Droughts in Syria: An Assessment of Impacts and Options for Improving the Resilience of the Poor

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Abstract

Droughts in Syria have occurred during almost every second year over the past half century, and may become even more frequent in the future. This paper assesses the economic and social implications of droughts using a dynamic computable general equilibrium model for Syria. Results show that growth in economic output (GDP) during drought years can be close to one percentage point lower compared to non-drought years. Food security and the poor are hard hit by droughts, mainly through the loss of capital, incomes and higher food/feed prices. Poverty levels increase by about 0.3 to 1.2 percentage points during an average drought and stay above "non-drought levels" even when the drought is over. Poor farm households are hardest hit, followed by rural nonfarm and urban households. Actions for improving the resilience of the poor should focus on agriculture, non-farm employment opportunities and social safety nets.

Keywords: Syria, Middle East and North Africa, drought, poverty, food security
JEL: C68, O53, Q54

1 Introduction

Droughts in Syria have occurred frequently during the past 50 years. From 1961 to 2009, Syria suffered through almost a quarter century's worth of drought, a figure quite significant in that it makes up slightly over 40 percent of this period in Syria's history. Low levels of rainfall, especially when persisting for several months or even years, is one of the major characteristics of droughts. Not only the frequency of droughts but also the length of the dry period matters, where prolonged periods of low rainfall tend to exacerbate the impacts. However, the time and space variations in rainfall often make it difficult to assess and compare the severity of droughts spatially, which is important both for drought monitoring and for drafting drought impact mitigation and adaptation policies.

The most direct effects of droughts are reductions in agricultural yields or, in extreme cases, the complete loss of the harvest, in particular for rainfed agriculture that has little capacity to cope with climate variability. Droughts also affect the livestock sector, especially animals that rely on pastures for feed. On the other hand, in addition to these direct effects on the agricultural sector and farm households, indirect effects of droughts are likely to affect other sectors of the economy and nonfarm households. Experience from the 2007–2009 droughts confirms that drought impacts reach beyond the agricultural sector and the rural poor in Syria. Narratives suggest that the recent droughts have been especially damaging for small-scale farmers and herders, while affecting nonfarm households through higher prices and thus reductions in real incomes. In addition, reductions in wheat yields have made Syria a net wheat importer over the past three years, with macroeconomic implications on the balance of payments and concerns about macro-level food security. Although these general directions of drought impacts in Syria are well known, the potential size of drought impacts in terms of GDP lost and changes in poverty are not as well understood.

This paper aims at contributing to a better understanding of the severity of droughts across sub-national zones and of droughts on the overall economy, food security and poverty. To quantitatively evaluate and characterize historical droughts of Syria, we use the Palmer Drought Severity Index, or PDSI, as a drought indicator (PALMER, 1965; WELLS et al., 2004). The index is a comprehensive drought measure that permits time and space comparison of drought severity. Besides the complex nature of drought phenomena, conducting drought impact assessments is also often complicated by the availability of data. Isolating drought effects can be challenging, and if data are incomplete, it may not always be possible to assess the direct and indirect effects, which is why computable general equilibrium (CGE) models have become an increasingly popular tool for disaster impact assessments (PAUW et al., 2010). Within the CGE literature, the most common analyses are ex ante, to assess the impacts of hypothetical events (for example, BOYD and IBARRARAN, 2009), and ex post, to evaluate the impacts of historical events (for example, HORRIDGE et al., 2005). This drought impact assessment uses a dynamic recursive country CGE model to assess the potential impacts of future droughts in Syria. We apply an ex post approach by using the data from a historical drought event in Syria and, more specifically, the changes in yields and losses in livestock that occurred during 1999-2001. This approach allows us to look beyond the reductions in agricultural production and also isolate the impacts on the broader economy and households.

The remainder of this paper is structured as follows. Section two describes the major methods used in this paper, the PDSI and the DCGE model. Section 3 presents the main features of the Syrian economy, food security and households relevant for the study; it also shows the major patterns of historic drought events by agro-ecological zone. Section 4 presents the results and section 5 concludes with recommendations for policy.

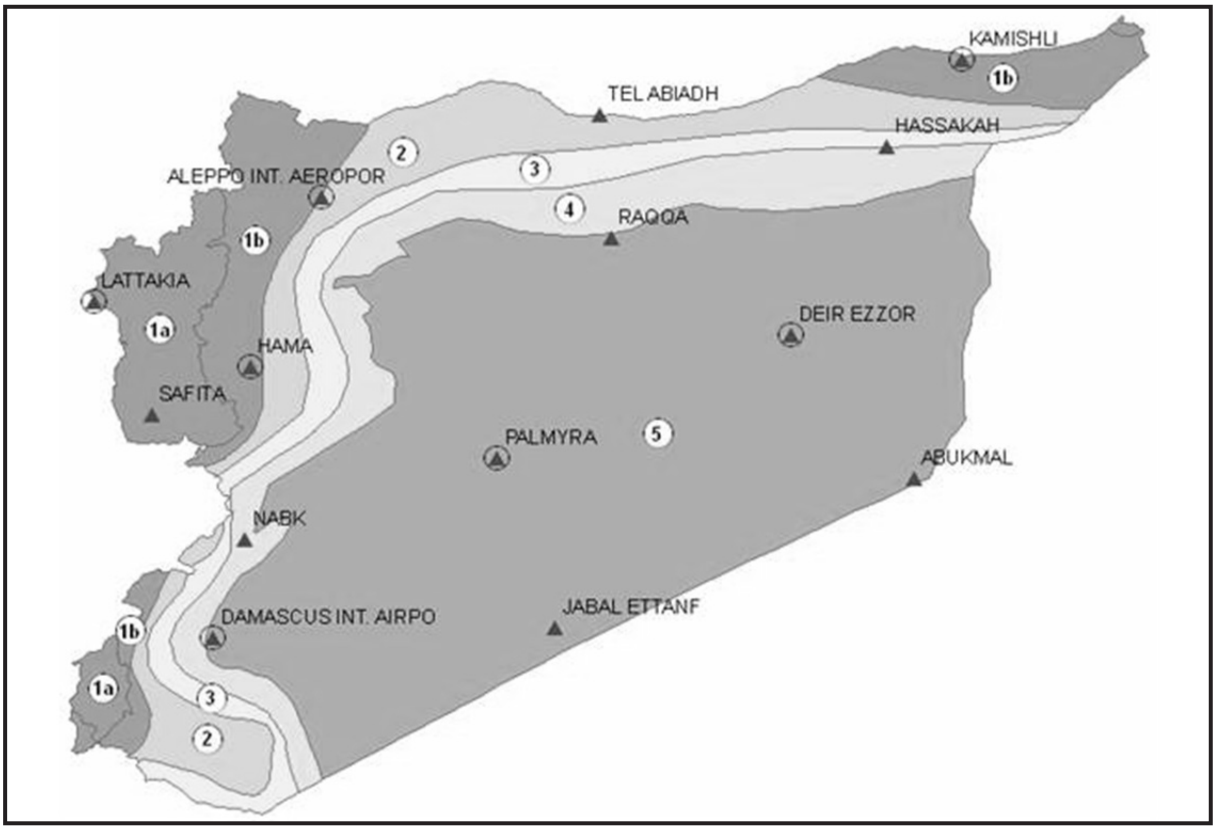
2 Modeling Drought Impacts

2.1 Palmer Drought Severity Index

The PDSI properties allow for the averaging of monthly PDSI values over locations for large-scale assessment. Instead of being based purely on precipitation, PDSI is based on a water balance model that takes into account precipitation, water recharge, runoff, and loss. The basis of the index is the difference between the amount of precipitation required to retain a normal water balance level and the amount of actual precipitation (WELLS et al., 2004). PALMER'S original PDSI was calibrated using selected weather stations in the United States (PALMER, 1965). WELLS et al. (2004) proposed an improvement of PDSI by *self-calibrating* parameters in PDSI according to the characteristics of the local climate. This improvement allows the index to be more consistent and predictable as well as to more realistically represent the climates of diverse locations. Therefore, we used the self-calibrating PDSI in analyzing drought occurrences and severity in Syria.

