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Predicting Locust Invasions in Eastern India: Strategies and Awareness for Long-Term Control

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Wind direction, a key factor in forecasting locust migration, indicates a potential desert locust invasion in eastern Indian states. Current control measures are in place, but we recommend additional vigilance regarding locust eggs. The rainfall from Super Cyclones like Amphan creates favourable breeding conditions for locusts. Additionally, these locusts may damage the Indian states again through reverse migration. To minimize damage, a long-term control policy extending until the Kharif season (June to October) is essential. Increasing farmer awareness and engaging local ecology groups can significantly enhance desert locust reporting and control efforts. By implementing a robust, multi-faceted strategy that includes long-term control policies, farmer education, and community engagement, we can mitigate the impact of desert locust invasions and protect the agricultural productivity and livelihoods of the affected regions.

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Keywords: Desert locust; locust migration; breeding conditions; Eastern Indian States.

1. INTRODUCTION

An extra degree of concern in the post-corona situation has been raised by the eastward movement of the Desert Locust (*Schistocerca gregaria* [1]) swarm in the Indian states of Rajasthan, Uttar Pradesh and Madhya Pradesh [2] (Fig. 1). According to FAO Locust Watch, the strong western wind linked to storm Amphan, which began in the Bay of Bengal, is the factor that is driving the movement [3]. All of the central and northern Indian states having excessive rainfall (20–59%) may also foster the ideal growing conditions for the locust swarm (Fig. 1). The first recorded sighting of the swarm occurred during the second week of April near Jaisalmer, Rajasthan (the Indo-Pak border area) [4]. The swarms have plagued six Indian states since then (May 31, 2020): Rajasthan, Gujarat, Uttar Pradesh, Madhya Pradesh, Maharashtra and Tamil Nadu.

Previous studies on behaviour of desert locust have suggested wind, temperature and vegetation have a definite role in its migration [5]. Once the migration reached a region with 20–35°C temperatures and recent widespread severe rains, it stopped. The female deposits egg-pods holding hundreds of eggs after probing the soil and determining that there is sufficient soil moisture(0.1 to 0.2 m3/m3) [6,7]. The swarm continues to migrate after depositing, laying eggs

