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Tajikistan's vulnerability to climate change

by

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Tajikistan's vulnerability to climate change[1]

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Tajikistan is classified by the World Bank as one of the CIS countries that are most vulnerable to climate change risks. This paper provides a closer look at a set of variables that determine Tajikistan's vulnerability to risk in general and to climate change risk in particular. After presenting some background information on Tajikistan (Chapter 1), we provide a conceptual introduction to vulnerability and discuss some quantitative approaches to vulnerability assessment that have been recently applied in the literature (Chapters 2-4). We then use official statistical data for Tajikistan to assess quantitatively a range of basic variables that are recognized in the literature as determinants or drivers of vulnerability (Chapter 5). These variables include measures of income and poverty, debt and financial insecurity, agricultural land and livestock endowments, as well as population density and irrigation as measures of stress on land and water resources. Farm commercialization and diversification strategies are considered as factors that increase family incomes and reduce risk, thus mitigating vulnerability. The statistical analysis provides a quantitative picture of the components of Tajikistan's vulnerability and their changes over time. In the end we briefly consider food insecurity and its implications for Tajikistan's vulnerability (Chapter 6). The concluding chapter presents a summary list of variables that can be used to assess the dimensions of vulnerability and resilience for Tajikistan.

[1] This paper was written as a background study for the Pilot Program for Climate Resilience (PPCR) in Tajikistan, Phase 1, Component A5, Agriculture and Sustainable Land Management (SLM), February-August 2011. The author has benefitted from fruitful discussions with the PPCR team in Dushanbe – Bettina Wolfgram, Shane Stevenson, Julie Zaehringer, and Hanspeter Liniger.

1. Tajikistan: country background

Tajikistan is a highly agrarian country with a rural population of more than 70% of total and agriculture accounting for 65% of employment and around 25% of GDP (averages for 1995-2009). As is typical of economies dependent on agriculture, Tajikistan has low income per capita. Back in the Soviet period (1990) Tajikistan was the poorest republic with a staggering 45% of its population in the lowest income "septile" (Uzbekistan, the next poorest in the Soviet ranking, had 34% of the population in the lowest income group). Today Tajikistan still has the lowest income per capita among the CIS countries, which practically puts it at the border line between Middle Income and Low Income countries. Tajikistan's GDP per capita in 2009 was around $2,000 (PPP, current international dollars), compared with $18,000 for Russia, $7,000 for Azerbaijan, and $6,000 for Ukraine (WDI 2009).). Tajikistan also has high rural poverty: 43% of the rural population live below $2.15 per day (PPP), compared with 30% for the urban population (TajStat 2010). These poverty rates based on the 2009 standard of living survey are lower than the corresponding rates recorded in 2003 and 2007, showing a clear decline in poverty headcounts over time. Comparison with other Central Asian countries shows that in 2003 Tajikistan had the highest rate of rural poverty in Europe and Central Asia region: 76% of the population lived below $2.15 per day (PPP) compared with 72% in Kyrgyzstan and 55% in Uzbekistan (World Bank 2003: 242). The highly agrarian structure of employment in the economy and the high rates of rural poverty imply that improvements in agricultural performance have substantial potential to improve the livelihoods of the rural population.

Land and water resources

Tajikistan is a mountainous country, with 93% of its surface area taken up by a complex of east-west and north-south ranges forming the Tyan-Shan and Pamir systems. Almost half the country is at altitudes of more than 3,000 m. Huge glaciers covering more than 8,000 sq. km, mainly in the Pamir Mountains, are the primary source of water for Tajikistan's many rivers. Tajikistan is second only to Russia in its water resources among the CIS countries, and its glaciers also feed the rivers of Uzbekistan to the west.

Cultivable agriculture in this mountainous country is confined primarily to irrigated river valleys. There are only four well-defined valley systems in Tajikistan:

(1) the Ferghana Valley in the north of the country along the Syr Darya (this is the south-western part of the valley that stretches from Uzbekistan into Tajikistan);
(2) the broad Khatlon lowlands in the south-west, extending from Kulyab in the east to the border with Uzbekistan in the west;
(3) the Gissar Valley between Dushanbe and Tursunzade, just north of Khatlon;
(4) the narrow strip of the Zeravshan Valley extending east to west between Ferghana and Gissar valleys.

The climate in Tajikistan is warm and dry and arable agriculture is heavily dependent on irrigation. Crop production in water-abundant river valleys was maximized by the traditional expedient of extending artificial irrigation networks. The irrigation-ready area increased from 450,000 hectares in 1960 to 700,000 hectares in 1990, and stabilized thereafter at around 720,000 hectares, 80% of this in arable land. However, the physical condition of the irrigation network has steadily deteriorated since independence and today much of the irrigation infrastructure (pumps, metal pipes, concrete conduits) is not functioning, leaving significant portions of irrigation-ready area without water

deliveries. Tajikistan does not appear to suffer from water shortage in the usual sense: there is an abundance of water flowing in the rivers and the main irrigation canals. This water, however, does not always reach the agricultural end-users due to weak and degraded infrastructure. Effective shortages of irrigation water reaching the fields are acutely exacerbated during the spring, when low water levels in hydroelectric power stations lead to country-wide power shutdowns, rendering inoperable the old electric pumps on which most of the irrigation network still relies.

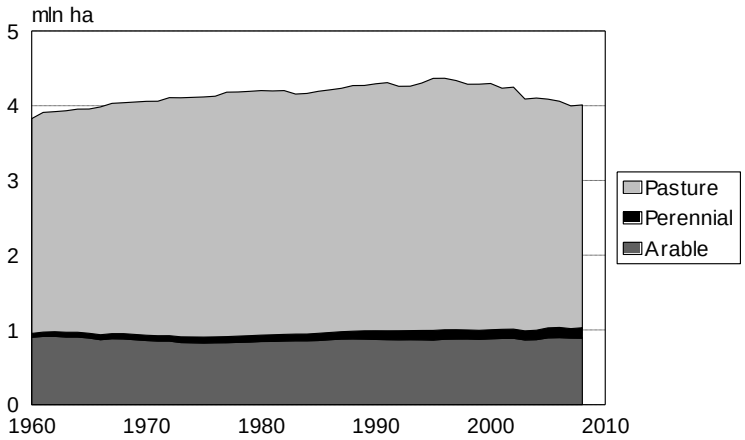


Figure 1.1. Composition of agricultural land, 1960-2008 (million hectares). Source: Agriculture in Tajikistan, various years.

Less than 30% of Tajikistan's territory is agricultural land. The stock of agricultural land in Tajikistan increased gradually and slightly from 3.8 million hectares in 1960 to 4.3 million hectares in 1990-1995 and then declined back to 4.0 million hectares in 2009 (**Figure 1.1**). Pastures dominate the structure of agricultural land in Tajikistan, as in all Central Asian countries: they account for more than 75% of agricultural land over the entire period. Only the remaining 25% (just 7% of total territory) is cultivable – arable land and land under perennials. The area of arable land has remained fairly constant at around 850,000 hectares since 1980 (**Figure 1.2**), while the rural population more than doubled from 2.6 million to 5.5 million. The density of rural population per hectare of arable land accordingly rose from 3.1 per hectare in 1980 to 6.3 per hectare in 2009. The stress of rural population on arable land resources in Tajikistan is similar to that in Kyrgyzstan, Turkmenistan, and Uzbekistan, but an order of magnitude higher than in Kazakhstan, Russia, and Ukraine

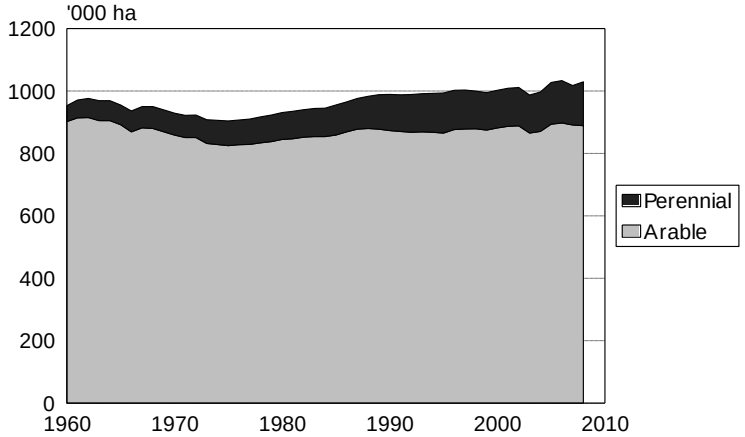


Figure 1.2. Composition of cultivable land, 1960-2008 ('000 hectares). Cultivable land is divided into arable land (thick bottom gray layer) and land in orchards and vineyards (thin top black layer); arable includes fallow. Source: Agriculture in Tajikistan, various years.

Since cultivable land – arable land and land under orchards and vineyards – has generally remained steady at around 1 million hectares since 1990 (**Figure 1.2**), the slight decline in total agricultural land observed since 1995 (**Figure 1.1**) is the outcome of declining pastures, not shrinking arable land. Between 1995 and 2009 pastures shrank by more than 400,000 hectares – a decrease of 12% from 3.4 million hectares to 3 million hectares. Cultivable land increased during the same period by

36,000 hectares – a positive change of 4%. Because of the huge area differences between pastures and cultivable land it is impossible to detect from country level data any possible conversion of one land use type into another. Since the decrease in pastures was accompanied by a commensurate decrease in total agricultural land (370,000 hectares – the balance between decrease in pastures and increase in cultivable land), we can only conclude that more than 10% of pastures was generally abandoned and withdrawn from agricultural use between 1995 and 2009. This may have been an outcome of increasing degradation (due to natural conditions) and exhaustion (due to overgrazing) of Tajikistan's pastures.

The structure of land resources shows considerable variability across regions (**Figure 1.3**). GBAO is clearly the least agricultural region, with negligible endowments of cultivable land. Sughd is the most agricultural region, with more cultivable land than even Khatlon. RRP occupies an intermediate position, with 80% of its agricultural resources in pastures. Irrigation coverage follows the same pattern: the share of irrigated agricultural land is just 3% in GBAO, 20%-30% in Khatlon and Sughd, and 10% in RRP.

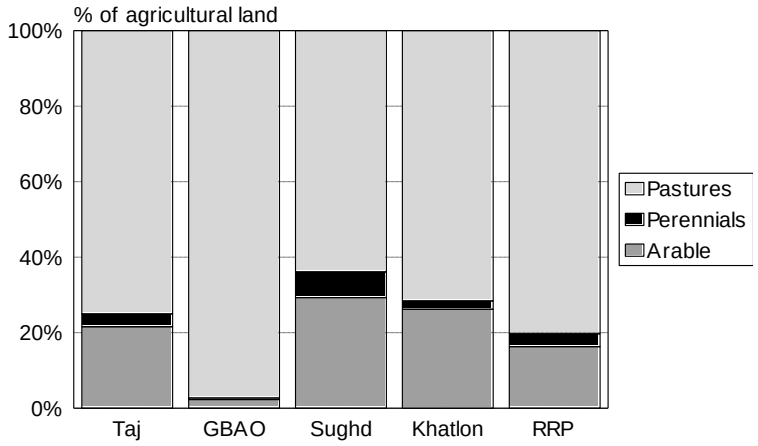


Figure 1.3. Structure of land resources by region, 2009. Source: Agriculture in Tajikistan 2010.

Despite persistent reports of massive land degradation in Tajikistan, there is no statistical evidence of significant abandonment of agricultural land beyond the 10% loss of pastures. Abandonment of farm land can be measured by the difference between the total stock of arable land (the potential for crop production) and the actual cropped area. Kazakhstan, Kyrgyzstan, Russia, and Ukraine all suffer from large-scale abandonment of arable land since 1990: the sown area in these countries has declined relative to the available stock of arable land. In Tajikistan the cropped (sown) area actually increased during the transition (especially after 1995, see **Table 1.1**) and since 2000 the ratio of sown to arable land has been around 100%, implying that virtually all available arable area is reported under crops (**Figure 1.4**). Farm surveys also generally show that most of the land allocated to farms is cultivated, with very little land left unused. In the World Bank's 2009 CSRP baseline survey, the unused portion of land in surveyed farms was less than 1%. The glaring inconsistency between the reported statistical data and the general feeling of observers that there are large areas of unused land requires close examination and further study. It may be that much of the arable land officially reported as sown or cropped is in fact badly exhausted and therefore produces much below average yields. However, this is not observed in harvest and crop yield statistics, which generally track the sown areas and do not reveal troubling signs of under-productivity (possibly with the exception of cotton).

Table 1.1. Utilization of arable land 1980-2009

	Total sown, '000 ha	Arable (incl. fallow), '000 ha	Ratio of sown to arable, %
1980	763.6	845	90
1985	802.8	859	93
1990	824.2	873.3	94
1995	758.0	865.1	88
1998	827.6	879.1	94
2000	864.3	881.7	98
2003	886.9	865.3	102
2006	900.2	897.7	100
2007	891.1	891.4	100
2008	888.9	889.0	100
2009	875.1	884.6	99

Source: Prior to 1995 from CISSTAT; 1995-2009 from Agriculture in Tajikistan, various years.

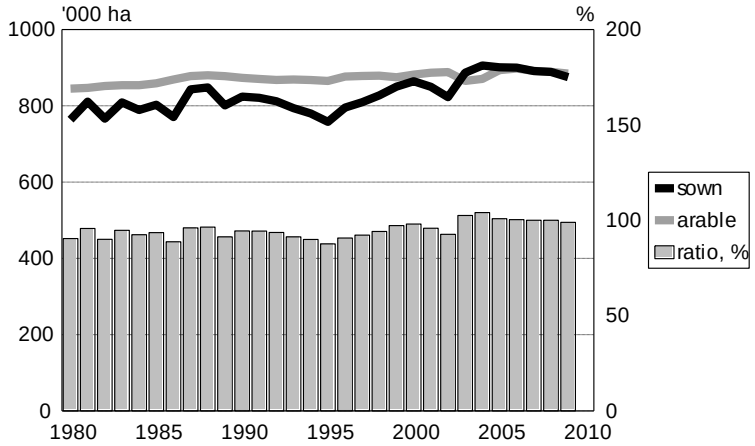


Figure 1.4. Utilization of arable land in Tajikistan 1980-2009. Gray curve – arable land, black curve – cropped area, bars – cropped area in percent of arable land. Source: Prior to 1995 from CISSTAT; 1995-2009 from Agriculture in Tajikistan, various years.

Land reform and changes in farm structure

Land in Tajikistan is exclusively owned by the state and is given to farmers and households in use rights. The essence of land reform is therefore reallocation of state-owned agricultural land among producers through the mechanism of land use rights – not land privatization. Since 1992 agricultural land has been mostly reallocated from the Soviet-era collective and state farms to so-called dehkan (peasant) farms, which exist in three organizational forms: individual dehkan farms, family dehkan farms, and partnership (or "collective") dehkan farms. Individual and family dehkan farms are the smallest (about 5 hectares on average) and partnership dehkan farms the largest (100-200 hectares), but the number of large partnership dehkan farms is rapidly shrinking as part of the government's program to reallocate land to individual farm members. Dehkan farms coexist with household plots – the traditional smallholder "private" agriculture that continues from the Soviet era after substantial augmentation with "presidential lands" (allocated by presidential decrees in two waves in 1995 and 1997). Despite the expansion, household plots remain very small, averaging 0.3 hectares, an order of magnitude smaller than the average dehkan farms.

Every rural family has a household plot. Therefore, every dehkan farm, in addition to land it received through reallocation of the holdings of former collective and state farms, also has a household plot assigned to the farmer's family. Not every rural resident, however, is a dehkan farmer: there are 750,000 rural households in Tajikistan (all with household plots) and only 50,000 dehkan farms. The huge number of household plots accounts for the small average size of these plots.

The land reform in Tajikistan has had two main effects in terms of the allocation of arable land to different farm types. First, nearly 20% of arable land is now in household plots, which represents a many-fold increase from the traditional 4%-5% in the Soviet period. Second, dehkan farms increased in area from less than one-half percent of arable land in 1995 to 65% in 2009. The family farm sector, combining household plots and dehkan farms, thus accounts for 85% of arable land in 2009, up from just 5% in 1991, while the share of agricultural enterprises (the corporate farms that succeeded the traditional collective and state farms) has dropped from 95% in 1991 to just 25% in 2009 (**Figure 1.5**). As the number of partnership ("collective") dehkan farms is also rapidly shrinking, we conclude that land use in Tajikistan has been effectively individualized since 1991.

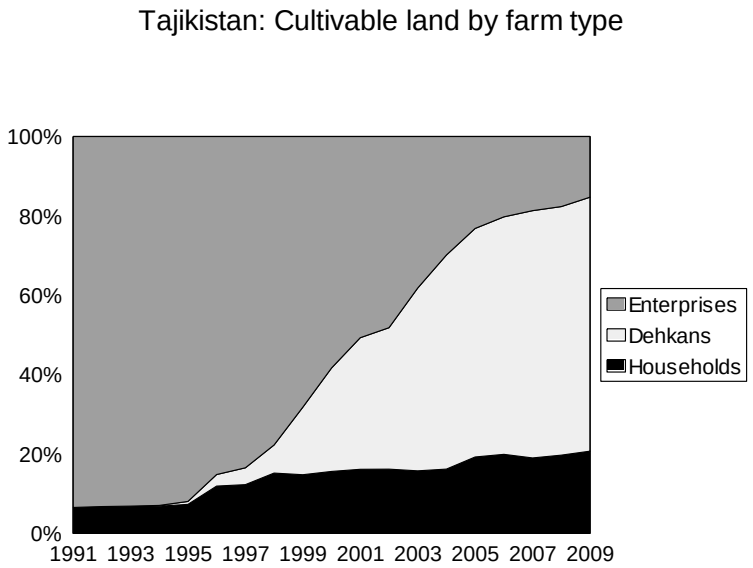


Figure 1.5. Structure of cultivable land by farm type 1991-2009. Cultivable land combines arable land and land under perennials. Source: Agriculture in Tajikistan, various years.

