Northeast Syria Crop Monitoring and Food Security Situation Update:

Impact of low rainfall and other crop stressors on winter crops - iMMAP Data Cube

Food Security and Livelihoods (FSL) Sector- North East Syria and iMMAP Food Security Analysis and Geoinformatics Units

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Executive Summary

Introduction: The 2021 winter cropping season in North-East Syria has been severely impacted by poor rainfall. This paper summarizes the progress of the season through March and highlights the impact at the level of both districts and rainfall stability zones within North-East Syria in terms of area (in hectares) of robust crop stand. It also discusses other stressors to crops and coping strategies available to farmers in the short term. Full analysis, including production inference for the 2021 winter season, is forthcoming once remote sensing data is available for the season peak in April and pending availability of previous crop yield statistics from partners.

Key findings: Comparing the mid-point of the previous cropping seasons, in the 2021 winter season, NES has experienced greater negative impact from low rainfall than the devasting drought year of 2018, particularly in high-crop producing rainfed areas of Al-Hasakeh Governorate. Hectarage of robust crop stand is 33-50% lower in Al-Hasakeh Governorate than at the same time period in 2018. The Self Administration of North East Syria (SANES) Economic Department projects losses of up to 75% of rainfed crop yield in Al-Hasakeh Governorate and 10-25% of irrigated yields across NES.

Rainfed crops are particularly hard hit. Small hectarage of rainfed wheat and barley in northern areas of Al-Hasakeh Governorate (Rainfall Zone 1) may be viable for harvest. All other rainfed areas are expected to have very low harvest. Irrigated land across NES is also impacted, as farmers must rely more upon irrigation water sources due to lack of rainfall. Irrigated lands along the Euphrates River in Ar-Raqqa and Deir-ez-Zor Governorates are threatened further due to very low water flow from Turkey. Low water levels in the Euphrates river basin reduces water available for irrigation and disrupts electricity supply (generated at the Tishreen Dam) used for irrigation pumps. These areas show a relative fair crop stand compared to 2018, though still significantly lag behind 2019 and 2020.

These trends of erratic rainfall will cause reduced grain stocks, wheat, flour, and bread price increase, and threaten food security and livelihoods in NES and other areas of Syria dependent on cereal grain imports from NES. The collapse of winter crop harvest is also causing reduced fodder stocks and thereby threatening livestock-based livelihoods and the long-term viability of agricultural producers in NES, specifically in terms of seed availability and land preparation activities for the upcoming summer 2021 and the winter 2022 cropping seasons. The depreciation of the Syrian Pound and related spikes in agricultural input prices further compound these challenges.

Response: Food Security and Livelihoods (FSL) Cluster organizations and the SANES Economic Office are pursuing options for support to actors along the wheat-flour to bread economic value chain. Short term livelihood support plans include: pre-positioning for the distribution of seeds to farmers for the upcoming seasons, including improved, drought-tolerant wheat varietals; improvement of irrigation systems; farmer capacity building through training on climate-smart agriculture and rangeland management; contingency planning and community mobilization for drought cycle management; monitoring of household vulnerabilities and the food security situation to inform interventions that ensure the provision of emergency food assistance in targeted areas.

1. Situation Overview

Reports of extremely low rainfall and prolonged dry spells in North East Syria (NES) during the 2020-2021 winter season have prompted an analysis of the current state of crop production in the region, particularly of food security- and livelihood-relevant crops: winter wheat and barley. Input from Food Security and Livelihood (FSL) Sector member organizations in North East Syria and regular FAO[1] and WFP[2] monitoring have indicated that rainfall was delayed at the start of the season (first rain coming in November rather than October 2020) and remained low through April 2021, causing stunted crop growth and crop physiology and threatening the health of crops throughout the growing cycle. Reports also indicated that low water availability was negatively affecting both rainfed and, to a lesser extent, irrigated crops. With prolonged dry spells, livestock keepers are also affected with poor growth of forage, reduced pasture stand, limited water for animal hygiene and consumption, and a likely increase in fodder prices.