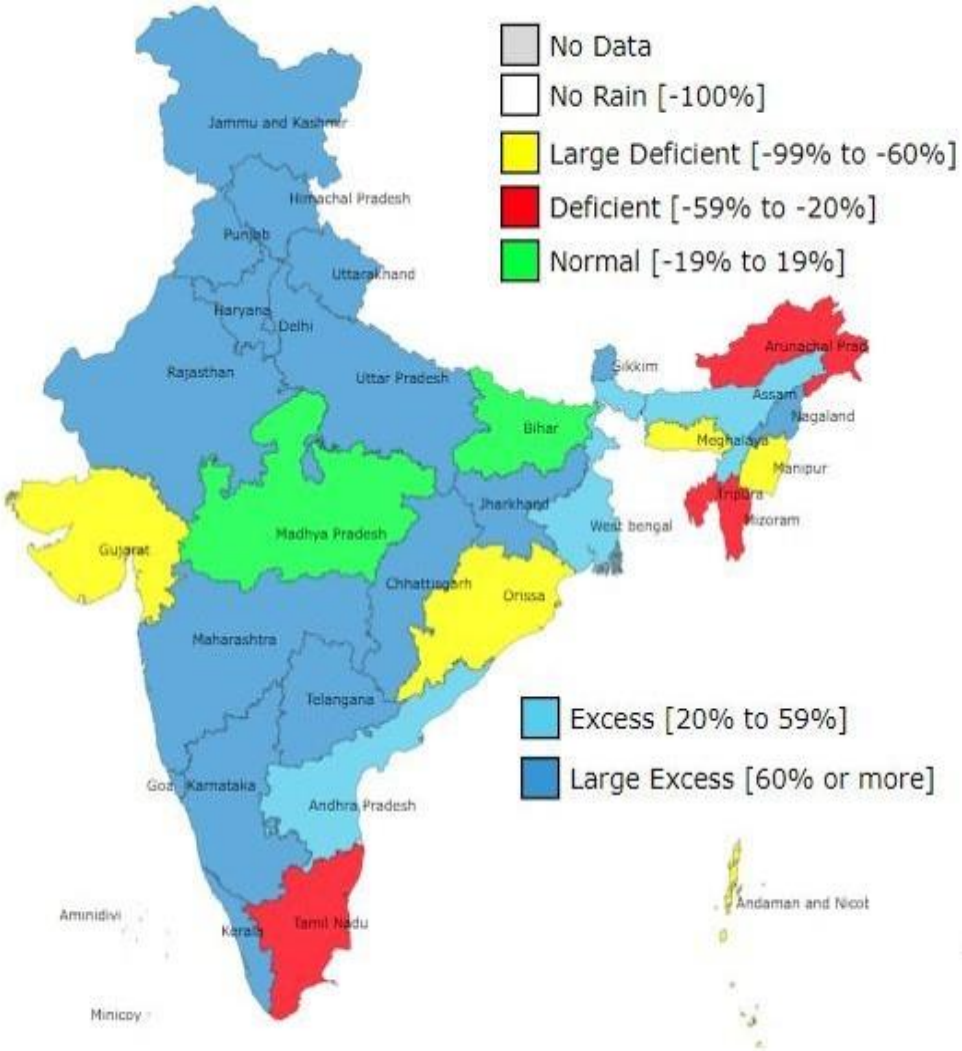

Fig. 1. Cumulative rainfall over the state from March to May; image sourced from Mausam-IMD (June 1, 2020)

in waves two and three hundreds of kilometers apart from the original location. The eggs may go through phases of dormancy and remain for three months, depending on the temperature and moisture content of the soil [8]. The higher temperature (>20°C) and moisture content (>0.1 m^3/m^3) lowered the incubation period. Laboratory studies revealed that in order for the eggs of the desert locust to fully mature, they need to take in around their own weight in water [9-11]. In natural conditions, eggs usually take up enough water from the earth in a few days after they are placed. It only takes around 20 millimeters of rain in a little amount of time, or its equivalent in runoff, to provide the eggs the moisture they need to properly mature. But according to research conducted in laboratories, if the eggs do not take up enough water in the first few days after laying, they can go into a latent condition and not begin to grow again for up to three years [8]. The present study aims to understand the environmental factors such as wind pattern, temperature and soil moisture that influences the migration pattern of desert locusts.

2. METHODOLOGY

The work done during the months of May and June, 2020. The present study involves the simulation of the HYSPLIT [12] air parcel trajectory model over four places in central India, namely Jhansi, Mahoba, Mandsaur and Indore. These areas were the sites of the locust swarm invasion that was reported during the final two weeks of May, 2020. Using the GFS (Global Forecast System) model data generated by the National Centre for Environmental Prediction, we have run the trajectory model at 100m amsl.

3. RESULTS

The outcome shows that from all four known desert locust invasion locations, the wind is blowing toward the eastern Indian states (Fig. 2). An alarm for all eastern Indian states is necessary because to the wide range of the alleged invasion region, which stretches from the Canary Islands in West Africa to Assam in India [5].

During the post-Amphan era, data on soil type and surface soil moisture were collected via the National Information System for Climate and Environment Studies (NICES). In addition, the NCEP/NCAR reanalysis included 2-meter temperature data for the fourth week of May (Fig. 3). These data sets are crucial for assessing the potential breeding conditions for locusts in the region.