The increase of land resources in household plots has inevitably led to an increase of their share in agricultural production (as measured by GAO – Gross Agricultural Output). While the share of agricultural enterprises (production cooperatives and traditional collective and state farms) in GAO dropped from 65% in 1995 to less than 10% in 2008, the share of household plots soared from 35% to 65%. The remaining 25% come from dehkan farms – the second component of the individual farm sector that started to contribute after 1997. Agricultural production, like land use, is now fully individualized in Tajikistan. Since household plots produce 65% of agricultural output on less than 20% of arable land, they are obviously much more productive than other farm types.

Use rights are legally conferred by a so-called land use certificate issued by the land authorities. According to latest information from the World Bank and the State Agency for Cartography and Geodesy (March 2011), 42,000 land use certificates have been issued, covering 85% of all dehkan farms. So far, land is nontransferable and mechanisms for transferability of land use right certificates may be incorporated in the next revision of the Land Code. Because of nontransferability of land use rights, land in practice cannot be mortgaged or used as collateral for credit (although this is theoretically allowed by the Law on Mortgage). Due to these marketability constraints land in Tajikistan cannot be regarded as a store of value for rural people in the same sense that livestock, machinery, or farm buildings are a store of value. Yet land is the main productive asset in agriculture and is thus an important source of income for the rural population. In a representative survey of 11,600 rural households conducted by TajStat in November-December 2010, 20% identified agriculture as the only or main source of income, while another 75% reported that agriculture was a supplementary income source.

2. Vulnerability: basic concepts and assessment principles

An individual or a household is *vulnerable to risks* (e.g., risks associated with climate change) if these risks may result in a loss of well-being to a level below some threshold. The opposite of vulnerability is resilience: an individual or a household not vulnerable to risk is characterized as resilient. The transition from vulnerability to resilience is continuous, encompassing a whole spectrum of gradations or states determined by different combinations of variables.

Vulnerability is a function of three dimensions:

- *Exposure to risks:* the chance that assets and livelihoods will be impacted by risk
- *Sensitivity to risks:* the susceptibility of assets and livelihoods exposed to risk
- *Adaptive capacity*: the ability to deploy social risk management strategies (i.e., adjustments in assets, livelihoods, behaviors, technologies, or policies) for reduction of risk and human vulnerability; adaptive capacity signifies ability to recover from, to prevent, or to mitigate the effects of risk.

For analytical purposes, vulnerability is generally regarded as dependent on two distinct sets of variables that directly impact on risks: geo-climatic (environmental) variables and socio-economic variables. The assignment of the two sets of variables – geo-climatic and socio-economic – into three sets of vulnerability dimensions – exposure, sensitivity, and adaptive capacity – is of necessity fuzzy. Nevertheless, it seems that geo-climatic variables mainly determine exposure to risks. These include, for instance, variability of temperature and precipitation, frequency of extremely hot and cold months, frequency of extremely dry or wet months, frequency of weather-related disasters, propensity to natural disasters (such as mudslides), and topographic indicators characterizing the mountainous nature of the terrain and the steepness of slopes. Geo-climatic variables in principle should also include indicators related to soil quality and soil degradation (water and wind erosion, salinization). Socio-economic variables largely determine the sensitivity to risks and the adaptive capacity, i.e., the ability to recover, prevent, or mitigate the effects of risks. These variables mainly characterize the sustainability of agricultural production under conditions of uncertainty, the income levels, and the various endowments, including both physical and human capitals. They also include a set of institutional measures relating to political stability, government effectiveness, rule of law, and control of corruption. Food insecurity measures, classifying households into severely food insecure, moderately food insecure, or food secure on the basis of per capita food consumption and household income sources, are also regarded as one of the components of vulnerability. In the conventional livelihoods framework the geo-climatic vulnerability variables loosely correspond to the natural capital, while the socio-economic variables correspond to physical and human capitals. In the absence of a rigorous theoretical framework, the choice of variables for vulnerability remains largely ad hoc, with different researchers and projects choosing different sets of variables to characterize vulnerability. The diversity of variable choices is demonstrated in the examples that follow.

There are two basic approaches to quantitative assessment of vulnerability in the recent literature. One approach combines the set of chosen variables into a single aggregated measure of vulnerability – the Vulnerability Index, the values of which make it possible to rank regions by hierarchically increasing vulnerability. This strand is best represented by recent World Bank work (Heltberg and Bonch-Osmolovskiy 2011). The other approach applies cluster analysis to classify a set of disaggregated variables into a limited number of relatively tight groups or clusters, which are then ranked by heuristic vulnerability descriptions. Each region in the universe under study is assigned to one of the clusters. This strand of research is represented by work carried out at the Potsdam

Institute for Climate Impact Research and other European institutions (see, e.g., Sietz et al. 2011, Kok et al. 2010, Sterzel et al. 2009). The Vulnerability Index approach has been applied to establish a comparative vulnerability ranking of the 28 countries in the World Bank's Europe and Central Asia (ECA) region (World Bank 2009; see **Tables 3.1-3.3** for more details) and, on a higher resolution, to rank Tajikistan's ten agro-climatic zones by vulnerability. The cluster-analysis approach, on the other hand, has been carried out on a global scale, covering the world's drylands, and the resolution is too coarse to obtain vulnerability rankings within Tajikistan or even among Central Asian countries. A special effort is required to collect district-level data for Tajikistan and thus establish a vulnerability classification of the districts.

Word Bank Vulnerability Index methodology

A fairly detailed list of vulnerability variables used to assess the World Bank Vulnerability Index for Tajikistan is presented in **Table 2.1**. The variables are classified into the three dimensions of vulnerability – exposure, sensitivity, and adaptive capacity. It is intuitively clear how an increase or a decrease in the value of each variable in **Table 2.1** affects vulnerability or resilience. These variables have been applied by a team at the World Bank Research Department to construct a vulnerability map of Tajikistan (**Figure 2.1**).

Table 2.1. Variables used to construct a vulnerability index by the World Bank Research Group

Sub-index	Variables
I. Exposure	1) Standard deviation of the average monthly temperature 1950-90
	2) The range between maximum and minimum average monthly temperature
	3) The frequency of extremely hot or cold months, defined as the frequency of months in which the average temperature exceeded 30 C or fell below -10 C
	4) The frequency of extremely dry months in the spring (less than 5 ml total precipitation per month) and summer (0 ml total precipitation per month)
	5) The standard deviation of monthly total precipitation
	6) The frequency of weather related disasters between 1998-2009
II. Sensitivity	
II.1. Sensitivity of agriculture	Area of irrigated land per capita
	Degree of diversification of crop land-use measured by the Herfindahl index
	Share of households whose main income source is agriculture
II.2. Demographic sensitivity	Share of the population below 5 and above 65 years of age
II.3. Sensitivity to adverse impacts on health	Under-five mortality rate
	Share of households relying on an unprotected water source
II.4. Sensitivity to poverty and hunger:	Share of households that report food insecurity
II.5. Sensitivity to the impacts of natural climatic disasters:	Mortality rate from natural climatic disasters
	Estimated per capita economic costs of these disasters
III. Adaptive capacity	
III.1. Consumption	Household consumption per capita
III.2. Education	Share of population with education above secondary
III.3. Income diversification	Herfindahl index of income diversification (higher value, more diversification)
III.4. institutional development and social capital	Trust (share of households with general trust in other people)
	Absence of corruption (share of households that never or only rarely have to pay bribes)
	Political involvement (share of households that participated in presidential elections)

Source: Heltberg and Bonch-Osmolovskiy 2011.

It is noteworthy that in the World Bank methodology the exposure dimension is only described by indicators related to variability of temperature and precipitation and by the frequency of weather-related disasters. Indicators representing topography and soil degradation are not included. Food security concerns are represented indirectly through income-related variables, such as consumption per capita and income diversification.

The variables in **Table 2.1** are expressed in different units and on different scales. The World Bank methodology accordingly combines them into dimensionless vulnerability indexes and then computes the value of vulnerability index for different regions within a country. An example of such index-based vulnerability mapping for Tajikistan is shown in **Figure 2.1** and **Table 2.2**, where the values of the vulnerability index are shown for the country's 10 agro-climatic zones. The three light-colored zones in **Figure 2.1** (zones 1, 4, 7) have the lowest vulnerability level, with vulnerability index values less than 0.4. The three dark-brown zones (zones 2, 8, 9) are the most vulnerable, with vulnerability index values greater than 0.5. The rest of the country is characterized as medium vulnerability, with index values between 0.4 and 0.5.

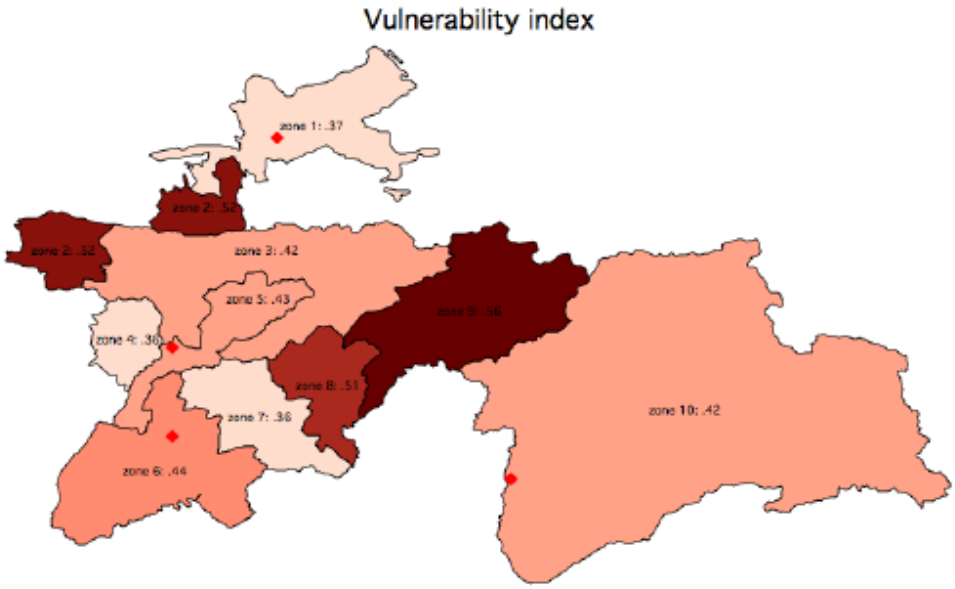


Figure 2.1. Vulnerability map for Tajikistan: mean values of vulnerability index for 10 agro-climatic zones (World Bank methodology). Source: see **Table 2.1**.

Table 2.2. Tajikistan: Vulnerability index by agro-climatic zone

Zone	Vulnerability index
1: North Sughd lowlands	0.37
2: South Sughd hills, Pedhzkent-Shakhristan-Ganchi	0.52
3: RRS-Sogd: Varzob-Zarafshan-Surkhob	0.42
4: West RRS lowland, Tursunzade-Shakhrinav-Gissar	0.36
5: West RRS hills, Rudaki-Vakhdat	0.43
6: South Khatlon lowlands	0.44
7: Southeast Khatlon hills	0.36
8: NE Khatlon hills	0.51
9: East RRS mountains	0.56
10: GBAO	0.42

Clustering methodology

Researchers working on global vulnerability by cluster-analysis methodology at the Potsdam Institute for Climate Impact Research have chosen a reduced set of just 5 or 7 variables (**Table 2.3**). These indicators are also categorized into geo-climatic and socio-economic variables and assigned to the three dimensions of vulnerability – exposure, sensitivity, adaptive capacity.

The problems with different units of measurement and different measurement scales are overcome in the Potsdam Institute methodology by applying cluster analysis, which classifies regions into a number of vulnerability clusters with different profiles of mean values of the chosen variables. The clustering algorithm combines a small number of variables (from 5 to 7) into well-defined clusters or groups that are sufficiently distant from one another in the space of all the variables used. There is no one single number representing each cluster: instead clusters are represented by profiles of mean values of the constituent variables and the combination of means in each cluster produces an interpretable pattern.

Table 2.3. Reduced set of vulnerability determining variables used in cluster analysis at the Potsdam Institute for Climate Impact Research

Category of determining variables	Dimensions of vulnerability	Specific examples
Geo-climatic (environmental) variables	(a) Exposure	Water scarcity, water stress (population density)
		Soil degradation (water and wind erosion, salinization)
		Agropotential: soil properties, rainfall, temperatures, topography, other natural agro-constraints
Socio-economic variables	(b) Sensitivity (c) Adaptive capacity	Human well-being (poverty, infant mortality, GDP or income per capita)
		Isolation (road density)
		Infrastructure, access to markets (road density)

Source: Sietz et al. (2011).

A kind of a vulnerability index for each cluster can be obtained by summing the variable means (after appropriate standardization). Thus, the cluster analysis carried out by Sietz et al. (2011) produced 7 distinct clusters with "sum of means" (taken over 5 variables) ranging from the high of 6 for cluster 1 to the low of 2 for cluster 7 (**Figure 2.2**). The five variables used in this cluster analysis (see legend to **Figure 2.2**) are defined and scaled so that higher values of each variable imply higher vulnerability. Cluster 1 with the highest "sum of means" is thus identified as the highest vulnerability cluster: it is characterized by high poverty, high water stress, pronounced agro-constraints (i.e., low soil quality), and high isolation (i.e., low connectedness among rural people or localities). Cluster 7 with the lowest "sum of means" is the lowest vulnerability cluster, with virtually zero poverty and very low water stress; only soil degradation, agro-constraints, and isolation moderately contribute to vulnerability in this cluster. In either methodology, the results are mapped onto a region to show the vulnerability levels of different subregions. To be useful, the analysis obviously requires data collection for geographical regions defined with sufficiently fine resolution.

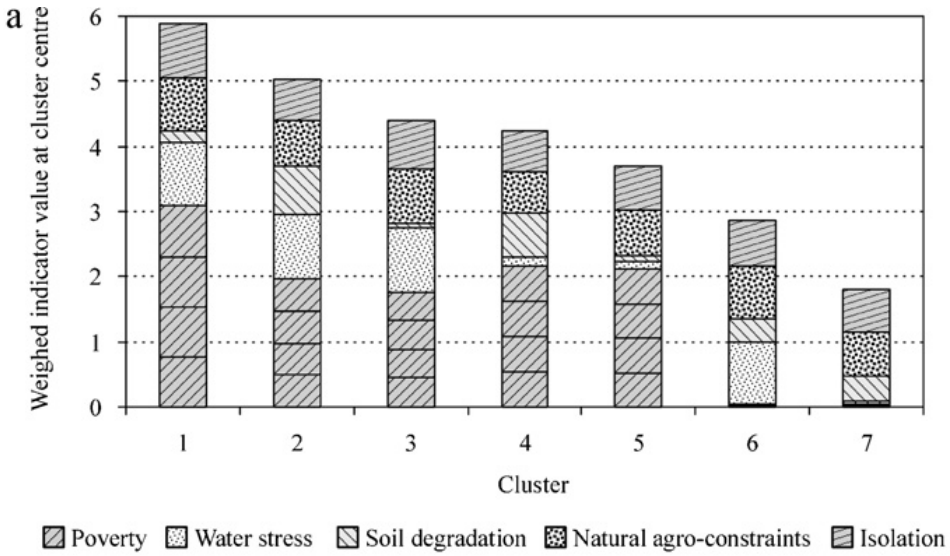


Figure 2.2. Vulnerability patterns obtained by cluster analysis of three geo-climatic and two socio-economic variables combined into seven clusters (Potsdam Institute methodology). Source: Sietz et al. (2011).

As is common in cluster analysis, examination of the numerical cluster profiles produces a "functional" description or interpretation of the clusters. Kok et al. (2010) used 7 variables (**Table 2.4**) to analyze the vulnerability of smallholder farmers in drylands around the world. The following "functional" descriptions were suggested for the 8 clusters generated by this analysis:

- two *developed clusters* with high average income and very low infant mortality that differ by agropotential ("less marginal" soil quality and "marginal" soil quality);
- two *resource-poor clusters* that show poor situation with respect to both water availability and soil quality, but differ strongly with respect to living conditions ("severe poverty" in one and "moderate poverty" in the other: the differences are evident in infant mortality and income per capita);
- two *"poor-water, better-soil" clusters* that differ in population density ("more populated" and "less populated");
- the *"overuse" cluster* with rich resource endowments but very poor socio-economic performance due to resource overuse and erosion;
- the "rivers" cluster with highest water availability, mainly due to river inflows.

The two developed clusters can be regarded as the least vulnerable. The "marginal" cluster with the lower agropotential and lower water resources is more exposed to risk than the "less marginal" cluster, but in both clusters high levels of human well-being ensure low sensitivity to risk and high adaptive capacity.

Both resource-poor clusters are highly exposed to risk because of their poor water availability and soil quality. The "severe poverty" cluster is furthermore highly sensitive to risk and has low adaptive capacity because of low levels of human well-being. The "moderate poverty" cluster is less sensitive and more adaptive.

In the "overuse" cluster the poor socio-economic performance due to extreme resource overuse results in high sensitivity to risk and low adaptive capacity.

Table 2.4. Indicators used for the analysis of the pattern of vulnerability of smallholder farmers in drylands (Kok et al., 2010, p. 27)

Core dimension	Vulnerability element	Indicator	Expected effect on vulnerability
Human well-being	Income	Average per capita income	−
	Income distribution (poverty)	Infant mortality	+
Pressure on resources	Demand for water	Population density	+
Connectedness/isolation	Soft and hard infrastructure	Infrastructure (road) density	−
Natural resources	Water supply	Renewable water resource	−
	Soil quality	Agropotential (achieved productivity compared to max feasible)	−
Use of natural resources	Soil overuse	Soil erosion	+

Summing the profile means of the 7 variables (as in **Figure 2.2**) on the basis of the profile diagrams for these five clusters (see Kok et al., 2010, pp. 30-32), we obtain the following approximate vulnerability ranking from lowest to highest: developed "less marginal" < developed "marginal" < resource poor "moderate poverty" < overused resources < resource poor "severe poverty". The resource poor cluster with severe poverty (low income per capita, high infant mortality) comes out as the most vulnerable: it is characterized by very high exposure (low natural capital) combined with high sensitivity and low adaptive capacity (due to low socio-economic indicators). It is noteworthy that resource overuse offsets the benefits of rich natural endowments and reduces the overuse cluster to the second most vulnerable position in the ranking. The two "mixed water, better soil" clusters are difficult to fit into this ranking from substantive considerations.

