



Food and Agriculture
Organization of the
United Nations

YEMEN

2021 Agrometeorological summary

November 2022



@YRC



For More Information, Please Contact:

FAO Representation

Yemen, Sana'a (YE-FSNIS@fao.org)



“Violent cloudbursts, biting winter conditions, dusty storms, and migratory pests dominated agrometeorological conditions throughout 2021”



Executive summary

Recent evidence suggests that large and abrupt extreme climatic events have increased in Yemen, thus frustrating food security efforts. Here, agrometeorological conditions for 2021 are reviewed based on ground and remotely-sensed data and November – December projections are given to inform food security decision-making processes.

What stands out from the findings is that violent cloudbursts, biting winter conditions, dusty storms, and migratory pests dominated agrometeorological conditions throughout 2021.

From November to December 2022, the World Meteorological Organization's Probabilistic Multi model Ensemble (PMME) shows that land surface temperatures are expected to be cooler than usual while no major rainfall shifts will be expected from the normal across the whole country.



Contents:

Executive summary	III
1. Introduction	1
2. Agrometeorological Hazards	1
2.1. Evolution of Heavy Rainfall, Flooding, and Dry Spells	4
2.2. Evolution of Temperature Extremes and Related Hazards	4
3. Governorate-level Projections of Hazards and Vulnerabilities across Yemen, Nov—Dec 2022	6

1. Introduction

The subtropical climate of Yemen can broadly be classified into two major seasons: winter and summer. During summer (June – September), daily maximum temperatures go beyond 40°C and are often exacerbated by a localised warming effect from dust particles that are carried from desert areas and spread across the country. In winter, temperatures usually plummet with some parts of the highlands often experiencing below 0°C. While rainfall regimes differ markedly across the country, coastal areas receive most of their rains in the winter months, while the Highlands follow two distinct rainy seasons: Saif (March-May) and Kharif (July-September). Overall, topography and maritime influences are the leading modes of climate variability across Yemen.

Aside from conflicts, climate variations together with management decisions are by far the major influencers on agricultural production among farming communities in Yemen. Weather and climate variations influence other environmental variables such as soil productivity, migratory pests, and the development of allergic respiratory diseases in farming communities. It therefore follows that the application of weather and climate knowledge to the management of the agricultural sector is indispensable.

As such, agricultural management decisions backed by a reliable climate information infrastructure can enhance production. This is especially true considering that types of crops grown, animals reared, agricultural technology used, and government guidance instituted can all be determined to some extent by agrometeorological conditions.

In light of climate change, it is estimated that 20 – 80% of inter-annual agricultural yield variations among small-scale farmers around the world are caused by meteorological variations^{1,2}, with other factors such as post-harvest losses occupying a much lesser percentage. Many attribution studies have documented that climate change has altered the likelihood and intensity of extreme weather events thus, making farming communities more susceptible to the ravages of extreme meteorological events. This report aims to summarise key meteorological events that impacted agricultural activities across Yemen in 2021 and give projections for the November – December 2022 period in order to inform early action planning.

2. Agrometeorological Hazards

2.1. Evolution of Heavy Rainfall, Flooding, and Dry spells

The beginning of 2021 was mainly characterised by dry weather conditions although some rainstorms accompanied by hail were reported by farmers between 10 – 20 January 2021 in the Central Highlands (North of Ibb and southern part of Dhamar).

Light rainfall was reported in February 2021 and thus, no flood hazards were experienced throughout the month. However, the light rainfall that was received encouraged the re-emergence of Desert Locusts towards the end of the month. Several swarms were observed by the Desert Locust Control Centre (DLCC) during surveys, and farmers in the Tihama Plain (the western coastal strip of the Red Sea) and other locations along the Gulf of Aden, as well as the Arabian Sea coast. Although increased breeding of DL was expected during February due to the light rainfall, monitoring by DLCC reported very little breeding.

¹ <https://www.fao.org/news/story/en/item/1395127/icode/>

² <https://iopscience.iop.org/article/10.1088/1748-9326/ab154b>

A spill-over of drier-than-usual conditions from February to March was observed across the country. These generally dry conditions led to a decrease in moisture of the topsoil across cropped areas, which increased crop water requirements and thus, negatively affected agricultural activities, especially for small-scale farmers with little or no access to groundwater irrigation facilities.

