

A 100-km Raster Dataset of Locust Distribution for Nine Historical Periods in the Northern Hemisphere

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Abstract: Locust plagues are natural disasters caused by the large-scale occurrence and migration of locusts. Locust occurrence can be transnational and transcontinental; therefore, one of the basic tasks for global locust control is to understand its large-scale spatial and temporal characteristics. In this study, we extracted the temporal and spatial information of locusts in the northern hemisphere from multiple resources, including international English articles, historical documents, and the “Chinese Meteorological Records of the Third Millennium,” and estimated areas of locust occurrence over a period of time. The kernel density method was used to obtain a dataset that included nine periods of locust disaster distribution in the northern hemisphere: before 1000, 1000–1200, 1200–1300, 1300–1500, 1500–1700, 1700–1850, 1850–1900, 1900–1950, and 1950–2000. The data were in Equal Earth projections, with a spatial resolution of 100 km. The dataset was archived in .tif format and consisted of 18 data files with a size of 43.8 KB.

Keywords: locust plague; northern hemisphere; millennium; historical distribution

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Dataset Availability Statement:

The dataset supporting this paper was published and is accessible through the Digital Journal of Global Change *Data Repository* at: <https://doi.org/10.3974/geodb.2022.04.07.V1> or <https://cstr.science.org.cn/CSTR:20146.11.2022.04.07.V1>.

1 Introduction

A locust plague is a disaster caused by locusts, insects of the order Orthoptera, family Locustidae. Locusts are widely distributed—in tropical and temperate grasslands and deserts worldwide. Under certain conditions, locust populations explode and migrate widely, eating crops and grassland vegetation, causing severe economic losses and famine. One of the main

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locust species that causes locust plagues in China and around the world is the migratory locust (*Locusta migratoria*), belonging to the subfamily Acridoidea (Oedipodinae)^[1,2]. Another locust species that frequently causes locust plagues is the desert locust (*Schistocerca gregaria*), which is found mainly in Africa and throughout western Asia and extends to parts of southern Asia^[3,4]. In North America, locust plagues are mainly caused by the Rocky Mountain locust (*Melanoplus spretus*) and the high plains grasshopper (*Dissosteira longipennis*)^[5,6].

The locust plague is a worldwide disaster. In early human history, locust plagues have been documented in Egypt, Hebrew, ancient Greece, and China. The Exodus and Revelation chapters of the Bible classified locust plagues as a major disaster. In 2020, desert locust plagues hit many parts of the world, from Africa to South Asia, with a massive infestation in East Africa that devastated hundreds of thousands of acres of farmland and reduced food production in India by 30%–50%. In 2003, locust outbreaks in the western U.S. states of Nevada, Utah, and Idaho caused large economic losses. Historically, locusts have caused one of the three major agricultural disasters in China, along with droughts and floods. Since ancient times, locust plagues in China have been widely documented, mostly in the Hebei, Henan, and Shandong provinces^[7]. From 1856 to 1858, locusts plagued Guangdong, Jiangxi, Hunan, Tibet, and the north area of China. The Qing Shilu records that “the locusts covered the sky, blocking the windows and piling up the doors, leaving no gaps in the rooms” and that “the locusts ate all the seedlings, and large numbers of people died.”.

The occurrence of locust plagues is related to many factors, such as locust characteristics, climate, and human activities. Therefore, the prevention and control of locust plagues face significant challenges. Understanding the spatial and temporal characteristics of locust occurrence through its historical distribution is an important basic task for analyzing the factors of locust occurrence. At present, although scholars in China have done a lot of work on the historical dynamics of locust occurrence^[7,8], these studies are often limited to textual descriptions or time series only^[9–11]. Concurrently, the literature and data from other countries are fragmented and lack systematic organization. Moreover, locusts, as a global disaster, can occur across countries and continents, and local data do not reflect the full distribution characteristics. Therefore, a large-scale spatial and temporal distribution dataset of locust occurrence is important and must be developed.