3. Vulnerability to climate change

> *"In terms of hazards and impacts [of climate change] we can expect more of the same… except more intensely and more frequently and perhaps in different places"*
> Philip Buckle, "Pilot Program for Climate Resilience",
> Presentation at the PPCR National Workshop, Dushanbe, 5 April 2011

Vulnerability is driven by exposure and sensitivity to risk, and risk in turn is determined by uncertainty and variability – both environmental and socio-economic. People who live in regions with high climatic variability are more exposed to risk than people in regions with more stable climate; this is true regardless of whether they are wealthy or poor. On the other hand, poor people with less physical and human capitals are more sensitive to risk and have less ability to adapt or cope with risks, regardless of climate variability in their habitat. Thus, poor people living in regions with high natural (e.g., climatic) variability are the most vulnerable; well-endowed people living in regions with stable natural (climatic) conditions are the least vulnerable; all the other combinations fall in between.

Climate change is just one element that contributes to increased variability. To quote from the June 2011 Oxfam report, "Already existing vulnerabilities would be further compounded by climate change" (Oxfam 2011). Climate scientists agree regarding *general* climate trends predicted for Central Asia: temperature will rise above global mean increases; precipitation will be higher in winter, lower in summer; we will witness Increase in frequency of extreme events. However, *specific* impacts of climate change on agriculture and rural population are unclear. It has been argued that the existing "adaptation deficit" – excessive vulnerability to current climate variability – is a good proxy of future vulnerability to climate change (WDR 2009). This view is essentially echoed by Philip Buckle's statement cited above. Climate change involves an *increase in uncertainty*, increasing exposure to risk. Therefore, to combat vulnerability to climate change we

need tools for operating under uncertainty. These tools in turn require a legal and policy framework aimed at improving adaptive capacity.

Construction of vulnerability indices for 28 transition countries in Europe and Central Asia (ECA) has shown that Tajikistan has moderate exposure to climate change risks in the sense of likelihood to experience the greatest increases in climate extremes by the end of the 21st century: five ECA countries – Russia, Albania, Turkey, Armenia, and Macedonia – have higher exposure to climate change. However, Tajikistan is estimated to be the most sensitive to climate change risks and to have the lowest adaptive or coping capacity among the 28 ECA countries (**Table 3.1**). The overall vulnerability index constructed by weighting the three sub-indexes identifies Tajikistan as the most vulnerable to climate change risks among all ECA countries. Tajikistan's high vulnerability is determined by the combination of its high sensitivity and negligible adaptive capacity.

Table 3.1. Vulnerability index components for Tajikistan

	Index value for Tajikistan	Tajikistan's rank among 28 ECA countries
Exposure	16	6/28
Sensitivity	24	1/28
Adaptive capacity	<1	28/28
Vulnerability	24	1/28

Source: World Bank 2009, Figures 1.2-1.5, pp. 6-7.

To the extent that the current "adaptation deficit" – the vulnerability to the current climate – is a proxy for vulnerability to climate change in the future, the incidence and impact of natural disasters over the last decades provides an alternative measure of vulnerability. Tajikistan shares with Albania the first place among ECA countries by measures of population affected by natural disasters and by the extent of economic losses resulting from natural disasters (**Table 3.2**). The 2000–2001 drought in the region was estimated to have cost Tajikistan 5% its GDP (World Bank 2006). Landslides (classes 4-6) affect 36% of Tajikistan's area and 11% of its population; they cost Tajikistan more than 2,000 fatalities between 1980 and 2000 (Pusch 2004).

Table 3.2. Impact of natural disasters 1990-2008

	Affected population (per 1,000 persons)	Rank	Economic losses (per $1 million of GDP)	Rank
Tajikistan	25	2/28	135	1/28
Albania	65	1/28	25	3/28
Moldova	40	3/28	50	2/28
Macedonia	30	4/28	10	4/28

Source: World Bank 2009, Figure 1.6, p. 8.

The potential economic loss from future natural disasters is estimated at upwards of 70% of GDP for Tajikistan (Pusch 2004; this includes catastrophic events that have an annual probability of occurrence of just 0.5%, i.e., are expected to occur on average once in every 200 years). Much of the loss potential is from floods and mudslides (the rest is from earthquakes), which only strengthens the conclusion that Tajikistan is highly vulnerable to climate change risks. Tajikistan, with the rest of Central Asia and the Trans-Caucasus, is especially vulnerable to drought for both geographic reasons (high interannual rainfall variability, dependence on snowmelt) and structural reasons (economies heavily dependent on agriculture, inadequate hydrometeorological monitoring, and poor water management planning).

Table 3.3 lists the variables that were used to calculate the components of the index of vulnerability to climate change for ECA countries. Note again that this set of variables does not include measures of soil degradation and soil quality, which are always included in clustering studies.

Table 3.3. Variables included in the index of vulnerability to climate change for ECA countries

Vulnerability sub-indexes	Categories of indicators	Specific indicators used
Exposure	Temperature and precipitation indicators (annual and seasonal)	Changes projected for 2070-2100 relative to 1961-1990: • Additional hot, dry, and wet years • Additional hot, dry, and wet summers • Additional hot, dry, and wet winters
Sensitivity	Physical indicators	Renewable water resources per capita Extent of air pollution (worsens the impact of heat waves)
	Importance of agriculture in the economy	Share of employment Share of productive assets
	Other socio-economic indicators	Share of electricity derived from hydroelectric plants Overall quality of infrastructure Share of population over 65
Adaptive capacity	Social indicators	Income inequality
	Economic indicators	GDP per capita
	Institutional measures: Worldwide Governance Indicators (Kaufmann et al. 2008)	Voice and accountability Political stability Absence of violence Aggregate governance measures: • government effectiveness • regulatory quality • rule of law • control of corruption

Source: based on World Bank 2009, p. 5.

4. Vulnerability and soil degradation: sustainable land management (SLM) as a vulnerability reducing tool

Soil erosion (and soil quality more generally) are among the main vulnerability components used in cluster analysis (although these variables are not directly included in the vulnerability index approach). In fact, soil erosion and agropotential are second only to average per capita income in their importance for generating the distinct clusters (Kok et al. 2010, pp. 28-29).

It is usually claimed that widespread unsustainable land management in Tajikistan has led to large-scale land degradation. It is universally recognized that erosion is a direct threat to future production and farmers' incomes (UNECE 2004), but unfortunately no public authority in Tajikistan regularly collects data on soil quality and land degradation. This probably explains while soil degradation is not included as a component in the calculation of the vulnerability index for Tajikistan. Available estimates suggest that 82.3% of all land and 97.9% of agricultural land in Tajikistan suffers some level of erosion – of this 88.7% suffer high and medium level of erosion. The same source reports that erosion affects 60% of the irrigated land (UNECE 2004) and that degradation from erosion fostered by overgrazing involves approximately 3 million hectares, or 85% of total pastureland area (ADB 2004).

These fragmentary estimates indeed suggest that erosion and soil degradation are important problems in Tajikistan, and as such are likely to have a significant impact on vulnerability. Sustainable Land Management (SLM) is a standard answer both to preventing further degradation and to mitigating existing erosion and degradation hazards.

SLM involves the adoption of land use systems that, through appropriate management practices, enables land users to *maximize the economic and social benefits from the land* while maintaining or

enhancing the ecological support functions of the land resources. The scope of SLM includes management of soil, water, vegetation, and animal resources (TerrAfrica 2011).

From a slightly different perspective, SLM incorporates land management systems that combine technologies, policies, and activities aimed at *integrating socio-economic principles with environmental concerns* in a way that to satisfies "the five pillars of SLM" (Guidelines 2009):

(i) Maintain or enhance production;
(ii) Reduce the level of production risk;
(iii) Protect the potential of natural resources and prevent degradation of soil and water quality;
(iv) Ensure economic viability;
(v) Achieve social acceptability.

In so far as SLM acts to prevent and mitigate soil erosion and degradation while maintaining or enhancing production and reducing production risks, it is an obvious candidate for being used to reduce vulnerability to existing risks, including the risk of climate change.

Tajik farmers are familiar with traditional SLM practices, which have been known and used since the Soviet times (see, e.g., Bekturova and Romanova 2007). In plant production these practices include crop rotation, sowing of perennial grasses after cotton or wheat, attention to irrigation systems, and preservation of soil fertility through fertilizer application. In recent years they are becoming acquainted with more innovative SLM techniques, such as terracing of steep slopes, agro-forestry measures (planting trees on arable land to reduce wind and water erosion), shift from field crops to orchards, and fencing. In livestock production, mobility of animals is traditionally used as the main mechanism to prevent pasture degradation. This includes not only seasonal migration to distant pastures, but also the practice of pasture rotation, whereby the area is divided into distinct segments for one-day grazing and it is the chaban's duty to direct the animals each day to a new segment where the grasses have had time to recover. **Table 4.1** lists the measures applied by Tajik farmers to combat land degregation according to a recent survey. Overall, more than 90% of the farmers surveyed reported applying some anti-degradation measures.

Table 4.1. SLM measures practiced by Tajik farmers to combat soil degradation

Measure	Farmers, % (n=420)	Heads of farms, % (n=120)
Apply any measure	91	94
Soil fertility (apply fertilizer, compost)	84	84
Improve irrigation system	47	57
Crop rotation	38	43
Sowing perennial grasses	9 (2% with rotation)	12 (all w/rotation)
All conventional measures	76	68
Agro-forestry (plant trees on arable land)	9	15
Shift to orchards	5	15
Terracing	2	6
Pasture fencing	0.5	2.5
"Innovative" measures	15	26

Source: Helvetas survey, March 2011

An interesting example of using SLM to enhance production and reduce production risks that goes beyond attention to soil degradation is provided by a module on development of agricultural production implemented by CAWMP – the World Bank's Community Agricultural Watershed Management Project. The underlying conception was to increase productivity (for both crops and livestock) and improve farm services (including processing) with the objective of raising rural incomes and thus reducing vulnerability to risk.

The project provided financial support for annual crops, orchards, livestock, food processing, development of distribution channels, machinery leasing, and micro-credit. The specific aims included the following activities (CAWMP 2011, pp. 70-71):

1. Increasing crop productivity through use of improved technologies:
    - Fruit trees and walnuts, vineyards, vegetables, potatoes, wheat, and oats;
    - Medicinal and pharmaceutical plants;
    - Mulberry trees for silk production;
    - Construction of simple and low-cost greehouses;
    - Production of seed potatoes (including potato seeds);
    - Production of seeds for feed crops (cereals and grasses);
    - Establishment of nurseries;
    - Improvement of crop production systems, including mixed cultivation of crops and vegetables;
    - Improved cereal and tree varieties (forest plantations);
    - Improved technologies aimed at cost-efficient increases of production

2. Food processing
    - Processing of oilseeds, fruits, and vegetables
    - Grading, sorting, and packing of fruits and vegetables
    - Dairy and meat processing
    - Warehouses and storage capacity for agricultural products

3. Improving livestock productivity
    - Increasing headcount of breeds adapted to local conditions
    - Animal selection and breeding
    - Development of poultry production
    - Organization of private veterinary services
    - Establishment of cattle fattening lots

4. Support services
    - Maintenance, repair, and assembly of small-scale farm machinery
    - Establishment of forges and smithies
    - Bee-keeping
    - Poultry-keeping

5. Vulnerability factors for Tajikistan: some quantitative data

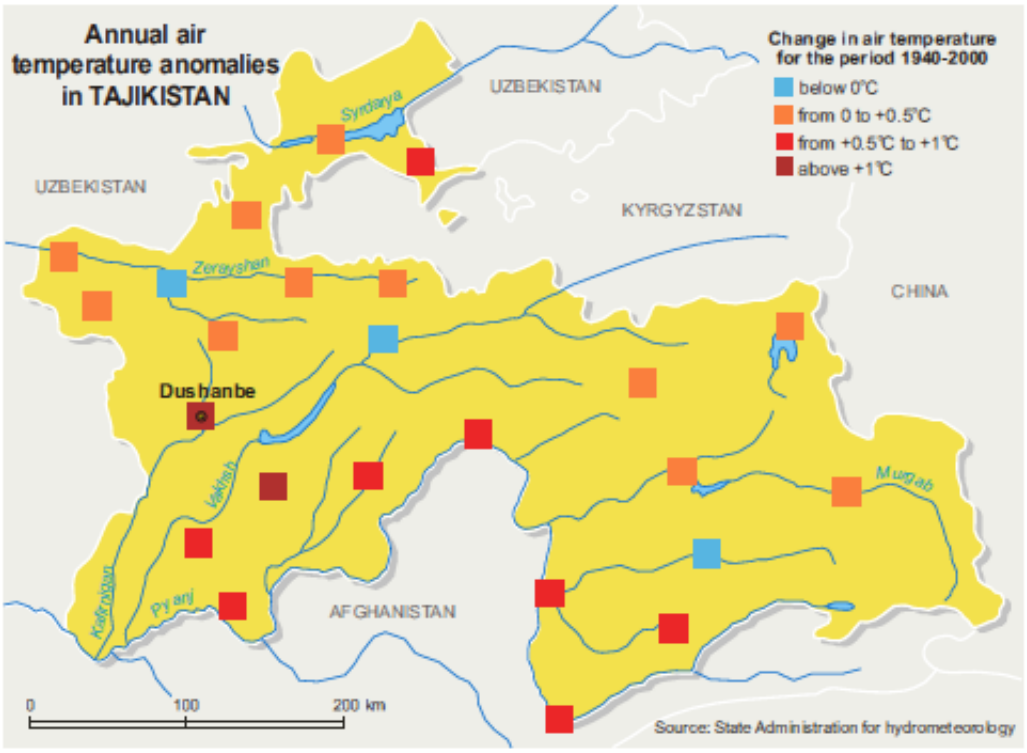
In this chapter we review quantitative data available for a selection of geo-climatic and socio-economic indicators that determine Tajikistan's vulnerability to risks, measured in the three dimensions of exposure, sensitivity, and adaptive capacity. These quantitative data can be used to substantiate statements regarding Tajikistan's vulnerability in general and vulnerability to climate change in particular. Data needs for future research are briefly discussed at the end of the chapter. Some information about food insecurity in Tajikistan is presented in **Chapter 6** that follows.

Exposure to climate change: some geo-climatic indicators for Tajikistan

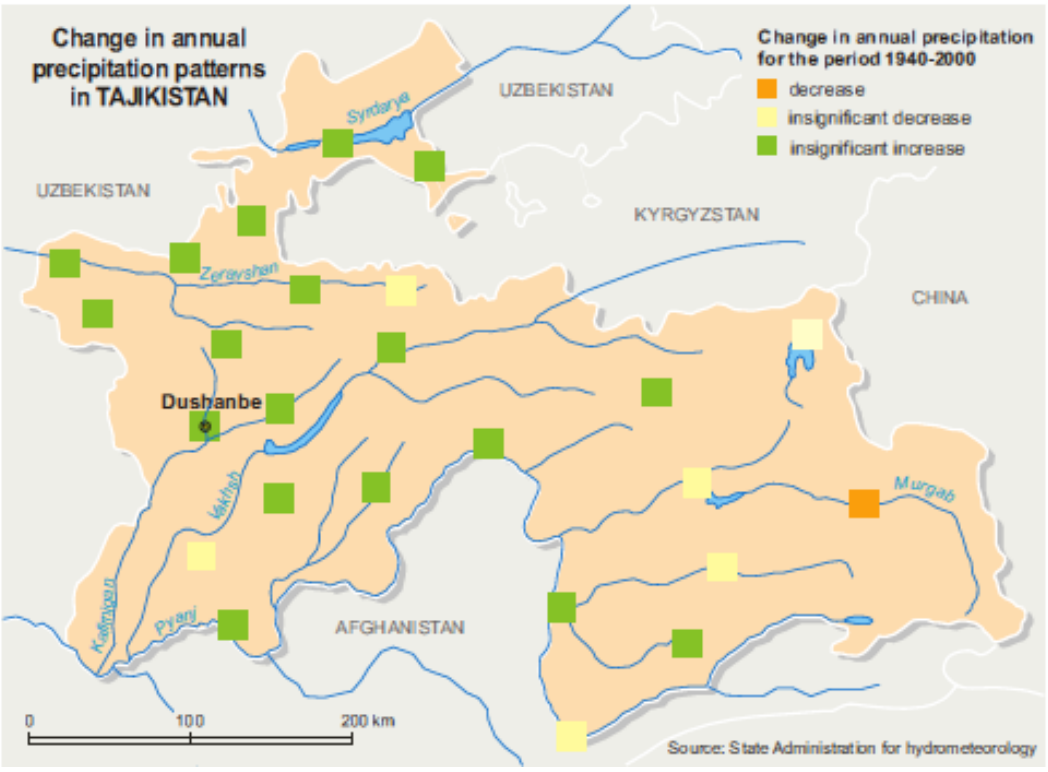
Climate scientists agree regarding general climate trends predicted for Central Asia (Cruz et al. 2007, Ch. 10, pp. 472-483):

- temperature will rise above global mean increases;
- precipitation will be higher in winter, lower in summer;
- frequency of extreme events (mudflows, avalanches) will increase.

The projected decline in summer precipitation is likely to lead to expansion of deserts and periodic severe water stress conditions. This may be accompanied by an increase in the frequency of very dry spring, summer, and autumn seasons.



Map 5.1. Changes in annual temperature in Tajikistan.