To analyze the severity and frequency of drought events, we divide Syria into five agroecological zones that are mainly defined according to rainfall quantities. An agroecological zone is a land unit defined by major climate indicators measured over the length of the moisture availability period. In Syria, the climate, terrain, and soil characteristics of its five major agroecological zones (figure 1) also largely define the farming systems. As described by FAO (2010), zone 1 receives annual average rainfall of more than 350 mm. It makes up 14.5 percent of Syria's land area and consists of two subzones, with the first receiving more than 600 mm of rainfall annually and where the yields of rainfed crops are certain for all the years. Zone 2 receives 250–350 mm of precipitation annually. The main crops in zone 2 are wheat, barley, and summer crops. This zone makes up 13.3 percent of the country's land area. Zone 3 receives 250 mm of precipitation annually, with a 50 percent chance in any year that rainfall is no less than this amount, thus ensuring production in one to two years out of every three. This zone mainly grows grain crops, but legumes are also grown here. Zone 3 makes up 7.1 percent of Syria's total area. Zone 4 is a marginal zone, receiving 200–250 mm of precipitation annually. Only barley can be grown in this zone, and it can be used as permanent pastures. Zone 4 makes up 9.9 percent of the total land area. Zone 5 is the steppe lands that make up 54.7 percent of the country's total area and receives less than 200 mm precipitation annually (UNDP and GEF, 2010). The land in zone 5 is not suitable for rainfed cultivation.

Figure 1. Agroecological zones in Syria



Source: IFPRI based on LANDSCAN

A negative value for the PDSI indicates dry conditions, and a positive value indicates wet conditions. The annual drought indexes discussed below are mean annual values averaged over a calendar year using monthly index values. Monthly PDSI indexes are calculated for 1961–2009 for the five agroecological zones and are then averaged over calendar years to create annual drought indexes for each zone for the 1960–2009 period. Threshold values are chosen for the index, allowing for the classification of the growing seasons into very severe drought years (< –3.0), drought years (–2.99 < PDSI < –1.50), near-normal years (–1.49 < PDSI < 1.49), moderately wet years (1.5 < PDSI < 2.99) and very wet years (PDSI > 3.0). The threshold values are set as described in PALMER (1965) and WELLS et al. (2004). It is worth noting that the original near-normal range given by PALMER (1965) was –0.49 to 0.49. We relaxed the index range for near-normal in order to have an improved differentiation of year types in Syria where much land has arid or semi-arid climate.

2.2 Dynamic Computable General Equilibrium Model (DCGE)

We therefore develop an economywide model for Syria with five agroecological zones, consistent with the drought index analysis (figure 1) to capture the major linkages between droughts, production, and households.

Given the importance of agriculture, the model captures both the sectoral and spatial heterogeneity of crop production and its linkages to other sectors such as food processing, manufacturing, and services. The model includes 23 production activities, 19 commodities, 9 factors of production, and 20 household types. The 17 agricultural production activities are split into livestock (4), fish (1), and crop production activities (12), where all crop production activities are specific to each agroecological zone (table A1). In addition, wheat and barley production activities are divided into irrigated and nonirrigated production systems. Major data sources for the underlying social accounting matrix (SAM), which has been compiled by the authors, include a 2007 macro SAM developed by the National Development Planning Commission (table A2), the Household Income and Expenditure Survey (HIES 2006/07), and the National Agricultural Policy Center's (NAPC's) comprehensive dataset on agricultural production, trade, and inputs. Specifically, the NAPC database is used to build a new agricultural supply use table based on crop budgets by agroecological zone. These data sources have been complemented with information from FAOSTAT (FAO, 2010).

The model runs for a period of five years and is recursive dynamic; that is, the dynamics occur between each year. Investments are savings-driven, and savings grow proportionally to household incomes. In the baseline scenario, as well as in all other scenarios, we assume that the nominal exchange rate is fixed and serves as the numeraire. The government budget is flexible, which means that the government can adjust to changes in revenues and spending by increasing or decreasing the budget deficit. Government consumption, which is exogenous, is assumed to grow at 4 percent annually. The Syrian workforce is expected to grow at the same rate as the population grows, following an average long-term trend of 1.5 percent growth as projected by the UN (UN, 2010). Labor supply is thus assumed exogenous in the model, and labor is fully mobile across sectors. It is split into skilled, semiskilled, and unskilled labor and into government and private sector. Accordingly, different wage rates for labor are employed within the public and the private sectors, determined by the market equilibrium between total labor supply and total labor demand. Capital is fully employed and mobile. Land is fixed, which means that current cultivated land cannot be expanded in the future. This assumption reflects the scarcity and overuse of water in Syria and thus partly captures the limited growth potential of the agricultural sector due to water constraints. Agriculture accounts for 90 percent of total water usage in Syria and for an estimated water deficit of nearly 5 billion cubic meters per year by 2025; therefore, addressing the severe water constraint becomes imperative for Syria's agricultural sector, as well as its economy as a whole. Annual Total Factor Productivity (TFP) growth changes in all nonagricultural and agricultural sectors annually to complete the set of values for the exogenous variables. TFP growth for nonagricultural sectors is assumed to be 1 percent annually, and TFP for the agricultural sectors is assumed to grow at annual rates of 0.5 percent. These different rates of TFP growth in the agricultural and nonagricultural sectors reflect the expected structural change under a business-as-usual scenario that is observed in all successfully transforming countries (BREISINGER and DIAO, 2008). a summary of the main equations can be found in table A3.

The model captures some autonomous adaptation to droughts. A set of several elasticities guide these changes. The main elasticities include the substitution elasticity between primary inputs in the value-added production function, which determines the ease with which, for example, users of fuel can substitute this fuel for other inputs, the elasticity between domestically produced and consumed goods and exported or imported goods such as rice and wheat, and the income elasticity in the demand functions. The income elasticity with regard to food, for example, determines how consumers react to higher prices. We estimated the income elasticity for Syria from a semilog inverse function suggested by KING and BYERLEE (1978) and based on the data from HIES (table A4). For the factor substitution elasticity we choose 3.0, the elasticity of transformation is 4.0, and the Armington elasticity is 6.0 for all goods and services.

The model includes 20 representative household groups for distributional and poverty effects. The household groups are first separated by rural or urban location. We then split urban into metropolitan and town households and rural into farm and nonfarm households. Each of these household types is further split by their respective expenditure quintile to capture the distinctive patterns of income and consumption and the distributional impacts of climate change. The DCGE model also links to a microsimulation model, which allows for the endogenous estimation of drought impacts on poverty reduction. The endogenous changes derived from the DCGE model for the 20 representative households are used to recalculate consumption expenditure of their corresponding households in the HIES survey dataset. We use the DCGE and microsimulation model and design the drought impact scenario (table 1). Results of the drought scenario are presented relative to the baseline.

Table 1. Drought scenario

Scenarios	Change in model	Input
Baseline	See text	See text
Drought impacts	Crop yields and livestock production	Palmer index and historical data

Source: authors

3 Economic Structure, Food Security and Poverty

Before the uprisings in Syria started, progress on economic reforms, especially in the fields of trade, taxes, subsidies, foreign direct investment, and the development of non-oil industries had been made over the past years. Economic growth averaged more than 5 percent during the period 2004–2008, and the incidence of poverty declined to about 12 percent in 2006–2007.Yet, an increase in drought frequencies may threaten Syria's progress in development and pose a significant burden on economic growth and household incomes, especially those of the poor.

Agricultural and related processing contributes about 19 percent to GDP, about half of which is produced in agroecological zone 1. Livestock alone makes up close to 6 percent of GDP, dominated by sheep production (3.1 percent). Vegetables and fruits contribute 2.5 percent and 3.0 percent to GDP, respectively, followed by cereals, with 3.3 percent (table 2). Nonirrigated cereals production is mostly concentrated in agro-ecological zones 1 and 2, as are water-intensive crops such as fruits and vegetables (table 3). In terms of their contributions to GDP, zone 2 is the second largest contributor, followed by zones 5, 3, and 4.

Food- and agriculture-related processing makes up about 50 percent of household consumption expenditure. Within this category, food processing constitutes the largest share of consumption, followed by meat, fruits, vegetables, and cereals. Energy and water constitute 4.8 percent of total private consumption expenditures; however, potentially rising energy prices are more likely to affect household consumption. For example, higher world oil prices would raise domestic prices for fuel, which increases transport cost. Since transport is an important input in the production of many goods and services, overall price levels are expected to rise, causing real household incomes to fall.

Table 2. Structure of the Syrian economy by sector (2007)

	GDP	Private consumption	Import intensity	Export intensity
Wheat	2.8	0.1	7.9	1.1
Barley	0.4		42.1	87.1
Other cereals	0.1	1.1	72.9	0.7
Fruits	3.0	8.3	1.5	5.1
Vegetables	2.5	6.5	1.8	30.4
Olives	1.0	0.5	0.0	42.8
Cotton	1.1			
Other crops	0.6	1.0	19.4	14.0
Sheep	3.1	5.1	0.1	0.5
Cattle	1.8	4.3	0.2	0.1
Camels	0.1	0.0		
Poultry	0.7	3.6	0.1	
Fish	0.2	0.5		
Food processing	1.5	20.4	12.9	16.9
Manufacturing	12.9	13.1	77.2	80.3
Mining	24.5		87.9	42.9
Energy and water	6.2	4.8		
Public services	11.7	0.8		
Private services	25.7	29.7	17.8	45.8
Total	100	100	28.2	34.8

Note: Import intensities are calculated as shares of total domestic consumption (final and intermediate). Export intensities are the ratios of exports to domestic production.

