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Spatial distribution of outbreak of locust swarms: a geographical analysis of vulnerability and preventions in India

Distribución espacial del bruto de enjambres de langostas: un análisis geográfico de vulnerabilidad y prevenciones en la India

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ABSTRACT

Current outbreak of locust swarms in the different parts of the world has also emerged as a big problem for the Indian agricultural sector and associated livelihood options. Being known for their transient nature, locust swarms contain millions of locusts. These swarms are; therefore, pose danger to the world because of their disastrous impact on food crops, fodder and food security around the world. The outbreak has been historically noticed in several regions of the world where it has affected the agriculture system of the many countries and has caused a major cause of the slowdown of the economy. This paper examines the origin and migration trends of locust swarms in the world in general and India in particular. Also, the paper evaluates the recent outbreak of locusts in India by assessing its devastating impact on the Indian Agricultural Sector and the track routes of the swarms in India in different months. The paper highlights preventive measures that have been used in monitoring and control of locust swarms. The outbreaks of locust in India is not new, but has been encountered in the past. The intensity and migratory frequency is increasing with time. The area, magnitude and impacts of the locust swarms is also growing with time and space. Since the outbreak results in social, economic and

environmental consequences, therefore, adequate measures and planning are required to tackle the crisis.

Keywords: Locusts, Swarms, Vulnerability, Prevention Measures, Spatial distribution

RESUMEN

El brote actual de enjambres de langostas en las diferentes partes del mundo también se ha convertido en un gran problema para el sector agrícola indio y las opciones de sustento asociadas. Siendo conocido por su naturaleza transitoria, la langosta enjambres que contienen millones de langostas. Estos enjambres son, por lo tanto, una de las plagas más peligrosas del mundo que pueden tener un impacto desastroso en los alimentos, los cultivos alimentarios, el forraje y la seguridad alimentaria en todo el mundo. El brote se ha observado históricamente en varias regiones del mundo que afectaron el sistema agrícola de muchos países y la principal causa de la desaceleración de la economía. Este documento examina las tendencias de origen y migración de los enjambres de langostas en el mundo en general y en la India en particular. También el papel evalúa el reciente brote de langostas en la India junto con la evaluación de su impacto devastador en el sector agrícola indio y las rutas de seguimiento de los enjambres en la India en diferentes meses. Al final, el documento destaca las medidas preventivas que se han utilizado en el monitoreo y prevención de enjambres de langostas. Los brotes de langosta en la India no son nuevos, pero también se han encontrado en el pasado. La intensidad y el número de colmenas y la frecuencia migratoria aumentan con el tiempo. El área, la magnitud y los impactos de los enjambres de langostas también está creciendo con el tiempo y el espacio. Dado que el brote tiene consecuencias sociales, económicas y ambientales, por lo tanto, se requieren medidas y planificación adecuadas para hacer frente a la crisis.

Palabras clave: Langostas, Enjambres, Vulnerabilidad, Medidas de Prevención, Distribución espacial.

INTRODUCTION

It is a well-known fact that the growth of population is potentially exponential (geometric:1, 2, 4, 8…) while the supply of food production and other resources is linear (arithmetic: 1, 2, 3, 4...) (Malthus 1798). The economic prosperity and food security of various regions of the world are being affected by several factors. The locusts' outbreak has further aggravated the problem. The population of the world is estimated to increase to 9.7 billion in the year 2050 (UN 2017). Food production needs to be improved in order to feed the ever-increasing global population. Therefore, the level of pressure on land may increase, and the protection of crops against any threat, either natural or anthropogenic, has become a major

challenge. The relationship between people and locusts is historically old and presently has become a serious challenge to food security all over the world. The locust outbreaks are another most damaging factor to agricultural production after flood and drought (Pandey 2002). In West African country like Senegal, the problem of locusts is second only to the drought (D'Alessandro et al. 2015). The outstanding capability of locust swarms to scurry over long distances and unexpectedly descend on communities has been considered as a mystery. Therefore, swarms of locusts have been viewed as a curse or divine punishment, which the Bible and the Quran describe as one of the most devastating plagues of Egypt. (El-Mallakh and El-Mallakh 1994). Locusts originate primarily in desert regions that are devoid of any human population, such as across North Africa, Middle East and South-West Asia (Maghreb/MENA). The invasion zone of this specie is largest as compared to any other locusts' species that are most commonly seen in agricultural areas (Popov et al. 1991). Locusts have adapted to arid habitats and drought conditions, and they can resorb water and moisture from vegetation under dry and hot environment and feed exclusively at night vicariously (Abushama 1970; COPR 1982).