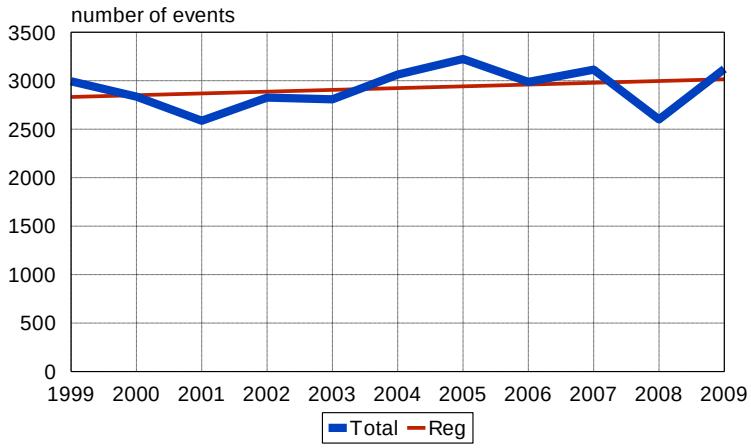
Map 5.2. Changes in annual precipitation in Tajikistan.

Long term meteorological records indicate that the mean temperature in Central Asia has been rising at a rate of 1 to 2 deg C per century, with no clear trend in precipitation during 1900-1996 (Cruz et al. 2007, Ch. 10, pp. 475). Hydromet (2008) data for Tajikistan show that the mean temperature change between 1940 and 2000 did not exceed 0.5 deg C over most of the country, with changes between 0.5 and 1 deg C observed mainly along the Pianj River on the southern border (**Map 5.1**). More extreme warming (above 1 deg C) was observed only in Dushanbe and Dangara, primarily due to urbanization effects. While precipitation levels virtually did not increase between 1940 and 2000 (**Map 5.2**), accelerated melting of glaciers – Tajikistan's main water source -- has been well documented in recent years. Glacier melting may lead to reduced river flow and to drying up of some glacial springs at altitudes of 2,500-3,000 meters (Kamolidinov).

The frequency of natural disasters as reported by TajStat and Hydromet has remained fairly stable since 1999, without a clear upward trend (**Figure 5.1**). Drought appears to be the most significant recurring extreme event in Tajikistan, with 9 drought years recorded between 1992 and 2010 (Monitoring 2011). While droughts are often locally restricted, the droughts in 2000 and 2001 covered the entire country and affected 3 million people (for comparison, the locally restricted drought in 1993 affected 67,500 people) (TajESC 2007). The 2000–2001 droughts were estimated to have cost Tajikistan 5% of its GDP (World Bank 2006). During the 60 year period since 1940, there were 8 instances of country-wide droughts (1940, 1947, 1956, 1971, 1980, 1988, 2000, and 2001) that affected the entire rural population (Hydromet 2008).

Mudflows, landslides, floods, and heavy rains are among the most common natural disasters in Tajikistan, occurring mainly in the spring and the early summer (April-June). Earthquakes also recur fairly frequently, but in much smaller numbers. The extreme events in Tajikistan lead to relatively few fatalities, but they affect large segments of the population and cause considerable damage to property. Thus, between 2000 and 2006 natural disasters affected more than 250,000 people (with 186 fatalities) causing damage to 50,000 buildings in total amount of US$250 million, or about $35 million each year (TajESC 2007). Tajikistan shares with Albania the first place among 28 ECA countries by measures of population affected by natural disasters and by the extent of economic losses resulting from natural disasters (World Bank 2009, Figure 1.6, p. 8).

Natural disasters recorded between 1999 and 2009



Source: TajStat, Committee of Emergency Situations

Figure 5.1. Natural disasters recorded between 1999 and 2009: actual (thick curve) and trend fit (thin line). Source: TajStat and TajESC.

Sensitivity and adaptive capacity: socio-economic vulnerability indicators for Tajikistan

We review the available statistical data on the following range of socio-economic indicators of vulnerability and resilience that are commonly used in vulnerability assessment literature:

- Income and poverty
- Alternative indicators of poverty: infant mortality and undernourishment
- Debt and financial insecurity
- Agricultural land
- Commercialization (share of production sold)
- Population density: stress on land and water resources
- Irrigation: stress on water resources
- Livestock
- Diversification of income and farm production

Income and poverty

Human well-being is one of the leading factors that reduce vulnerability and improve resilience. In this section we present quantitative data on four components of human well-being:

- GDP per capita from macroeconomic statistics,
- family income per capita from national household surveys,
- poverty in terms of poverty lines
- infant mortality as a proxy for poverty

GDP per capita is a common measure of human well-being, and this indicator is readily available from international sources for all countries in the world (see *World Development Indicators*, World Bank on-line database). Tajikistan has a very low GDP per capita – the lowest among all CIS countries, which practically puts it at the border line between Middle Income and Low Income countries (**Figure 5.2**). Tajikistan GDP per capita in 2009 was around $2,000 (PPP, current international dollars), compared with $18,000 for Russia, $7,000 for Azerbaijan, and $6,000 for Ukraine.

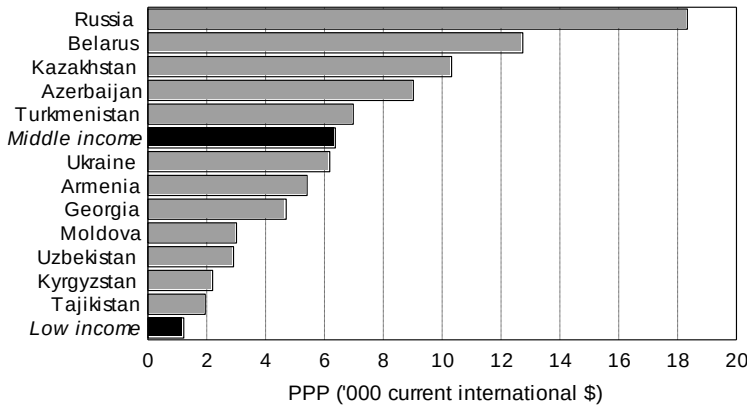


Figure 5.2. GDP per capita for CIS countries, 2009 (PPP, current international dollars). Source: WDI 2010.

Low GDP per capita is a sign of Tajikistan's high vulnerability. It is encouraging to note, however, that GDP per capita has been increasing since 1997 both in nominal US dollars and in constant 2000 dollars (**Figure 5.3**). GDP per capita in constant 2000 dollars doubled between 1997 and 2009, rising from $115 to $230. This positive trend obviously has a mitigating effect on vulnerability.

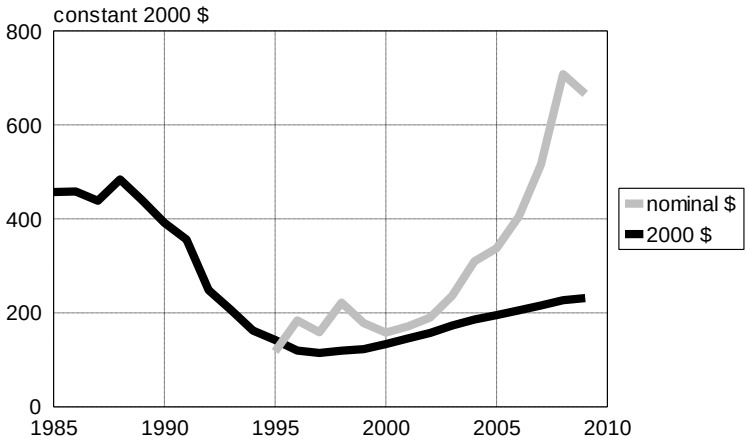


Figure 5.3. Tajikistan's GDP per capita 1985-2009: constant 2000 US$ and nominal US$. Source: WDI 2008-2010, nominal from Statistical Yearbooks of Tajikistan (various years).

While GDP per capita is a universally acceptable and internationally comparable indicator of human well-being, it is often preferable to use *per capita income* or expenditure as a measure of well-being on the household or family level. Income data are obtained from household surveys, which are generally objective and representative, but in their raw form they do not show if the reported income is sufficient to satisfy the basic needs and necessities of households. The per capita income in Tajikistan in 2009 was 156 somoni per month, which is roughly $40 at the exchange rates prevailing at that time.[2] Adjusted for inflation, per capita income more than doubled in real terms between 2003 and 2009, rising from 71 somoni per month to 156 somoni per month over six years (in constant 2009 values). Similarly to GDP per capita, this trend of increasing real household income (**Figure 5.4**) suggests decreasing vulnerability (due to reduction of sensitivity and improvement of adaptive capacity). Unfortunately, no separate data are published for rural incomes and these results are averages for the entire population, including both rural and urban.

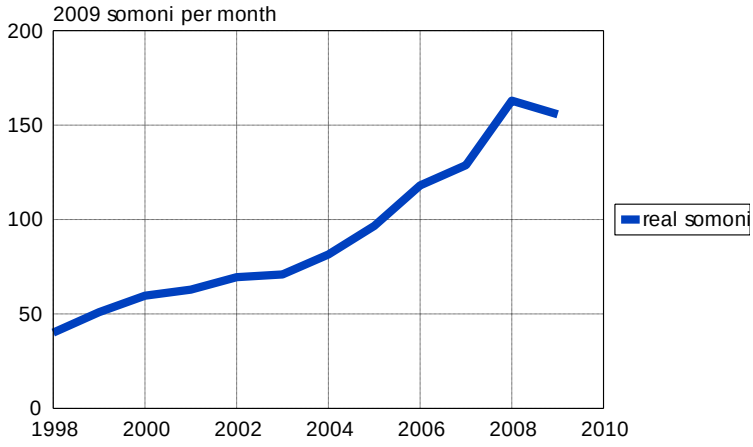


Figure 5.4. Income per capita in constant 2009 values, 1998-2009. Source: Statistical Yearbooks of Tajikistan, 2007, 2010.

[2] This number based on household surveys is taken from the Statistical Yearbook 2010, p. 113. A higher number (235.2 somoni per capita per month, or $60) is given in TajStat (2010), based on the 2009 standard of living survey. The reason for the difference is not clear due to lack of precise definitions in the published sources, but perhaps the Statistical Yearbook actually reports money income (contrary to what the table heading says), while the standard of living survey reports total income.

To get a more precise picture of income sufficiency, the per capita incomes have to be compared to *poverty levels* derived from household surveys ("Analysis of poverty in Tajikistan", TajStat, 2010). Poverty headcounts in Tajikistan are estimated relative to two sets of poverty lines: (a) national poverty lines based on minimum consumption needs; (b) international poverty line corresponding to $2.15 PPP per day. National poverty lines are defined as absolute poverty line (the expenditure on basic consumption needs, estimated at 195 somoni per capita per month) and as extreme poverty line (the expenditure to purchase a "minimum food basket"of 2,250 calories per person per day, estimated at 124 somoni per capita per month). According to the TajStat report based on the 2009 standard of living survey, 51% of the rural population are poor (i.e., fall below the absolute poverty line of 195 somoni per month) and 16% are extremely poor (below 124 somoni per month). Urban poverty rates are lower: 37% poor and 9.5% extremely poor. Thus, poverty remains widespread – especially in rural areas – despite the increases in human well-being as measured by both GDP per capita and household income.

Table 5.1. Changes in poverty rates 2003-2009 (percent of headcounts below the respective poverty lines)

	2003	2007	2009	Absolute change 2003-2009, percentage points
Absolute poverty line				
Urban	68.8	49.4	36.7	−32.1
Rural	73.8	55.0	50.8	−23.0
Tajikistan	72.4	53.5	46.7	−25.7
Extreme poverty line				
Urban	39.4	18.9	9.5	−29.9
Rural	42.3	16.4	15.6	−26.7
Tajikistan	41.5	17.1	13.8	−27.7
$2.15 PPP poverty line				
Urban	59.1	40.3	30.3	−28.8
Rural	65.1	41.1	43.4	−21.7
Tajikistan	63.5	40.9	39.6	−23.9

Source: TajStat (2010).

Nevertheless, the growth in per capita incomes since 2003 has inevitably reduced the number of rural poor, although to a lesser extent than in urban areas (**Table 5.1**). The same pattern is observed in headcounts relative to the $2.15 PPP international poverty line. **Figure 5.5** illustrates the decrease in rural poverty from 2003 to 2009, with absolute poverty dropping from 74% to 51% and extreme poverty from 42% to 16%.

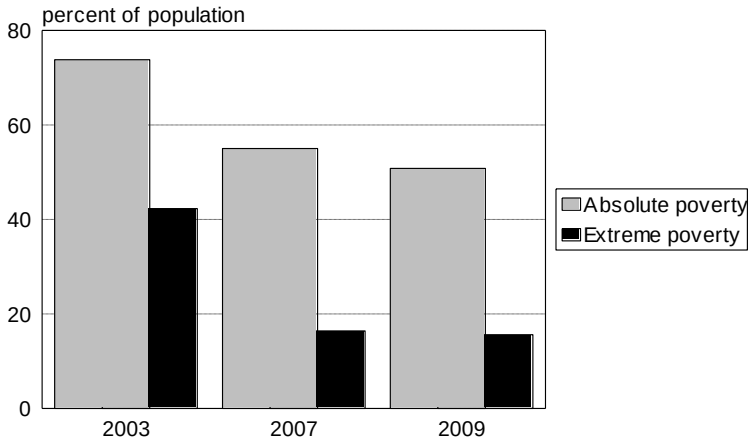


Figure 5.5. Rural poverty rates 2003-2009. Source: TajStat (2010).

Alternative indicators of poverty: infant mortality and undernourishment

An indirect indicator of poverty is provided by *infant mortality*. Tajikistan's infant mortality in 2010 is estimated at 34 deaths (under the age of 1 year) per 1,000 live births (Demographic Yearbook, 2010, p . 123). This is very high compared with the European Union, where infant mortality is below 4.5 deaths per 1,000 live births for all 27 Member States and as low as 3.5 for the Western EU countries, excluding the New Members (Eurostat 2008). It is also high compared with Russia and Ukraine, where infant mortality rate is around 10 per 1,000 live births (Demoscope 2010).

Yet infant mortality in Tajikistan is steadily decreasing over time, consistently with Millennium Development Goals that originally prescribed reduction of child mortality by two-thirds. The steady decrease is evident both in the Ministry of Health estimates, which are available since 1980 (thin black curve in **Figure 5.6**), and in the more recent survey results (Multi-indicator Cluster Survey, 2005, 2005; Living Standards Survey, 2007; Infant and Child Mortality Survey, 2010; thick curves in **Figure 5.6**). The downward trend is clear despite the substantial difference in estimated values attributable to differences in methodology. Rural infant mortality has generally been higher than urban infant mortality, both according to MinHealth estimates and according to the recent surveys. The infant mortality rate among the rural population decreased from 94 in 2000 to 33 in 2010 (Demographic Yearbook, 2010, p . 123).

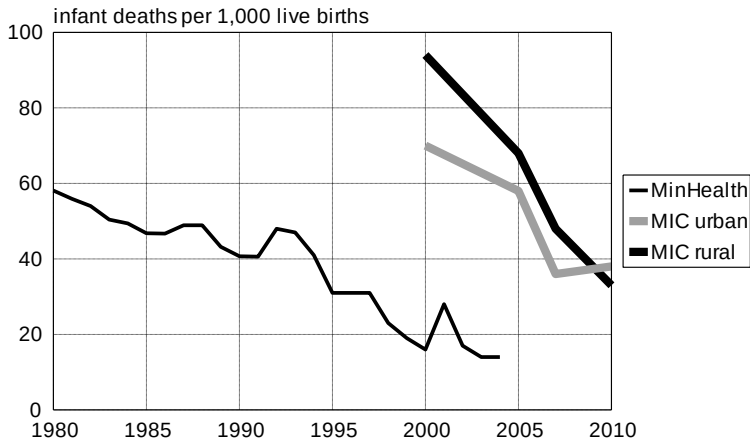


Figure 5.6. Infant mortality rate: infant deaths per 1,000 live births: Ministry of Health estimates (thin black curve); survey estimates (two thick curves for urban and rural areas separately).

Infant mortality data lead to three conclusions:

- Comparatively high levels of infant mortality suggest high vulnerability in Tajikistan.
- Decrease in infant mortality over time points to a definite decrease in vulnerability associated with this factor.
- Higher rural infant mortality suggests that the rural population is more vulnerable in this respect than the urban population.

Undernourishment is another proxy for poverty (as well as food insecurity). Undernourishment estimates are regularly published for a wide range of countries by FAO and World Food Program in their annual publication *The State of Food Security in the World* (SOFI). The proportion of undernourished population in Tajikistan followed an increasing trend from 1991 to 2000, rising from about 30% to 70% of the total population during the first decade of transition and the years of the civil war. In 2000, however, the trend reversed and the proportion of undernourished had

dropped back to 30% by 2007 (no estimates for later years are available at this time). The changeover from rising to declining undernourishment in 2000 is clearly visible in **Figure 5.7**.

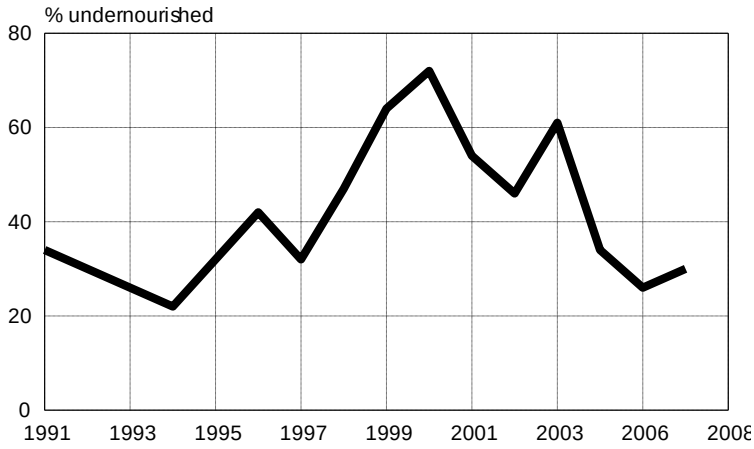


Figure 5.7. Proportion of undernourished in total population in Tajikistan. Source: SOFI 2000-2010.