Source: Syria DCGE model

Table 3. Agricultural value added, by zone and crop (2007) (share)

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Total
Wheat	7.1	6.0	1.2	1.7	3.2	19.2
Durum	4.3	2.5	0.4	0.5	1.3	9.0
Irrigated	2.7	1.9	0.4	0.5	1.3	6.8
Non-irrigated	1.6	0.6				2.1
Soft	2.8	3.5	0.8	1.2	2.0	10.3
Irrigated	1.6	2.3	0.7	1.2	2.0	7.7
Non-irrigated	1.2	1.2	0.1			2.6
Barley	0.3	1.6	0.7	0.3	0.2	3.1
Irrigated		0.1	0.0	0.1	0.2	0.3
Non-irrigated	0.3	1.6	0.7	0.3		2.8
Other cereals	0.0	0.1	0.1	0.2	0.6	1.0
Fruits	17.9	4.3	1.8	0.7	0.9	25.6
Vegetables	12.5	6.8	1.6	2.1	5.3	28.3
Olives	4.9	1.9	0.4	0.3	0.5	7.9
Cotton	2.8	3.2	0.8	1.1	2.1	10.2
Other crops	2.7	1.1	0.2	0.2	0.4	4.7
Total	48.3	25.0	6.9	6.6	13.2	

Source: Syria DCGE model

Another dimension of development, especially in times of crisis like droughts, is food security, which can be defined as a situation of all people having access to food.[1] According to this definition, food security mainly depends on a country's ability to import food or produce food or both (macro level), and on households' ability to produce food or buy food or both (micro level). Macro-level food security can be measured as the ratio of total exports to food imports; therefore, food security by definition does not equal food self-sufficiency - a fact of particular relevance for the Middle East and North Africa (MENA) region (DIAZ BONILLA et al., 2002; YU et al., 2009; BREISINGER et al., 2010). The rationale for using this measure is that exports generate foreign exchange earnings and incomes, which generally help financing food imports and food purchases at household levels. In fact, a country can be food secure if it exports enough goods and services to finance food imports. However, this does not necessarily imply that all households, in all regions and income brackets, have access to sufficient food at all times.

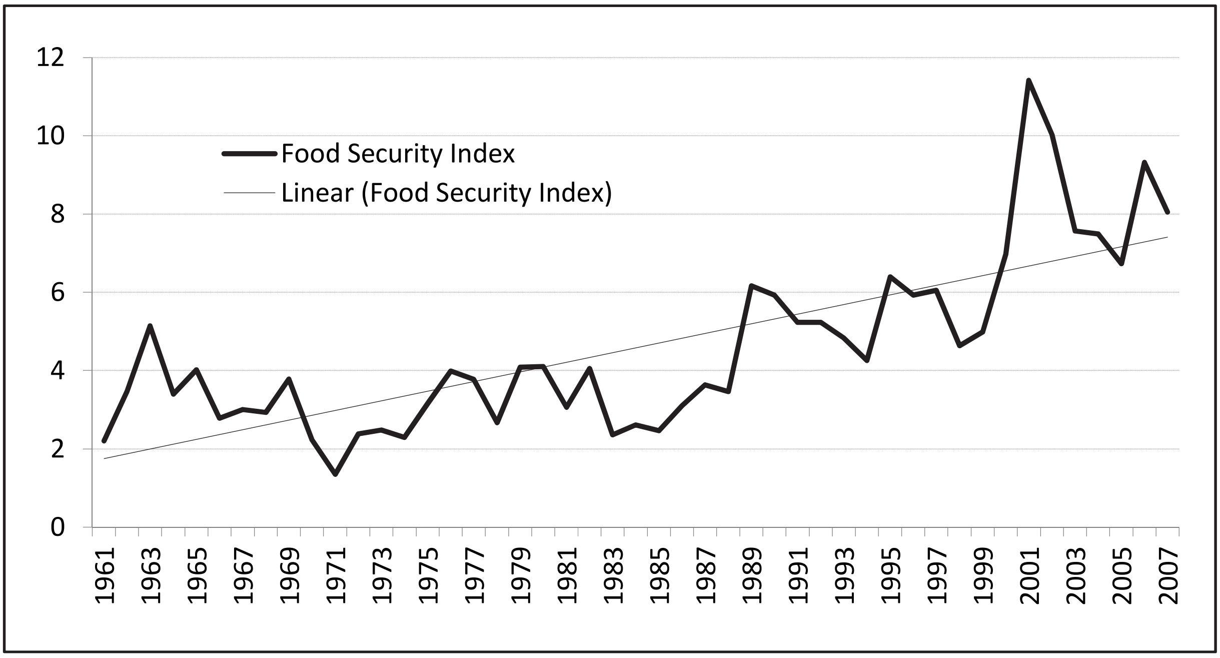
Syria's food security index has climbed steadily from 1961 to 2007 (figure 2), yet food security remains much lower than in neighboring Turkey and the international average (BREISINGER et al., 2010). The index is likely to have worsened during the 2008 global food crisis, but before the crisis it had been steadily increasing. This increase was mainly due to Syria's increase in total merchandise exports relative to its food imports, rising from an index of 2.2 in 1961 to 8.0 in 2007. This experience in Syria, in addition to that in neighboring Turkey, confirms that contrary to the often held position that food security only depends on improving agricultural production, it can also be improved by increasing total exports (incl. non-agricultural goods and services). Turkey's food security index has averaged around 30 since the 1990s, indicating that the country uses only about 4 percent of its export earnings to import food. Turkey's high levels of food security have been supported by a strong export performance.

Turkey's strong performance in food security can, among others, be explained by sound macroeconomic policies that have fostered environment for strong growth (IMF, 2005; IMF, 2010). Its average annual GDP growth rate came at 8 percent from 2000 to 2005. During that period too, it registered the lowest inflation figures in over a generation, steadied and appreciated its lira, reduced its domestic debt, and maintained on average a steady annual increase in its agricultural value added by an average of

[1] The most widely accepted definition of food security is the one adopted by the 1996 World Food Summit (WFS): "Food security, at the individual, household, national, regional and global levels [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996).

2 percent (IMF, 2005).[2] Thus, continuing policies of economic diversification and improving competitiveness will be important contributor to improve food security in Syria also.

Figure 2. Macro food security in Syria (1961-2007)



Source: authors' calculations based on FAOSTAT

A major determinant of food security at the household level is household income. Dividing households according to their location, occupation, and income quintiles allows for the analysis of income and distributional effects of climate change. The top 20 percent of households earn about 40 percent of all household incomes (as reported in HIES 2006/07), and the bottom quintile earns about 13 percent of all incomes. Broadly in line with the estimate of agricultural GDP, farm households earn about 21 percent of all household incomes However, within farm households are large discrepancies. Farmers in the top quintile account for 44 percent of all income earned by farm households, but those in the bottom quintile, only 13 percent. As expected, skill levels of labor are strongly related to household income levels (table 4). Poor households earn most of their income from unskilled labor, and households in higher income quintiles rely more on skilled labor and capital earnings.

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[2] Despite substantial macroeconomic improvements, Turkey still maintains some vulnerabilities such as a high unemployment rate (at 10 percent), dollarization of its economy, high public debt figures, a growing capital account, and decreasing exports (IMF, 2010).

It is against these structural characteristics of the Syrian economy and its households that the next sections analyze the impacts of droughts.

Table 4. Structure of household income sources (by type and quintile) (2007)

	Labor		Capital	Land	Livestock	Total
	Skilled	*Unskilled*				
City 1	3.3	70.0	26.7			100.0
2	6.8	61.2	32.1			100.0
3	13.2	59.3	27.5			100.0
4	19.9	40.8	39.3			100.0
5	11.3	13.1	75.6			100.0
Town 1	3.7	63.6	27.4	4.6	0.8	100.0
2	6.6	70.8	17.1	4.7	0.8	100.0
3	7.2	61.5	25.4	5.0	0.8	100.0
4	10.1	45.7	39.3	4.1	0.8	100.0
5	8.3	22.4	65.4	3.1	0.7	100.0
Rural nonfarm 1	2.0	55.4	42.6			100.0
2	4.2	46.5	49.3			100.0
3	6.3	50.8	42.8			100.0
4	6.2	44.8	49.0			100.0
5	5.1	25.6	69.4			100.0
Rural farm 1	0.9	35.1	21.7	35.3	7.0	100.0
2	1.8	34.1	21.0	36.7	6.4	100.0
3	2.1	36.8	19.3	36.2	5.5	100.0
4	3.0	39.4	13.8	37.7	6.1	100.0
5	1.4	12.8	71.1	12.8	2.0	100.0

Source: Syria DCGE model

4 Impacts of Drought

4.1 Drought Characteristics and Physical Impacts

From an agricultural and food security perspective, a drought's spatial extent can prove as important as its severity measure, and disaster risk management is especially challenging when droughts occur in different zones at the same time. The more the spread of drought occurs across the zones at once, the more serious the implications may be on the country's food security and economic stability in general. Food self-sufficiency is not a necessary condition for food security; however, a longer-lasting nationwide drought occurrence would severely impact not only rural livelihoods and the agricultural sector but all livelihoods and the consequent implications on poverty.