Early April was characterised by a late onset of the rainy season, however, in the second half of April and early May, torrential rains were reported across much of the country triggering flash floods. The largest flood impact was experienced in Aden, Hadramaut, Hajjah, Lahj, Abyan, Dhamar, Marib, and Al Bayda governorates. Field reports by FAO staff indicate that the number of affected families went up from 3,730 on 4 May to 6,855 by 9 May.

Although in April and May the locust situation was relatively calm, in June, some immature swarms were seen coming from the north heading towards Sa'ada governorate while another swarm was seen north of Sana'a in the Highlands. A few adults were also spotted in Shabwah causing damage to the already-standing crop.

July started with widespread rainfall across several governorates. As of mid-August, about 13,600 households were documented to have been critically affected by torrential rains and associated flooding, especially in Hajjah, Marib, Sana'a, and Taizz governorates. Towards the end of August 2021, rainfall was observed to have decreased across the eastern parts of the country while the southwestern parts remained dominated by wet weather conditions, resulting in floods and landslides compounded by the 4.6 magnitude earthquake on August 28 that shook Hadramaut Governorate³. Although the earthquake did not cause any damage, saturated soils became softer and unstable thus, contributing to floods and landslides. The heavy rainfall reported in both July and August across the country resulted in increased fodder production and increased incidences of fungal and bacterial diseases on vegetables and fruit crops. In Ibb, Dhamar, Sana'a, and Al Mahwit governorates, rainfall was accompanied by heavy hail, which damaged vegetables and fruit trees. The already fragile vegetables were also affected by the spread of Fall Armyworms (FAW; *Spodoptera frugiperda*), especially across rainfall-prone areas. By the end of September 2021, further reductions in rainfall were noted. Additionally, widespread DL hopper groups formed in many areas, especially the interior parts of Shabwah, Abyan, and Lahj Governorates.

While much of the October – December trimester was dry, its beginning was very wet with floods being reported in Hadramaut (Al Mukalla) governorate. The torrential rainfall was heavily influenced by the remnants of cyclone Shaheen⁴ which made landfall in Oman and Iran.

Taken together, the month-to-month distribution of rainfall in 2021 was characterised by above-average performance in April, May, August, and July in which about 800, 840, 1350, and 2030 mm were reported by rain gauge networks respectively. Clearly, most of the rainfall was received in July while March and January were the driest as expected during that season. Months with the most rainfall were accompanied by violent cloudbursts and consequently flash floods that destroyed crops and critical infrastructure.

³ <https://bit.ly/3TkpruJ>

⁴ <https://rmets.onlinelibrary.wiley.com/doi/10.1002/wea.4193>

Spatially, most rains were reported in Ibb, Hajjah, and Al Maharah Governorates. It is notable however that in both Al Maharah and Hadramaut, rains were heavier along the coasts than inland; this pattern can be attributed to the influence of maritime air along coasts while inland, desert conditions suppressed rainfall. Overall, at an annual average of about 150 mm, heavy rainfall experienced in 2021 across Yemen has a return period of about seven years and is at the wetter end of the country’s rainfall spectrum. For agricultural tactical purposes, crops that tolerate heavy rainfall of about 120 mm are encouraged as this amount of rainfall has a yearly return period with a high degree of accuracy. In a nutshell, 120 mm is below the required amount for total dependence on rainfed agriculture of ordinary cereal crops. For good yields, cereal crops such as millet, maize, wheat, barley, and sorghum, supplementing rainfed agriculture with irrigation is strongly encouraged. As an alternative, drought-tolerant crops such as bush beans and hybrid maize (e.g., HM-5) are encouraged⁵.

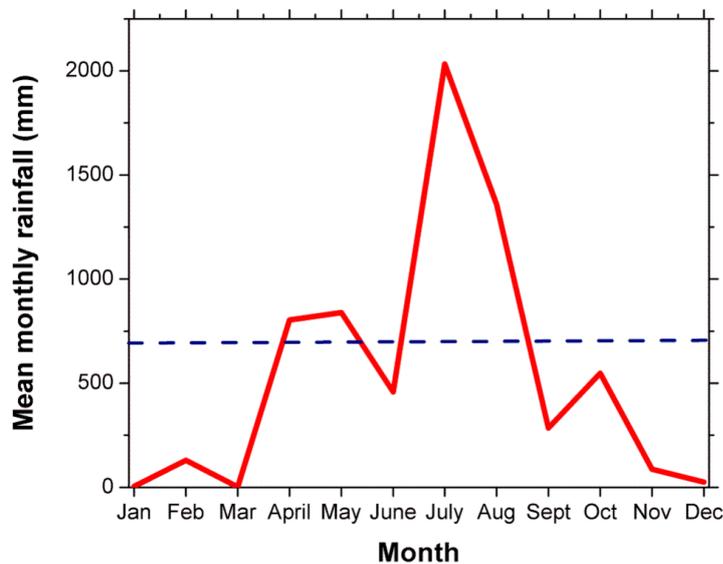


Fig. 1. Mean monthly rainfall (mm) over Yemen based on 22 ground weather stations for the period January – December 2021. The blue dashed curve shows average rainfall (mm).