Still, the levels of undernourishment in Tajikistan are high relative to other regions. Tajikistan's 30% of undernourished in 2005-2007 should be compared to the average of 10% for all of Central Asia, 7% for Trans-Caucasia (Armenia, Georgia, Azerbaijan), and 16% for all developing countries in the world. Thus, undernourishment in Tajikistan, like poverty and infant mortality, has been decreasing in recent years, which clearly reduces vulnerability over time. Yet undernourishment remains comparatively high, which suggests a high level of vulnerability by this indicator as well.

Debt and financial insecurity

Debt is not always a bad sign that indicates financial stress and increased vulnerability. In principle, many households borrow for a variety of purposes ranging from consumption to investment in household assets and then successfully repay their debt. Many businesses (i.e., dehkan farms) routinely borrow for both working capital and investment. Debt increases financial stress and vulnerability only when it becomes excessive compared to income and repayment capacity. Various food security assessments in Tajikistan (WFP, IPC, Save the Children) suggest that household debt levels may be increasing due to a combination of external factors, such as unfavorable climatic conditions that adversely affect harvest (i.e., food supply and marketable surplus) or rising food and fuel prices. In the latest WFP assessment (April/May 2008) 70% of rural respondents identified increased debt as a main difficulty during the previous year (WFP 2008, Figure 17), Figure 17) and almost 90% reported that they resorted to food purchase on credit as a coping strategy (WFP 2008, p. 33).

A recent "Save the Children" survey in Khatlon indicated that household debt doubled from 660 somoni to over 1,100 somoni in the course of 2010 and that more than half the respondents reported they were unable to pay off their debts each year (70% in Kulyab region and 47% in Kurgan-Tyube; SCP 2011, p. 11). A survey conducted by WFP/IPC in February 2011 showed that 42% of households surveyed took new loans during the previous three months. The purpose of the loan was to buy food or pay for health care (81% of borrowers). The median loan amount was more than 500 somoni (more than $100) to be repaid in 2-3 months or longer. The loans were mostly obtained from friends and relatives, but also from micro-credit organizations and NGOs (yet the loans were generally reported as interest-free). As with all WFP vulnerability data, there is considerable variability in the results between successive surveys. In a previous survey conducted in 2008, none of the households surveyed by WFP reported an increase in the level of debts during the past 6 months and only 30% reported that they had any debt (WFP 2008, p. 33).

The generally grim picture of household debt painted by various advocacy groups is at variance with the results that emerge from the latest rural household survey conducted by TajStat in November-December 2010. In this survey, based on a representative sample of 11,600 rural households, just 2.4% of respondents reported any borrowing. Among these, 1.3% borrowed from commercial banks, 1% borrowed from relatives (both inside Tajikistan and abroad), and 0.3% indicates borrowing from other sources (including humanitarian aid). These representative national findings pointing to limited borrowing by rural households are consistent with the existing evidence worldwide, which suggests that rural people are conservative and risk averse, showing considerable resistance to borrowing. The household debt situation in Tajikistan is thus unclear and requires further study to reconcile the discrepancies. Yet there is no doubt that, given the generally high poverty levels in Tajikistan, increasing indebtedness will definitely increase the vulnerability of rural households.

More information is available on the indebtedness of dehkan farms, especially the cotton-growing contingent. Farm debt is a permanent topic of discussion among policy makers and international donors in Tajikistan. Dehkan farms initially inherited their debt from the parent farm during the reorganization process; they may have accumulated additional new debt in the course of their operations. It is generally argued that the two debt components combined place many dehkan farms at a risk of default and bankruptcy. In the latest WFP survey (April/May 2008) 44% of dehkan farms reported outstanding debt; in the World Bank 2009 CSRP baseline survey the percentage of indebted dehkan farms is higher (54%). Survey results indicate, however, that the debt burden is concentrated in relatively large "collective" dehkan farms, while the smaller individual and family dehkan farms have much lower debt levels that do not jeopardize their repayment ability. Thus, the Helvetas survey of small dehkan farms (April 2011) showed that only 14% of respondents had any debt and that in most cases this debt was inherited during reorganization (10% of farms). In the World Bank 2009 CSRP baseline survey individual and family dehkan farms had debt levels that were substantially less than farm revenue (which implies reasonable repayment capacity), while the debt of collective dehkan farms and other corporate farms exceeded farm revenue (implying insolvency).

Overall it seems that dehkan farms do not face high financial vulnerability, and it is only the larger collective and corporate farms that may be under financial stress. It should be noted, however, that each collective dehkan farm is the source of livelihood for hundreds of families and massive unmanaged bankruptcies of the insolvent collective farms will unavoidably affect the vulnerability and well-being of large segments of Tajikistan's rural population. The government should continue working toward debt resolution through reorganization of indebted dehkan farms while scrupulously ensuring that the farm members do not lose their land and are not saddled with residual debts for which they were not responsible.

Agricultural land

Empirical evidence convincingly shows that more land leads to higher per capita incomes and higher family well-being. Land also increases the family's readiness to sell its farm products, with sales revenue making an additional contribution to family income. Land and commercialization are thus important factors for increasing family income and reducing vulnerability.

Land in Tajikistan is exclusively owned by the state and is given to farmers and households in use rights. So far, land is nontransferable and mechanisms for transferability of land use right certificates may be incorporated in the next revision of the Land Code. Because of nontransferability of land use rights, land in practice cannot be mortgaged or used as collateral for credit (although this is theoretically allowed by the Law on Mortgage). Due to these marketability constraints land in

Tajikistan cannot be regarded as a store of value for rural people in the same sense that livestock, machinery, or farm buildings are a store of value. Yet land is the main productive asset in agriculture and is thus an important source of income for the rural population.

Table 5.2. Structure of rural family income from different surveys (percent of total income for rural families)

	LSMS 2003	LSMS 2007	Helvetas 2011
Wages	35	31	34
Own farm	48	49	38**
Remittances	9	13	16
Social transfer	7	5	4
Other*	1	1	9

*"Other" includes land rental, non-farm business income, and subsidies/grants for education; in the Helvetas survey of dehkan farms, non-farm entrepreneurial activity accounts for a relatively large share of 6% of total income.
**Does not include the value of own products consumed in the household.

Agriculture is an important source of family income in Tajikistan. Although official statistics do not publish the structure of family income by sources, they indicate that based on household surveys (Statistical Yearbook, 2010, p. 112-113) the household plot – which is the private family farm cultivated by every rural household – accounts for about 20% of per capita income on average, for both rural and urban households (this translates into almost 30% of per capita income for the rural population, since urban household produce much less agricultural output) . For more detailed information on the role of agriculture in household income we have to turn to cross-sectional surveys conducted by various donor organizations, often in cooperation with TajStat. The World Bank's Living Standards Measurement Surveys (LSMS, 2003, 2007) indicate that income from the own farm accounts for nearly 50% of total family income for rural households (**Table 5.2**). In a recent survey conducted by Helvetas among dehkan farmers (March 2011), admittedly with a non-representative sample of only 400 respondents, sale of farm products contributed nearly 40% of the family cash income. This does not allow for the value of own farm products consumed in the household, which may increase the share of agriculture to 50% or even 60% of total family income. Despite these differences, the income structure is fairly consistent across different surveys. In response to a specific question in the Helvetas survey, 70% of respondents indicated that agriculture was the main (and in some instances the only) source of family income.

Evidence from all CIS countries conclusively shows that per capita family incomes and family well-being increase with the increase of the land allotment in family farms. **Figure 5.8** shows the effect of farm size on family income and income per capita based on the 2003 household survey in Georgia. **Figure 5.9** based on a 2003 WB survey in Azerbaijan shows that families with more land (7 hectares) are more likely to perceive their well-being as "high" compared with families that have only 1.7-2 hectares. New evidence for Tajikistan (PPCR farm survey, May 2011) also demonstrates that larger farms are associated with a higher level of well-being (**Figure 5.10**, the bars for farm size on the left-hand side of the diagram): respondents who report a high level of well-being (income sufficient to sustain a comfortable consumption regime) have farms that average 34 hectares, compared with 12 hectares for respondents reporting a low level of well-being (income sufficient to purchase food and daily necessities only). Land thus also acts as a factor that reduces vulnerability of the rural population.

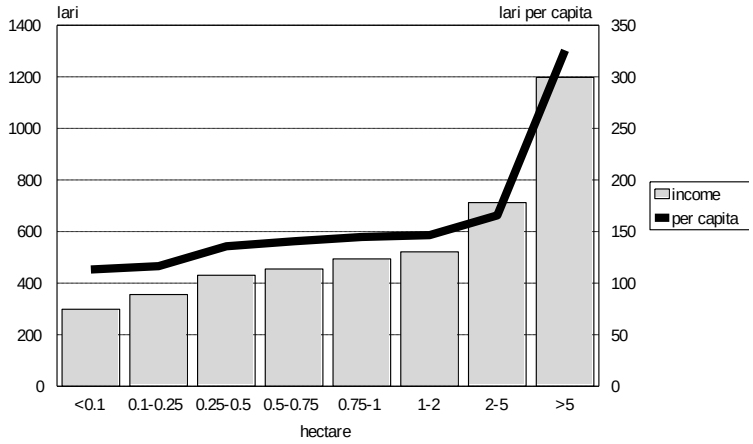


Figure 5.8. Family income and income per capita increase with farm size. Source: Georgia Household Survey 2009.

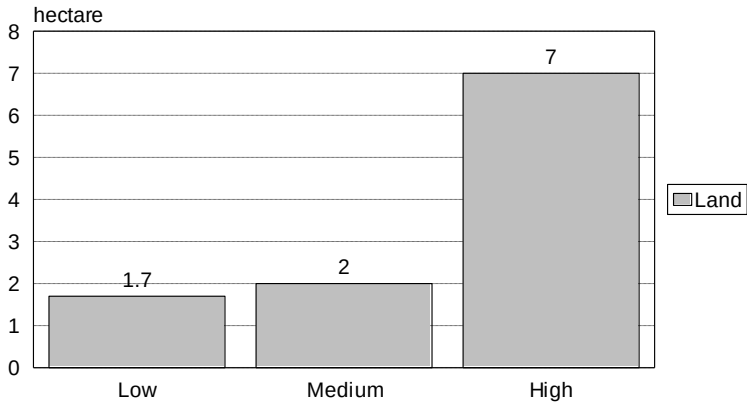


Figure 5.9. Perceived family well-being increases with farm size. Source: Azerbaijan WB survey 2003.

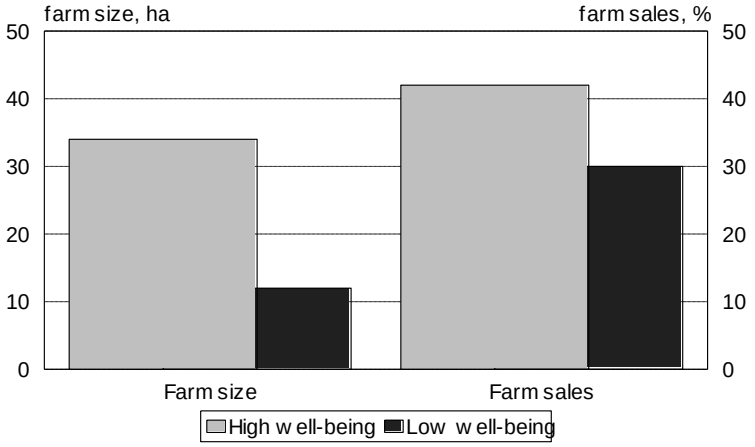


Figure 5.10. Farm size and share of farm sales in family income for different levels of well-being. "High" is interpreted as comfortable consumption regime; "low" indicates that the family is able to purchase food and daily necessities only. Source: PPCR farm survey, May 2011.

Most Tajik farms are quite small. There are nearly 50,000 dehkan farms in Tajikistan today plus 750,000 household plots. Most of the land, however, is in dehkan farms and the household plots account for less than 25% of cultivable land (arable plus perennials) and only 6% of all agricultural land (including pastures). As a result, the average household plot is very small – a mere 0.3 hectares (**Table 5.3**). The average dehkan farm is much larger, with 17 hectares of cultivable land and 70 hectares of agricultural land (including pastures and hay meadows). However, these global averages are biased upward by the small (and shrinking) contingent of relatively large collective ("partnership") dehkan farms, which according to a recent surveys control on average 100-200 hectares. Dehkan farms of the other two types – individual and family – are still much larger than the tiny household plots, but they are substantially smaller than the collective dehkan farms. Tajik

agricultural producers thus can be ranked from smallest to largest as follows: household plots < family DF < individual DF < "partnership" DF.

The farm size estimates presented in **Table 5.3** show that household plots – the bulk of the rural agricultural population – are highly vulnerable to risk due to insufficient land allotment. Family and individual dehkan farms, while obviously not over-endowed with land, are less vulnerable than household plots but more vulnerable than "partnership" dehkan farms, which are positively large in the Tajik context.

Table 5.3. Average farm sizes according to official statistics and survey results (2009)

	Agricultural land	Arable land and perennials
Household plots (official statistics)		
Total land, ha	242,800	207,000
Number of rural households	757,608	757,608
Average farm size, ha	0.32	0.27
Dehkan farms of all types (official statistics)		
Total land, ha	2,655,800	639,100
Number of farms	37,966	37,966
Average farm size, ha	70	17
Dehkan farms by type (average size, ha)	WB baseline survey, May 2009	Helvetas, March 2011
Collective dehkan farms	107	238
Individual dehkan farms	26	10
Family dehkan farms	8	3
All dehkan farms surveyed	42	62

The small household plots, despite their high vulnerability due to limited land holdings, have managed to demonstrate exceptional adaptive capacity over time by achieving productivity levels that are orders of magnitude above those achieved by the larger dehkan farms (**Figure 5.9**). They are also the main driver for agricultural growth: while Tajikistan's gross agricultural output doubled between 1997 and 2008, the output produced by household plots increased by a factor of 2.5, offsetting (together with dehkan farms) the shrinking production of agricultural enterprises.

At the same time it is noteworthy in **Figure 5.11** that dehkan farms as a group are not doing better than farm enterprises on average. This result is contrary to theoretical expectations that individual and family farms will outperform corporate farms (enterprises), but it may stem from the fact that at least one-third of the dehkan farms are not individual farms at all: they are collective farms (partnerships) created in the process of reorganization of traditional farm enterprises and their incentives are closer to those of corporate farms than individual farms. Indeed, a November 2003 FAO mission found that "… many of these [collective dehkan] farms were only cosmetically reorganized and most of the members do not have sub-certificates or even know they have a right to a portion of the land. The management structures have remained the same in many of the farms as well" (FAO 2004). Under these circumstances we should not be surprised that the productivity of dehkan farms taken as a heterogeneous group is not different from that of the farm enterprises they succeeded. No statistical information is available on collective, individual, and family dehkan separately and future analytical efforts based on surveys should attempt to separate the performance of individual and family dehkan farms from collective dehkan farms.

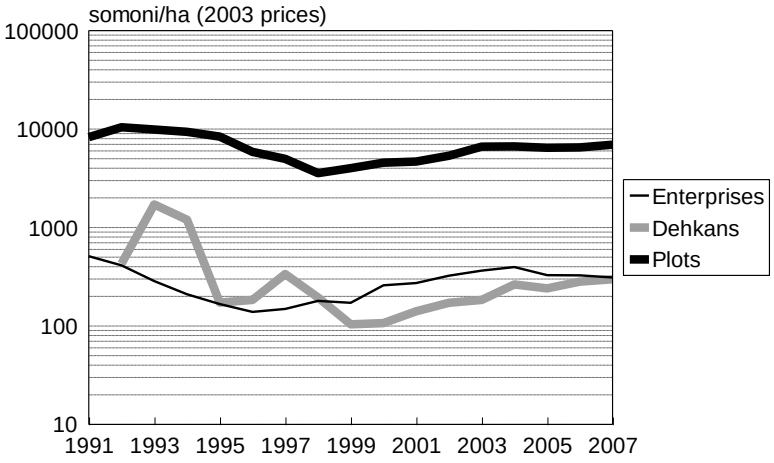


Figure 5.11. Productivity of land by farm type, 1991-2007 (GAO per hectare of agricultural land, by type of farm, somoni per ha in constant 2003 prices, log scale).

A clear policy prescription is to augment the land allotments of the highly productive rural households with the object of reducing their sensitivity to risk and thus further increasing their contribution to Tajikstan's agricultural growth (see **Box 5.1**). Despite the ambiguity regarding the productivity of dehkan farms as a mixed group, It is probably also desirable to enable individual and family dehkan farms to increase their land holdings based on theoretical expectations of higher productivity in individual forms of organization.

Box 5.1. How to enlarge small farms?

How can farm sizes be increased? One obvious way is to implement another wave of land distribution from the state reserve. However, there is virtually no reserve of arable land for further allocation to users: the state land reserve is less than 1% of arable land (land balance data for January 2010). However, 15% of arable land (nearly 130,000 hectares) is managed by corporate farms ("agricultural enterprises"), which achieve relatively low productivity levels. In addition to land in corporate farms, about 20% of Tajikistan's arable land (160,000 hectares) is held in collective dehqan farms, which as noted above are not significantly different from the former corporate farms that they succeeded. As no exact information on the proportion and size of collective dehqan farms is available, this figure is a rough estimate based on Land Agency data from January 2006. In fact, this land may have decreased since 2006-2007 given the evidence on ongoing transformation of "partnership" dehqan farms into individual and family farms since 2007 "in the interest of increasing efficiency". Still it seems that over 250,000 hectares of arable land today is in various collective structures (enterprises and "partnership" dehqan farms). This is a large hidden reserve amounting to nearly 30% of Tajikistan's 870,000 hectares of arable land that can be made available for distribution to individual or family farms as part of the land reform program.