Dwindling foreign currency earnings become scarce with harsh implications for food security.

Droughts in Syria have occurred frequently during the past 50 years. On average, the drought periods lasted close to four and a half years each time; however, the drought years of the 1970s were especially notable because they affected four out of the five agricultural zones in Syria and lasted for 10 consecutive years. Following these droughts, the intensity and frequency of the drought periods varied across Syria and its different agroecological zones. Over the past half century, nearly 40 percent of the time drought occurred in zones 2, 3, and 4 (table 5). The probability of a drought was only slightly lower in zones 1 and 5. In zone 5, however, multiyear droughts are more frequent, which can be more harmful because water storage (for example, in reservoirs, soil, and aquifers) and food storage may likely be depleted before a prolonged drought terminates, forcing herders to reduce their animal stocks. It is also worth noting that the average length of a drought is extremely long in zone 4. The International Disaster Database of the Center for Research on Epidemiology of Disasters (CRED, 2009) ranked the droughts in 1999 and 2008 among the top 10 natural disasters in Syria since 1990.

Normal weather conditions (that is, with a Palmer Z index between -1.5 and 1.5) were simultaneously observed across all five agroecological zones only during the 1960s and to some extent the 1980s. However, other than the sixties and eighties, normal weather only occurred simultaneously in two to three zones, indicating that Syria is prone to extreme weather events especially during the past 20 years. Moderately wet conditions, with a Palmer Z index of greater than 1.5 and less than 3, are very rare in Syria and have only once been experienced by all five zones simultaneously, in 1969 and in 1988. As for very wet events – a Palmer Z index of greater than 3 – the data does not show a single year when all five agro ecological zones witnessed such a phenomenon. The frequency and length of droughts varies significantly by agroecological zone. Zones 1, 2, 3, and 4 have witnessed longer drought periods ranging from four to nine and a half years (table 5). Zone 5, on the other hand, has witnessed the most frequent occurrences of drought during this 50-year period. And overall, except for zone 1 and to a lesser extent zone 5, droughts have become more frequent and have lasted longer in Syria from 1970 onward.

Table 5. Drought characteristics (1961-2009)

	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**	**Zone 5**	**National**
Number of drought years	13.0	19.0	19.0	21.0	16.0	**22.0**
Number of droughts ≥ 2 years	2.0	3.0	2.0	2.0	5.0	**5.0**
Average length of drought period	6.0	5.3	4.0	9.5	2.6	**4.4**

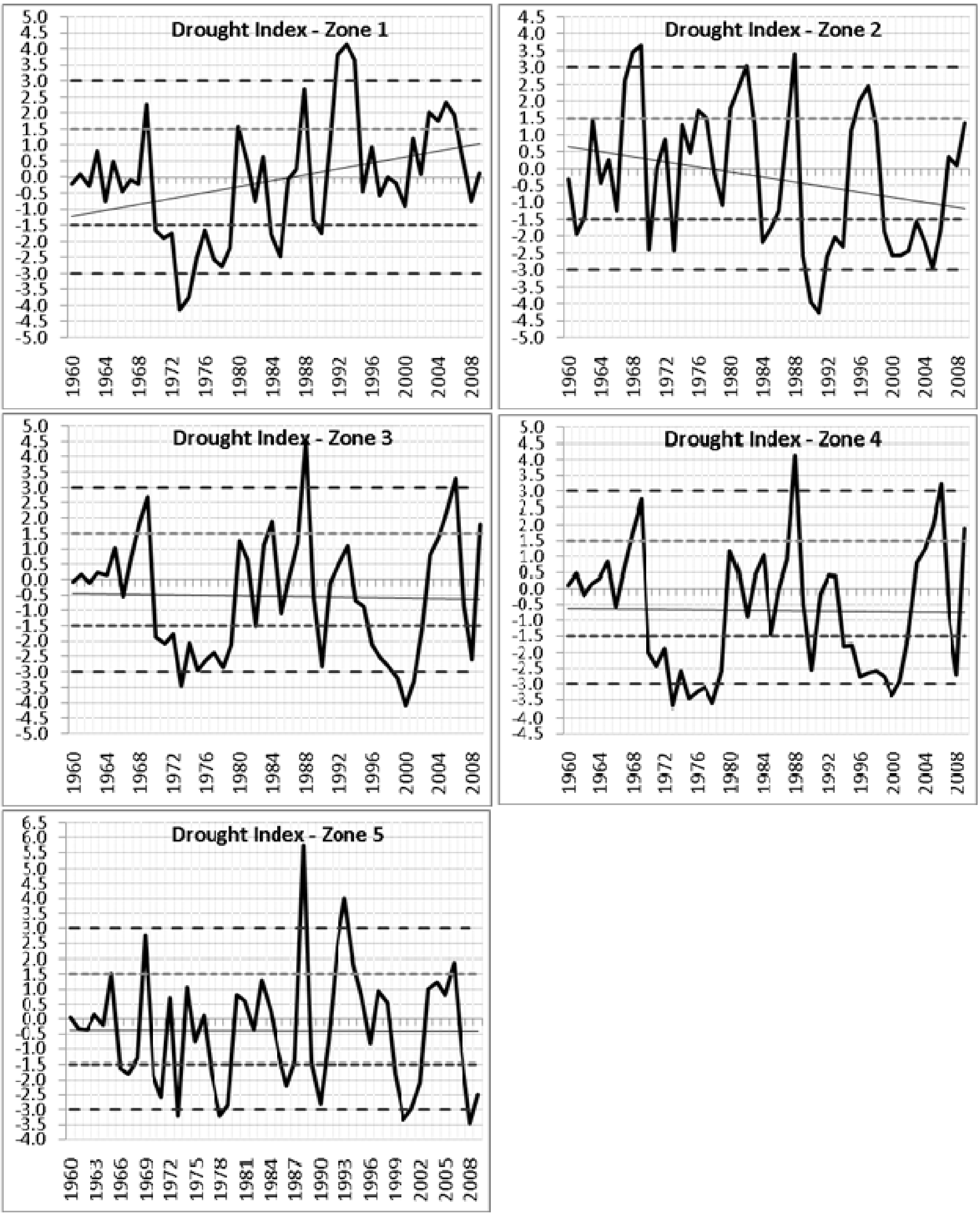
Source: authors' calculations

Droughts have become more frequent during the past twenty years in zone 2, yet no clear evidence indicates that droughts have become more frequent in other zones (figure 3). In fact, using Student's T-Test and a significance level of 0.10, we found that zone 2 has an increasing trend of drought occurrences while zone 1 shows a decreasing trend of drought occurrences. Trends in the other zones are not significant. This seems to contradict the general perception of people suffering from droughts, especially Bedouins and farmers. One possible explanation is that the *impacts* of droughts may have become more severe due to higher population densities and groundwater depletion. For example, the farm animal population has increased along with the citizenry population. As a consequence, less pasture is available for herders and their animals to migrate to during droughts, with devastating consequences for the survival of their animals. Therefore, even for the same severity of drought, the socio-economic consequences can be much greater than that in the past.

Based on this analysis we use an ex ante approach to assess the impact of droughts on agriculture, the economy, and poverty and focus on the 1999-2001 drought for this impact assessment. The 1999–2001 droughts lasted three years, consistent with the average drought period during the past 50 years, and it affected four out of five agroecological zones, thus making it a nationwide event (figure 1 and table 5). We also choose this drought for practical reasons because crop data are available for the whole drought period and by agroecological zone from the Syrian Agricultural Database (SADB), which is not the case for the years before 1985 and for the most recent drought of 2008–2010. In essence, we thus use an average historical event and assess what impact it would have if a similar event would recur in the future.

We use historic data for changes in crop yields and livestock numbers (goats, sheep, cattle, camels) to implement the drought shocks in the dynamic CGE (DCGE) model, and we assume that the changes in yields and livestock numbers are entirely caused by the drought event. For the three years following 1998, table 6 shows the severe impact of this drought that affected Syria on three of its strategic crops: wheat, barley, and cotton. The most common theme that the figures below show are sharp decreases in yields in the initial years of drought and then slow recovery. The most adversely affected zones were zones 4 and 5, and consequently, crops grown in those zones fared the worst, especially wheat and barley. The yields for cotton were also volatile every year from 1998 to 2001, albeit not as much as the yields of barley and wheat.