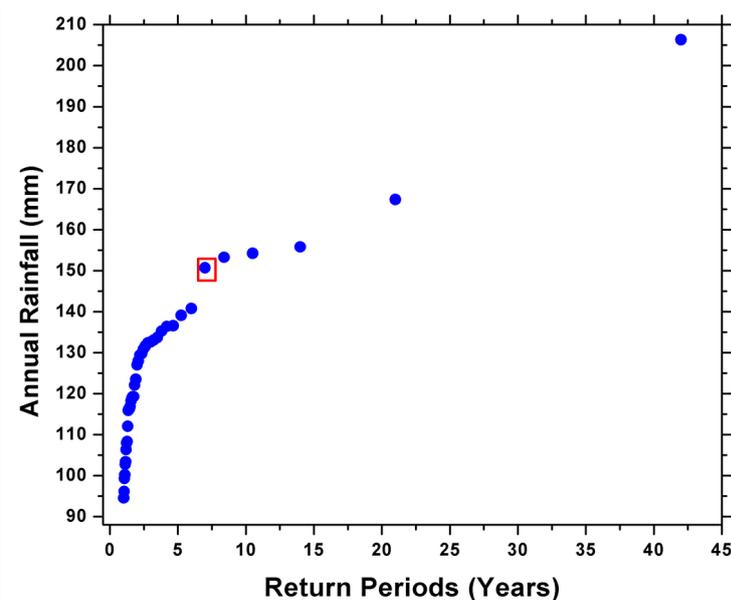


Fig. 2. Return periods of heavy rainfall events across Yemen based on CHIRPS⁶ data for the period 1981 – 2021. The red square indicates 2021 rainfall performance.

⁵ <https://bit.ly/3fTAQUM>

⁶ <https://chc.ucsb.edu/data/chirps>

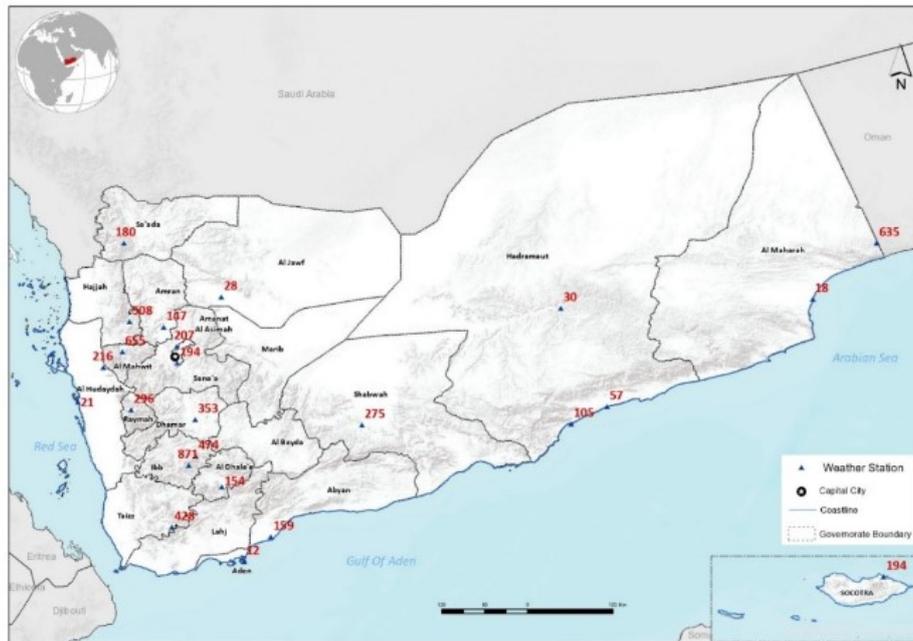


Fig. 3. Spatial distribution of cumulative rainfall (mm) over Yemen for the period January – December 2021.