Since the options for additional land distribution are inherently limited, farmers should be allowed to adjust the size of their holdings through land market transactions. The development of a land market in Tajikistan will have a significant effect on rural incomes and poverty alleviation, as land markets allow size adjustment through a mechanism that allows land to flow from less efficient or inactive user to more efficient and productive ones. The only feasible way for land markets to develop in Tajikistan today is by allowing transferability of land use certificates. This option is included as one of the amendments in the new Land Code currently under discussion. Beyond the transferability issue, it should be noted that each land market transaction has to be recorded in the land titling and registration system, which today is not geared to respond adequately to the anticipated increase in the level of operations. The entire cadastral system should be streamlined and modernized to avoid undesirable obstacles to the development of land market transactions.

Commercialization

Farm size has a direct effect on family well-being by increasing food production, which in itself improves the family's food security and reduces vulnerability. But farm size also has an indirect effect on family income: larger farms are more likely to sell some of their output because they produce a larger surplus after satisfying the family's food needs. Sales of farm products bring in

cash revenue, which increases the family's available income. The effect of sales on family income is demonstrated in **Figure 5.12** (Moldova) and **Figure 5.13** (Georgia), where households that sell some of their output ("sellers") are seen to have higher income than households that consume their entire output in the family ("non-sellers"). Unfortunately no comparable results are as yet available for Tajikistan.

The results for Moldova (WB/FAO survey, 2000) actually show that sales revenue accounts for the entire difference between the income of "sellers" and "non-sellers". The results for Georgia (USAID/Hebrew University survey, 2003) explicitly introduce the farm size dimension into the picture: "sellers" have larger farms than "non-sellers" (2 hectares compared with 1 hectare) and their base family income is higher even before adding the sales revenue. For Georgia we thus have a clear demonstration of the two-fold effect of farm size: more income due to more production (even without sales, simply through increased consumption of own farm product) plus an additional increment due to revenue from the sale of surplus.

Such diagrams cannot be constructed for Tajikistan, as no data are available on absolute income levels from surveys in this country. Still, the recent PPCR farm survey (May 2011) shows that in Tajikistan also greater commercial orientation is associated with higher levels of well-being – a qualitative measure of family income. The positive effect of commercialization on well-being is demonstrated in **Figure 5.10** (right-hand side of the diagram), where respondents who fall in the "high" well-being category earn a higher share of their family income from farm sales than respondents in the "low" well-being category (42% compared with 30%).

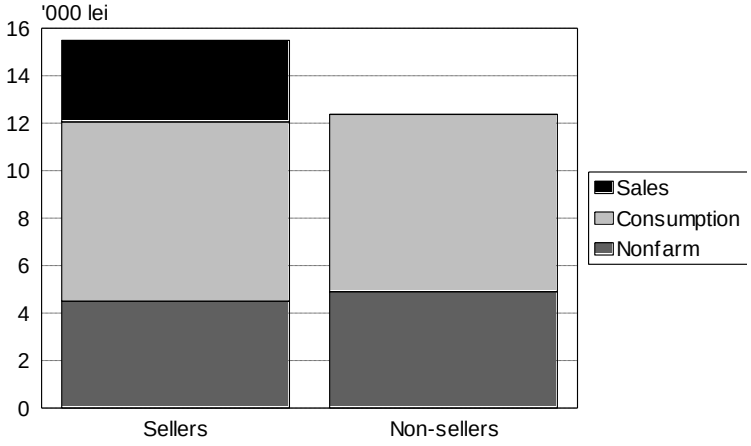


Figure 5.12. Moldova: structure of family income for "commercial" and "non-commercial" households. Source: WB/FAO baseline survey, 2000.

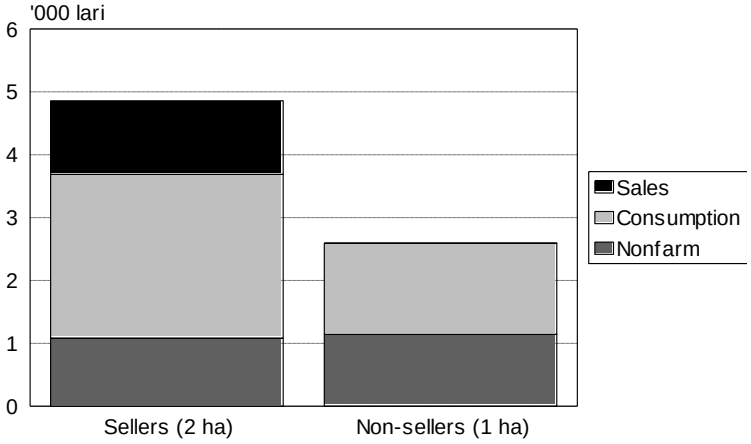


Figure 5.13. Georgia: structure of family income for "commercial" and "non-commercial" households. Average farm size: 2 ha for "commercial", 1 ha for "non-commercial". Source: USAID/Hebrew University survey, 2003.

Land reform was the mechanism that distributed more land to rural households and farmers. We can thus argue that land reform had a mutually reinforcing two-fold effect on rural incomes: more land led to more income through increased production and consumption; in addition, more land created greater surplus and thus increased the commercial orientation of the households; commercialization created additional sales revenue, which further augmented and reinforced the income effect of land.

Population density: stress on land and water resources

Tajikistan's land resources are inherently limited, while its population – especially the rural population – is growing rapidly. During the three decades from 1979 to 2009 the rural population more than doubled from 2.6 million to 5.5 million – a long-term growth rate of 2.6% per annum. The total population grew during the same period at a slightly lower annual rate of 2.2%, rising from 3.9 million to 7.5 million. These trends have led to an inevitable increase in population density, which rose from 27.4 per km^2 in 1979 to 52.6 per km^2 thirty years later.

Population density is always used as one of the vulnerability indicators: higher population density creates higher stress on both land and water resources and thus translated into higher vulnerability (higher sensitivity or lower adaptive capacity or both). In the context of agriculture and rural livelihoods, it is important to look at the density of rural population, not the density of total population. It is also necessary to calculate the density per hectare of agricultural or arable land, not per hectare of total territory, as this is the resource base from which rural people derive their livelihoods.

The area of arable land has remained fairly constant at around 850,000 hectares since 1980, while the rural population more than doubled. The density of rural population per hectare of arable land accordingly rose from 3.1 per hectare in 1980 to 6.3 per hectare in 2009 (here arable land includes fallow). The stress of rural population on arable land resources in Tajikistan is similar to that in Kyrgyzstan, Turkmenistan, and Uzbekistan, but an order of magnitude higher than in Kazakhstan, Russia, and Ukraine.

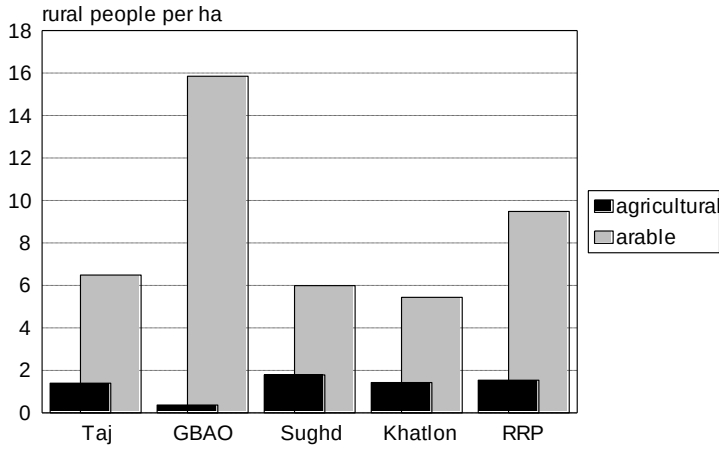


Figure 5.14. Rural population density per hectare of agricultural/arable land, 2009. Source: Agriculture in Tajikistan 2010; Demographic Yearbooks 2010.

The stress on arable land is much higher than the stress on agricultural land (**Table 5.4, Figure 5.42**), primarily because of the huge extent of pastures in Tajikistan (nearly 80% of agricultural land in the country). There is also considerable variability in stress on land resources across the four administrative regions of Tajikistan – GBAO, Sughd, Khatlon, and RRP.

Table 5.4. Rural population density per hectare of agricultural/arable land, 2009

	Taj	GBAO	Sughd	Khatlon	RRP
Total population, '000	7529.6	220.6	2216.9	2700.2	1685.8
Rural population, '000	5542.1	191.3	1656.5	2235.7	1458.6
Population density per km^2	52.6	3.4	87.3	108.9	58.9
Agricultural land, ha	3,957,585	522,294	923,679	1,565,752	944,500
Arable land, ha	854,214	12,066	276,531	410,804	153,827
Irrigated arable land, ha	582,417	10,353	196,468	290,988	83,644
Rural population per hectare					
Agricultural land	1.4	0.4	1.8	1.4	1.5
Arable land	6.5	15.9	6.0	5.4	9.5
Irrigated arable land	9.5	18.5	8.4	7.7	17.4

GBAO has the highest stress on arable land, mainly because there so little of it in this mountainous region. Conversely, GBAO has the lowest stress on agricultural land, which includes pastures: this is due to the combined effect of small total population and huge pasture areas in the region. RRP is next in the vulnerability ranking, with Sughd and Khatlon roughly tied for the third place. [3] The density of rural population per hectare of *irrigated* arable land follows basically the same ranking, with a small difference: by rural population density per hectare of irrigated arable GBAO is much closer to Khatlon than by population density per hectare of all irrigated land. This is due to the fact that in GBAO almost 90% of arable land is irrigated, compared with less than 65% in Khatlon.

Irrigation: stress on water resources

Tajikistan is a semi-arid country and agricultural land use is largely dependent on irrigation. Arable agriculture in water-abundant river valleys was maximized by the traditional expedient of extending artificial irrigation networks. The irrigation-ready area increased from 450,000 hectares in 1960 to 720,000 hectares in 2009, or 18% of all agricultural land. This average irrigation rate masks huge differences between irrigation of arable land and irrigation of pastures. Of the total irrigated area, 580,000 hectares (80%) is irrigated arable land and 140,000 hectares (20%) is irrigated pastures. As a result, irrigation covers nearly two-thirds of arable land and less than 5% of Tajikistan's pastures.

Table 5.5. Structure of different land use types across regions (percent of agricultural land)

	Agricultural		All land uses	Arable		Pastures	
	rainfed	irrigated		Rainfed	irrigated	rainfed	irrigated
Tajikistan	81.8	18.2	100.0	6.9	14.7	74.9	3.5
GBAO	96.8	3.2	100.0	0.3	2.0	96.5	1.2
Sughd	71.4	28.6	100.0	8.5	20.8	62.9	7.8
Khatlon	78.9	21.1	100.0	7.7	18.6	71.3	2.5
RRP	89.1	10.9	100.0	7.4	8.9	81.6	2.1

There is considerable variation in irrigation coverage across regions. **Table 5.5** and **Figure 5.15** present a view of irrigated land in percent of total agricultural land. Here agricultural land is classified into four components that add up to 100%: rainfed arable, irrigated arable, rainfed

[3] The vulnerability ranking by total population density is quite different (**Table 5.4**, third line): Khatlon > Sughd > RRP > GBAO. Overall, this does not even match the ranking obtained by rural population density per ha of agricultural land (Sughd > RRP > Khatlon > GBAO), except that in both rankings GBAO is the least vulnerable.

pastures, and irrigated pastures. In this view, basically all of GBAO is unirrigated, rainfed pastures (97% of agricultural land). RRP has relatively little arable land (17%), and although more than half of it is irrigated, the dominant land use in this region is also rainfed pastures (82% of agricultural land). Khatlon and Sughd are better endowed with arable land (more than 25% of agricultural land) and more than two-thirds of it is irrigated.

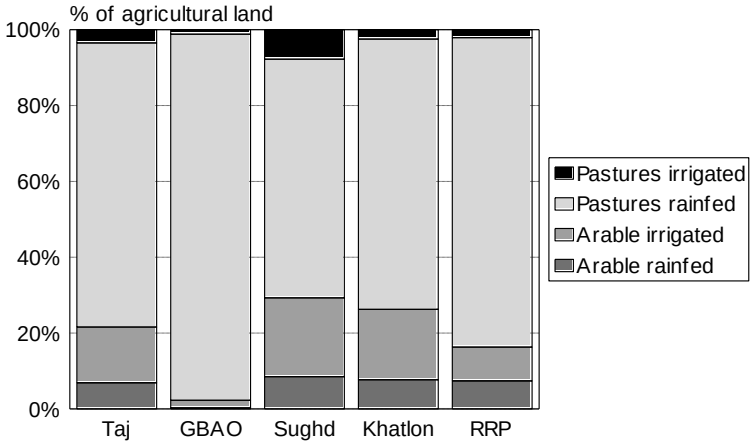


Figure 5.15. Proportions of irrigated and rain-fed land: pastures and arable, 2009. Source: Agriculture in Tajikistan 2010.

A different view is obtained by calculating the irrigation coverage for each land use type – arable land and pastures – separately. **Figure 5.16** shows how the irrigation shares vary across regions. Nationally, as noted above, 66% of all arable land and 4% of pastures is irrigated. Breaking this down by region, we see that the share of irrigated arable land declines from 87% for GBAO to 56% for RRP (**Figure 5.16**). Share of irrigated pastures is generally below 5%. Sughd is an exception, with 10% of pastures under irrigation.

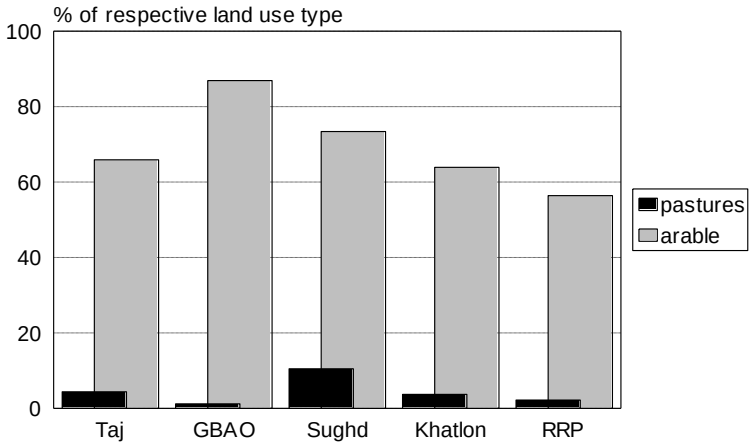


Figure 5.18. Irrigation shares for arable land and pastures by region, 2009. Source: Agriculture in Tajikistan 2010.

Livestock

Tajikistan's agriculture is based mainly on crops whereas livestock production accounts for less than 30% of gross agricultural output (2005-2009 data). For comparison, livestock represents 45% of agricultural production in neighboring Kyrgyzstan (and also in Kazakhstan and Russia). The crop/livestock shares probably vary across regions (the corresponding data are not readily available), but nationally Tajikistan's agriculture is characterized by a relatively low level of crop/livestock diversification and is thus potentially more vulnerable to risk (including climate change risk).

The animal headcount increased sharply after 1998, rising from 1.3 million cow equivalents in 1997-1998 to 2.1 million cow equivalents in 2007 (**Figure 5.17**, black curve). The livestock in Tajikistan is a mix of cattle and sheep, with over 1 million head of cattle and around 3 million head of sheep and goats. While in absolute numbers small ruminants outnumber large cattle, sheep account for only 18% of the weighted-average headcount in cow equivalents (calculated with a weight of 10 head of sheep per 1 cow equivalent), while about 80% of the livestock herd is cattle.

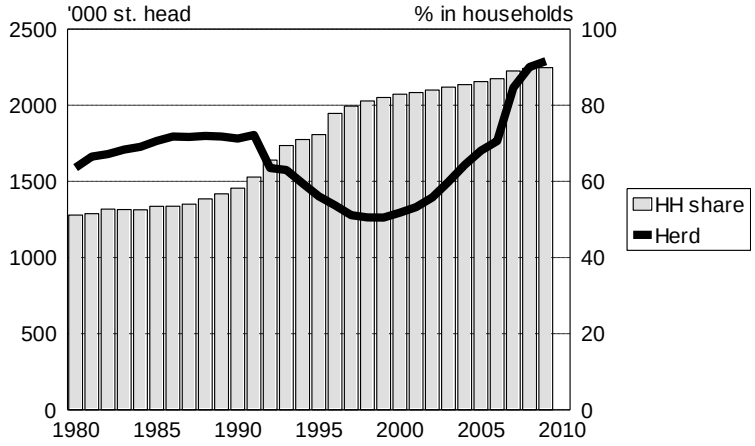


Figure 5.17. Livestock herd, 1980-2009 ('000 standard head). Source: pre-1990 from CISSTAT 2010; after 1990 from Agriculture in Tajikistan, various years.

The livestock herd is concentrated almost totally in rural households. Already back in the Soviet era the household plots controlled 60% of the livestock herd (in cow equivalents). By 2007 the share of household plots had risen to 90% of the animal headcount (**Figure 5.17**, gray bars). The remaining 10% is divided between corporate farms and dehkan farms. In 2009, some 760,000 rural households had 1.7 million head of cattle, including 910,000 cows. These numbers translate into an average of 2.2 head of cattle and 1.2 cows per rural household (**Table 5.6**). The growing livestock herd is thus dispersed among a very large number of rural households, each with 1-2 animals. The small numbers of animals per household are naturally reflected in low levels of livestock production (milk, meat, fattened live animals) and low levels of livestock-related wealth, increasing the vulnerability of the rural households in this dimension.

Table 5.6. Livestock in rural households 2009

	Headcount in rural households	% of national headcount	Average per household*
Cattle	1,676.3	92	2.2
Cows	909.7	96	1.2
Sheep & goats	3456.9	82	4.6

*Based on 757,608 rural households (Standard of Living Survey 2007, TajStat and Unicef)
Source: Agriculture in Tajikistan 2010.

The household herd continues increasing because livestock is an important source of both food and income for the rural households. There is a ready cash market for live animals, while milk is easily sold to dairies or directly to consumers. All households periodically sell some of their live animals in the livestock bazaar or to intermediaries, but they always treat their herd as a store of value, carefully replenishing the stock to ensure continued growth of the headcount. We do not find evidence of large-scale distress sell-offs of livestock despite some alarmist statements by advocacy groups (see, e.g., SCP April 2011, p. 11). **Figure 5.18** shows that the headcount of household animals increased between 2004 and 2009 in all oblasts, and the highest increase (nearly by 60%) was registered in Khatlon, despite its characterization as a high-vulnerability region where emergency sell-off of animals is most likely to take place.

