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Correlation and related impact of migratory routes of seasonal birds in India and Japanese encephalitis (JE) epidemic regions in India

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Abstract. Japanese encephalitis (JE) which is also called epidemic encephalitis B, is able to cause severe inflammation in human body especially the central nervous system (CNS). Base on the fact that birds are able to transmit virus as same as pigs in the local regions in India, here will be more discussions and analyses about the correlation and related impact of migratory routes of seasonal birds in India and JE epidemic regions in India base on the case studies in the upcoming articles. Additionally, to figure out the solution of the problem of the continuously JE epidemic over the whole country. Throughout the process, a tight relation between wild birds and JEV was discovered from the previous researches, which also reflected the tendency of JE endemic in regions in India affected by the distribution of bird sanctuaries. Based on policies established for other epidemic prevention before in other countries, a few suggestions were listed to give a supportive reference for potential JE epidemics. This can either enhance the security of citizens living in the endemic area and raise the awareness to wildlife around them.

Keywords: Japanese encephalitis (JE), seasonal migratory bird, reservoir host, JE SA-14-14-2 vaccine

1. Introduction

Epidemic encephalitis B is a type of epidemic infection that mainly causes by the epidemic encephalitis virus. The virus has 5 genotype, typeImainly exist in the eastern Asia whereas type III mainly exist in the southern Asia. The pathogen of epidemic encephalitis virus was isolated first time from Japanese researchers in 1934 thus it is also called Japanese encephalitis (JE) [1,2]. The clinical feature can be high fever, hyperspasmia, headache, central respiratory feature [1]. Since the first clinical case discovered in 1950 in India, more JE cases begun to be reported in southern, western and eastern states and the epidemic started spreading to the northern India (figure 1 and figure 2). Uttar Pradesh experienced the most severe JE in history in 2005, with 3867 confirmed cases and 1315 death that the mortality rate is roughly 34%. In some regions of the southern India the infection percentage is 70% which is even higher, and the majority of the patients are children between 5–9-year-old.

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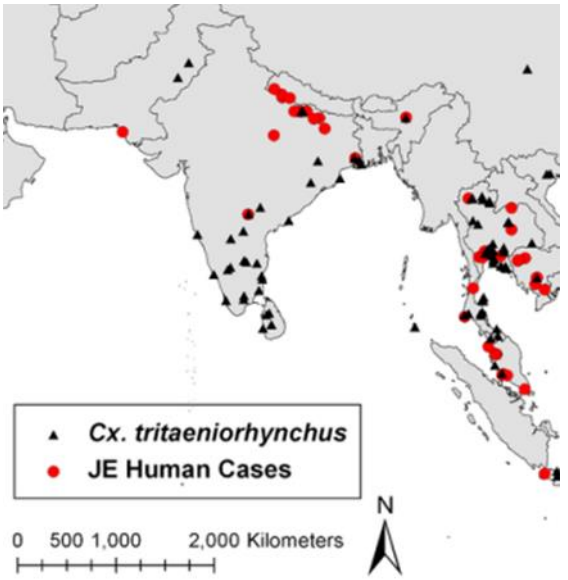

Figure 1. JE cases were reported in India.

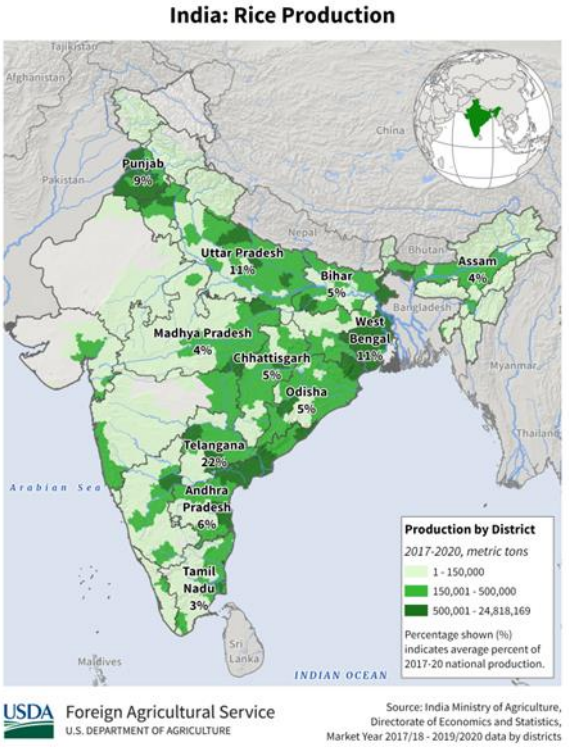

Figure 2. The rice planting land distribution in India [3].