This analysis is based on available data through mid-March of the 2020-2021 winter season. Using this data, it is too early to make firm predictions of the effect of dry spells on crop yields/harvest for the current season. The aim of this analysis will be to provide a review of the status of crop growth in NES and outline factors affecting crop production in anticipation of more complete analysis once winter crop season peak is detected - expected mid-to-late April 2021, with data available starting in early-to-mid May 2021. This analysis relies primarily on remote sensing outputs from the iMMAP Data Cube, focusing on estimating crop phenology trends (based on Enhanced Vegetation Index (EVI)) and area under crop (based on Normalized Difference Vegetation Index (NDVI)) to illustrate the progress of the current season as compared to the 2018, 2019, and 2020 winter seasons.

The iMMAP Data Cube (IDC) is designed to assist the humanitarian and development sectors in addressing crucial environmental, economic and social challenges by harnessing long term time-series earth observation data from satellites as well as climate models. With the advances in machine learning, data mining and computing infrastructures, the IDC can manage big data queries and rapidly yield time-series analysis of large satellite data archives such as Sentinel 2 and Landsat spanning as far back as 30 years.

1 FAO,GIEWS, Earth Observation, Syrian Arab Republic
2 Seasonal: Rainfall and Vegetation: Visualizations - Dataviz | WFP - VAM

2. Crop Phenology

The crop phenology is extracted from a time-series of the EVI-based on the Sentinel-2 satellite updated every 5 days. An increase in the EVI relates to an increase in photosynthetic activity in the plants while suppressing background soil effects. EVI phenometrics for 2021 across Al-Hasakeh Governorate (Figure 1) demonstrated the impact of low rainfall throughout the growing period, keeping EVI relatively low up until measurement ends in early March. Phenometrics are comparable to the 2018 winter season, in which crop yields were very low. However, the 2021 winter crop season has not yet reached its peak, which generally occurs between mid-March and mid-April, and is expected to be mid-to-late-April 2021 due to low rainfall in the beginning of the winter season. In contrast, the 2018 winter season reached its peak in mid-March, meaning that the 2021 winter season may improve as compared to 2018.

Therefore, full analysis of the impact of low rainfall on 2021 crop yields should be conducted once data are available for all of April, to capture the peak of crop growth and understand relation to past years. Once the peak growth is detected, estimation of lands under irrigation and the inference of crop yields and subsequent effects on markets and food security will be possible.

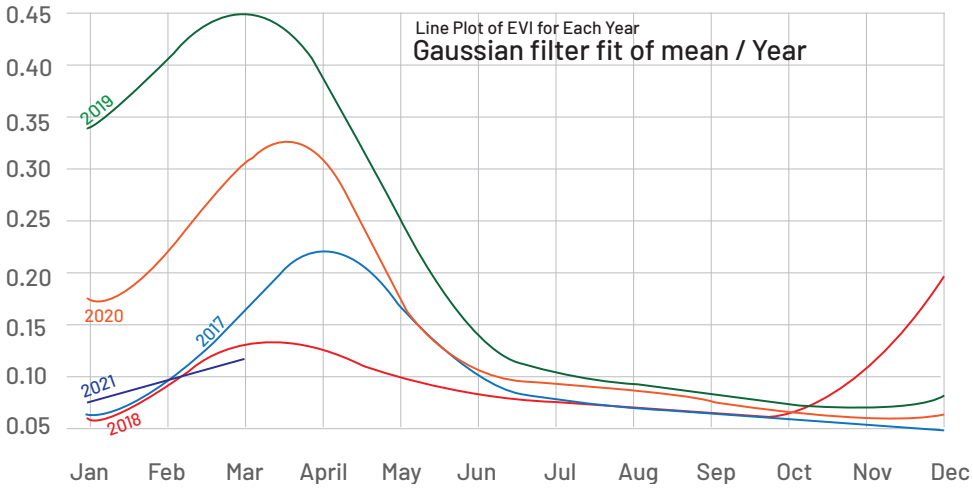

Figure 1. **Crop phenology using Enhanced Vegetation Index (EVI) for Al-Hasakeh Governorate, 2017-2021**

3. Area Under Crop Production

Area under crop production is estimated by the area in hectares over the NDVI threshold corresponding to robust vegetation growth consistent with crop physiological development. Years are compared with each other in the same timeframe, February 1 - March 15. This area – as seen in Figure 2 – is presented by district for the three core governorates in NES, plus the two districts of Aleppo governorate included in NES.[3] In Al-Hasakeh governorate, area is also presented by rainfall stability zone, a key factor influencing rainfed wheat production in NES.

