Overall, the shortage of people willing or able to work in agriculture has led to an abandonment of valuable resources—not only the rich pasture areas at higher elevations, but also irrigated fields in more remote places above the village lands, as observed in Pisan, Minapin, and Hopar, among others. This seems contradictory to the increasing land shortage described above, but implies that new opportunities and aspirations brought about by education, work migration, and local jobs or businesses have had more pronounced effects on food system changes than limitations imposed by the natural environment. This observation is also reflected in the fact that households increasingly build larger and more comfortable houses at the expense of irrigated cropland (Figure 2a, b). Moreover, there are complex interrelations or feedbacks between these processes: decreasing farm sizes and the difficulties involved with cultivating remote land have certainly contributed to changing livelihood ideals and a reduced commitment to agriculture. In what way have these changes altered the resilience of food systems in Nagar?

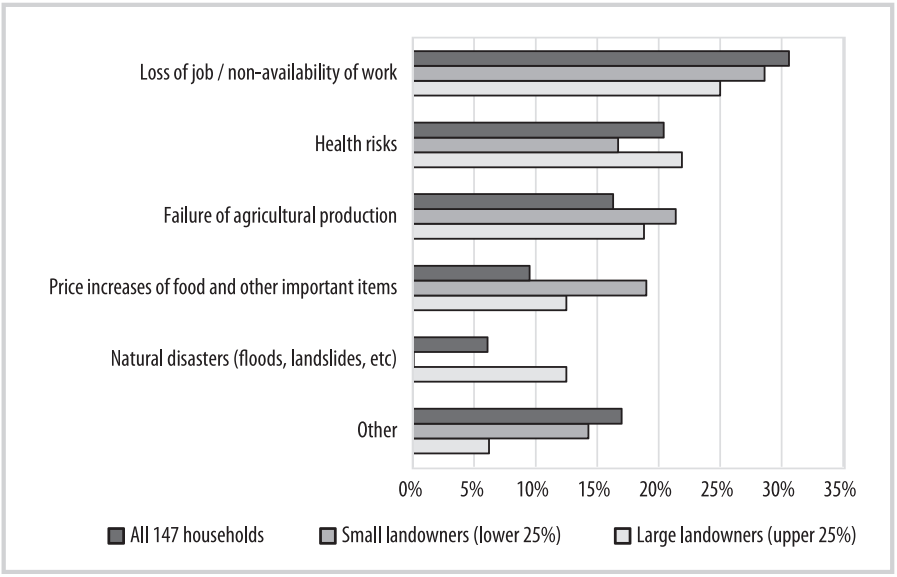
Changing resilience of food systems in Nagar

There is an overwhelming perception among people in Nagar that food security has greatly improved because of the far-reaching livelihood transformations of recent decades. Food shortages that regularly occurred before first harvest in the late spring months are no longer an issue, and weather-related crop failure or livestock losses can be buffered through off-farm incomes and access to affordable food supplies from downcountry Pakistan.

Returning to the 3 dimensions of resilience defined earlier, it can be argued that the manifold changes of food systems in Nagar have demonstrated their capacity "to *transform* in ways that enhance [their] functioning" (Keck and Sakdapolrak 2013: 8). Through the integration of diverse new actors and elements related to markets, off-farm livelihoods, and government policies in Gilgit-Baltistan and beyond, the food security of the local population has increased considerably. At the same time, the capacity of food systems "to *persist* in [their] current state of functioning while facing disturbance and change" (Keck and Sakdapolrak 2013: 8) has improved significantly. The transformation from subsistence farming to diversified livelihoods and the increased multilocality of food systems have led to diversification of risks, thus increasing people's resilience when faced with local production failures that once had severe consequences. These processes have also apparently improved the capacity of food systems in Nagar "to *adapt* to future challenges" (Keck and Sakdapolrak 2013: 8) through increased ability to flexibly draw on a variety of income and food sources in Nagar and beyond.

At the same time, the changes described have also had negative implications for food system resilience. Elders often point to a decrease in food self-sufficiency when discussing the effects of changing farming systems. They describe farming as a more sustainable source of livelihood than off-farm incomes, as households are more autonomous when they can use their own resources at

FIGURE 3 Ranking of threats to households' wellbeing, livelihood, and food security. Only the highest-ranked threats or "problems" (Urdu: *masla*) are presented here. The 5 main threats were identified during exploratory qualitative interviews, and the 147 respondents were free to include other threats in their ranking. The interviewees were asked to rank the threats according to the severity for their household, including aspects of general wellbeing, livelihood, and food security. The ranking results are differentiated according to the land ownership status of the households. (Data source: same as Table 1)