As a threatening disease, JE is mainly transmitted by Culex triaeniorhynchus which commonly reproducing in the lands planting rice and pounds etc. [3]. The tight relation between the rice planting land distribution and the population of Culex triaeniorhynchus is available in the figure 2 and figure 3. There are numbers of Culex triaeniorhynchus produced every day during the breeding season thus the residents living around have the highest possibility to be bitten by infected Culex triaeniorhynchus [4].

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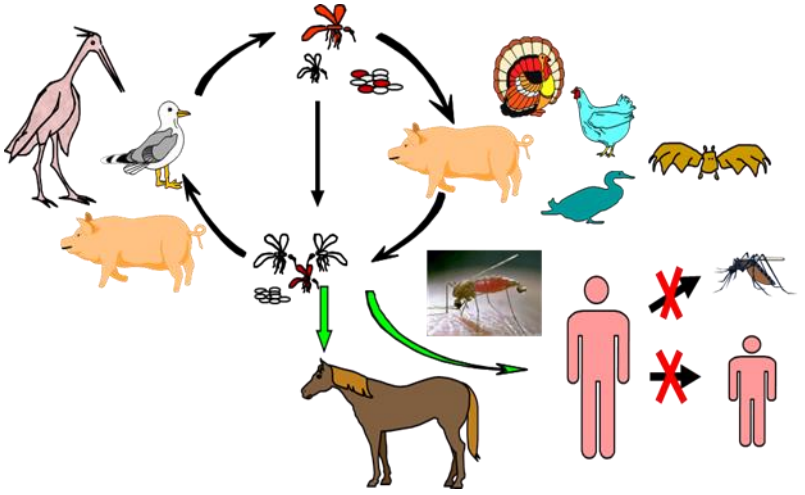

Figure 3. Diagram of Culex triaeniorhynchus transmitting JE [5].

Culex triaeniorhynchu are unable to pass the virus through generations that intermediates are required to preserve the virus and transmit back to them again which also enabled them to infect human [2]. Therefore, JEV can widen the epidemic range and causing longer impacts. In epidemic seasons or epidemic areas, the JE will widely spread in the piggeries previously before the virus infecting human, which shows that pigs are an essential factor of JE [2]. Though it was confirmed that pigs are the main factor to deliver the JEV, the seasonal migratory birds are more likely to be the object that transmit virus over regions or countries. Otherwise, there is no appropriate reason to explain the tendency shows on the diagram of JE epidemic distribution below, that the lands planting rice, piggeries and population distribution in India roughly divided apart which means JEV can merely transmit JEV from the southern to the northern. Whereas base on the recent reports these regions all present similar clinical symptoms on the JE patients.

Hence, in the following writing, a problem will be listed based on the backgrounds, with is more detailed analysis to confirm seasonal migratory birds are an important factor in the JE transmission as same as pigs, and also discuss the reason why other livestock or wildlife unable to play the same role as wild birds, what is the percentage the bird transmitted JE occupied in the JE infection origins and how can we enhance the precaution to JE through the analysis of bird migration. There are numbers of detailed problems wait to be solved throughout the project.

2. Case description

There are roughly 60 diseases are either directly or directly transmitted by birds. Not only seasonal migratory birds are able to transmit JEV, whereas most water areas beside residential portions are ideal place for both Culex triaeniorhynchu reproduction and wild bird living. It confirmed that the existence of birds in the local regions is vital to the epidemic, zoonotic diseases like JE cannot only be controlled from human aspects, but also accessible from reservoirs and medians. Combine with the current ecology of native birds in India that mainly distribute around water, they are the second possible object to be the JEV carrier while no piggeries instructing within residential areas. Additionally, the invention and popularize of JE vaccine for pigs decreased the seroprevalence of domestic pigs, which significantly descended the possibility JEV living on pigs [6]. Hence, it is equally important to focus on the reducing of the probability that JEV transmitted via wild birds, also for severe epidemics which mainly brought by JEV on wild those endemic regions with less distribution of piggeries [6,7]. Another seroprevalence test during 2005 to 2006 which carried out at Hokkaido (with least JE endemic area in Japan) showed 90% sera positive rate of specific JE antibodies in wild birds they caught, included wild ducks, Anas acuta, Anas penelope and Anas poecilorhyncha etc. through the analysis [7].