The method used allows rapid comparison of relative land cover change between recent seasons, but does not attempt to differentiate crop types or present hectarage of specific crops. In high rainfall years such as 2019 and 2020, non-crop vegetative photosynthetic activity likely representing forage on rangeland and wild vegetation may reach this threshold and introduce some error and reduce comparability. This makes comparison with the drought year of 2018 the most useful and operationally relevant for humanitarian action. Also, because data is not yet available for the peak of the 2021 winter crop season, the presented hectarage of crop stand should be interpreted with caution and not directly as the final hectarage of crop stand across the study area for the 2021 winter crop season.

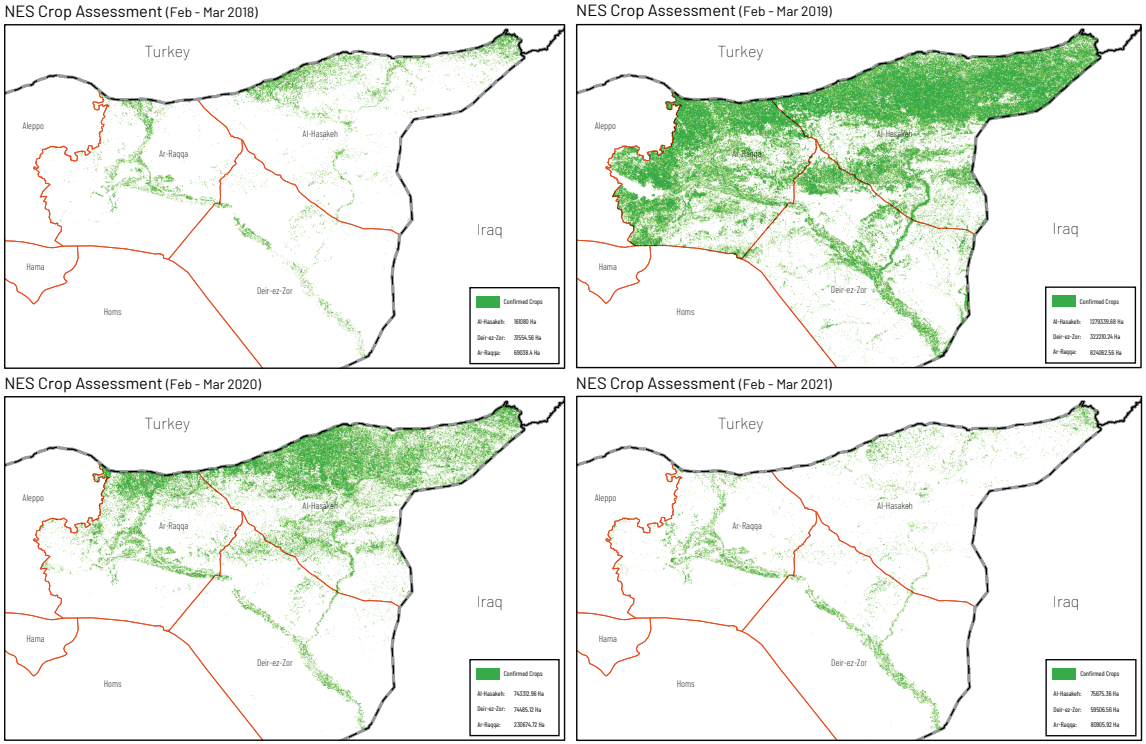

Figure 2. NES Crop Classification, 2018-2021

3 Figures are given for GoS-defined administrative boundaries and thus include areas under various actors' territorial control. Thus, figures may overestimate the area currently accessible within NES. The Turkish-controlled Ras Al Ain and Tal Abiad Districts are not included in this analysis, as reporting for these areas is through the North West Syria (NWS) Cluster.