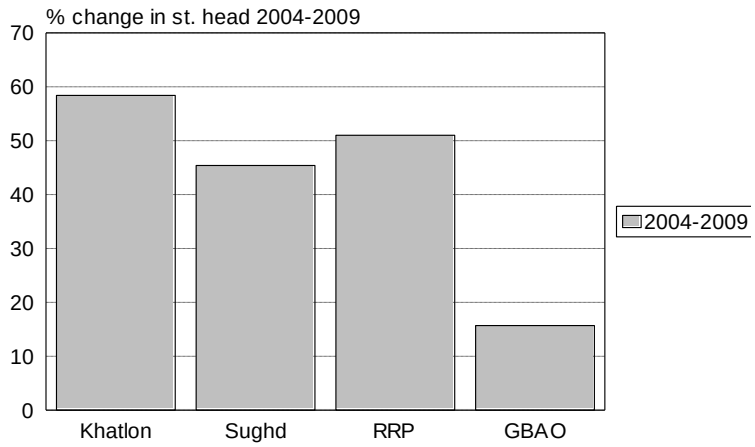


Figure 5.18. Change in household animals 2004-2009 (percent of standard head). Source: Agriculture in Tajikistan 2010

The performance of the livestock sector is far from satisfactory. Milk yields in Tajikistan are the lowest among all CIS countries, averaging 800 kg per cow per year (**Figure 5.19**). Inadequate supply of animal feed may be one of the reasons for low livestock performance. Despite the increase in animal headcount, the area sown to feed crops declined precipitously after 1990, dropping from 230,000 hectares to 110,000-120,000 hectares in recent years (**Figure 5.20**). The quantity of feed harvested also fell sharply and in 2007 it was merely 15%-30% of the harvest in 1990 (depending on the particular feed crop). These changes are largely the outcome of government policies that impose production targets for wheat and cotton and in effect discourageor even prohibit allocation of land for feed crops.

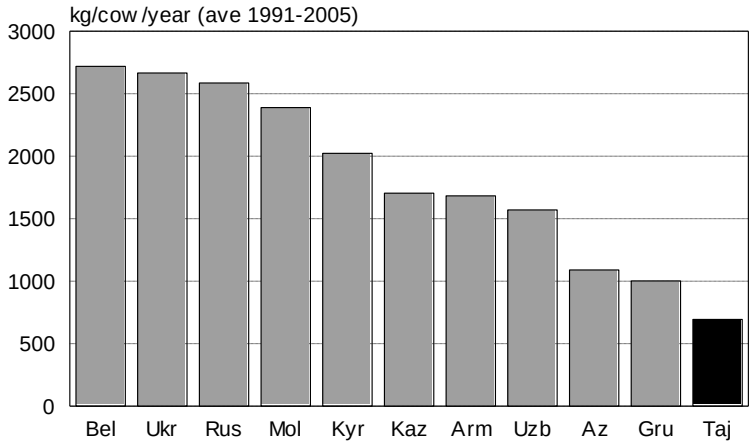


Figure 5.19. Milk yields in Tajikistan and other CIS countries (averages for 1991-2005). Source: CISSTAT, 2010.

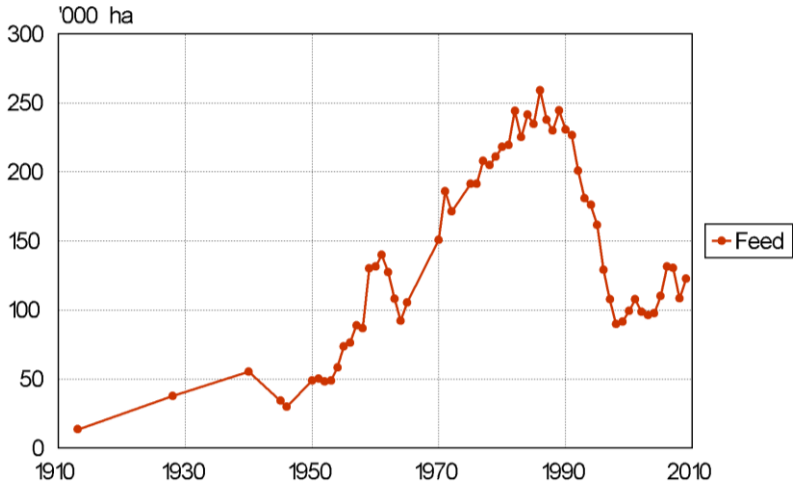


Figure 5.20. Area sown to feed crops. Source: Agriculture in Tajikistan, various years.

In principle, decrease in feed crops should be compensated by increased grazing, but in reality the area of pastures has decreased by 300,000 hectares (about 10%) since 1997. These two factors combined indicate a sharp contraction of the feed base for both cattle and small ruminants. The rural households are thus forced to rely even more heavily than before on low-quality feed, obtained by grazing their few animals on the grassy verges of roads and canals and on post-harvest stubble in the fields. Inadequate quantity and quality of animal feed acts to increase the vulnerability of livestock in rural households. Integrated crop-livestock management approaches are ideally suited to smallholder agriculture: they exploit crop-livestock synergies on small farms by using manure from animals to fertilize the fields and thus increase the production of feed crops for the animals (and also food crops for people). The feed situation can be partially improved by paying more attention to cooperative grazing arrangements, which include organization and proper management of common pastures near Villages. The problem of feed shortages may be addressed by scientific research through selection programs aimed to introduce fodder varieties that are both high yielding and tolerant to Tajikistan's harsh climatic conditions.

In addition to feed, animal health and genetics have a significant effect on livestock performance. Attention to animal health requires a well-organized veterinary service, either private or state-run, whereas improvement of animal genetics requires wide-scale adoption of artificial insemination and development of selection procedures that emphasize breeds adapted to local conditions. Breed improvements will increase the productivity of livestock and make it possible to produce larger quantities while actually reducing the number of animals and thus relieving some of the stress on feed resources.

Just as population density determines the stress on land and water resources, livestock density (animal headcount per hectare of pasture) determines the stress on pastures. **Table 5.7** shows the variation of livestock density across regions: it is lowest in GBAO (26 standard head per 100 ha) and highest in Sughd (almost 100 standard head per 100 ha). Overall, the livestock densities in Sughd and RRP are close to those in Khatlon, and GBAO emerges as a low-stress outlier.

Table 5.7. Livestock density by oblast (standard head per 100 ha of pasture, 2009)

	Large ruminants, head	Small ruminants, head	Standard head*	Pasture, ha**	Density, st. head/100 ha
Tajikistan	1,829,997	4,200,184	2,250,015	3,103,371	73
GBAO	101,646	305,108	132,157	510,228	26
Sughd	505,368	1,181,833	623,551	647,148	96
Khatlon	756,419	1,720,638	928,483	1,154,948	80
RRP	466,564	992,605	565,825	790,673	72

*Calculated assuming 10 head of small ruminants are equivalent to 1 head of large ruminants.
**Estimated as the difference between agricultural land and arable land, as no data are available on pasture areas by oblast.
Source: Agriculture in Tajikistan 2010.

Diversification of income and farm production

Diversification is a standard risk-reducing tool in economic theory and financial practice, which is also important for reduction of vulnerability. Tajik farmers diversify both their income sources and their production. However, in both dimensions diversification is still not sufficient. Family incomes are based on agriculture to the extent of 50%-70% of the total, which clearly implies significant dependence on a single source with all the associated risks. Diversification of income sources is generally achieved by accepting wage employment outside agriculture and by expanding entreprensurial activities. Wage employment (including remittances for family members working

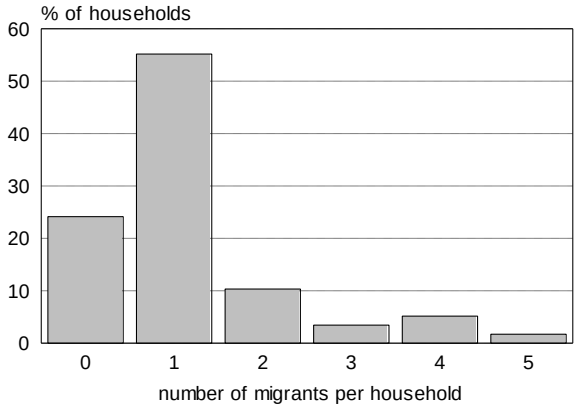
abroad as migrants) constitutes already now a significant component of family income (see **Table 5.2 and Box 5.2**). Income from entrepreneurial activities, however, is so far negligible. Policy measures should be put in place to encourage development of off-farm activities in rural areas, including small-scale processing (dairy and meat, dried fruits, jams), cottage industries (carpet weaving, traditional arts and crafts), small business initiatives (transport, trade, intermediation). Encouragement of off-farm activities requires an intelligent public awareness and education campaign, with information and support materials developed and provided by the government and NGOs; it may also require micro-financing through reasonably priced loans or grants and possibly innovative tax measures to provide additional incentives.

We have seen that nationally agriculture is based 70% on crop production and only 30% on livestock. In dehkan farms livestock production accounts for less than 3% of total output (the product mix in household plots is more balanced, with 40% of production in livestock; average for 2004-2009, TajStat data). In a recent Helvetas survey (March 2011), only 24% of dehkan farms surveyed reported that their activities included both crop and livestock production; the remaining 76% produced crops, but no livestock. Tajikistan's agriculture thus bears an unbalanced risk due to the dominance of crop enterprises with their exposure to the vagaries of weather and climate change. Measures designed to improve the productivity of livestock will inevitably result in higher output and increase the share of livestock production in national agriculture, leading to a more balanced and less vulnerable product mix.

Box 5.2. Remittances from migrants help build household wealth

Shahtuti Bolo is a village of 569 inhabitants in Hakimi Jamoat, Nurabad District, RRP, located at the end of a single mud track some 5 km from the jamoat center, 40 minutes by a mudslide-prone track from the main communication route between Dushanbe and Garm. A small survey designed to collect data on energy usage prior to implementation of a rural energy efficiency program was conducted in spring 2011 among all 58 households in the village. The survey unexpectedly provided interesting insights into the role of remittances from migrants working abroad to the well-being of the village population.

Three-quarters of the households in the village (44 out of 58) have someone working abroad (basically in Russia). The number of migrant workers is generally 1-2 per household, but 10% of the households in the village report from 3 to 5 migrants. A total of 67 people work abroad, which constitutes 23% of the working-age population in the village (aged 16 to 60). According to informal interviews in the village, the migrants usually work abroad from March to October and return home for the winter months.



Shahtuti Bolo: distribution of households by number of migrants working abroad.

There is a clear relationship between various household wealth indicators and the fact that at least one of the family members works abroad. Families with migrants are more likely to have a car; families with migrants can afford to spend more on coal and on fuel in general; families with migrants have more livestock.

Furthermore, all three indicators increase as the number of migrants in the household increases. The differences are statistically significant, except for livestock.

Wealth indicator	Families without migrants	Families with migrants	1 migrant	2 migrants	3 and more migrants
Has a car, % of households	29	68*	63	83	83
Expenditure on fuel, somoni/year	1,390	2,240*	2,000^	2,700	3,000^
Number of animals, st. head	1.7	2.3	2.1	2.8	3.2

*Difference between families with and without migrants statistically significant at p=0.1.
^Difference between families with 1 migrant and 3 or more migrants statistically significant at p=0.1.

Wealth creation in Shahtuti Bolo is thus facilitated by the earnings of migrant workers abroad. This is a positive effect of labor migration, but it is apparently achieved at a huge human cost, not least because of the discrimination and violence that Tajik migrants suffer in Russia and other countries where they go to work. It is interesting to note that, unlike the model of a Turkish "gaestarbeiter" in Europe, Tajik migrants work abroad mainly during the summer months and return home in the winter. Many of them return permanently after a number of years, once they have accumulated sufficient wealth. Returning migrants contribute in various ways to the rejuvenation of their community, e.g., by building new modern homes, as is seen in the photograph from Jamoat Sayed near Shaartuz.

New houses being built by returning migrants from Russia. Jamoat Sayed, near Shaartuz (8 April 2011).

With regard to crop enterprises in aggregate, it is important to look at the specific product mix and assess the extent of diversification between different crops and varieties. Although Tajikistan was one of the main cotton-growing countries in the USSR, it never became a cotton monoculture. Both cotton and cereals (mainly wheat) were always present in Tajikistan's crop mix, occupying in varying proportions up to 70%-80% of total sown area (**Figure 5.21, Table 5.8)**. The remainder was split between feed crops and horticulture (potatoes, vegetables, melons, fruits, and grapes), with area under feed crops shrinking significantly since 1980 and the area devoted to horticultural crops increasing with the progress of farm reforms after 1995. Here again, as with the crop/livestock mix, we witness basic diversification of crop production, but the diversification is not particularly pronounced: technical crops (mainly cotton) and cereals (mainly wheat) dominate the cultivated area.

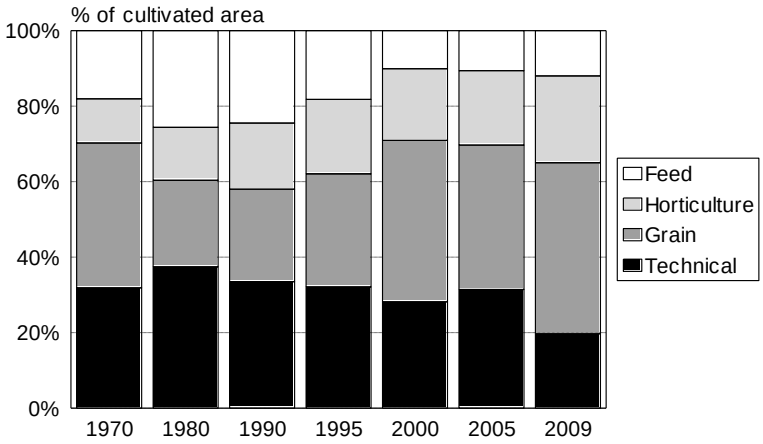


Figure 5.21. Structure of cultivated area by main crop groups 1970-2009. Source: Agriculture in Tajikistan, various years.

Table 5.8. Structure of cultivated land 1970-2009

	Total cultivated, '000 ha*	Cereals, %	Cotton, %	Vegetables**, %	Fruits^, %	Feed crops, %
1970	834.9	38.4	30.4	3.3	8.4	18.1
1975	781.0	25.6	34.8	4.0	10.1	24.5
1980	849.7	22.9	36.3	3.9	10.1	25.6
1985	898.3	23.3	34.7	4.2	10.6	26.1
1990	940.0	24.5	32.3	5.1	12.3	24.5
1995	886.6	29.9	30.2	5.2	14.5	18.2
1998	948.2	42.9	25.6	5.9	12.7	9.4
2000	985.0	42.8	24.2	6.7	12.3	10.1
2005	1034.8	38.2	27.9	6.8	12.9	10.6
2009	1020.1	45.3	16.6	8.8	14.2	12.0

*Cropped and under perennials (orchards and vineyards).
** Includes potatoes, vegetables, and melons.
^Fruits and grapes. Source: Agriculture in Tajikistan, various years.

Formal analysis of land use diversification over time in terms of the (normalized) Herfindahl index for five crop groups (cotton with other technical crops, cereals, vegetables, fruits, and feed crops) leads to two conclusions:

- the diversification levels are relatively high: around 0.1 on a scale of 0 to 1, where 0 is full diversification with all crop groups cultivated in equal shares and 1 is complete specialization of all land in one crop group;
- diversification increased significantly between 1970 and 1995, with the (normalized) Herfindahl index dropping from 0.11 to 0.06 (close to perfect diversification of all crop groups in equal shares), whereas between 1995 and 2009 we conversely witness a certain increase in specialization as the Herfindahl index rose back to an average of 0.10-0.11 in 2000-2009. Intuitively, the increase in specialization since 2000 is evident in the rising share of land in cereals relative to other crops.

The main changes in cropping structure since 1980s have been an increase in the area under cereals, decreases in the area under both cotton and feed crops, and an increase in the area devoted to horticultural crops – both vegetables and fruits (**Table 5.8**). Greater emphasis on food crops – grain and vegetables – presumably improves the food security of the population and thus contributes to reduction of vulnerability. The increase in area sown to wheat reflects the government's policy emphasizing self-sufficiency and food security. The increase in horticultural crops (potatoes, vegetables, melons) is a reflection of the growing role of small household plots, which specialized in horticulture already during the Soviet period.

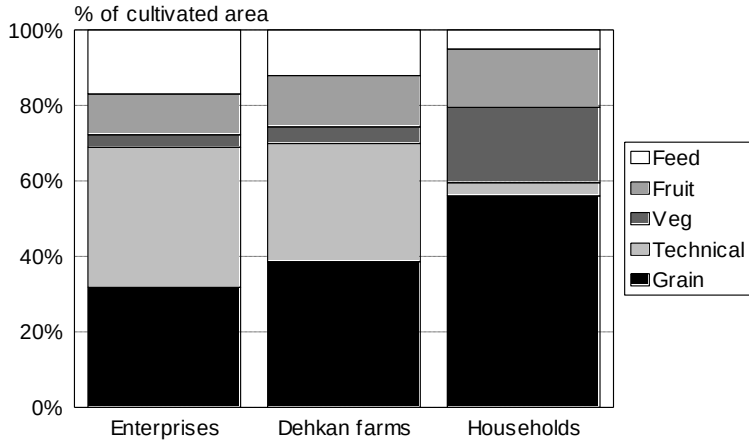


Figure 5.22. Structure of cultivated land in farms of different types, averages for 2005-2009. Source: Statistical yeabooks, various years.