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There are three approaches that wild birds associated with the JE transmission, which included birds with infectious JE symptoms bitten by Culex triaeniorhynchus thus the latter carries the virus and transmit to human, birds with infectious JE symptoms directly transmit to human, and birds with infectious JE symptoms transferred to livestock around then the latter bitten by Culex triaeniorhynchus and infect human.

Serology makes the JE infection detectable in human body hence it also can be used in livestock to test the presence of antigens. There are several sera positive tests of animals carried out in Malaysia 1953, which significantly showed that other than bovine (93%), equines (90%), only pigs came up with nearly 100% neutralizing antibodies for JEV. Wild birds were firstly confirmed that able to carry can spread JEV in 1958s, Japan, which indicated that wild birds are able to amplify JEV.[8] In addition, JE infected birds had similarities of the virusemia with birds infected by flavivirues, due to the property that flavivirus are transmitting via mosquitoes of Cluex species, and mainly taking wild birds as reservoir host and amplifying reservoir [8]. After the JE was confirmed as insect-borne disease in 1970 in Malaysia, researchers also tested the sera positive rate of other animals, hence the seroprevalence rate of birds was noted as 16%, which is higher than the average in animals but much lower than pigs (46%) [8].

The main difference that makes birds stand out from bovines and equines is that JEV inside birds can cause high-concentration viremia inside the circulatory system, including viremic and non-viremic.

The main difference makes birds stand out form bovine and equines are that JEV inside birds is able to cause high concentration virusemia inside the circulatory system. The investigation of clinical symptoms on birds associated with a process called Seroconversion. which is a more appropriate approach to justify the state of JE infection.[8] It can be defined as a turning point that specific antibodies presented inside the circulatory system. It was reported that seroconversion approximately happens after two weeks after the samples injected JEV genotype I or III, and the majority of the samples came up with virusemia (97.3%). Another experiment carried out to investigate the impact of mosquitoes-transmitted JE on ducklings, which not only confirmed that most genotype of JEV are able to be transferred between adult birds and young birds without high fatality percentage, but also have 50%-100% possibility receiving and spreading JEV via Cluex triaeniorhynchu [7]. Either way, the previous studies offered a clue that either poultry and wild birds in any age are the most powerful reservoir hosts and amplifying reservoir compared with other livestock except pigs.

3. Correlation of waterfowl distribution and corresponding policies in states

In short, wild birds like water duck, common teals, pintail duck, cormorant, night heron, Indian shag, heron, egret, little cormorant are always available in Indian sanctuaries along the CAF during migratory season [9]. Those wetland sanctuaries supply appropriate environments for wild birds during the breeding season (June to July), such as heron, egret and little cormorant, whereas wild birds living in the freezing area like painted stork, Indian darters and Sarus cranes etc. will arrive at the southern India from Siberia before the winter, and stay in the sanctuaries for a period of time till the temperature in the high latitude area risen again [9]. Most bird sanctuaries open to the public for free, and the existence lasting impacting the wild bird distribution and the ecosystem surrounding residential quarters [9]. Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West bengal and Assam contributing to the majority of JE clinical cases, which is available in figure 4. Based on statistics, 72 bird sanctuaries established in India, which most sanctuaries are concentrate in JE endemic states such as Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Tamil Nadu and Uttar Pradesh etc.

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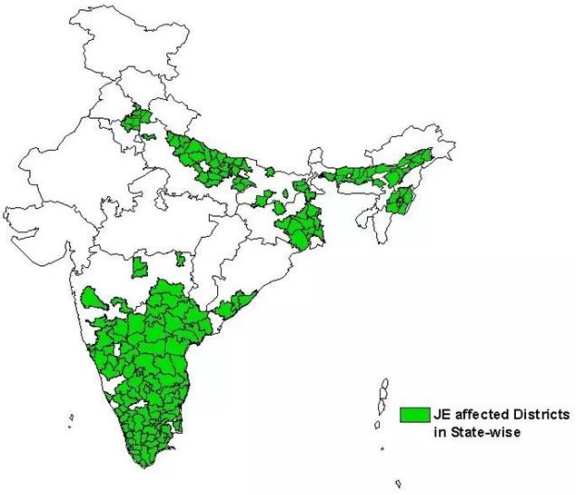

Figure 4. JE affected Districts in State-wise [2].