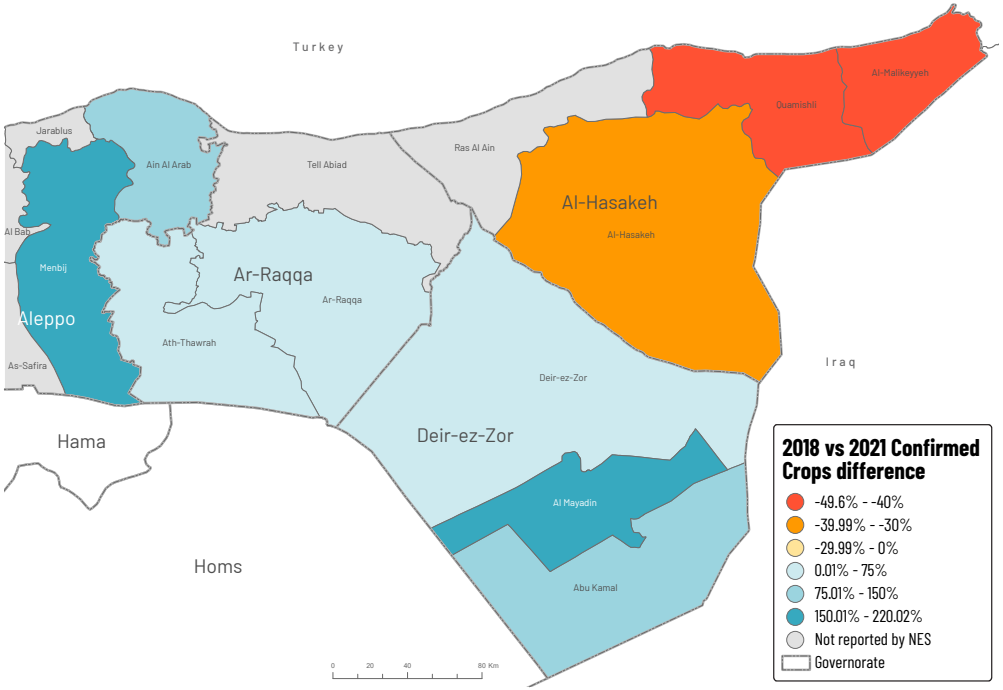

Figure 3. % Difference of Confirmed Crop Area in Hectares between 2018 and 2021 by District

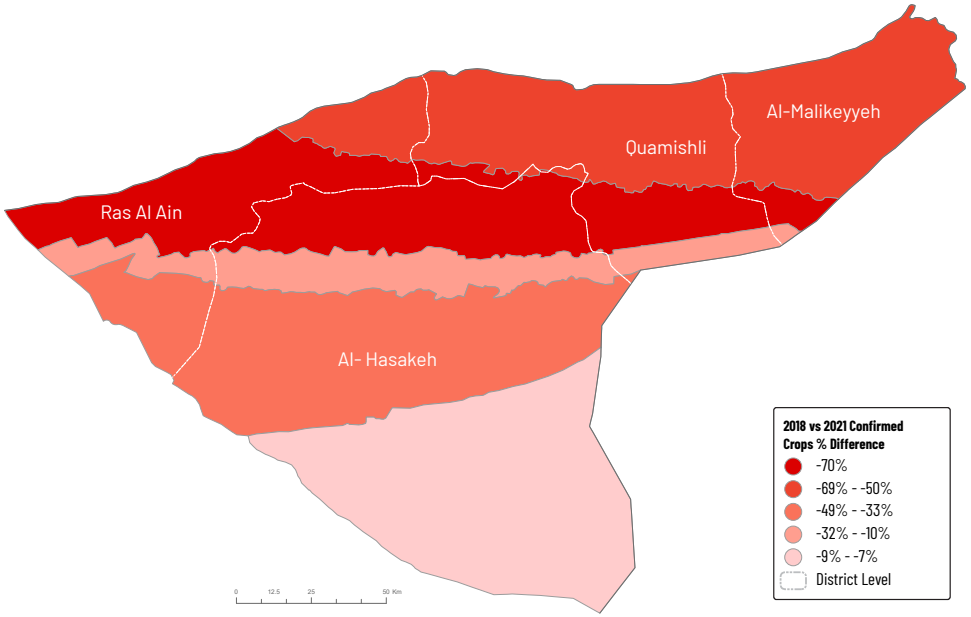

Figure 4. % Difference of Confirmed Crop Area in Hectares between 2018 and 2021 by Rainfall Stability Zones (See Appendix 1 for complete rainfall stability zones map)

DISTRICT	2021 (CURRENT)	2020 (% CHANGE)	2019 (% CHANGE)	2018 (% CHANGE)`
Al-Hasakeh	24,001 ha	298,773 ha (-92%)	531,557 ha (-95%)	**36,041 ha (-33%)**
Quamishli	15,140 ha	171,792 ha (-91%)	301,255 ha (-95%)	**27,353 ha (-45%)**
Al-Malikeyyeh	17,254 ha	96,743 ha (-82%)	195,238 ha (-91%)	**34,233 ha (-50%)**