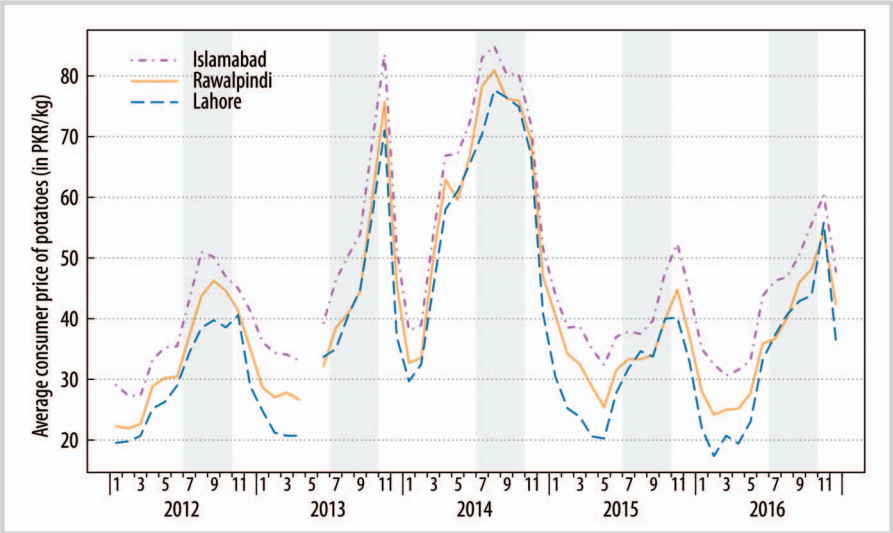
hand. As only about one third of income-generating household members have relatively secure jobs in the public sector, most sources of off-farm income are vulnerable to economic and other crises such as a sudden illness of the main income earner. As revealed by a ranking of threats conducted in our household survey, loss of a job and nonavailability of work are considered the main threats facing households, followed by health risks (Figure 3). A degree of self-sufficiency in terms of food production can help a household to cope with such challenges—not without reason, selling of agricultural land is generally disapproved of in Nagar. Nonetheless, the problem of decreasing farm sizes remains. The median area of farmland owned by households is 0.25 ha including orchards, making it virtually impossible for the majority of households to achieve food self-sufficiency: this amount of land just suffices to produce enough wheat for an average household size in Nagar, but only at the expense of fruit production, crop rotation, and fodder production needed for livestock. In addition, several other developments have contributed to loss of self-sufficiency. First, the expansion of fruit orchards has reduced the land resources that can be utilized to produce food staples in times of need. Second, the decline of animal husbandry and the abandonment of more remote fields have narrowed the overall resource base utilized for subsistence production. Third, yields in the village cropland have reportedly decreased because of improper cultivation practices and reduced soil productivity. Elder farmers often complain about a loss of commitment in the farming practices of their fellow villagers: "Nowadays, young people don't put proper attention to crop production—so the production has decreased! So, it is important to work hard" (interview in Sikanderabad, 20 September 2014).

Moreover, many farmers observe a decline in soil productivity, interpreting it as a result of increased potato production that is often accompanied by insufficient crop rotation and excessive use of synthetic fertilizer. Aware of the negative effects of these practices, farmers appear to accept them as a trade-off in return for higher yields of profitable potatoes. Furthermore, the scarcity of livestock manure has likely caused a significant reduction in organic soil content, which mineral fertilizers cannot make up for, thus adding to the nutrient depletion of soils.

Notwithstanding the overall improvement in food security, the decrease in food self-sufficiency has led to a variety of new risks and challenges that may impact the resilience of food systems in Nagar in the future:

1. *Political dependencies*. The government subsidy on imported wheat has become a constituent element of local food systems, thus creating a strong dependency on the central government. A withdrawal or significant reduction of this subsidy could cause major food crises for poorer households, who have neither the income nor the agricultural resources needed to buffer rising food prices. Not surprisingly, attempts by the central government to reduce the subsidy have been met with heavy protests in Gilgit-Baltistan (Anonymous 2012; Nagri 2014). As shown in Figure 3, almost 20% of respondents with relatively little farmland rank price increases of important consumption items—mainly food—as the biggest threat to their household.
2. *Market dependencies and economic risks*. While the wheat subsidy has buffered price changes of the main staple food so far, price fluctuations can also indirectly affect

FIGURE 4 Fluctuations of potato prices in selected cities of the Punjab (Pakistan) between January 2012 and December 2016. Gray areas indicate the months of potato harvest in Nagar. While prices during these months were at a record high in 2014, they dropped to less than half of 2014 prices in the following year, causing major income losses for farmers in Nagar. (Data source: Pakistan Bureau of Statistics 2017)



food security through loss of income: in recent years, local potato prices have fluctuated by as much as 300% from year to year because of complex market dynamics in downcountry Pakistan (Figure 4). Other economic risks related to the loss of food self-sufficiency include the already mentioned dependency on off-farm incomes.