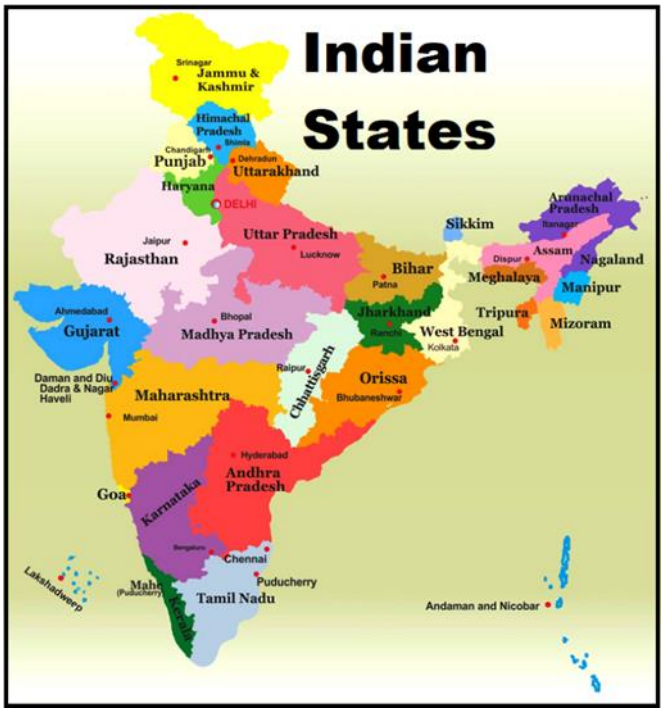

Figure 5. India States [9].

Hence wild bird is an important existence in the JE transmission process. Other than that, combine with the country we mainly focusing on, various factors strongly impacted the epidemic in local regions. Continuously drought and the changing climates caused more arid lands in major cities in the northern and western India. The severe condition strongly impacted the migration route of many migratory birds and the elimination of wild bird habitats, and also stimulated the establishment of policies about the instruction of reservoirs and artificial rivers. The corresponding actions and results included the disqualification of water resources around residential areas, mosquito growth in the stagnant water and changes of wild bird habitats etc., which ultimately leads to either the transmission of flavivirus (mainly spreading via mosquito) to non-endemic areas and amplification of the range of JE epidemic. For

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example, North-South water transfer project since 1980s, this proposal was suggested for lessen droughts, though this also offered ideal water areas for mosquito growth.

In addition, the central Asian flyway (CAF) displayed the primary migratory routes of wild birds in central Asia, which involved the main land of southern India and the isolated islands chains in the southern British India Ocean (figure 6) [10]. Over 279 populations of 182 migratory species are participating in this route, also including approximately 16%(29) globally threatened and near-threatened species.[10] The destination for the most major winter waterbirds is the southernmost of the central Asia. and there are sanctuaries established along the route such as the Keoladeo National park, the outskirts of Mumbai, the Kutch Great Indian Bustard Sanctuary, Gujarat and Pathiramanal etc [10].

During the annual migration, the bird sanctuaries offered seasonal migratory birds a suitable condition to live, though for most of the wild birds they are temporary places for rest. For birds from the northernmost of Russia, they will crossover the whole Siberian plain then stay in the northern India, mainly in Uttar Pradesh. Apart from that, birds inhabit in China Tibet also have to cross the China-India border to arrive to the easternmost India, migrating to states like Assam, Arunachal Pradesh and Meghalaya etc. What information these factors referred to, is that the migrating routes of wild birds are playing an important role in the JE endemic areas. In short, this explained how can the JEV been spread to areas with less bird sanctuary distribution——foreign birds brought the virus whether they got infected in India or countries along the CNF to destinations they arriving at. For instance, this can be the reason why Assam contributing such a high JE case (~36%) in India [11].

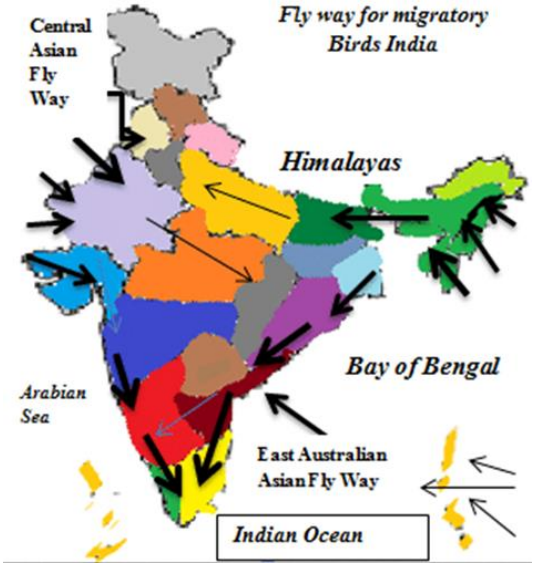

Figure 6. The central Asian flyway of wild birds in the main land of southern India and the isolated islands chains in the southern British India Ocean [10].