Table 1.1. Al-Hasakeh, by District *

All areas of Al-Hasakeh Governorate display dramatic decreases in cropped areas compared to previous years (Table 1.1). Al-Hasakeh is the governorate expected to have the greatest impact from low rainfall due to the high prevalence of rainfed agriculture. Losses of 33-50% of cropped area as compared to the 2018 winter season are of particular concern. Still, the 2021 winter season may improve somewhat compared to 2018, as noted above.

DISTRICT	2021 (CURRENT)	2020 (% CHANGE)	2019 (% CHANGE)	2018 (% CHANGE)
Zone 1 (350-600mm)	39,699 ha	264,986 ha (-85%)	426,364 ha (-91%)	**79,621 ha (-50%)**
Zone 2 (250-350mm - ⅔ of years)	18,391 ha	276,063 ha (-93%)	428,398 ha (-96%)	**60,478 ha (-70%)**
Zone 3 (250-350mm - ½ of years)	5,485 ha	65,942 ha (-92%)	133,691 ha (-96%)	**6,070 ha (-10%)**
Zone 4 (200-250mm)	4,457 ha	85,267 ha (-95%)	160,756 ha (-97%)	**6,689 ha (-34%)**
Zone 5 (0-200mm)	7,646 ha	51,054 ha (-85%)	130,116 ha (-94%)	**8,222 ha (-7%)**

Table 1.2. Al Hasakeh, by Rainfall Stability Zone *

Analysis by rainfall stability zone in Al-Hasakeh governorate shows dramatic decreases compared to previous years, including compared to 2018 (Table 1.2). Zone 2 appears to be of most concern, likely exacerbated by restricted access to a significant portion of Zone 2 lying in Ras Al Ain under Turkish control. Zones 1-3 are the primary areas for rainfed wheat, which has been reported by FSL Cluster partners as suffering from severe crop damage due to wilting caused by prolonged dry spells. Poor performance of crops in these zones in Al-Hasakeh is particularly concerning for potentially devastating effects on food production and security.

* All areas presented in tables are estimates based on remote sensing indices intended to provide approximate figures in order to draw comparison of crop stand and land cover change between seasons. These figures are taken at a stage of the season which may or may not represent peak crop growth and acreage available for harvest. In especially high rainfall years, forage on rangeland and wild vegetation may meet the NDVI threshold and introduce error. These figures should not be interpreted as official statistics on crop acreage for any season.

DISTRICT	2021 (CURRENT)	2020 (% CHANGE)	2019 (% CHANGE)	2018 (% CHANGE)
Ar-Raqqa	57,371 ha	80,658 ha (-29%)	274,892 ha (-79%)	**41,209 ha (+39%)**
Ath-Thawrah	6,207 ha	13,616 ha (-54%)	240,420 ha (-97%)	**4,412 ha (+41%)**

Table 2. Ar-Raqqa *

In Ar-Raqqa Governorate, crop production is primarily irrigated and has not suffered as much from the reduction in rainfall (Table 2). In Ar-Raqqa and Ath-Thawrah districts, where crop production is primarily irrigated, cultivation appears to be faring better than in 2018, but is 29% and 54% below 2020 - a relatively high rainfall year. Because irrigated crops often receive a mixture of rainfall and irrigation water, farmers have relied more heavily on irrigation water during the current low rainfall year. This impact of low rainfall is also combined with the effects of electricity shortages on water pumping and low utilization and quality of agricultural inputs.

DISTRICT	2021 (CURRENT)	2020 (% CHANGE)	2019 (% CHANGE)	2018 (% CHANGE)
Deir-ez-Zor	35,264 ha	55,082 ha (-36%)	245,782 ha (-86%)	**22,149 ha (+59%)**
Abu Kamal	11,000 ha	9,414 ha (+17%)	46,586 ha (-76%)	**5,177 ha (+112%)**
Al Mayadin	13,243 ha	9,991 ha (+33%)	29,844 ha (-56%)	**4,228 ha (+213%)**

Table 3. Deir-ez-Zor *

As the vast majority of Deir-ez-Zor governorate falls within rainfall stability zones 4 and 5, very little rainfed crop is grown in these areas (see Appendix 1). All districts show an improvement over the drought year of 2018 (Table 3). Deir-ez-Zor district shows a 36% decline against 2020, indicating the difficulties with irrigated and small areas of rainfed crops during 2021. Abu Kamal and Al Mayadin districts have also improved over 2020, by 17% and 33%, respectively - the only districts in NES to do so. This is important to note given the reported presence of desert locust in the Al Shafah area of southern Abu Kamal.