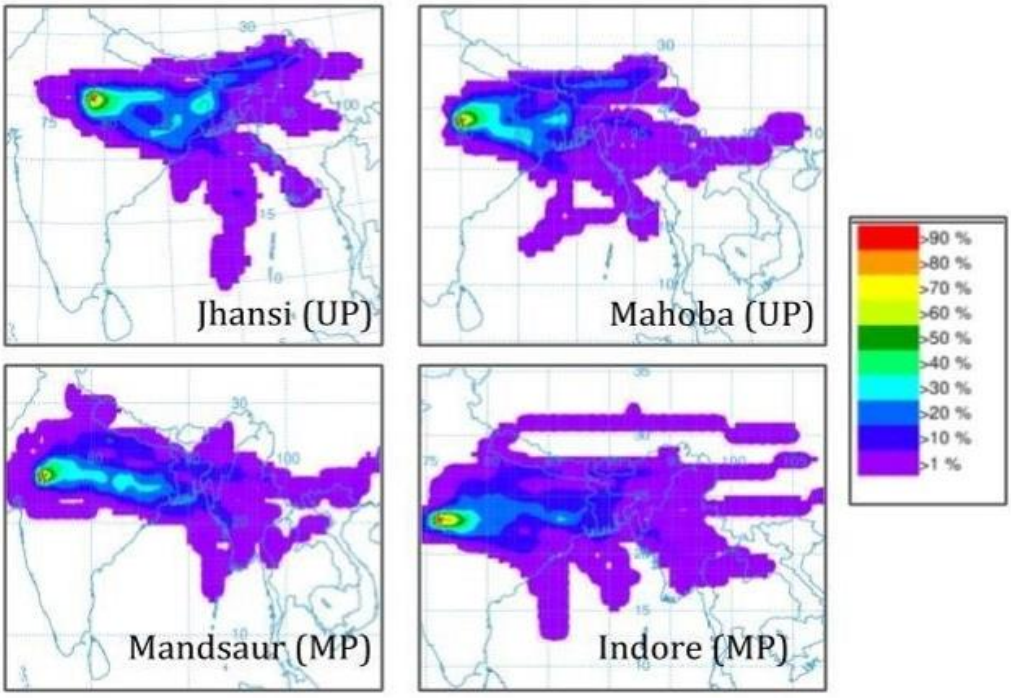

Fig. 2. Forward forecasting trajectory till June 12, 2020 the area invaded by locusts in May, 2020. The percentage difference between the total number of trajectories and the colour bar is displayed