Locust swarms feed on a variety of crops and vegetation, ranging broadly from vegetables, cereal crops, groundnuts, coffee, fruits such as banana, citrus fruits, and many other form of foliage (COPR 1982). This specie is known as the most dangerous pest for agriculture (Steedman 1990). Locusts are capable of eating food that is equal to their weight. A locust can weigh up to 2 grams (FAO 2020). A small swarm may have as much as 80 million locusts, and it may consume food equivalent to what can feed about 35,000 people in a single day. Large warms have a devastating impact and can eat green vegetation weighing around 2 million metric tons (WB 2020). The situation of famine and starvation can prevail if agricultural damage occurs on a large scale (National Geographic 2020). Developing countries face famine and starvation frequently due to locusts. Locusts can cause crop damage and crop failure at a macro level, and worsen the severity of the problem of food crisis among the developing countries. Considering the threat, it becomes the need of the hour to adopt preventive measures that enhance the security of crops. The impact of locust outbreaks on agriculture may be short term, but it causes a very long term effect on the livelihood of the people (De Vreyer et al. 2014). No locust plagues have occurred since 2005, but several localised outbreaks have happened and led to the formation of the swarm (FAO 2019). The numbers and distribution of locusts are affected by human activities directly or indirectly, and land use and land cover changes have a significant impact on locust breeding (Serville 1838). The management of locust upsurges is possible through provision of adequate infrastructure. The infrastructure for early detection and early treatment of the threat becomes crucial, and the need for international cooperation cannot be denied (Lockwood et al. 2001; Toleubayev et al. 2007)

The objectives of the present study where, first, to identify the spatial distribution of swarm of the locust; and second to analyse the vulnerability of India to locust swarms and develop strategies that reduce that vulnerability.

MATERIAL AND METHODS

The present paper is based on primary field observation method (FOM). The field observation was done in the Jaisalmer District, in Rajasthan. The invasion of locust swarms in Jaisalmer was reported in December 2019. Pre-structured questionnaires were used in informal interviews in Jaisalmer at the household level. Stratified Random Sampling (SRS) was used in the selection of the households that were surveyed. Telephonic conversations were also conducted to determine the impact and challenges of locust outbreak in Jaisalmer. Personalised case studies were also done during the fieldwork. Apart from observational analysis, several secondary data sources were used to trace the movement of locust swarms in several areas in India and the other parts of the world.

For better analysis, historical prognostication of locust in the world has been done to show the spatial and temporal movements of the locust outbreak. Based on secondary data and literature reviews, a specific map has been prepared for the Middle East and North Africa (MENA) and Maghreb/ Middle East Countries. Descriptive analysis has been attempted based on literature reviews, news updates and reviews of the articles available. Geographic Information Systems (GIS) was used for preparing the maps. India has experienced a major locust outbreak after 26 years. Thus, it becomes essential to trace the destinations of swarms. This paper examines the spatial movement of locust swarms in the year 2020. The article further describes the vulnerability, challenges and impacts posed in the agriculture sector of India. Seven Indian states have been recently impacted by locust outbreak, such as Rajasthan, Gujarat, Madhya Pradesh, Punjab, Haryana, Maharashtra and Uttar Pradesh. Other states have been categorised in different groups according to vulnerability and potential threats.

RESULTS AND DISCUSSIONS

An outbreak of locust swarm: The situation in India: Locusts are insects that resemble grasshoppers. They usually having single lifestyle, but live in certain favourable environmental conditions such as dry weather force locusts to come together in an area of patchy growth with remaining vegetation left in any region. Under intermittently suitable conditions this sudden crowding releases serotonin in their central nervous systems, and start breeding. Serotonin triggers several dramatic changes and makes locusts more sociable, promotes rapid movements

and enhances appetite. When their population becomes dense enough, they become migratory (National Geographic 2020). Table 1 gives a general description of the locusts.

Table 1: Key Elements about Locust Swarms.

Common Name	Locusts
Size	0.5 to 3 inches
Diet	Herbivore
Weight	0.07 ounces
Look Like	Short-horned Grasshoppers
Average life span	3-5 Months

Source: Compiled by Authors, 2020, Based on FAO, 2019.