DISTRICT	2021 (CURRENT)	2020 (% CHANGE)	2019 (% CHANGE)	2018 (% CHANGE)
Menbij	95,639 ha	119,312 ha (-20%)	287,662 ha (-67%)	**29,885 ha (+220%)**
Ain Al Arab	28,024 ha	84,739 ha (-67%)	209,913 ha (-87%)	**12,102 ha (+132%)**

Table 4. Aleppo (2 Districts in NES) *

In the two districts of Aleppo within NES, area under crop appears to be stronger than 2018, but still lags 2020 (Table 4). Ain Al Arab, which falls primarily within rainfall zones 2 and 3 (Appendix 1) displays a 132% increase in area under crop as compared to 2018.

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4. Euphrates River Flow

Throughout the winter 2020-2021 season, reports from officials in the Self Administration of North East Syria (SANES) and INGO Solidarity International indicate that the flow of water from the Euphrates River crossing into Lake Assad from Turkey has been severely restricted since late January 2021. Under the 1987 Syria-Turkey Agreement on the Euphrates, water flow at the Syrian border should remain between 500-1,000 cubic meters per second but has been reduced to around 200-250 cubic meters per second since February 2021. According to Solidarity International reports, 150m3/s are needed to fulfill irrigation needs along the Euphrates, with an additional 25m3/s for drinking water, 75m3/s for evaporation from reservoirs, and 300m3/s for Iraq's downstream water rights under the 1987 agreement.

The resulting cumulative decline in water levels in the reservoir has been dramatic. Water extent analysis using the Water Observation from Space (WOfS) algorithm in the iMMAP Open Data Cube indicates an overall reduction of more than 9km2 of the total waterbody extent within the area of northern Lake Assad analyzed between December 2020 and April 2021. Aside from posing grave risks to drinking water supply and restricting electricity production at the Tishreen Dam, the reduced water flow also threatens to limit access to irrigation water for farmers in Ar-Raqqa and Deir-ez-Zor Governorates, including irrigated wheat and barley fields. Irrigated production in these areas is even more essential during the current season where low rainfall has severely threatened the yield of rainfed wheat and barley. The impacts of low river flow may be felt most acutely during the summer 2021 crop season, as these crops are in the planting and early vegetative growth stage, and these crops rely more on irrigation water as summer rains are much lower.