2.2. Evolution of Temperature Extremes and Related Hazards

The month-to-month temperature distribution was dominated by below 0°C in January and December and these cold temperatures had severe impacts on agricultural activities. Notably, the lowest temperatures were reported in Amran, Dhamar, and Sana’a. The cold weather conditions encouraged the spread of diseases mainly on vegetables and fruits. These diseases included late blight and *Tuta-absoluta* on tomatoes, while powdery mildew affected squash.

With temperatures reaching as low as -2°C in Amran Governorate, December was atypically the coldest month in 2021. Biting winter conditions negatively affected farmers, crops, and livestock. For instance, most farmers in Dhamar, Sana’a, and Amran lost their vegetables to cold weather which led to demand exceeding supply and thus, triggered price hikes in these governorates. The cold weather conditions also encouraged the spread of livestock diseases such as plague and pneumonia. Regarding human health, cold weather mainly affected children and old people who are most susceptible to influenza and cold shocks.

High-temperature conditions dominated most of March 2021 and these were coupled with gusty winds which encouraged the resurgence of dusty storms that blanketed the eastern deserts, coastal regions, and parts of the Highlands. Due to dusty conditions, an increase in asthmatic attacks, especially among children, was reported throughout March. Further, due to dryness and a general increase in temperatures, changes in edaphic attributes were reported across the country by both ground-based data and remote sensing products. The high temperature was also found to heighten the delay in the onset of the rainy season which led to failed germination and stunted growth of early sorghum and millet. This caused increased costs for farmers as they replanted the same crops (in Southern Highlands) or shifted to other crops for the season (in Northern and Central Highlands, farmers shifted to wheat and barley).

Spatially, the highest temperatures were concentrated in Al Maharah, Hadramaut, Shabwah, and parts of south-eastern Lahj Governorates, while the lowest was reported in southern Taizz, Dhamar, eastern Ibb, northern Sana'a, eastern Hajjah, and much of Amran Governorate. The spatial distribution of minimum temperatures agrees with the topography of the region with Southern Uplands, Central and Northern Highlands generally being colder than the rest of the country. These high elevations force air to rise, expand, and cool down compared to the rest of the country.

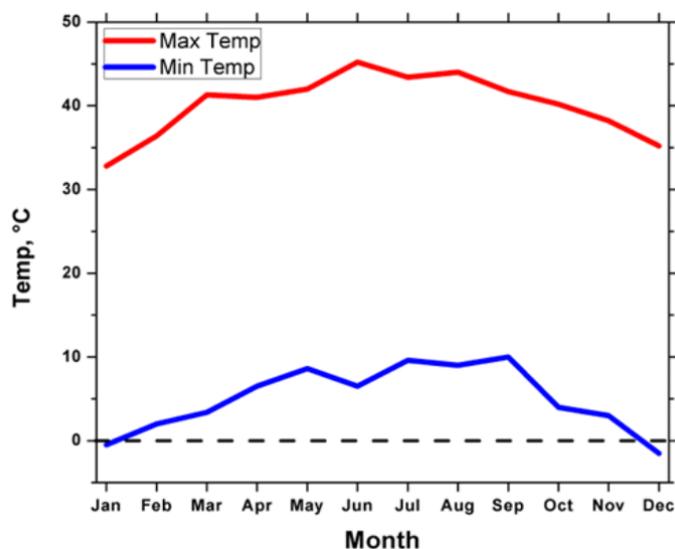


Fig. 4. Monthly maximum (red curve) and minimum (blue curve) temperatures (°C) over Yemen based on station data from the Civil Aviation and Meteorological Authority (CAMA) for the period January – December 2021. The horizontal black dotted curve indicates 0°C.