Locusts are not a threat unless they are in a group. Once they form a group, they have a devastating impact on vegetated areas. The general life cycle of a locust can be understood with the help of figure 1.

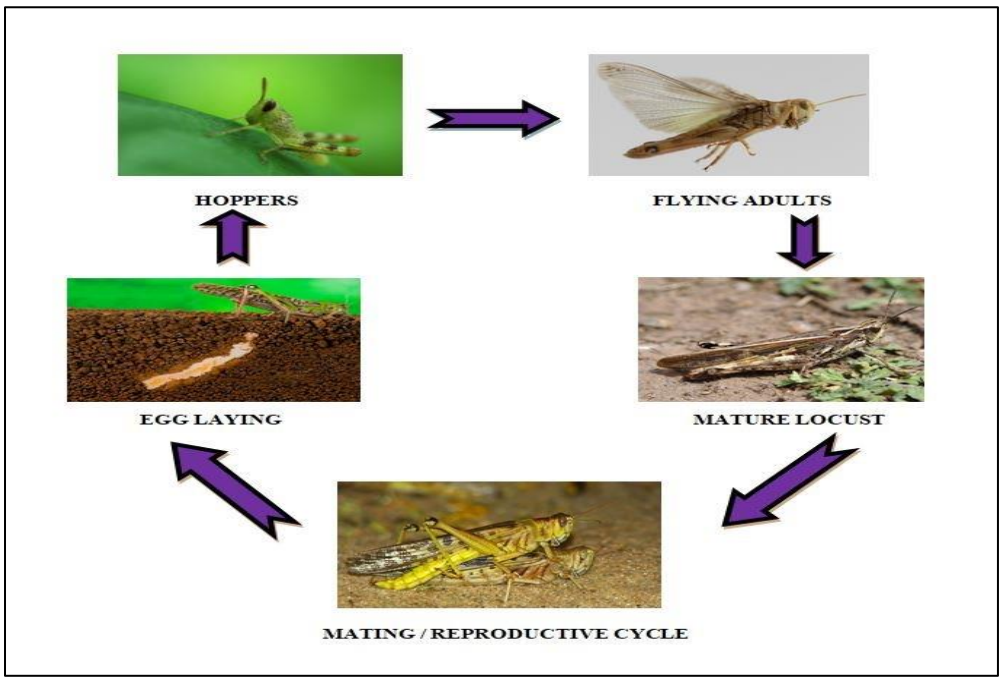

Figure 1: The Life Cycle of the Earth. Source: Compiled by Authors- 2020, Based on FAO-2019.

Origin of locust swarms: The origin of locusts is in African deserts and therefore they are primarily known as desert locusts. Desert locusts are a very notorious species of insects. After hatching, they become migratory and spread to other regions of the world and keep breeding at the same time. From Africa, they migrate along the direction of the prevailing wind and scanty rainfall, cross around 60 nations, covering the Middle East, Pakistan and finally reach India and spread to most parts of India. Several outbreaks occurred have in the past and spread to other regions (figure. 2).