Figure 3. Drought index (1960-2009)



Source: IFPRI (2010) and authors' calculations

Table 6. Yield variability during 1999-2001 drought

	Tons/Ha	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Wheat, non-irrigated	1998	2.3	1.13	0.46	0.08	0.33
	1999	1.04	0.38	0.07	0	0
	2000	1.19	0.34	0.07	0.02	0
	2001	2.57	1.59	1.46	1.28	0.78
Wheat, irrigated	1998	3.8	3.58	3.14	3.45	3.55
	1999	3.13	3.31	2.69	3.26	3.23
	2000	3.66	4.08	3.05	3.83	3.37
	2001	4.2	4.27	3.64	4.05	3.75
Barley, non-irrigated	1998	2.09	1.05	0.4	0.09	0.3
	1999	1.31	0.6	0.12	0.01	0.07
	2000	0.71	0.25	0.08	0.02	0
	2001	2.59	2	1.39	1	0.91
Barley, irrigated	1998	0	3.22	3.11	2.99	2.81
	1999	2.4	2.32	1.66	2.11	2.46
	2000	2.52	1.93	1.87	1.79	0.89
	2001	3.46	2.97	2.95	2.75	2.22
Cotton	1998	3.96	3.9	3.61	3.36	3.25
	1999	4.34	4.05	3.89	3.37	2.92
	2000	4.38	4.09	4.19	3.84	3.38
	2001	4.36	3.89	4.38	3.76	3.21

Source: SYRIAN AGRICULTURAL DATABASE (SADB) (2008)

The 1999–2001 droughts led to severe yield reductions and in some zones even to complete crop failure. For example, yields for irrigated wheat plummeted from between 3.1 and 3.8 tons per hectare in the pre-drought year of 1998 to 2.7 to 3.1 tons per hectare in 1999, and between 0.8 and 2.3 tons per hectare to 1.0 tons per hectare and complete crop failure in 1999 for non-irrigated wheat across all zones. Barley was also hard hit, yet to a lesser extent than wheat, with reductions between 13 and 47 percent between 1998 and 1999. In the second drought year, yields continued to fall in most zones, yet yields started to recover in zones 1 and 3. The annual yields for cotton were also volatile from 1998 to 2001, albeit not as much as the yields of barley and wheat.

Both rainfed crops and irrigated crops are hard hit by droughts. While the impact of droughts on rainfed crops is straightforward, the impact on irrigated yields is more modest and depends on how droughts may affect groundwater levels, river flows, or both. Table 6 also indicates that there is a difference among crops. While yields for irrigated wheat and barley drop sharply in most agroecological zones, cotton yields appear to be largely unaffected by rainfall variations. For both irrigated and rainfed crops, yields quickly rebound when the drought is over.

Livestock made up more than 5 percent of Syrian gross domestic product (GDP) and about 30 percent of agricultural GDP in 2007; thus, drought-related reductions in number of livestock are expected to have economy-wide implications. Sheep and goats make up the largest share of GDP (3.2 percent), followed by cattle (1.5 percent), camels (0.1 percent), and poultry (0.6 percent). The CGE model reflects this structure and includes these livestock categories as separate production activities. The relative reduction in livestock production is based on the reduction of livestock numbers observed during 1999–2001, which are then translated into reduction of livestock-specific capital and (TFP) (table 7).

Historic evidence shows that while livestock may be more resilient than crops during short droughts, multi-year droughts can severely reduce the availability of fodder (McDonald, 2000). In addition, the livestock density per square kilometer matters. This density has dramatically increased during the past few decades due to rapidly rising livestock numbers, leaving Bedouins with fewer options to migrate and less land available for each herding family with their animals. Thus, the vulnerability to drought impacts is likely to increase in the future.

Table 7. Annual changes in the number of animals during 1999–2001 drought (%)

	Sheep	Goats	Sheep and goats	Cattle	Camels
1997	5.4	1.7	5.1	5.8	5.1
1998	11.5	0.1	10.7	8.7	19.2
1999	–9.2	–5.0	–9.0	4.9	49.2
2000	–3.5	0.4	–3.3	0.7	0.3
2001	–8.5	–6.7	–8.3	–15.0	–8.7
2002	9.2	–4.8	8.2	3.6	2.5
2003	13.3	9.2	13.0	8.1	21.6

Source: authors' calculations based on SADB (2008) and FAOSTAT online

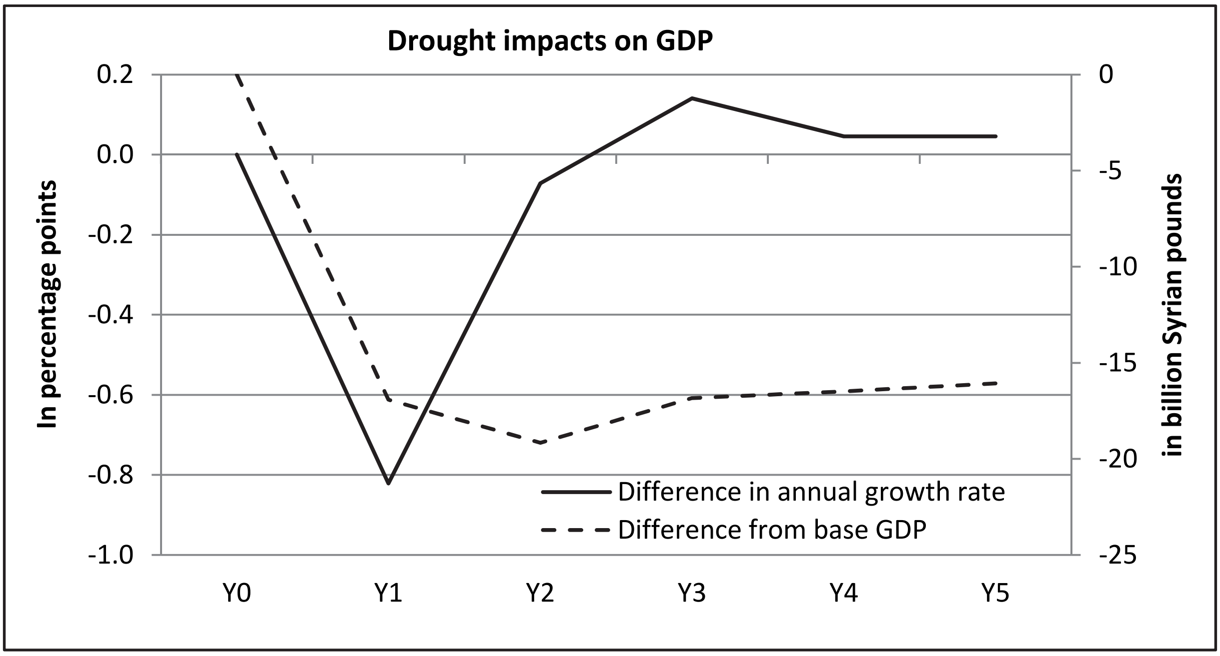
The effect on livestock during the drought episode 1999-2011 has varied and the severity of the impact was disproportionate among the different livestock raised in Syria (table 7). The production of camels, vis-à-vis other livestock, has shown the least volatility during these drought years, confirming the conventional wisdom that camels are most water stress resistant due to their ability to store large amounts of water. However, especially sheep herds and goats suffered big losses during 1999–2001, from –3.3 percent to –9.0 percent annually. Cattle were less affected, which can be explained by the fact that a large number of cattle may rely on feed rather than pasture.

4.2 Drought Impact on the Economy, Food Security and Poverty

Droughts have implications for the macroeconomy. Aggregate private consumption is reduced, driven by a loss of real income through both higher prices and loss of income. Demand for imports increases, especially for agricultural goods and food processing to substitute for previously domestically produced goods. Imported food and domestically produced food are not perfect substitutes, which leads to an increase in domestic food prices, albeit at lower levels than would be the case without international trade. Higher inflation leads to an appreciation of the real exchange rate, which makes exports more expensive. The appreciation of the exchange rate helps imports, yet the overall effect on the trade balance remains negative. The drought also has implications for the labor market. Labor from agriculture moves to other sectors and lowers real incomes. Thus other sectors benefit and increase output, but these benefits do not compensate for the loss in agricultural output and are dampened by the reduction in demand. Investment increases during the entire period, reflecting the necessity to replace stocks that have been lost during drought (for example livestock).