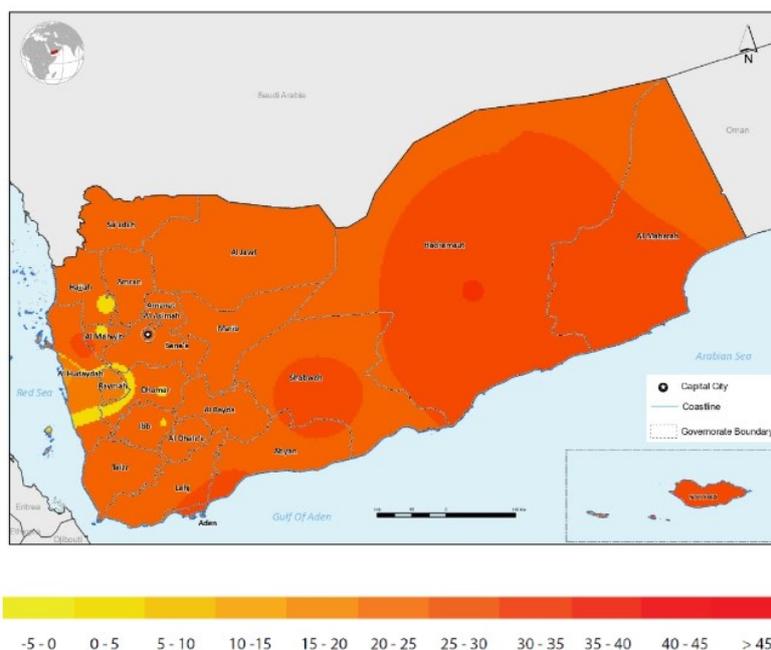


Fig. 5. Spatial distribution of maximum temperature (°C) over Yemen for the period January – December 2021 based on ground data from the Civil Aviation and Meteorological Authority (CAMA).

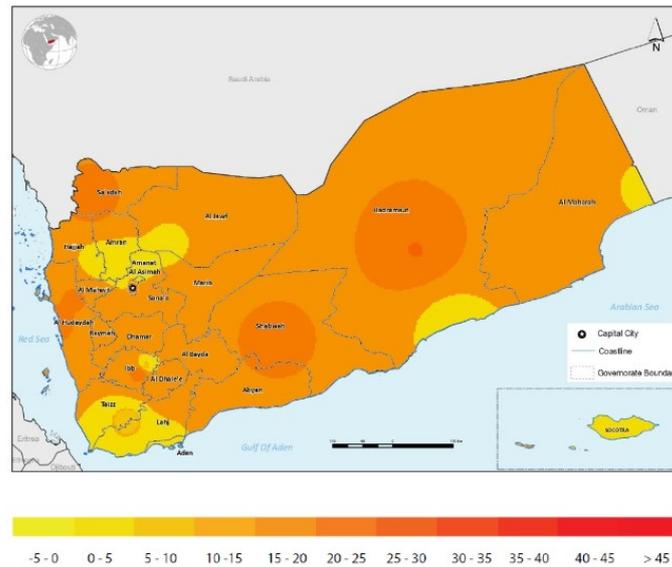


Fig. 6 Spatial distribution of minimum temperature (°C) over Yemen for the period January – December 2021 based on ground data from the Civil Aviation and Meteorological Authority (CAMA).

3. Governorate-level Projections of Hazards and Vulnerabilities across Yemen, Nov – Dec 2022

Temperatures: October marks the transition period from hot to cooler temperatures across much of Yemen. From November to December 2022, there is a high likelihood of normal to slightly below normal temperatures across much of the country. The cool temperatures are likely to encourage the formation of frost, especially from mid-December onwards in Amran, Dhamar, Al Bayda, Al Dhale'e, Al Jawf, Al Maharah, Al Mahwit, Amanat Al Asimah, and other highland governorates. The expected wave of frost in the highlands will threaten the growth of crops. Decision-making should account for the possibility of more diseases, predominantly on vegetables and fruits. Some of these diseases may include fungal infections, late blight, and Tuta-Absoluta which usually attack tomatoes. An increase of powdery mildew affecting pumpkins should also be expected. If untreated, these diseases spread quickly across fields and can cause absolute crop failure. An increase in insect infestations, whiteflies, and mould (Fusarium) is also to be expected particularly on onion and garlic crops in the Central and Northern Highlands as well as mountainous areas. The cold weather may also affect human health, particularly children who are more susceptible to influenza and cold shocks.

Rainfall: No major shifts from the usual rainfall seasonality are expected across the country. It should however be noted that October/November to early December is usually characterised by an increase in tropical cyclonic activities which tend to bring devastating winds, storm surges, and heavy rainfall to Yemen. The wetter conditions will likely encourage the spread of Desert Locusts across the country. Detailed governorate-level projections are given in Table 1; decision-making processes should account for these projections for early warning purposes.