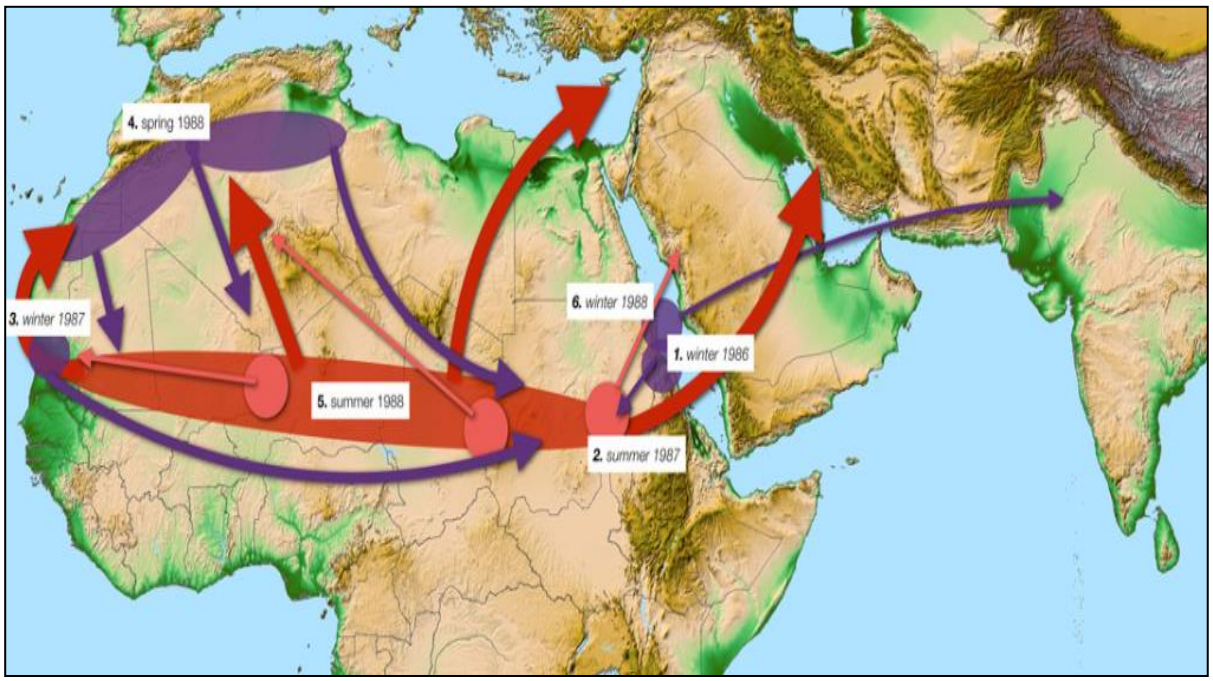

Figure 2: Historical Prognostication of Locust Outbreak. Source: Compiled by Authors-2020

The recent locust outbreak wave has its origins in the Arabian Peninsula (figure 3). The role of the tropical cyclone is seen as the main reason for the emergence of breeding centres. The cyclones bring heavy storms and rain, thus creating favourable conditions for locust breeding. Further intensification of the humid and moist environment helps locusts to reproduce rapidly. Two major cyclones in the Arabian Peninsula (Mekunu and Luban) brought heavy rainfall and helped locusts to breed rapidly. Enough rain created ephemeral lakes in the desert which was the favourable condition to breed. Similar cyclones or storms keep condition that favour locusts, as demonstrated in Pawan in the Indian Ocean in December 2019 proved to provide another breeding centre, and locust breeding was continued. By February 2020, locust swarms threatened many regions of the world.

This has happened at the time when India is battling with coronavirus (COVID-19) pandemic and threats are rising at the same time huge swarms threatening standing crops and the desert locust creating a new challenge for India. Swarms of the desert locust were

spotted in December 2019, and now they have spread across seven Indian states, namely, Rajasthan, Gujarat, Madhya Pradesh, Punjab, Haryana, Maharashtra, and Uttar Pradesh**.**