The reduction in economic output during drought years ranges between 0.0 and 0.8 percentage points of annual GDP. Figure 4 shows that a drought leads to a sharp reduction in GDP growth rate and economic output. While both indicators (growth and annual GDP) decline in the first year relative to a situation without drought, the growth rate increases more quickly than economic output. In fact, this phenomenon is common for all kinds of economic shocks: during initial phases the decline in growth is sharpest, because even when economic output in subsequent years is as low as in the initial phase the growth rate remains flat. However, relative to a situation without crisis or drought, output remains lower throughout the whole period. In fact, the GDP growth resumes to pre-drought levels after three years, yet annual output only slowly catches up with levels that had been achieved without drought.

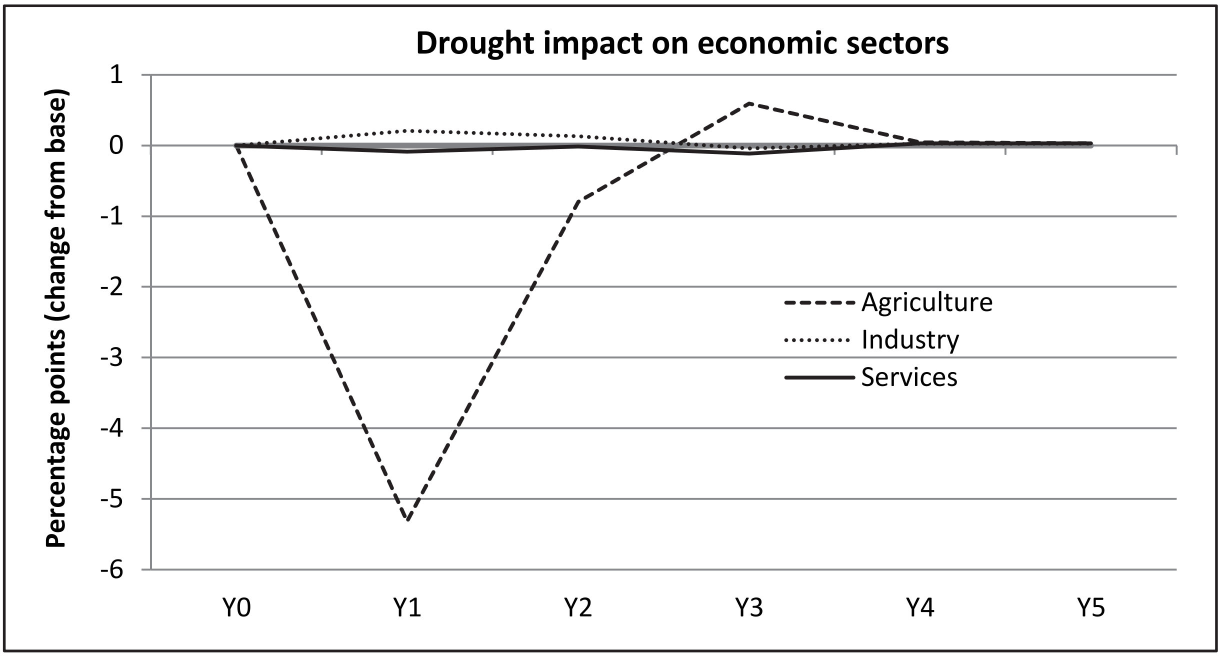
Figure 4. Loss in GDP from drought



Note: Y1-Y5 stands for year one to year 5 of the projected drought.
Source: Syria DCGE model

Agriculture is the sector hardest hit by drought, whereas the industry and service sectors are relatively more resilient (figure 5). The loss in yields and animals cannot be compensated by the resulting higher prices of agricultural commodities and so leads to a sharp contraction in agricultural GDP growth. In the initial year of drought, the service sector also contracts due to a decrease in aggregate demand. However, model results suggest that industrial sectors may benefit from drought, albeit to a low extent. This can be explained mainly by changes in factor rents. Droughts lead people to migrate out of agricultural activities to seek jobs in other sectors. This lowers the economy-wide wage rates, especially for low-skilled labor. The industrial and service sectors, which use this type of labor extensively, benefit from the lower labor costs and so become more competitive.

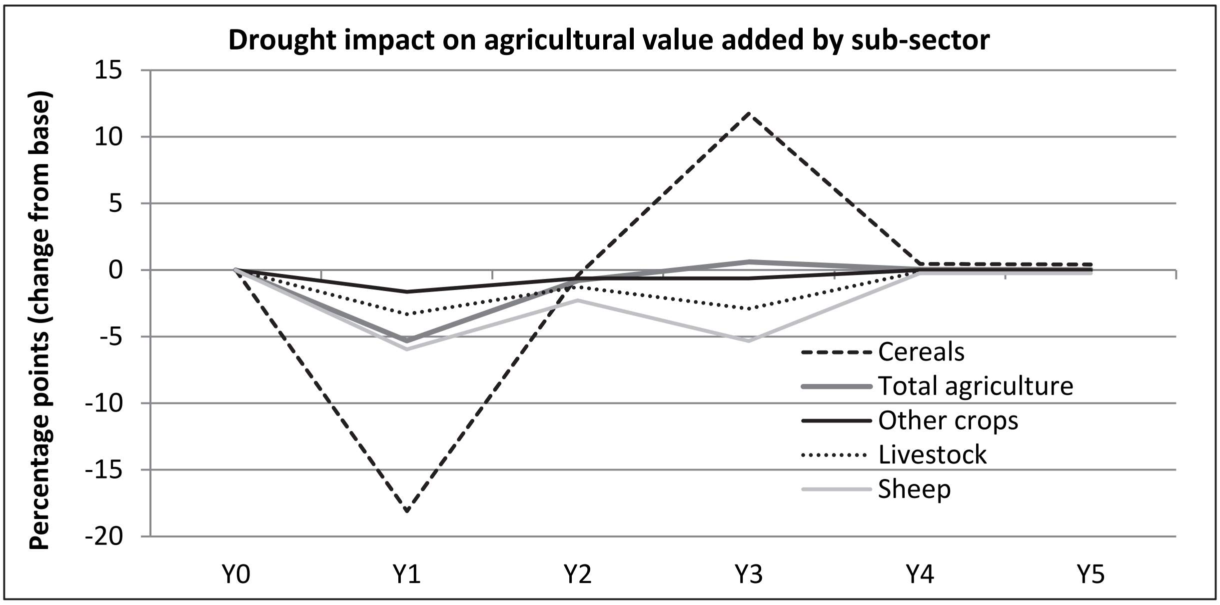
Figure 5. Drought impacts by sector



Note: Y1-Y5 stands for year one to year 5 of the projected drought.
Source: Syria DCGE model

Within agricultural sub-sectors, cereals are the hardest hit by drought, followed by sheep production (figure 6). Rainfed wheat in Syria is mainly grown in zones 2 and 3, while barley is mainly in zones 4 and 5 in Syria. Given the severity and duration of the drought in these zones, yields of rainfed cereals suffer more than other farm activity. This is especially so during the initial years of drought where value added for cereals decreased by nearly 20 percent from 2007 to 2009. Other crop and livestock activities also decline, rebounding a little only to decrease again with the prolonged drought.

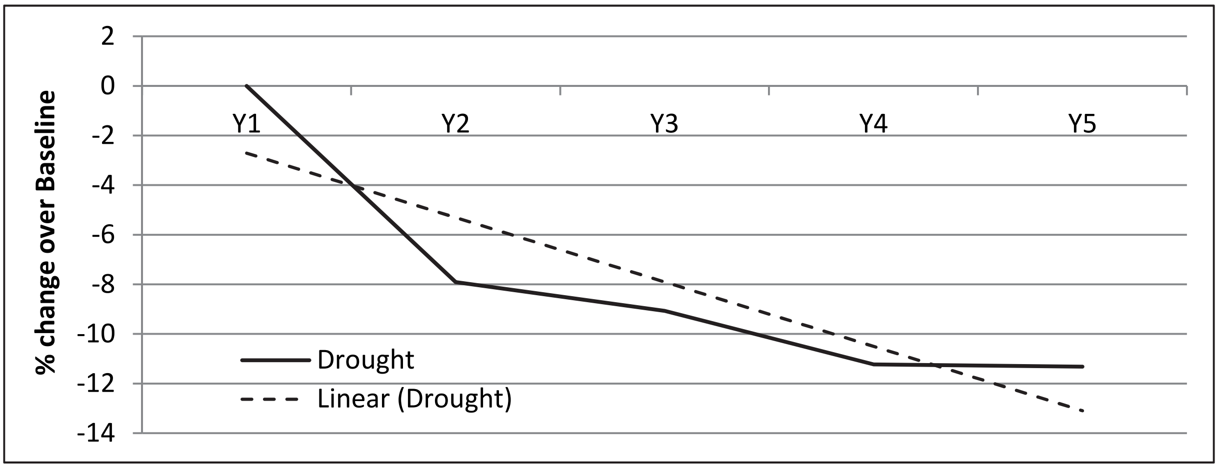
Figure 6. Loss in agricultural GDP from drought by subsector



Note: Y1-Y5 stands for year one to year 5 of the projected drought.
Source: Syria DCGE model

Macro-level food security is a serious concern during drought, as the reduction in food production requires a sharp increase in food imports. At the same time, exports show little change and thus the food security index follows a decreasing trend under drought conditions. Household-level food security is also likely to decline, especially among the poorest household groups, an issue that we capture with changes in poverty levels (figure 7).