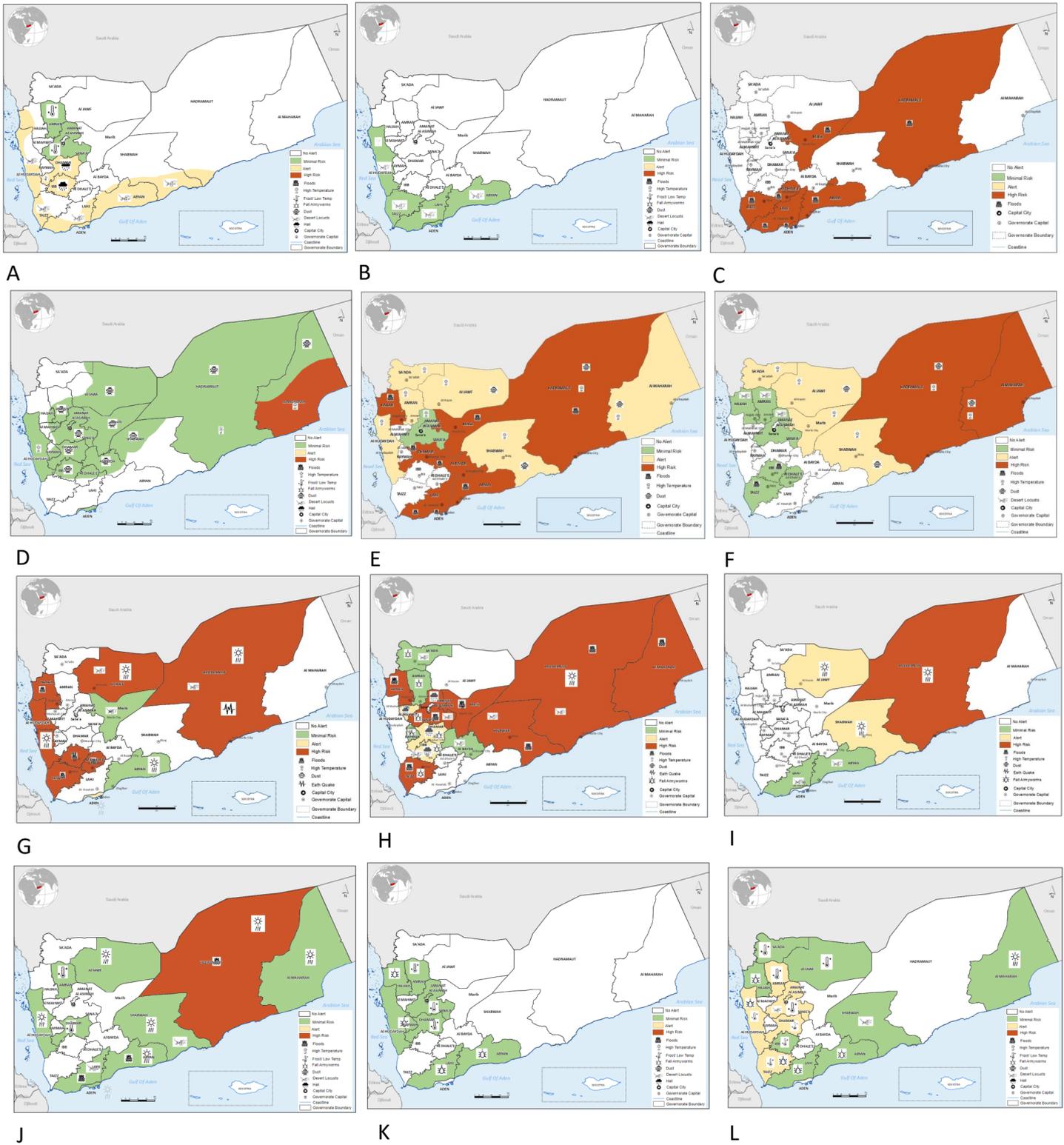


Fig. 7. Agrometeorological hazards in Yemen, January – December 2021 (i.e., A – L).

Table 1: Governorate-level occurrence (Jan – Oct 2022) and projections (Nov- Dec 2022) of Hazards and Vulnerabilities across Yemen.