4. Current epidemic encephalitis B vaccine introduction

Most common types of JE vaccine for human worldwide are inactivated mouse brain-derived vaccines, inactivated Vero cell-derived vaccines, live attenuated vaccines, and live recombinant (chimeric) vaccines [4, 12].

Inactivated vaccine bases on the culture of the virus or pathogen, then inactivate them under specific temperature or chemical environment. The highlight of the manufacturing procedure is that fully identical virus or pathogen be produced but with no pathogenicity and virulence, thus it is able to trigger the humoral immunity and enables the antibodies created clean the poison in humor without cause severe immune response. The drawback emerged within the property of this type of vaccine, that it involves a large quantity of injection, shorter immune period and weaker resistance. To modify the current vaccine, live attenuated JE vaccine was invented for both stronger immunity and longer, lasting protection, that

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it was suggested for children under 15-year-old. Since the JE vaccine injection policy established in 2014, children between 0-15 in 86% endemic area got least one dose, which assisted the inhibiting of potential JE epidemics.

Japanese Encephalitis Virus Vaccine Inactivated (JE-VAX), a typical JE precaution vaccine which was widely using in India before JE SA-14-14-2 vaccine was imported from China [10]. As a new live attenuated JE vaccine, it both presents stronger security and higher efficiency compared with the former. While JE SA-14-14-2 vaccine inducing into more states in India, the manufacture of JE-VAX was gradually shutoff [10]. The basic mechanism of JE SA-14-14-2 vaccine is called chimeric vaccine virus which is to use the yellow fever(YF) 17D as the base which coded with the gene sequence of the JE SA 14-14-2 strain to construct live attenuated vaccine, thus it can enhance the body immunize without cause damage to the blood brain barrier and leads to the destruction of neurons [12].

Thus, a problem emerged within the discovery, based on the tendency of the continuing epidemic in India, the JE SA-14-14-2 vaccine for human is suggested to get injection 1 or 2 months before the infection peak, or 1 or half month before visitors travelled to the epidemic areas. Two or more doses of JE SA-14-14-2 vaccine is involved in the state JE vaccination policy for children between 1-15, same as adults in the endemic areas. This ensured the resistance inside human body be enhanced. During the JE vaccination campaign in 2006, the free vaccination accesses and temporary vaccination clinics are available in particular states such as Assam, Uttar Pradesh (UP) and Tamil Nadu etc. For other states, JE vaccination for children is cost-free which already involved in the National Healthy Programme. However, for most adults the JE vaccine is both expensive and non-accessible. What reports showed is that approximately above 20% clinical cases are adults and the gender proportion are half and half. Due to the various factors, though the vaccination rate is high, the vaccine coverage control stuck at 39% and the vaccine efficiency of adults was descending since noted 90% at 2012. Hence it will be helpful if other approaches can be found to further restrict the JE epidemic.

5. Suggestions

To conclude with, it's either important for Indian citizens and the central Asia ecosystems to control the JE to avoid severe epidemics. Several advice are suggested to remit the infection and descend the possibility JE transmitting in a wider range, including screening the water resource distribution via satellite map to check if any idle lands beside residential areas have dirty water redundancy, and already have or have the potential to attract wild birds. This required to invite local staff to mark the areas where wild birds are most frequently available, thus the drainage system can be set up to avoid excess mosquito growth. For those outdoor water ponds that did not pass the water quality monitoring, the water area can be drained under the permission from residents then it can be used for other capital constructions. Clear procedures of submitting proposals to governmental administrations have to be constructed, and regular meetings need to be set up for discussing the content of the proposal.

Other than that, it will also help if the price of sanctuaries can be increased, for both decreasing the visitors and raise money for environment improvement and protection device establishment. Thus, the tourists have less possibility to get infection from the intimate contact with birds via biting by insects. Construct networks to monitor activities and traces of wild birds online, for response to the JE epidemic quicker and suspend the transmission between species. During the breeding period, frequent physical examination of both adult birds and birdling need to be planned as the regular conservation activity, for treating diseases and JE screening, which also assured a higher survival rate in birdling. From the aspect of feasibility, this either can be done by staffs from clinical institutions or professional researchers.