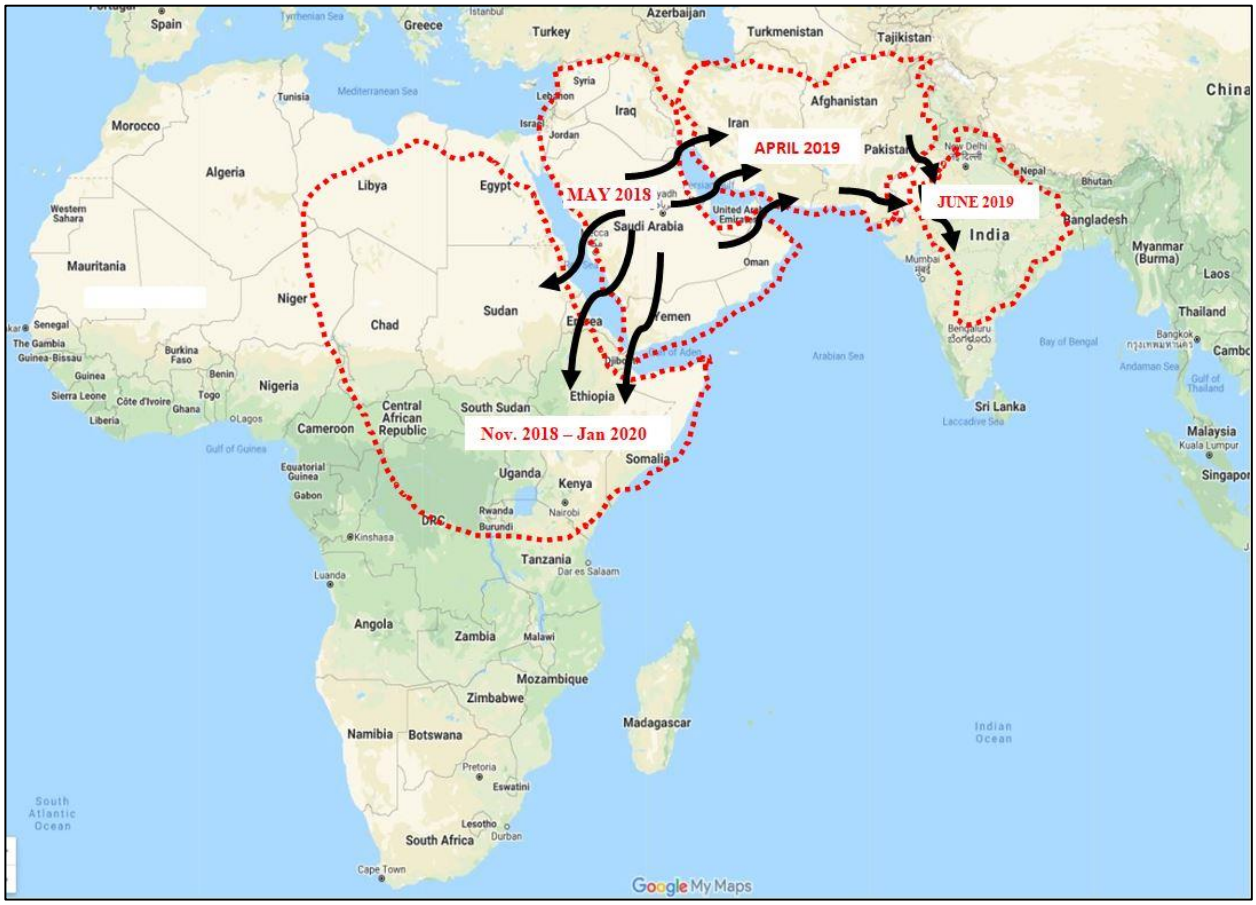

Figure 3: Temporal and Spatial Pattern Analysis of Locust Swarms Outbreaks and affected areas.

Source: Compiled by Authors, 2020 with the help of Google maps.

There is no shred of evidence that locusts attack humans or spread any disease. They do not carry any harmful pathogens that harm people or animals. Large swarms can completely eat the food and fodder grown for people and livestock. Feeding voraciously on agricultural produce can easily be devastated by the attack from locust. The communities that depend on crops for survival can face hunger and starvation if not swarms are not checked on time. The desert locust is the species which has the most economic impact in the world. Earlier humans were helpless to attacks of crop lands by locust swarms. Currently, there is no proper prevention method of controlling locusts, except regular checks on weather patterns and record of locust swarm movements, which can help experts to take mitigation measures.

Recently swarms were spotted in April 2019 along the superimposed boundary of India-Pakistan. After invading across the border, these swarms caused massive damage to Rabi crops in western Rajasthan (figure 4).

Figure 4: Locust. Source: Primary Survey, 2019.

The locusts enter into India from the northwest direction, and migrate into Rajasthan first, after that causing mass destruction and spread to the western and central states of India. Around 20 districts of Rajasthan were severely affected by locusts which caused damages to 90 thousand hectares of agricultural land (PTI 2020). Jaisalmer, Barmer, Jalore, Jodhpur, Bikaner, Ganganagar, Hanumangarh, Sirohi, Churu, Vilbhara, Nagur, Chittorgarh, Pratapgarh, and Jaipur were the most severely affected districts. Recently, a swarm was spotted in many districts of Gujarat, like Banaskantha, Mehsana, Kutch, Patan, and Sabarkantha, where they destroyed several crops, such as mustard, castor, cotton, fennel, and cumin and affected 25,000 hectares of agricultural areas (PTI 2020).