Governorate	Hazard occurrences										Hazard projections	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Abyan	Frost		Drought				More floods than usual in frequency and intensity	Human, animal, & plant diseases	Desert Locusts	Likely increase in the spread of human, animal, & plant diseases		
			Gusty winds & dusty storms	Extremely high temperature than usual								
	Fodder scarcity					Fodder scarcity			More floods than usual in frequency and intensity	Floods are likely to be usual in frequency and intensity		
	Human, animal, & plant diseases								African armyworms			
	Whitefly infestations		Water stress									
Aden	Human, animal, & plant diseases							Human, animal, & plant diseases			Likely increase in the spread of human, animal, & plant diseases	
	Fodder scarcity		Extremely high temperature than usual									
			Gusty winds & dusty storms			Fodder scarcity						
			Water stress									
Al Bayda	Water stress	Gusty winds & dusty storms						Human, animal, & plant diseases	Floods		High likelihood of frost occurrence	
	Frost	Drought				Fodder scarcity						
	Fodder scarcity		Water stress		Human, animal, & plant diseases					Desert Locusts		High likelihood of fodder scarcity
Al Dhale'e	Frost			Water stress				Human, animal, & plant diseases	More floods than usual in frequency and intensity		High likelihood of frost occurrence	
	Drought									African armyworms	High likelihood of fodder scarcity	

Table 1: Governorate-level occurrence (Jan – Oct 2022) and projections (Nov- Dec 2022) of Hazards and Vulnerabilities across Yemen.

Governorate	Hazard occurrences										Hazard projections	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Al Hudaydah	Gusty winds & dusty storms							More floods than usual in frequency and intensity	African armyworms	High likelihood of Desert Locusts, Screwworms, & Tuta absoluta		
	Whitefly infestations		Human, animal, & plant diseases		Drought			Human, animal, & plant diseases				
	Tuta absoluta infestations		Extremely high temperature than usual					Floods				
Al Jawf	Water stress		Drought			Fodder scarcity		More floods than usual in frequency and intensity	High likelihood of Desert Locusts	High likelihood of frost occurrence		
	Gusty winds & dusty storms							Human, animal, & plant diseases	Pest infestations	High likelihood of fodder scarcity		
	Fodder scarcity			Gusty winds & dusty storms	Human, animal, & plant diseases			Human, animal, & plant diseases				
			Water stress		Extremely high temperature than usual							
Al Maharah	Gusty winds & dusty storms					Fodder scarcity	More floods than usual in frequency and intensity	Human, animal, & plant diseases	Floods are likely to be usual in frequency and intensity			
			Extremely high temperature than usual									
			Water stress									
	Drought											
Al Mahwit	Water stress	Gusty winds & dusty storms		Floods	Drought	Fodder scarcity	More floods than usual in frequency and intensity	Desert Locusts	High likelihood of frost occurrence			
			Water stress									

Table 1: Governorate-level occurrence (Jan – Oct 2022) and projections (Nov- Dec 2022) of Hazards and Vulnerabilities across Yemen.

Governorate	Hazard occurrences										Hazard projections	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
	Drought											
	Fodder scarcity	Human, animal, & plant diseases						Human, animal, & plant diseases				
	Frost											
Amanat Al Asimah	Water stress		Drought		Drought		More floods than usual in frequency and intensity	Floods		High likelihood of frost occurrence		
	Drought		Gusty winds & dusty storms									
	Frost		Water stress	Floods	Human, animal, & plant diseases			Desert Locusts	High likelihood of fodder scarcity			
Amran	Water stress	Drought					More floods than usual in frequency and intensity	Floods	High likelihood of frost occurrence			
		Gusty winds & dusty storms			Human, animal, & plant diseases			African armyworms				
	Fodder scarcity	Human, animal, & plant diseases	Water stress				Human, animal, & plant diseases	Desert Locusts	High likelihood of fodder scarcity			
Dhamar	Water stress	Gusty winds & dusty storms		Floods	Drought	Fodder scarcity	More floods than usual in frequency and intensity	Floods	High likelihood of frost occurrence			
	Frost	Human, animal, & plant diseases	Drought					African armyworms				
	fodder scarcity		Water stress		Human, animal, & plant diseases		Human, animal, & plant diseases	Desert Locusts	High likelihood of fodder scarcity			
Hadramaut Inlands & Coastal	Drought		Drought				More floods than usual in frequency and intensity	Extremely high temperature than usual				
		Gusty winds & dusty storms	Extremely high temperature than usual					More floods than usual in frequency and intensity				
	Whitefly infestations	Human, animal, & plant diseases		Water stress			Human, animal, & plant diseases	Pest infestations				
			Gusty winds & dusty storms					Human, animal, & plant diseases				

Table 1: Governorate-level occurrence (Jan – Oct 2022) and projections (Nov- Dec 2022) of Hazards and Vulnerabilities across Yemen.