Figure 7. Food security index



Note: *The annual food security index has been adjusted by the annual consumer price index (CPI).
Y1-Y5 stands for year one to year 5 of the projected drought
Source: Syria DCGE model

Poverty increases across Syria among all household groups as a result of drought (table 8). This increase in poverty is explained by a combination of declining incomes and a higher cost for consumption. In the absence of any mitigation policies, by the third drought year, the national poverty rate would have increased by 0.64 percentage points over the baseline scenario. After the peak of the drought, poverty declines but remains above baseline levels for several years.

Table 8. Poverty impact of drought (percentage point change from baseline)

		Change from Baseline					
	Initial	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**Y6**
National	12.3	0.48	0.46	0.64	0.43	0.46	0.37
Rural	15.1	0.69	0.57	0.69	0.52	0.67	0.45
Farm	18.7	1.24	0.37	0.60	0.36	0.28	0.30
Nonfarm	13.3	0.41	0.84	0.94	0.58	1.35	0.67
Urban	9.9	0.30	0.43	0.56	0.49	0.32	0.34

Note: Y1-Y5 stands for year one to year 5 of the projected drought.
Source: Syria DCGE model

Poverty increases the most in rural areas, where drought impacts cause the number of people living below the poverty line to increase by 0.69 percentage points compared with 0.56 in urban areas. Of all groups, the nonfarm sector shows the highest increase in poverty rate. This can be explained by the fact that Bedouins, who are likely to be among the hardest hit, are not considered farmers in the underlying model.[3] However, it is important to note that the most vulnerable household groups, such as the Bedouins see much higher increases in poverty than the aggregate results suggest. It is estimated that about 1.5 million Bedouins live in Syria. The livelihood of Bedouin households is mainly from sheepherding and to a lesser extent camel herding.

Droughts have been especially damaging for small-scale farmers and herders. Interviews with communities in Al Badia suggest that households with 200 sheep or fewer were often forced to give up herding and move to the large towns and cities, hence losing their livelihood. In some Bedouin communities, 70–80 percent of households left their traditional livelihood behind. Bedouins with larger numbers of sheep, camelherders, and households with diversified sources of income such as remittances and off-farm incomes, are more resilient. However, the impacts of drought are felt across all households and communities: reduced nutrition levels, lower education attendance levels, and reduced mobility (TIKJOEB and VERNER, pers. vomm. 2010).

3 The household survey did not allow for identifying Bedouin households.

5 Conclusions and Policy Recommendations

Droughts in Syria have occurred frequently during the past 50 years. Throughout the fifty years, from 1961 to 2009, Syria suffered through [close to] a quarter century's worth of drought, a figure quite significant in that it makes up slightly over 40 percent of this period in Syria's history. An increase of the frequency and severity of droughts would not only hurt agricultural sector but also the Syrian economy and its poor. Results show that growth in economic output (GDP) during drought years can be close to 1 percentage point lower compared to non-drought years. Food security and the poor are also hard hit by droughts. Spiking food imports and increasing prices are the main driver of lower food security. National poverty levels increase by about 0.6 percent during a drought, with higher incidences at local levels. The rural nonfarm poor are hardest hit with poverty rate increases of more than 1.0 percentage points. There are several recommendations for policy makers that emerge from the literature on how to mitigate the negative impacts of droughts.

Improving the resilience to drought-induced food security shocks can be achieved by improving trade and social transfer systems. Increasing and diversifying exports of goods and services will allow Syria to accumulate foreign reserves, which allows for importing additional food in times of droughts and other crises. At the household level, drought management should be combined with social safety nets and long-term development goals. Drought management should become part of the overall economic development planning framework by recognizing the role of social transfers in building economic resilience among communities vulnerable to disasters, and it should be implemented by the relevant Syrian authorities, international agencies, and donors. Such initiatives include direct transfers, cash-for-work programs, community asset building through public works, assistance in undertaking microenterprises, other productive activities, and nutrition and health programs. These initiatives would work at the field level and play a key role in providing immediate relief after disasters as well as assist in recovery and rehabilitation activities. The effectiveness of their roles in past droughts should be evaluated to estimate present and future needs for capacity building, funding, and the possible expansion of their role in disaster management.

Improvements in agriculture can also make an important contribution to increasing the resilience to droughts. Scientific advancement in breeding more drought-resistant varieties will be crucial in the future of rainfed agriculture in Syria. Investing in the development of drought-resistant seeds and encouraging farmers to adopt these seeds may mitigate adverse consequences on rainfed agriculture and safeguard farmers from drought-induced yield losses. In addition to developing heat- and drought-resistant cultivars that would weather the expected decrease in water availability and increase in temperature, an important part of investment, research, and development in agriculture would also include changes in crop practices – optimum sowing dates, choice of cultivars, planned plant density (HAINOUN, 2008), reevaluation and redesigning of irrigation, and water-harvesting practices to sustain a healthy agricultural sector.

Irrigation efficiency must be improved where economically viable to get “more crop per drop”. Irrigated crops are less affected by droughts; however, expanding irrigation is possible only to a limited extent, especially in Syria and all other countries in the MENA region, which have severely constrained water resources. Therefore, increasing irrigation efficiency becomes necessary for the future of irrigated agriculture in Syria. In addition, a system that conserves rainfall and efficiently distributes water in other zones should also be a part of the national plan to further investment in water, an increasingly scarce resource. However, it is important to note that increasing irrigation efficency often increases yields but translates only partly into water savings.

Even if the severity and frequency of droughts remains constant, the Syrian people are likely to suffer increasingly negative socioeconomic impacts as a result of higher population and livestock density and increasing groundwater depletion. Herders in particular are hit increasingly hard, mainly because of the sharp spike in livestock density and the competition for pasture land. Structuring and legislating the livestock sector to highlight its income-generating prominence in the Syrian economy will significantly contribute to different mitigation and adaptation measures. Adaptation methods may be categorized under general climate variability adaptation and more specific livestock sector adaptation. The former includes various targets, from collecting and structuring information and data, to conducting the necessary research, to disseminating findings, and finally to monitoring the impacts. Adaptation methods for the sector may be broadly classified under the following focuses: improve grazing management, improve animal biocapacity, enhance rural livelihoods, improve market access, and increase the studies on climate change and its impact on the Syrian economy (BATIMA, 2006).

To adapt the rural space to a more volatile climate, the physical, financial, social, and risk-management infrastructure will need improvements to enhance rural livelihoods. These may be achieved by promoting a strong education for rural households and increasing nonfarm income opportunities and relationships through improving market access to major cities in their vicinity. Consequently, these developed and sustainable channels are fundamental to develop and disseminate new technologies, information, and support to herders. One way to help mitigate risks is to assess whether erecting an *index based livestock insurance* (IBLI) (AYANTUNDE et al., 2010) may provide the herders with the necessary coverage to maintain their livelihoods.

Index-based weather insurance schemes can be a powerful tool to mitigate the risk to small farmers’ livelihoods due to weather variability and consequent crop loss. The most conventional method followed is single insurance policies that cover a single crop for a specific weather failure (ROBLES, 2010; HILL, 2010a). Innovative methods of weather insurance schemes have been introduced in some countries (HILL, 2010a, 2010b) and could be introduced in Syria as well.[4] One tool is to introduce simple weather securities designed to insure against different weather events for different months or different phases of the crop cycle. The securities are set up against a relevant weather index, such as rainfall, and a range of weather occurrences is chosen. If the weather event falls within that range, then the farmer receives a fixed payment, which the farmer decides upon. The amount paid to the farmer will depend on how severe the weather event occurrence is, based on the weather index. The farmer decides how much to insure for and pays a percentage of that amount for the weather insurance *ticket.* The larger the range of weather incidence chosen, the larger the percentage of the insured amount paid for the ticket (ROBLES, 2010). The impact on farmer welfare may then be measured from their resulting consumption and production decisions.

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[4] For more information, see Using Simple Weather Securities to Insure Rain-Dependent Farmers in Ethiopia and Smallholder Access to Weather Securities: Demand and Impact on Consumption and Production Decisions at http://www.ifpri.org/book-744/node/7125 and http://www.ifpri.org/book-744/node/7124, respectively.