2 Metadata of the Dataset

A summary of the full name, authors, geographic region, year, temporal resolution, spatial resolution, dataset composition, data publication and sharing service, and data sharing policy of the 100-km raster dataset of locust plagues for nine historical periods in the northern hemisphere^[12] is shown in Table 1.

3 Methods

3.1 Data Sources

Because this study aimed to respond to the spatial distribution of locust occurrence in the northern hemisphere, this dataset was developed by obtaining geographic information on

locust occurrence from domestic and foreign historical documents and then mapping the spatial distribution in different time periods in the northern hemisphere. The data sources were divided into domestic and foreign. China has a wealth of historical documents with recorded locust plagues. In this study, the locust data in the Chinese region were mainly extracted from the Chinese Meteorological Records of the Third Millennium^[14,15]. The foreign data was mainly searched by Google Scholar, including relevant journal articles and publications (Table 2). The English keywords used included locust plague, locust outbreak, locust swarming, and locust disaster. More than 9,500 records were collected both at home and abroad.

3.2 Locust Historical Distribution Construction

This dataset was based on historical records and focused on reconstructing changes in the

Table 1 Metadata summary of the 100-km raster dataset of locust plagues for nine historical periods in the northern hemisphere

Items	Description
Dataset full name	100-km raster dataset of locust plagues for nine historical periods in the northern hemisphere
Dataset short name	LocustPlagueNH
Author Information	Yan, C. ACA-0195-2022, Institute of Zoology, Chinese Academy of Sciences, College of Ecology, Lanzhou University, yanchuan@lzu.edu.cn Tian, H. D., Institute of Zoology, Chinese Academy of Sciences, tienhuitung@gmail.com Liu, R., College of Ecology, Lanzhou University, rliu20@lzu.edu.cn
Geographical region	Northern hemisphere
Year	1000–2000 A.D.
Temporal resolution	Over 100 years
Spatial resolution	100 km, equal earth projection
Data format	.tif
Data size	43.8 KB
Data files	Including the northern hemisphere distribution of nine time sections before 1000 A.D., 1000–1200 A.D., 1200–1300 A.D., 1300–1500 A.D., 1500–1700 A.D., 1700–1850 A.D., 1850–1900 A.D., 1900–1950 A.D., and after 1950 A.D.
Foundations	Ministry of Science and Technology of P. R. China (2017YFA0603304)
Data computing environment	R
Data publisher	Global Change Research Data Publishing & Repository http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	Data from the Global Change Research Data Publishing & Repository includes metadata, datasets (in the <i>Digital Journal of Global Change Data Repository</i>), and publications (in the <i>Journal of Global Change Data & Discovery</i>). Data sharing policy includes: (1) Data are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use Data subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute Data subject to written permission from the GCdataPR Editorial Office and the issuance of a Data redistribution license; and (4) If Data are used to compile new datasets, the ‘ten per cent principal’ should be followed such that Data records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset ^[13]
Communication and searchable system	DOI, CSTR, Crossref, DCI, CSCD, CNKI, SciEngine, WDS/ISC, GEOSS