Labor intensive horticultural crops are ideally suited for small farms, with their abundance of relatively cheap labor, which may in fact explain the growth in horticulture since 1998. Tajik press has recently begun promoting horticulture as an alternative to declining cotton production (Ferghana.news 2009). **Figure 5.22** shows that vegetables account for a much larger share of the cultivated area in household plots than in either dehkan farms or agricultural enterprises. The share of land in grain is also much higher in household plots, presumably because grain is used to feed the omnipresent household animals, thus compensating for the virtually total absence of feed crops on the small allotments. As a result of these two factors, the Herfindahl index points to higher specialization of household plots than other farm types (0.23 for household plots compared with 0.10 for dehkan farms and agricultural enterprises).

To encourage further diversification of dehkan farms away from cotton and wheat, the government should scrupulously observe the full intent of the "freedom to farm" provisions:

- farms should not be subject to any production targets on cotton or wheat;
- there should be no further intervention of local and regional authorities in farm decisions regarding product mix or land allocation to different crops;
- farmers should be allowed to exercise their land use rights without any administrative restrictions;
- farmers should be free to decide where and how to sell their output;
- farmers should not be coerced to work with a particular marketers or processor;
- goods must be allowed to move free across oblast/raion lines in search for the best market prices.

It is important to ensure realistic options for access to alternative sources of credit, which is essential for expanding farm operations in new directions. In addition to borrowing from commercial banks, farmers should be able to borrow from micro-finance institutions and should be encouraged to create credit cooperatives or credit unions. Raising credit requires collateral, and the issue of bankable farm collateral should be addressed in existing legislation by making land use certificates both transferable and mortgageable. These provisions require amendment of the Land Code and the Mortgage Law.

Future research on vulnerability and SLM policies in Tajikistan

This chapter has reviewed some vulnerability variability for which sufficient statistical data are available. Future research on rural vulnerability in Tajikistan requires a database consisting of a much wider range of both geo-climatic and socio-economic variables. These variables should be

collected at a district level, for each of the 50-odd districts in Tajikistan, with the goal of achieving a substantially higher spatial resolution than so far. The data can be analyzed by the two main methodologies – the World Bank vulnerability index methodology and the Potsdam Institute clustering methodology – to construct a district-level vulnerability map of Tajikistan. The district-level vulnerability results can then be aggregated to the level of agro-climatic zones or other zoning as developed, e.g., for food security purposes by World Food Program (see **Chapter 6**) or other donor organizations.

Table 5.9. Selected variables with potential relevance for SLM policies and vulnerability analysis

Province/district level variables (from official statistics)	**Farm level variables (from surveys/interviews)**
Land resources: arable, perennials, meadows, pastures; irrigated/rainfed	Farm land resources: ha and structure)
Rural population	Land quality, access to water
Rural population density: per ha of arable land, per ha of irrigated land	Land rights (security of tenure, titles, land transactions)
Livestock density: head per ha pastures	Human capital: family size, dependency ratio, age structure, educational attainment
Crop/livestock mix	Migrants
Product diversification	Farm labor force (family, hired)
Family income, per capita income: level, structure	Farm machinery: ownership, use, channels
Non-agricultural employment opportunities: share of employed in agriculture/outside agriculture	Purchased inputs: availability, use, channels
Regional share of agriculture in country's total GAO	Water: availability and access
Regional share of agriculture in GDP	Livestock: headcount and herd structure
Terrain (mountains, valleys, rivers)	Crop/livestock mix, processing
Climate characteristics	Product diversification
Record of climate change	Consumption and sale of farm products
Frequency of natural disasters (by type)	Sale channels
Regional soil quality	Non-farm activity (wage employment, entrepreneurial)
Political environment (coercion, corruption, reform attitudes, etc.)	Cooperation: production, inputs, machinery, sales, processing, water, credit
	"Freedom to farm"
	Family income and well-being
	SLM needs and practices on the farm
	Experience with climate change and natural disasters

Table 5.9 is a partial listing of variables that can be included in such a vulnerability database. The data collection effort requires close cooperation with the State Statistics Agency (the source for district-level socio-economic variables) and Hydromet (the source for district-level geo-climatic variables). It also requires carefully designed survey work intended to supplement district-level data with farm-level data for higher resolution analysis of vulnerability factors. This approach separating data collection for vulnerability analysis into national-level statistics and farm-level surveys is similar to that advocated for the proposed food security monitoring and evaluation system in Tajikistan (WFP 2008, pp. 59-60).

The creation and maintenance of the vulnerability database is a costly and time-consuming undertaking that should be supported by international donors, possibly as part of the planned Phase 2 of the Pilot Program for Climate Resilience (PPCR) in Tajikistan.

6. Food insecurity in Tajikistan

Food security in Tajikistan is a topical issue regularly addressed by WFP, FAO, the World Bank, Save the Children program, and other international donors. Intuitively it is clear that food security influences vulnerability: greater food insecurity implies higher vulnerability (see **Box 6.1**). The food security literature has coined the term "vulnerability to food insecurity" and relies primarily on food consumption and food access characteristics to define households that are "highly vulnerable" or "very vulnerable" to food insecurity" (see, e.g., WFP 2005). Thus, households with very poor food consumption are classified by WFP as very vulnerable to food insecurity (WFP 2005, p. 94). It seems that WFP treats vulnerability as a subset of food security, whereas our approach to vulnerability regards food security as one of the component of vulnerability in the broader sense of exposure, sensitivity, and adaptation to risks. Thus, "food security" is introduced as one of the sectors of vulnerability in the list of potential indicators for human vulnerability assessment proposed by Lioubimtseva and Henebry (2009). Unfortunately, this definition of "food security" is not identical with the definition of food security as used by WFP in the food security literature.

Box 6.1. What is food security?

Food security was defined years ago by the World Bank as "access by all people at all times to sufficient food for an active, healthy life." In practical terms, this encompasses the physiological needs of individuals; the complementarities and trade-offs among food and other basic necessities (especially health care and education, but others as well); changes over time in terms of people's livelihood strategies and the assets to which they have access; and uncertainty and risk (that is, vulnerability). Clearly, food security is about much more than just how much people have to eat. Yet, having "enough" food to eat is clearly the most important outcome of being food secure, and while physiological requirements differ, people largely know whether they have "enough" or not.

The Coping Strategies Index: Field Methods Manual
Dan Maxwell, Ben Watkins, Robin Wheeler, Greg Collins, Care and WFP, Nairobi (2003), p. 4

In the WFP paradigm, food security assessment (situation analysis) consists of three main components collected in household surveys (WFP 2008):

- Food security, as determined by food consumption and food access capacity;
- Coping strategies;
- Contextual analysis, including agricultural production, access to human, social, financial, physical, and natural assets, and the situation in shops and markets (used to characterize the household livelihoods and identify the main factors associated with food insecurity). The component of contextual analysis make it possible to characterize the household livelihoods and and identify the main factors associated with food insecurity.

Among the two components of food security, food consumption patterns give an idea of the adequacy of the household diet, while food access capacity is determined by the household income sources. Food consumption is a physical index (a score) reflecting diversity and frequency with which different food groups were consumed by the households (during the last 7 days of recall). Food access capacity reflects the type of main income source and considers the dependence on this source, its regularity, reliability, and sustainability, as well as the level of income. Food access capacity is differentiated into poor, average, and good according to different sources of income (**Table 6.1**, left-hand panel). The three food access groups are crossed with three consumptions groups (poor, borderline, acceptable) to classify the population into three levels of food security: severe food insecurity, moderate food insecurity, and food security (**Table 6.1**, right-hand panel). Although food access is only one of the components in food security assessment, respondents

identify poor food access as the main cause of food insecurity. Poor food access in the respondents' view is characterized by the following attributes:

- low food self-sufficiency (insufficient own production even in normal times);
- damage to crops and livestock during the survey year;
- high market prices for food;
- insufficient income

Table 6.1. Food access capacity and food security situation of rural population

Food access capacity	Income sources	Frequency	Food security groups	Frequency	Estimated population
Poor	Pensions Sale of handicrafts	4%	Severely insecure	12%	0.5 million
Average	Wage labor Self-employment Remittances Cotton sales	70%	Moderately insecure	22%	1.18 million
Good	Other crop sales (wheat, potatoes, vegetables, fruits) Sale of live animals and animal products Government service Trade	26%	Food secure	66%	3.25 million

Source: WFPA 2008, p. 23.

The common coping strategy is to decrease food consumption and to switch to less expensive foods. Among severely food insecure, 25% report that they go days without eating. **Box 6.2** gives more details of coping strategies of food insecure households.

Box 6.2. Coping strategies frequently associated with food insecurity

- Rely on less preferred/less expensive foods (99% severely food insecure HHs, 88% moderately, 74% food
- secure HHs)
- Spend entire days without eating (26% severely food insecure HHs, 19% moderately food insecure HHs,
- 9% food secure HHs)
- Borrow food (12-17% food insecure HHs, 32% food secure HHs)
- Purchase food on credit (11% severely food insecure HHs, 22% moderately, 38% food secure HHs)
- Limit portion size at meals (95% severely food insecure HHs, 80% moderately, 61% food secure)
- Restrict adults' consumption in order for small children to eat (86% severely food insecure, 75%
- moderately, 53% food secure)
- Reduce number of meals per day (93% severely food insecure HHs, 78% moderately, 58% food secure)
- Take children out of school (12-13% food insecure HHs, 6% food secure HHs)
- Increase labor migration (52% severely food insecure HHs, 36% moderately food insecure HHs, 28% food
- secure HHs)

The overall food insecurity situation in Tajikstan based on the April/May 2008 assessment is shown in **Figure 6.1**. Most of Sughd (except Mastchah), western RRP (Hissar-Shakhrinav-Tursunzade), and perhaps paradoxically all of GBAO have the lowest levels of food insecurity. Eastern RRP (Rasht) and eastern Khatlon (plus a pocket in northwestern Khatlon) have the highest levels of food insecurity. Central RRP and most of central and western Khatlon are characterized by moderate food insecurity. This WFP food security map is largely similar to the distribution of the World Bank Vulnerability Index (see **Figure 2.1)** , except for two regions: the district of Penjikent in the west of Zerafshan Valley and the districts of Shahristan and Ghanchi north of the Zerafshan Range. These

districts have a high vulnerability index but a low food insecurity score. Excluding the three discordant districts, we observe a high (negative) correlation between the WFP food security score and the WB Vulnerability Index (r = –0.62): a high food security score is generally associated with a low vulnerability index and a low food security score is generally associated with a high vulnerability index (**Figure 6.2**). This points to satisfactory consistency of the two vulnerability classification systems, especially given that the correspondence between the 19 WPF zones and the 10 World Bank vulnerability mapping zones is sometimes fuzzy.

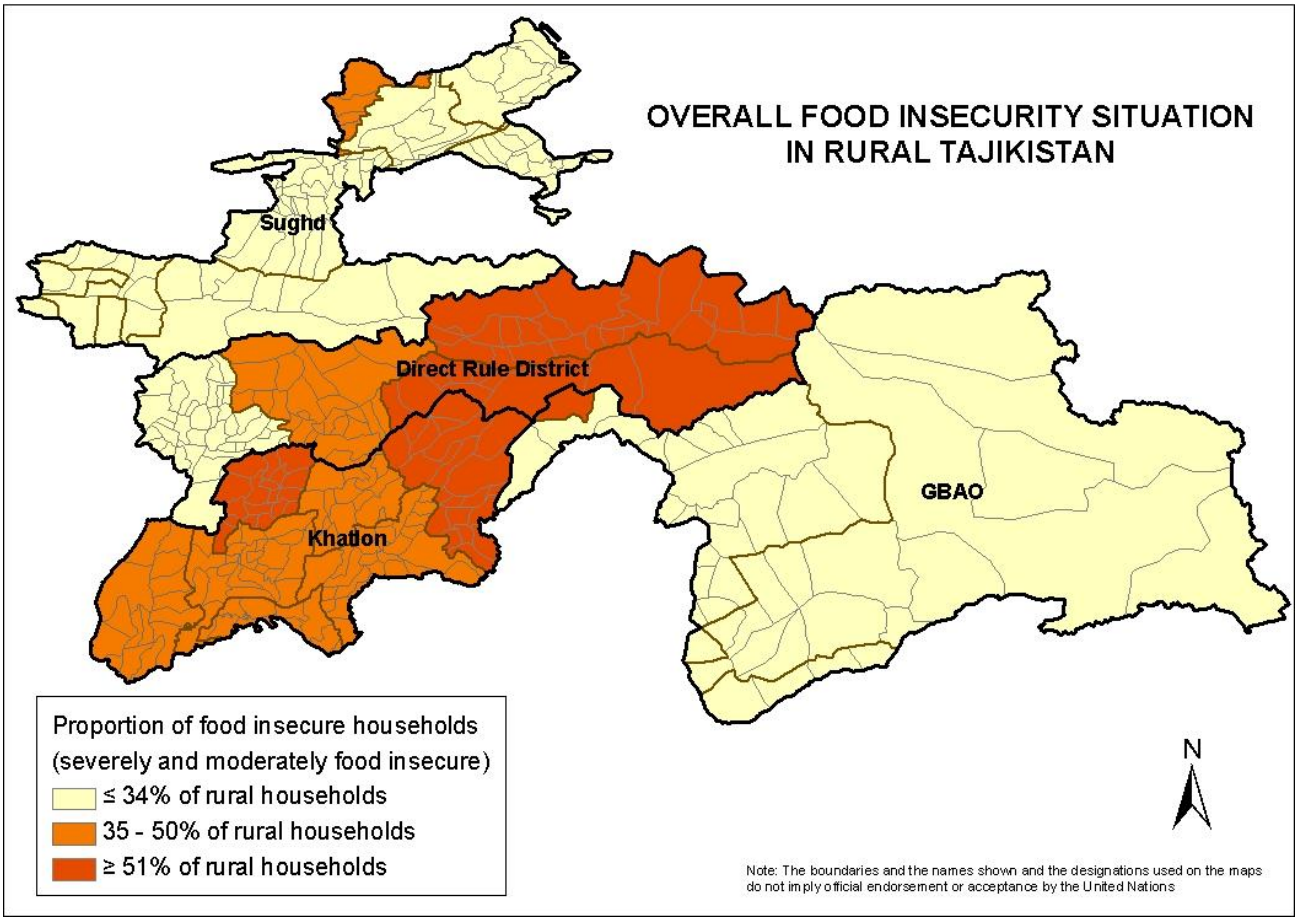


Figure 6.1. Overall food insecurity in rural Tajikistan, April/May 2008 assessment (WFP 2008).

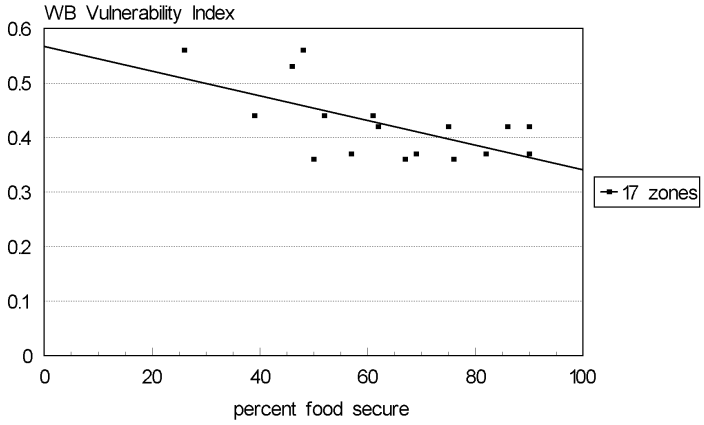


Figure 6.2. World Bank Vulnerability Index vs. WFP food security score (R^2=0.39). Data from **Table 6.2.**

Table 6.2. Proportion of food secure households and WB Vulnerability index by WFP zone

Oblast	WFP zone*	Proportion of food secure households (%)**	WB Vulnerability Index (**Figure 2.1, Table 2.2**)
RRP	13	48	0.56
	14	76	0.36
	15	62	0.42
	17	26	0.56
GBAO	6	86	0.42
	8	90	0.42
Khatlon	1	61	0.44
	5	39	0.44
	7	67	0.36
	9	50	0.36
	18	52	0.44
	19	46	0.53
Sughd	2	57	0.37
	3	90	0.52
	4	82	0.37
	10	90	0.52
	11	75	0.42
	12	90	0.37
	16	69	0.37
Taj		67	

* WFP 2008.

** Visually estimated from WFP 2008, Figure 18.

7. Summary: Dimensions of vulnerability and resilience for Tajikistan

This summary lists the main variables that determine Tajikistan's vulnerability and resilience, including the results of their quantitative assessment based on Chapters 1 and 5.

Dimensions of vulnerability

- Renewable water resources plentiful, but derive from progressively shrinking glaciers (a climate change effect?)
- Arable agriculture dependent on irrigation:
    - Salinization of soil
    - Rising water table
    - Poor maintenance of irrigation network
    - Heavy dependence on electric pumps
    - One-third of arable land rainfed, without irrigation networks
- Total dependence on hydropower:
    - No electricity when water level in reservoirs too low
    - System expansion involves flooding, loss of agricultural land, relocation of rural population
- Smallholder agriculture with limited natural and physical assets:
    - Small land allotments
    - Small number of animals per household
    - No farm machinery
- Expansion of arable land restricted by steepness of slopes
- Household incomes restricted by physical and policy factors:
    - Insufficient off-farm job opportunities
    - Inadequate institutions for commercialization of farm output
    - Low-yield crop varieties
    - Low-productivity animal species
    - Insufficient "freedom to farm" (local authorities intervene in production and marketing decisions) restricts diversification
    - Heavy tax burden (especially the social tax)
- Fast population growth, high population density per hectare of irrigated land
- Grossly inadequate rural infrastructure
- Inadequate farm support services
- Increase in pests and plant diseases (a climate change effect?)

Dimensions of resilience

- Family-controlled farms flexible and responsive to change
- Plentiful water resources: efficient irrigation a question of proper organization
- Diversified agriculture (crops/livestock, field crops/horticulture)
- Increasing GDP per capita, declining poverty headcounts
- Social networks and structures
- Understanding of problems on the part of local authorities and readiness to help in critical situations (?)
- Human capital (accumulated knowledge and experience, education)

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