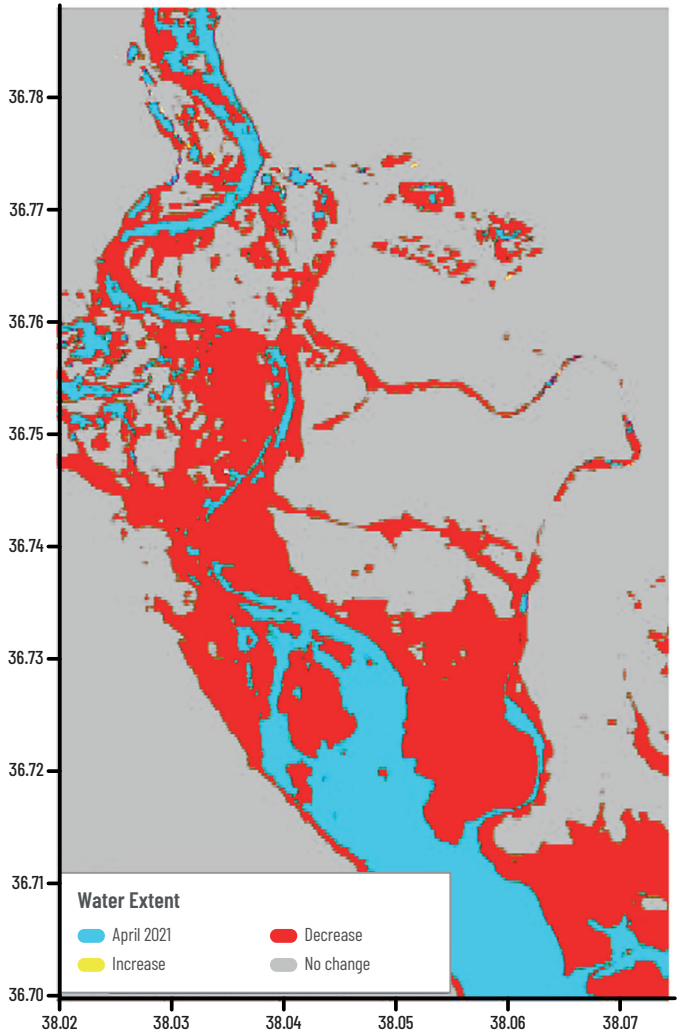


Figure 5. **Change in water extent between December 2020 and April 2021**

5. Coping Strategies and Policy Support for Farmers

The low rainfall in the winter 2021 season, linked to long-term climate change impacts in North East Syria, will likely have adverse impacts for rural households, which are largely dependent on agriculture and livestock assets. The Economic and Agriculture Office of SANES projects damage up to 75% of rainfed crops and 10-25% of irrigated crops. Remaining rainfall in the 2021 winter season could allow up to 25% of rainfed crops to be harvested as normal. While there is limited evidence to document the effect of various coping strategies on livestock productivity and rural livelihoods, there are several widely used strategies in NES available to farmers in the short term:

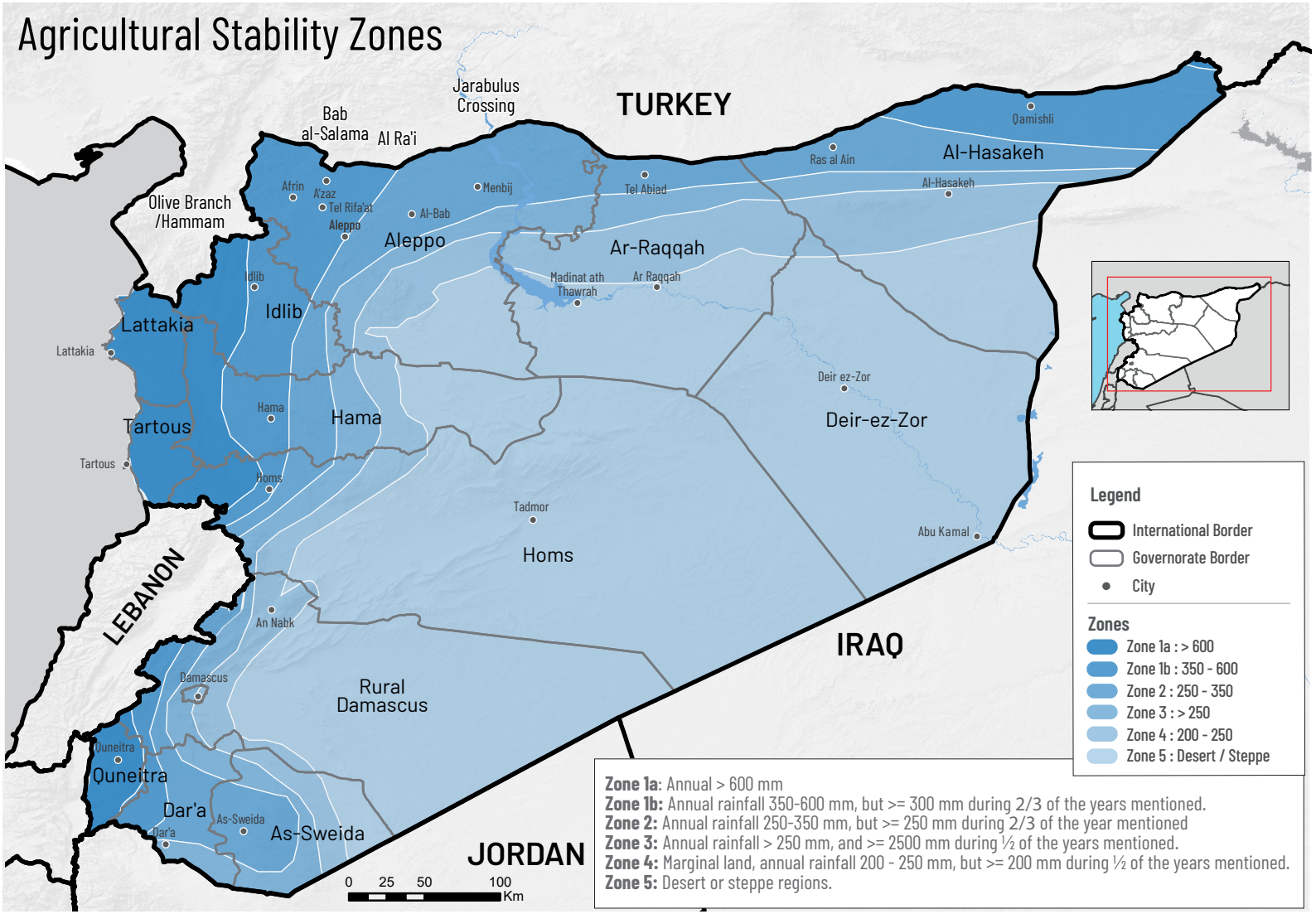
- Harvesting damaged crops to use as fodder to support livestock of the farm or to sell to livestock operations. These strategies allow an increase in milk production of livestock, providing short term revenue to offset losses of wheat crops.
- Identifying the capacity to convert damaged crop areas into alternative seasonal crops, such as vegetables. Limited financial capacity can create difficulties in accessing necessary equipment, seeds, and other materials required to implement this strategy. In rainfall zones 4 and 5, the only option may be to convert land to fallow.
- Farmers may also opt to sell livestock or agricultural lands, or migrate to pursue urban labor opportunities, providing short term increases in income and food security, but decreasing income generation potential from agricultural assets in the long term.