It will be a long-term program to make the suggestions become practical throughout the whole country. These proposals are considered to be the one has the highest feasibility. Other ideas such as the invention of JE vaccines for birds, the popularization of health management of poultry and so on, are not seems to be as possible as the former. One is because that improving the management of wild birds cannot generally making huge impacts on JE transmission, and it was came up with the idea to make it function in precaution aspects as far as it could. A few clinical spots will be set up in JE endemic areas under the approval of the proposals, for initiating long-term observation and data analysis. If the data

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reflects that the annual JE cases, advanced cases and fatal cases is lower than the number from the deduction of the tendency, both the level of the impact and the feasibility of the proposal will be directly proved. Hence the scope and staff size can be expanded as the following step. Either way, the data and analysis which summarized in the text can offer a new approach for avoiding and inhibiting JE transmission, enhance people's understanding to JE and eliminate potential risks for individuals as much as possible.

6. Conclusions

In order to solve the problem of the year-round trend of JE, the text provides a clear indication of the history of the JE endemic in India by briefly describing and organizing the elemental backgrounds of JE and transmission sources. In addition to recent research, wild birds have been identified as a critical component of JE transmission, nearly as important as pigs. Despite this, they have long been disregarded while medical organizations continue to focus on the negative aspects of pig farming. This case study aimed to raise awareness of seasonal migratory birds, which are responsible for a significant number of infection cases in India and may increase bird-related JE infection in the future due to altered migration patterns brought on by global warming. It also discussed and compared the viability of recently established solutions in India with the above-mentioned personal suggestions. Errors and mistakes cannot be avoided as the actions have moved from the theoretical to the practical level. There is still room for improvement regarding the essay's errors and incompleteness in certain sections, and overall, the majority of these findings are tied to the advancement of technology in the future, making the outcome inexplicable.

References

[1] Zhang, H., Cheng, J. (2015). Epidemic Encephalitis B. In: Li, H. (eds) Radiology of Infectious Diseases: Volume 1. Springer, Dordrecht. https://doi.org/10.1007/978-94-017-9882-2_14

[2] IndiaBioscience, Learning how Japanese Encephalitis Virus debilitates brain cells, Apr 04, 2017, https://indiabioscience.org/news/2017/learning-how-japanese-encephalitis-virus-debilitates-brain-cells

[3] International Production Assessment DivisionIndia, Rice Area, Yield and Production,2023, https://ipad.fas.usda.gov/countrysummary/Default.aspx?id=IN&crop=Rice

[4] WHO, Japanese encephalitis, 9 May 2019, https://www.who.int/news-room/fact-sheets/detail/japanese-encephalitis

[5] CDC, 2020, Prevention of Japanese encephalitis in flood areas, https://www.chinacdc.cn/jkzt/crb/zl/lxxyxny/nyzstd/202008/t20200829_218744.html

[6] Kulkarni, Reshma et al. "Japanese Encephalitis: A Brief Review on Indian Perspectives." The open virology journal vol. 12 121-130. 31 Aug. 2018,

[7] Hameed, Muddassar et al. "Potential Role of Birds in Japanese Encephalitis Virus Zoonotic Transmission and Genotype Shift." Viruses vol. 13,3 357. 24 Feb. 2021, doi:10.3390/v13030357.

[8] Kumar, Kiven et al. "Japanese encephalitis in Malaysia: An overview and timeline." Acta tropica vol. 185 (2018): 219-229.

[9] Bird sanctuaries, Incredible India, https://www.incredibleindia.org/content/incredible-india-v2/en/experiences/nature-and-wildlife/bird-sanctuaries.html

[10] Convention on the Conservation of Migratory Species of Wild Animals, Central Asian Flyway, https://www.cms.int/en/legalinstrument/central-asian-flyway

[11] Tandale, Babasaheb V et al. "Effectiveness of Japanese encephalitis SA 14-14-2 live attenuated vaccine among Indian children: Retrospective 1:4 matched case-control study." Journal of infection and public health vol. 11,5 (2018): 713-719.

[12] Live attenuated SA 14-14-2 Japanese encephalitis (JE) vaccine, https://www.who.int/groups/global-advisory-committee-on-vaccine-safety/topics/japanese-encephalitis-vaccines/sa-14-14-2-vaccine