3. *Environmental risks*. The dependency of food systems on food imports has also affected their resilience to natural hazards. Since its completion in 1978, the maintenance of the Karakoram Highway has successively been improved and road blockages seldom take more than a few days to get cleared. Nevertheless, in April 2016, the Karakoram Highway between Nagar and Islamabad was blocked for several weeks following heavy rainfall, and the Attabad landslide in 2010 cut off large parts of neighboring Hunza for almost 6 months (Cook and Butz 2013). The Attabad disaster revealed a functioning relief system with emergency supplies from China (Sökefeld 2012), but certain worst-case scenarios are still conceivable, such as major earthquake-triggered landslides blocking the valleys from different sides.

In other ways, the diversification of food systems has also increased their resilience to environmental risks. Floods and landslides often damage irrigation systems, leading to yield losses or even crop failure. Extreme rainfall events in the Karakoram may become more frequent because of a projected intensification of the Indian summer monsoon (Hewitt 1993, 2006; IPCC 2014: 1334). Moreover, informants in Nagar report a significant reduction of snowfall in recent decades, probably as a result of warming winters in the region as observed by Bocchiola and Diolaiuti (2013). These possible future effects of climate change would predominantly affect agriculture and further decrease food self-sufficiency.

Overall, the increased complexity and multilocality of food systems in Nagar have made them more resilient to food crises. The variety of risks has increased, and food system resilience is now more affected by nonlocal factors as compared to the 1970s. However, an increased variety of risks does not necessarily mean a decrease in resilience, as the severity of their impact needs to be taken into account. While each of these risks has the potential to create major disturbances, they affect only certain elements of the food system, not the system as a whole—at least not as fundamentally as production failures in the past did, when food systems mainly relied on local agriculture.

Nevertheless, local food production remains an important element of the food systems in Nagar, and the current underutilization of pastures and more remote land resources suggests that some potential exists to further improve self-sufficiency. This potential could be utilized to buffer future challenges such as economic crises or a possible withdrawal of the wheat subsidy. In 2016, for instance, the government of Gilgit-Baltistan started to promote the expansion of yak keeping in selected villages of Nagar to improve self-sufficiency in meat production. Still, it remains to be seen whether, and to what extent, this program accounts for wider food system transformations and addresses the shortage of people willing or able to work as shepherds.

The present case study has shown that food system resilience is inextricably linked to highland–lowland interactions. These findings likely hold true for Gilgit-Baltistan as a whole, as a very similar set of factors—the government wheat subsidy, new sources of income, access to downcountry markets, etc—has led to a transformation of livelihood and farming systems in other communities of

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the region (Pilardeaux 1997; Dittrich 1998; Kreutzmann 2006).

Moreover, it can be assumed that political, socioeconomic, and infrastructural developments have reshaped local food systems in a similar manner in most parts of the Hindu Kush–Himalayan region. As Hussain et al (2016: 932) found in a large-scale survey conducted in high mountain regions of Pakistan, India, Nepal, and China, households relying on farming as the main source of livelihood have become more the exception than the rule.

Conclusion

This article has provided some insights into the far-reaching transformations of food systems in Nagar as a result of major livelihood changes and processes of agricultural change. It has shown how these changes have made food systems more resilient to current and future challenges through livelihood diversification and improved access to food supplies beyond local production. Thus, contrary to the general assumption of the FAO study cited in the introduction of this article (FAO 2015), the vulnerability of local households to food insecurity has generally decreased.

This finding shows that measuring food security in mountains purely on the basis of self-sufficiency in food production (FAO 2015) is misleading. Such a 1-dimensional perspective may have been applicable some decades ago, but in an increasingly globalized world the multifaceted character of food systems calls for a multifaceted approach in research and food policy. Programs to improve food self-sufficiency can make an important contribution to resilience building, but their effect may be very limited if other elements of the increasingly complex food systems are not addressed. Depending on the local context, more indirect policy measures, such as fostering new sources of off-farm income, should be regarded as equally or even more important to improve food system resilience.

The conceptualizations of food systems and resilience outlined earlier have helped to apply a relatively broad and open research approach that emphasizes the heterogeneity of actors, elements, and processes that shape food systems in complex and often nonlinear ways. As the idea of "multiple stable states" implies, the study has also shown that resilience should not be understood as a universal condition: changing circumstances also require new forms of resilience. Regardless of the concepts and terminology used, this article has shown that research and policy related to food security must always take a systemic view of the multidimensional and multilocal relations shaping food systems in mountains and elsewhere.

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