Generally, coping strategies that preserve assets provide the best options for resilience in both the short and long term. Policy-makers in SANES are considering support to those engaged in agricultural livelihoods, including purchasing wheat and wheat seeds from farmers and providing seeds for future planting. SANES is also aiming to support farmers on irrigated lands with fuel, fertilizers, and pesticides, to maximize current season harvest. SANES reports that it is considering policy support options and assessing damage in the 2021 winter season. Long term adaptation measures to climate risk are also being considered.

6. Summary

- **Total area cultivated in NES as of March 2021 appears to be lagging behind the devastating drought year of 2018,** especially in areas depending primarily on rainfed agriculture in Al-Hasakeh governorate.
- Area of robust crop stand in wheat-producing areas of Al-Hasakeh - rainfall stability zones 1, 2, & 3 - is around 80,000 hectares and 56% less than in 2018, indicating a **severe dry spell causing poor crop productivity and the potential for a massive shock to markets for wheat and bread,** as well as the potential for severe negative consequences for food security in NES.
- Rainfed agriculture is also the cornerstone of livestock fodder markets, making the poor rainfall year particularly concerning for livestock-reliant populations and availability of livestock products in markets.
- **Cultivation is particularly low in the areas of Tell Abiad and Ras Al Ain districts under Turkish Operation Peace Spring control.** These areas will not contribute to food stocks in the rest of NES due to trade restrictions.
- The impacts of low rainfall in the current season primarily affect rainfed agricultural lands, but **low water availability overall is also negatively affecting irrigated agriculture,** as reported by FSL Cluster partners in NES and international organizations.
- **Irrigated lands in Raqqa and Deir-ez-Zor governorates** are faring better than rainfed lands in Al-Hasakeh governorate and better than in 2018, but are still **lagging significantly behind 2020** (a higher than average rainfall year). Decreased water levels coming from Turkey in the Euphrates River may be contributing to the observed decrease.
- Abu Kamal and Al Mayadin districts, which are outperforming 2018 and 2020 figures, may face the impact of rare desert locust outbreak, depending on the scale of outbreak and ability of adult locusts to reproduce.
- Fire risk is also high due to the hot, dry year producing large volumes of dry biomass that can easily become fuel.

Appendix 1. Rainfall Stability Zones in Syria



Source: Christiansen, Scott & Ryan, John & Singh, Murari & Ates, Serkan & Bahhady, Faik & Youssef, Omran & Mohamed, Khalil & Loss, Stephen. (2014). Potential legume alternatives to fallow and wheat monoculture for Mediterranean environments. Crop and Pasture Science. 66. 10.1071/CP14063.