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Appendix: Supplementary Tables

Table A1. Social Accounting Matrix (SAM) disaggregation

Activities	Commodities	Institutions
Durum Wheat Irrigated	Wheat	Enterprises
Durum Wheat	Barley	City Household, quintile 1
Soft Wheat Irrigated	Maize	City household, quintile 2
Soft Wheat	Other Cereals	City household, quintile 3
Barley Irrigated	Fruits	City household, quintile 4
Barley	Vegetables	City household, quintile 5
Other Cereals	Olives	Town Household, quintile 1
Fruits	Cotton	Town household, quintile 2
Vegetables	Other Crops	Town household, quintile 3
Olives	Sheep	Town household, quintile 4
Cotton	Cattle	Town household, quintile 5
Other Crops	Camel	Rural nonfarm Household, quintile 1
Sheep	Chicken	Rural nonfarm household, quintile 2
Cattle	Fish	Rural nonfarm household, quintile 3
Camel	Poultry	Rural nonfarm household, quintile 4
Chicken	Food Processing	Rural nonfarm household, quintile 5
Fish	Manufacturing	Rural farm Household, quintile 1
Food Processing	Mining	Rural farm household, quintile 2
Manufacturing	Energy and Water	Rural farm household, quintile 3
Mining	Public Services	Rural farm household, quintile 4
Energy and Water	Other Services	Rural farm household, quintile 5
Public Services	**Factors**	Other
Other Services	Private sector, unskilled	Government
	Private sector, semi-skilled	Direct taxes
	Private sector, skilled	Sales taxes
	Public sector, unskilled	Import tariffs
	Public sector, semi-skilled	Savings-investment
	Public Sector, skilled	Rest of the World
	Capital	
	Land	
	Livestock	

Source: Author's compilation based on disaggregation results.

Table A2. Macro Social Accounting Matrix (SAM)

	mact	mcom	mlab	mcap	mlnd	mhhd	mgov	mdtax	mstax	mmtax	ms-i	mrow	mtot
mact		3,714											3,714
mcom	1,462					1,205	248				619	772	4,307
mlab	650												650
mcap	1,553												1,553
mlnd	49												49
mhhd			650	1,141	49		21					10	1,872
mgov				331				197	-262	19		42	327
mdtax						197							197
mstax		-262											-262
mmtax		19											19
ms-i						470	57					93	619
mrow		835		81									916
mtot	3,714	4,307	650	1,553	49	1,872	327	197	-262	19	619	916	

Notes: mact: Activities, mcom: Commodities, mlab: Labor, mcap:Capital, mlnd: Land, mhhd: Households, mgov: Government, mdtax: Direct Taxes, mstax, mmtax: Tariffs, ms-i: Savings-Investment, mrow: Rest of the World, mtot: Total.

Source: authors' calculations

Table A3. Mathematical presentation of Dynamic Computable General Equilibrium (DCGE) Model: Core model equations

Production function	$Q_{ct} = \alpha_{ct} \cdot \prod_f F_{fct}^{\delta_{fc}}$		(1)
Factor payments	$W_{ft} \cdot \sum_c F_{fct} = \sum_c \delta_{fc} \cdot P_{ct} \cdot Q_{ct}$		(2)
Import supply	$P_{ct} \leq E_t \cdot W_c^m \perp M_{ct} \geq 0$		(3)
Export demand	$P_{ct} \geq E_t \cdot W_c^e \perp X_{ct} \geq 0$		(4)
Household income	$Y_{ht} = \sum_{fc} \theta_{hf} \cdot W_{ft} \cdot F_{fct} + r_h \cdot E_t$		(5)
Consumption demand	$P_{ct} \cdot D_{hct} = \beta_{hc} \cdot (1 - v_h) \cdot Y_{ht}$		(6)
Investment demand	$P_{ct} \cdot I_{ct} = \rho_c \cdot \left(\sum_h v_h \cdot Y_{ht} + E_t b\right)$		(7)
Current account balance	$w_c^m \cdot M_{ct} = w_c^e \cdot X_{ct} + \sum_h r_h + b$		(8)
Product market equilibrium	$Q_{ct} + M_{ct} = \sum_h D_{hct} + I_{ct} + X_{ct}$		(9)
Factor market equilibrium	$\sum_c F_{fct} = s_{ft}$		(10)
Land and labor expansion	$s_{ft} = s_{t-1} \cdot (1 + \varphi_f)$	*f* is land and labor	(11)
Capital accumulation	$s_{ft} = s_{t-1} \cdot (1 - \eta) + \sum_c \frac{P_{ct-1} \cdot I_{ct-1}}{k}$	*f* is capital	(12)
Technical change	$\alpha_{ct} = \alpha_{ct-1} \cdot (1 + y_c)$		(13)

Notes:

Subscripts

- *c* Commodities or economic sectors
- *f* Factor groups (land, labor, and capital)
- *h* Household groups
- *t* Time periods

Endogenous variables

- *D* Household consumption demand quantity
- *E* Exchange (local and foreign currency units)
- *F* Factor demand quantity
- *I* Investment demand quantity
- *M* Import supply quantity
- *P* Commodity price
- *Q* Output quantity
- *W* Average factor return
- *X* Export demand quantity
- *Y* Total household income

Exogenous variables

- *b* Foreign savings balance (foreign currency units)
- *r* Foreign remittances
- *s* Total factor supply
- *w* World import and export prices

Exogenous parameters

- α Production shift parameter (factor productivity)
- β Household average budget share
- γ Hicks neutral rate of technical change
- δ Factor input share parameter
- η Capital depreciation rate
- θ Household share of factor income
- κ Base price per unit of capital stock
- ρ Investment commodity expenditure share
- υ Household marginal propensity to save
- φ Land and labor supply growth rate

Source: THURLOW (2004)

Table A4. Income Elasticities Estimated for the Syria Dynamic Computable General Equilibrium (DCGE) Model

	Cereal	Fruits	Vegetables	Olives	Other Crops	Sheep & Goat	Cattle	Poultry	Fish	Food Processing	Manufacturing	Energy & Water	Services
City 1	0.60	1.70	0.80	2.40	0.80	1.40	1.00	0.90	4.10	1.30	1.10	1.30	0.70
City 2	0.60	1.20	0.70	1.50	0.80	1.00	0.80	0.80	1.70	1.20	1.10	1.20	0.90
City 3	0.70	0.90	0.70	1.40	0.90	0.80	0.70	0.70	1.30	1.00	1.10	1.10	1.00
City 4	0.70	0.80	0.60	1.10	1.00	0.70	0.70	0.70	1.20	1.00	1.10	0.80	1.00
City 5	0.60	0.60	0.60	1.20	1.00	0.50	0.60	0.70	0.70	0.80	1.10	0.70	1.10
Town 1	0.50	0.70	0.70	2.50	0.80	1.20	0.80	0.90	2.80	1.30	1.10	1.00	0.80
Town 2	0.50	0.60	0.60	1.70	0.70	0.90	0.80	0.80	1.90	1.20	1.00	1.00	1.00
Town 3	0.50	0.60	0.60	1.90	0.80	0.80	0.80	0.70	2.00	1.10	1.00	1.00	1.20
Town 4	0.50	0.60	0.60	0.90	0.70	0.70	0.80	0.70	1.10	0.90	0.90	0.80	1.30
Town 5	0.50	0.50	0.50	0.40	0.60	0.60	0.70	0.60	0.60	0.60	0.90	0.70	1.60
Rural nonfarm 1	0.60	1.80	0.70	2.70	0.80	2.00	0.80	0.90	4.60	1.10	1.00	1.00	0.90
Rural nonfarm 2	0.50	1.50	0.60	2.10	0.70	1.50	0.80	0.70	2.70	1.00	0.90	1.10	1.20
Rural nonfarm 3	0.50	1.20	0.60	1.40	0.60	1.60	0.70	0.60	1.90	0.90	0.90	1.10	1.40
Rural nonfarm 4	0.40	1.00	0.50	1.10	0.50	1.30	0.60	0.60	1.70	0.80	0.90	1.00	1.60
Rural nonfarm 5	0.50	0.80	0.50	1.10	0.40	1.30	0.50	0.50	1.10	0.70	0.90	0.90	1.50
Farm 1	0.70	1.60	0.70	3.60	0.80	1.60	1.00	1.10	8.00	1.10	0.90	1.10	0.90
Farm 2	0.60	1.30	0.70	2.00	0.80	1.30	1.10	0.90	2.50	0.90	0.90	1.00	1.30
Farm 3	0.40	1.20	0.60	2.30	0.60	1.20	0.80	0.70	1.40	0.90	0.90	1.10	1.40
Farm 4	0.40	1.10	0.60	1.10	0.50	1.30	0.90	0.60	2.00	0.80	0.90	1.00	1.60
Farm 5	0.40	0.90	0.50	0.80	0.50	1.40	0.70	0.60	1.00	0.70	0.90	0.90	1.60

Source: authors' calculations