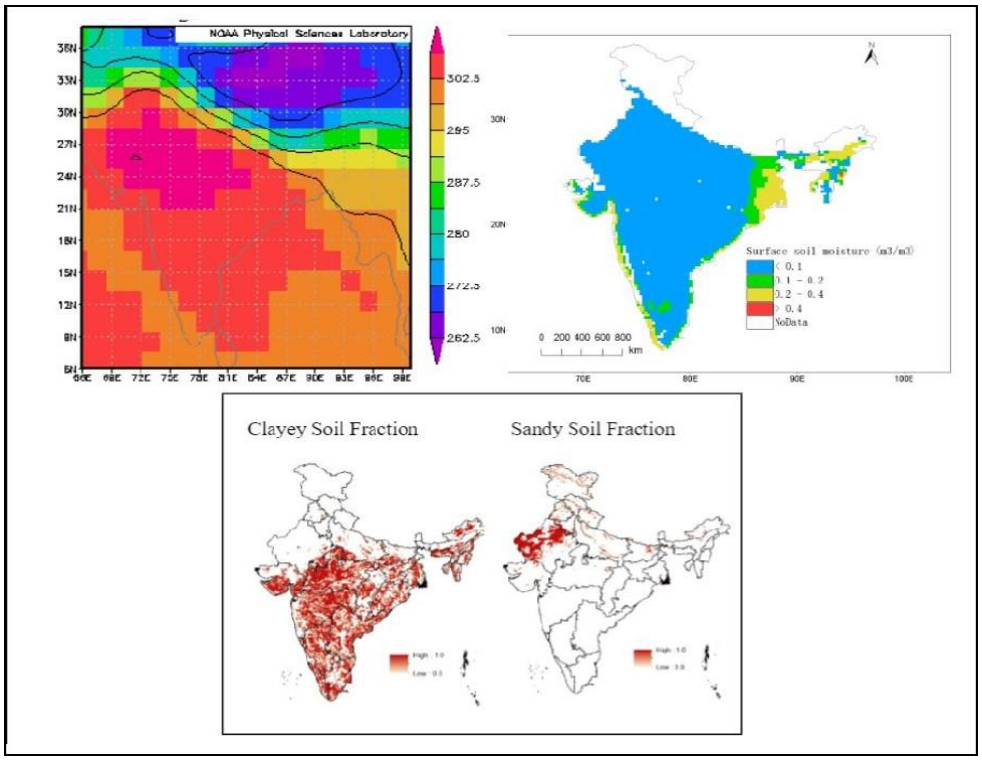

Fig. 3. Temperature (in K), soil moisture and soil types in May fourth week over India

The locust swarms that are currently sweeping throughout India are young. If certain conditions are satisfied, these locusts could begin to reproduce. For desert locusts, bare earth, sufficient precipitation, sandy or clayey soil and lush flora are the perfect breeding grounds. Based on available data, there is a possibility that desert locusts will emerge in dispersed sites throughout the central and eastern regions of the country under favourable conditions for mating and egg deposition.

The presence of these conditions is concerning because it suggests that the locusts could find suitable environments to breed and multiply. Sandy or clayey soils, which are prevalent in many parts of central and eastern India, combined with adequate moisture from recent rains, create an ideal setting for locust reproduction. Bare areas and green vegetation provide the necessary resources for the locusts to thrive and reproduce rapidly.

Given these findings, it is imperative to implement vigilant monitoring and control measures across these regions. Early detection of locust breeding sites and timely intervention can help mitigate the potential impact of a locust outbreak. Collaboration between local farmers, ecologists, and government agencies will be vital in managing this threat. By sharing information and resources, these groups can ensure a coordinated and effective response to prevent significant agricultural damage and economic losses. Long-term strategies, including community engagement and continuous monitoring, will be essential to managing the locust threat sustainably.

4. DISCUSSION AND CONCLUSION

The northern Indian states are home to the field and circle offices of the Locust Warning Organization (LWO) of India. But since there is now a chance that locusts will invade other states, it is crucial that agricultural field workers at the state level in other states receive instruction on how to recognize locusts and their swarming behavioral stages. The simplest approach in this case could be to provide field workers with training sessions. Amateur ecologists, wildlife photographers, and bird watchers may all form invaluable groups if they report any desert locust activity in their particular areas.

The latent stage of locust eggs is rather high, as reported [8]. Due to the reverse movement of

these locusts during monsoonal wind reversal in the impacted states, there is a strong probability of a second and third wave of invasion. Thus, it is necessary to maintain the locust monitoring and control measures till the conclusion of the Kharif season. Furthermore, it is possible for them to mate and deposit eggs along their migration route, thus it is also very advised to conduct regular, long-term observation in the locust invasion region.

Given the likelihood of a desert locust invasion, farmers in impacted and at-risk areas may be compelled to begin monsoonal farming at full capacity out of fear. To regain the farmers' trust, the relevant departments need to educate them about locusts and the methods used to manage them. The current invasion may be traced back to the acceleration of expanded migration brought on by climate change. Given the rising frequency of extreme weather events and other meteorological phenomena, farmers in the impacted area may soon be able to purchase a locust infection insurance policy.

Desert locust movement is not entirely dependent on wind direction [13]. Despite the fact that the air-parcel model has been employed in several studies [14-16] to predict locust migration, the very complicated phenomena depends on a number of variables. Limiting the locust population in the upwind area also considerably lessens the impact of downwind migration. As such, it is hard to predict with precision when the migratory swarm will move next. The Locust Warning Organization (LWO) has successfully contained the enormous swarms of locusts by deploying all of its personnel and state-of-the-art regulating devices in the field. The current policy paper concentrated on the if/else scenario, which might be useful in the near future for creating real-time contingency plans.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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