Governorate	Hazard occurrences										Hazard projections		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
Hajjah	Water stress		Drought	Floods	Drought		Human, animal, & plant diseases		High likelihood of Desert Locusts		High likelihood of frost occurrence		
		Gusty winds & dusty storms											
	Fodder scarcity	Human, animal, & plant diseases	Water stress		Human, animal, & plant diseases	Fodder scarcity					High likelihood of frost occurrence		
Ibb	Frost		Drought	Floods	Drought		Human, animal, & plant diseases		High likelihood of Desert Locusts		High likelihood of frost occurrence		
			Water stress										
			Gusty winds & dusty storms										
							More floods than usual in frequency and intensity	African armyworms			High likelihood of fodder scarcity		
Lahj	Desert Locusts	Human, animal, & plant diseases	Drought							Floods		Fall armyworms	
	Whitefly infestations		Water stress							High likelihood of Desert Locusts			
			Gusty winds & dusty storms							Human, animal, & plant diseases			
Marib	Human, animal, & plant diseases		Drought	Floods	Drought				More floods than usual in frequency and intensity		High likelihood of frost occurrence		
	Gusty winds & dusty storms												High likelihood of fodder scarcity
	Drought		Water stress										
Raymah	Water stress	Gusty winds & dusty storms		Floods	Drought	Fodder scarcity			Human, animal, & plant diseases	High likelihood	High likelihood of frost occurrence		
	fodder scarcity	Human, animal, & plant diseases	Water stress		Human, animal, & plant diseases							High likelihood of fodder scarcity	

Table 1: Governorate-level occurrence (Jan – Oct 2022) and projections (Nov- Dec 2022) of Hazards and Vulnerabilities across Yemen.

Governorate	Hazard occurrences										Hazard projections	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
	Drought Frost		Drought						Desert Locusts Floods	of Desert Locusts		Likely increase in the spread of human, animal, & plant diseases
Sa'ada	Water stress	Gusty winds & dusty storms			Human, animal, & plant diseases				Floods		High likelihood of frost occurrence	
	Human, animal, & plant diseases		Drought						African Armyworms			
	Frost		Water stress		Extremely high temperature than usual				Desert Locusts		High likelihood of fodder scarcity	
Sana'a	Water stress	Gusty winds & dusty storms		Floods	Drought		More floods than usual in frequency and intensity	Desert Locusts		High likelihood of frost occurrence		
	Frost	Human, animal, & plant diseases	Water stress		Human, animal, & plant diseases		Human, animal, & plant diseases	Floods		High likelihood of fodder scarcity		
Shabwah	Drought						Human, animal, & plant diseases		Floods		High likelihood of frost occurrence	
	Whitefly infestations	Human, animal, & plant diseases			Extremely high temperature than usual							
	Frost		Water stress		Human, animal, & plant diseases		Landslides				High likelihood of fodder scarcity	
		Gusty winds & dusty storms			Human, animal, & plant diseases		Floods		Desert Locusts			
Socotra		Drought									Floods are likely to be usual in frequency and intensity	
			Water stress								Pest infestations	

Table 1: Governorate-level occurrence (Jan – Oct 2022) and projections (Nov- Dec 2022) of Hazards and Vulnerabilities across Yemen.

Governorate	Hazard occurrences										Hazard projections	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Taizz	Desert Locusts		Water stress				Human, animal, & plant diseases		Desert Locusts			High likelihood of frost occurrence
			Gusty winds & dusty storms						African armyworms			
	Drought								Floods			High likelihood of fodder scarcity

Notes for Table 1:

- Projections contained in Table 1 were developed in four stages: first, primary data sources were consulted; these included documentation from the Civil Aviation and Meteorology Authority (CAMA) and the Ministry of Agriculture and Irrigation (MAI). The two agencies were considered primary data sources because they are the official repositories of agrometeorological data. Second, more information from secondary data sources was gathered and this included desk reviews of any published manuscript and reports by reputable journals/organizations. Third, more data was added through a two-day in-depth focus group discussion with FAO field data collectors. Lastly, the 12-member Probabilistic Multi-model Ensemble forecasts were used to infer projected rainfall and temperature effects on other variables.
- Colour codes represent hazards that are considered to be similar
- The most common human, animal, & plant diseases are malaria, respiratory diseases, mastitis, and dengue
- The most common pest infestations include Red Palm Weevil, Dubas, and Red crust insects
- Multi-hazards related to the severe monsoon season include but are not limited to fodder scarcity, difficulties with sea accessibility especially for farmers and importers, reduced food availability, and general price increases
- Frost occurs in highland districts only