Table 2 Data sources and literature on locust plague

Time period	Country or region	Data source
–1000 A.D.	Italy, Palestine, Poland, Russia, Turkey, Ukraine, North America	[16–19]
1000–1200 A.D.	Algeria, France, Germany, Greece, India, Iran, Iraq, Italy, Palestine, Philippines, Spain, Syria, Turkey, UK	[19]
1200–1300 A.D.	Iran, Italy, Russia	[16, 19]
1300–1500 A.D.	Austria, Cyprus, Czech Republic, France, Gambia, Germany, Hungary, Italy, Jamaica, Mexico, Poland, Romania, Serbia, Spain, Switzerland, United Kingdom	[16, 17, 19, 20]
1500–1700 A.D.	Austria, Cyprus, Czech Republic, Ethiopia, France, Germany, Guinea, Hungary, Italy, Jamaica, Lithuania, Poland, Portugal, Romania, Russia, Senegal, South Africa, Spain, Switzerland, Tanzania, Tunisia, Ukraine	[16, 17, 19–21]
1700–1850 A.D.	United States, Angola, Austria, Canada, Cyprus, Czech Republic, Egypt, Ethiopia, Algeria, France, Gambia, Germany, Gibraltar, Guatemala, Guinea-Bissau, Hungary, India, Iran, Italy, Jamaica, Lithuania, Moldova, Morocco, Mozambique, Namibia, Norway, Philippines, Poland, Portugal, Romania, Russia, Senegal, Sierra Leone, Silesia, South Africa, Spain, Sweden, Switzerland, Tunisia, Turkey, Uganda, United Kingdom, Ukraine, United States	[16, 17, 19–23]
1850–1900 A.D.	United States, Angola, Burkina Faso, Cameroon, Canada, Cape Verde, Chad, Cyprus, United Kingdom, Ethiopia, Finland, Algeria, Gambia, Germany, Greece, Guinea, Hungary, India, Indonesia, Iran, Iraq, Jordan, Kenya, Kuwait, Libya, Mali, Mauritania, Mexico, Moldova, Morocco, Namibia, Niger, Nigeria, Pakistan, Palestine, Philippines, Poland, Pomerania, Romania, Russia, Saudi Arabia, Senegal, South Africa, Spain, Sudan, Tanganyika, Tanzania, Togo, Tunisia, UK, Ukraine, Western Sahara, Yemen, Zambia, Zimbabwe	[17, 19, 21–29]
1900–1950 A.D.	Arabian Peninsula, Angola, Botswana, Bulgaria, Burkina Faso, Egypt, Algeria, Ghana, Hungary, India, Indonesia, Iran, Israel, Jordan, Kenya, Malaysia, Mali, Moldova, Namibia, Palestine, Philippines, Portugal, Romania, South Africa, Spain, Sudan, Tanzania, Togo, Uganda, United Kingdom, Yemen, Zambia	[17, 19, 21, 22, 24, 30–36]
1950–2000 A.D.	Arabian Peninsula, Botswana, Burkina Faso, Burundi, Cape Verde, Chad, Cuba, Djibouti, Egypt, Eritrea, Ethiopia, Algeria, Gambia, Greece, Guinea, Hungary, India, Indonesia, Iran, Iraq, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Kuwait, Lebanon, Libya, Malawi, Mali, Mauritania, Morocco, Mozambique, Niger, Oman, Pakistan, Philippines, Portugal, Qatar, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Somalia, South Africa, Spain, Sudan, Syria, Tanzania, UAE, Tunisia, Turkey, Uganda, United Kingdom, Western Sahara, Yemen, Zambia, Zimbabwe	[16, 19, 22, 24, 31, 32, 36–63]

distribution of locust occurrence at different times over the millennium. The latitude and longitude of locust occurrences were obtained by matching contemporary location information with historical records. Locust occurrence is often regional and migratory, and there are gaps in locust occurrence records worldwide. To analyze the overall variation of locust occurrence areas over a long time scale, this dataset estimated the locust occurrence areas according to the kernel density range estimation method for a certain time period (e.g., 1000–1200 A.D.). We then censored the locust occurrence areas with a resolution of 100×100 km (Equal Earth projection). The time intervals were before 1000, 1000–1200, 1200–1300, 1300–1500, 1500–1700, 1700–1850, 1850–1900, 1900–1950, and 1950–2000. Equal Earth and WGS-84 projections were used to build the dataset.

4 Data Results and Validation

In terms of the historical spatial distribution of locust occurrence, locusts in the northern hemisphere were mainly concentrated in the mid-latitudes in the last millennium, consistent with the suitable distribution area of locusts. In terms of longitude, locust records were mainly concentrated in Europe, Africa, and China (Figure 1, 2). In terms of time, locust records were mainly concentrated between 1400 A.D. and 1900 A.D. (Figure 2). The locust plague records in China were the most complete in the last millennium, especially in the

Ming and Qing dynasties.