In Maharashtra, where a large group of locusts covering a stretch of more than 17 km in length, the locust invasion occurred in mid-May, before into agricultural fields in the Nagpur District. After destroying cropped fields, the swarms moved towards the other districts of Maharashtra. The movement of hives was in the green areas where there were enough sources to feed and breed for locusts. It was in 1993 when Maharashtra encountered a similar locust attack (Hindustan Times 2020). The districts of Madhya Pradesh such as Neemuch, Mandsaur, Sheopur, Morena, Tikamgarh, and Panna have all been hit hard by swarms. This is the first large-scale attack of locust in Madhya Pradesh after 1993 (Hindustan Times 2020). Locust swarms moved eastward from the Ramtek Madhya Pradesh border towards the

Telangana State, where they caused panic among farmers and the general public. The Telangana government has deployed 47 ground teams to spray insecticides and take other measures to curb the menace (India Today 2020). The Union government, as well as state governments, are taking steps to eliminate the threat before the onset of the Kharif agriculture season in July to avoid the loss of crops/grains which was already damaged during the Ravi Season.

Locusts invasion was also recorded in the most populated state of India Uttar Pradesh too, where almost 17 districts of Uttar Pradesh were affected (India Today 2020). An adequate arrangement was made by government authorities to deal with the situation. Overnight swarm operations were carried out in many districts. Vehicles that were loaded with insecticides and pesticides were deployed during these operations. Seventy per cent of the locust population was eliminated in some districts (India Today 2020). Large-scale agricultural losses were minimised by adopting new mitigation measures. Locust swarms were spotted in few regions of Punjab and Haryana, triggering fear among farmers, though minor damages were caused in these areas due to beginning of Locust attack and prior management.

Analysis of locusts' track and information shows that there were many states which were at risk from swarm invasions, and declared as potentially threatened states (figure 5). Adequate mitigation measures in those areas were taken immediately after invasion warnings. These states took lessons from impacted states and engaged themselves in early warning and mitigation planning. The magnitude of swarm invasions kept on declining as the swarms moved away from Rajasthan to other states of India in an eastward direction. The impact was very high at the initial stage of the outbreak in the country and slowly decreased as the swarms moved from one place to other.