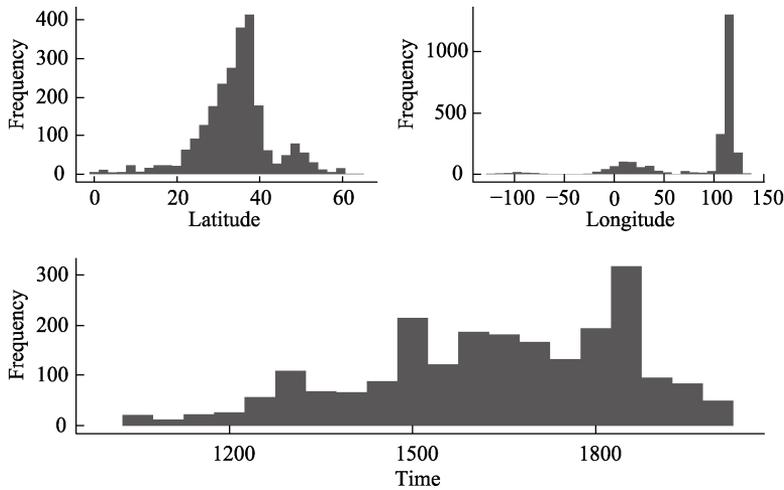


Figure 1 Frequency distribution of locust plagues in latitude, longitude, and time

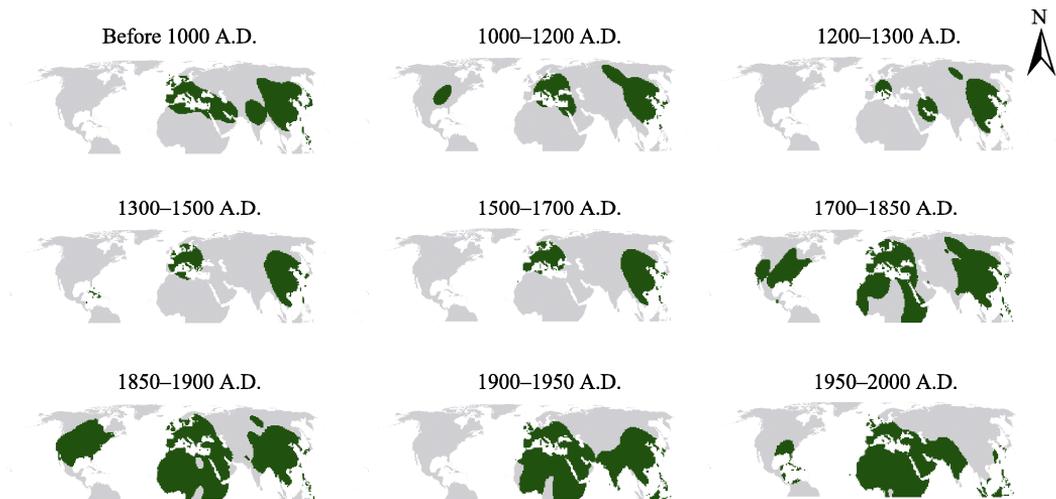


Figure 2 Historical distribution of locust plagues in the northern hemisphere over the past millennium (Equal Earth projection)

5 Conclusion

The historical records of locust occurrence and distribution may be more closely related to the state of national social development and the history of written records. Specifically, locust occurrences in Europe and the United States rarely became plagues after 1990 and in China after 1950, and records decreased significantly, whereas, Africa, the United States, and South Asia had more records only after 1700. Data from Central Asia may have been less recorded because of the lack of written records or geographic reasons. Overall, historically, China has been the most affected in terms of locust occurrence, which is consistent with its status as a historically large agricultural country. Similarly, locust plagues were more severe in North America during the locust agricultural development period. Notably, locust infestations in China and North America have been controlled extremely effectively owing to scientific and rational control measures.

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