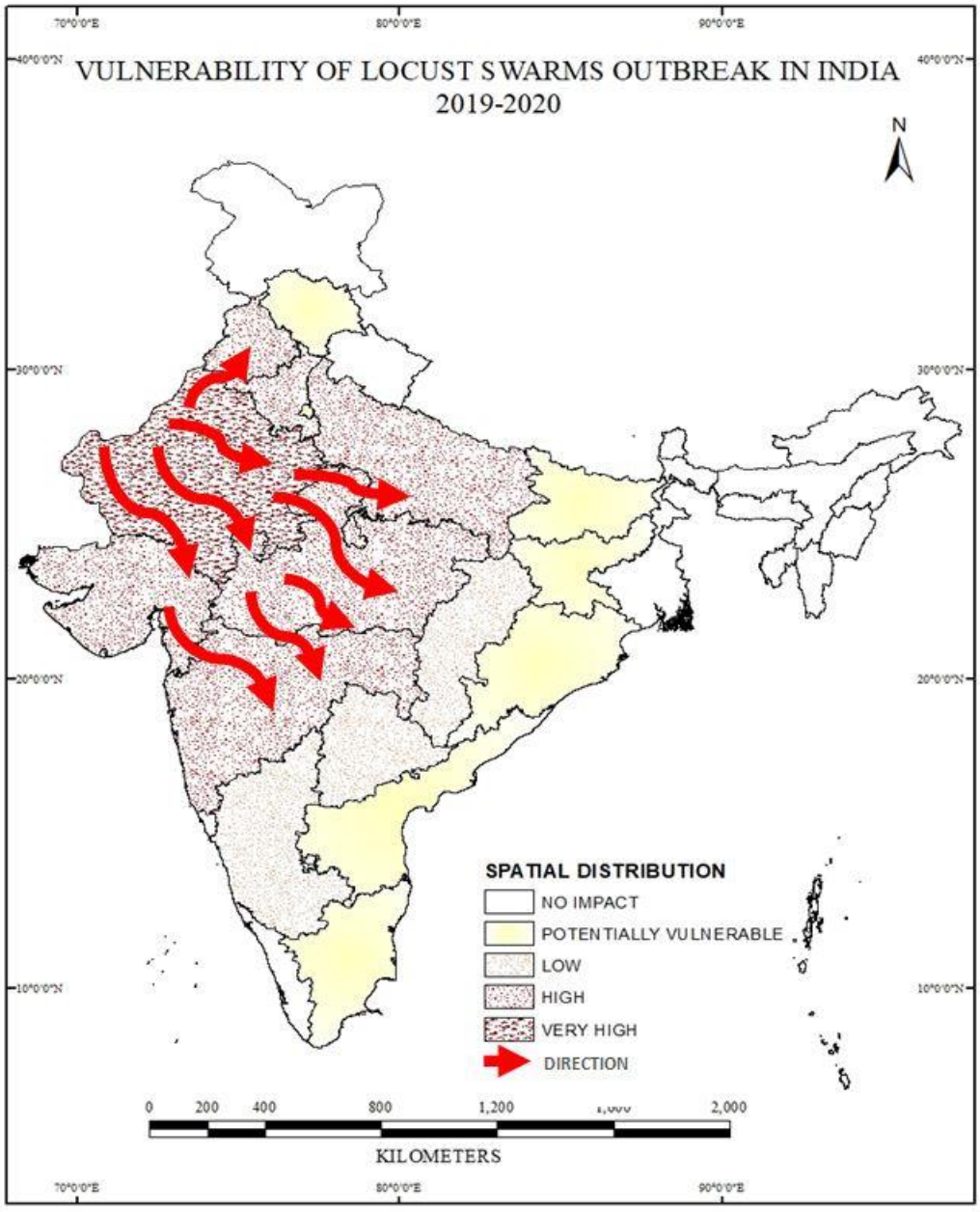

Figure 5: Spatial Concentrations of Locusts Swarms in India. Source: Compiled by Authors, 2020, Based on Several Readings.

Challenges: Locust swarms pose a severe risk to Indian agriculture, and it is necessary to monitor their movement to minimise damage. A considerable decline in agriculture output is caused by locust attack and the reduction in agricultural production at massive scale is a matter of concern for all the developing counties in general and India in particular (FAO 2019). One of the biggest challenges against such invasion is the lack of essential equipment. Large sprayers are limited in numbers. The large insecticide spraying aircraft are one of the most

effective ways to deal with such a crisis. The deployment of drones becomes essential for detecting the movement of swarms.

Locusts breed rapidly when conditions are a favourable and large number of cyclones at short interval have up-surged the locust attack by creating favourable breeding conditions for them. The moist and humid environment promotes its rapid growth. The swarms are getting more significant and worst with time, and their upsurge can be linked to climate change. The time taken by swarms to cause damage is too less as they can cause massive damage in a short duration of time. Large scale losses of crops have been seen in even an overnight. Therefore, it becomes necessary to be equipped with essential equipment. Standard strategies of combating locust swarms need to be developed as well. Integrated approaches, inclusive development, and adoption of preventive measures, strategies to control locusts, assessing the impact, vulnerability assessment and risk-reduction standards have to be considered.

Furthermore, proper planning and adoption with a focus on economic, institutional and financial issues should be ascertained. The creation of a framework that is sustainable for both environment and economy is a must. Integrated resource management with the use of advance technology such as GIS and remote sensing can play a vital role in locust control.

Preventive measures: Several measures are being used by the locals and government to minimise the crop damage by locust swarms. Pest-control measures such as using neem-based spray (2.5 litres per hectare) and spraying of the insecticides can reduce the loss and prove useful in protection against damage (figure 6). Large ditches were dug, and loud music is also played at some places. Chemicals and insecticides such as chlorpyrifos (commonly known as CPS) and malathion have been reported as effective (India Times 2020). Many experts suggest that spraying should be done early in the morning or late at night for the effective result (Outlook 2020). The Government of India has ordered sixty insecticide spraying machines and equipment from the United Kingdom. Further, 200 locust Circle Offices were created by the Union Government to monitor, control, as well as to conduct locust survey operations. Apart from this, several packages were given to State Governments by the Union Government for reliefs to farmers (Economic Times 2020).

Multi-source Earth Observation data linked with meteorological data, field survey data, as well as self-developed tools and models for prevention and controlling locust swarms, should be developed. Also, desert locust monitoring and forecasting, based on the Digital Earth Science Platform can be improved. The local farmers beat drums, utensils, tin containers

to remove locusts swarm from their field. The Indian Government conducted several global meetings between May-June on locust issues. Thus, international cooperation is a must to combat locust swarms (Economic Times 2020).

Figure 6: Vehicle used to Spray Insecticides on Locust Swarms, Jaisalmer (Rajasthan).
Source: Primary Survey, Captured by the Author, 2020.

Desert locust information service (dlis) – FAO: The DLIS is the most reliable early warning system as it monitors weather patterns, ecological conditions, and infestations of locust in potentially affected areas (FAO 2009). This is a method which helps in monitoring and preventing vegetation loss from the locust infestation. An early warning system is useful as the damage frequency, and food losses from swarms can be minimised. The locust affected countries and the Food and Agricultural Organisation have adopted systematic preventive and mitigation measure that relies on early action with the help of the early warning system (figure 7). The DLIS also releases monthly summary and forecasts for each country. This helps the countries to take the required measure against invasion or plan other actions against locust swarm.

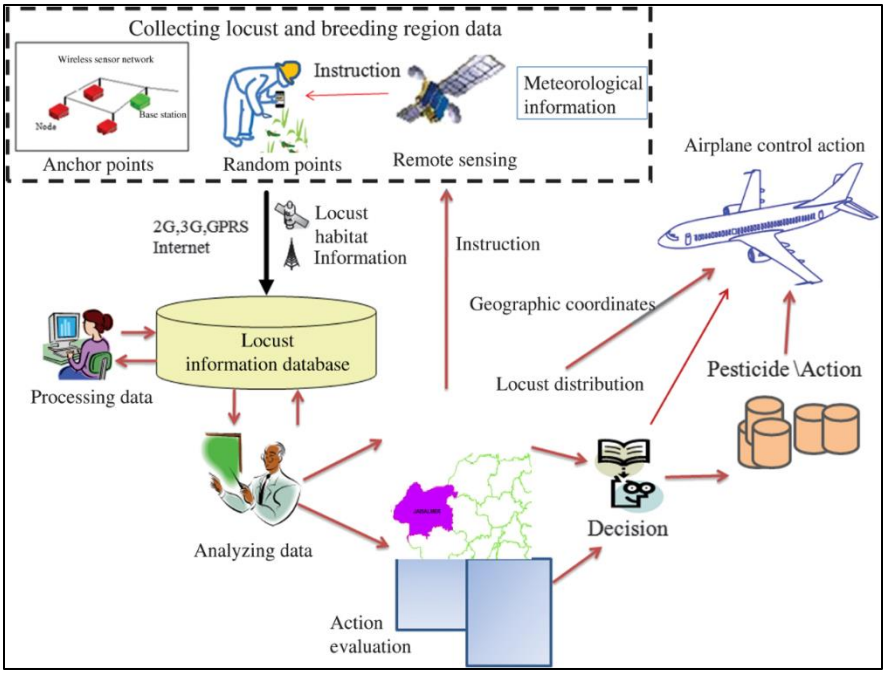

Figure 7: Technical Monitoring and Controlling System for Locusts Outbreak. Source: Compiled by the Author, 2020.

As conclusions, locusts are insects that resemble grasshoppers. There are several regions of the world where there is food scarcity. In food deficit regions, locust swarms can further worsen the situation by causing damage at the macro scale. In search of green vegetation, locusts migrate to the areas of lush vegetation, where they have plenty to eat, as well as areas that are favourable for breeding. The outbreak of locust swarms has emerged as a new challenge for the Indian agriculture sector. The suitable breeding conditions created by a large number of storms and depressions in several nations have up-surged locust invasions. The findings of this paper reveal that the recent wave of locust outbreak had its origin in Arabian Deserts. The cyclonic effects which cause temporary lakes in the desert suitable for breeding of locusts. Cyclones in the Indian Ocean kept on providing breeding ground. As a result, locust swarms spread to many provinces in Pakistan and enter India from the northwest into Rajasthan, from which they spread in three directions, North, East and South. The intensity of locust invasion (2020) was severe in western states that acted as a gateway to other states. However, not all the northern states were impacted by the outburst. Punjab and Haryana faced severe damage but somewhat lesser than what was expected.

The current outburst of swarms in India lasted for several months. The swarms moved in the parallel direction of rain and winds. It is expected that with the approaching monsoon,

the swarms will migrate towards Myanmar. The economic loss caused by locusts is immense and at some level leads to famine and starvation for poor and marginal farmers in many countries. Several measures can be taken to minimise the damage from locust swarms. Preventive measures are not adequate at present, but efforts have been made to reduce the loss at macro scale. Farming in India is a means of livelihood for more than half of the population. To secure the livelihood of the peasant population, sustainable and effective methods of locust control need to be developed so that the threat of locusts can be dealt at an early stage. The efficient tracking of locust breeding conditions and movement is crucial for effective monitoring and planning in order to control locust swarms in the world in general and in India in particular.

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