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Retrospective investigation of Newcastle disease reported in Turkey between 2017-2019

Tuba BAYİR[1,a, ✉], **İ. Safa GÜRCAN**[1,b]

[1]Ankara University, Faculty of Veterinary Medicine, Department of Biostatistics, Ankara, Turkey

[a]ORCID: 0000-0001-6381-0324; [b]ORCID: 0000-0002-0738-1518

✉Corresponding author: tbayir@ankara.edu.tr

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Abstract: This study was aimed to understand the spatial and seasonal epidemiology of Newcastle disease (ND) in Turkey using the outbreak data between 2017-2019 and also to calculate the case-fatality rates of this disease. It was also aimed to produce the maps by using Geographical Information Systems (GIS). Data were obtained from the World Animal Health Information System (WAHIS) database of the World Organization for Animal Health (OIE). Total number of 220 outbreaks of ND were registered in 47 provinces of Turkey between this years. Accordingly, 88,372 poultry birds transmitted the disease. The highest number of ND outbreaks, cases and

deaths was reported in The Black Sea Region. According to the regions there was a statistically significant difference in the number of outbreaks (P<0.05), but there was no statistically significant difference in terms of cases and deaths (P>0.05). On the other hand the highest number of ND outbreaks, cases and deaths was reported in the spring season. As a result of the comparisons according to the seasons, there was a statistically significant difference in the number of deaths (P<0.05), but there was no statistically significant difference in terms of outbreaks and cases (P>0.05). The spatial and seasonal distributions identified in this study should be taken into account while attempting to control the disease. Also, it is thought that the creation of spatial maps based on ND outbreaks that are common in Turkey will contribute to the determination of the areas where precautions should be taken against the disease.

Keywords: Case-fatality rate**,** geographic information system, Newcastle disease, spatial epidemiology.

2017-2019 yılları arasında Türkiye'de bildirilen Newcastle hastalığının retrospektif incelenmesi

Özet: Bu çalışmada, 2017-2019 yılları arasındaki salgın verileri kullanılarak Türkiye'de Newcastle hastalığının (ND) mekansal ve mevsimsel epidemiyolojisinin anlaşılması ve bu hastalığın vaka ölüm oranlarının hesaplanması amaçlanmıştır. Ayrıca Coğrafi Bilgi Sistemleri (CBS) kullanılarak haritaların üretilmesi hedeflenmiştir. Veriler, Dünya Hayvan Sağlığı Örgütü'nün (OIE) Dünya Hayvan Sağlığı Bilgi Sistemi (WAHIS) veri tabanından elde edilmiştir. Bu yıllar arasında Türkiye' nin 47 ilinde 220 ND salgını kaydedilmiştir. Buna göre 88,372 kanatlı kuşa hastalık bulaşmıştır. En fazla

ND salgınları, vakaları ve ölümleri Karadeniz Bölgesi'nde rapor edilmiştir. Bölgelere göre salgın sayılarında istatistiksel olarak anlamlı fark bulunurken (P<0,05), vaka ve ölüm sayıları açısından istatistiksel olarak anlamlı farklılık bulunmamıştır (P>0,05). Öte yandan en yüksek sayıda ND salgınları, vakaları ve ölümleri ilkbahar mevsiminde rapor edilmiştir. Mevsimlere göre yapılan karşılaştırmalar sonucunda ölüm sayılarında istatistiksel olarak anlamlı fark bulunurken (P<0,05), salgınlar ve vakalar açısından istatistiksel olarak anlamlı fark bulunmamıştır (P>0,05). Bu çalışmada belirlenen mekânsal ve mevsimsel dağılımlar, hastalık kontrol altına alınmaya çalışılırken dikkate alınmalıdır. Ayrıca, Türkiye'de sık görülen ND salgınlarına dayalı mekansal haritaların oluşturulmasının hastalığa karşı önlem alınması gereken alanların belirlenmesine katkı sağlayacağı düşünülmektedir.

Anahtar sözcükler: Coğrafi bilgi sistemleri, mekansal epidemiyoloji, Newcastle hastalığı, vaka ölüm oranı.

Introduction

Newcastle disease (ND) is caused by strains of Avian Paramyxovirus (APMV-1) in the family Paramyxoviridae, a subfamily of the order Mononegavirales (5, 15). Transmission of the disease occurs through direct contact of infected birds with each other, alimentary route, and inhalation of infected particles (27). The incubation period varies between 2-15 days (average 5-6); some species may be over 20 days (21). In the rapid spread of the disease, factors such as legal or illegal movement of infected birds, migrating wild birds, contaminated litter, manure and water are effective. The importance of these factors varies according to the situation (10, 20).

The clinical signs of the disease vary depending on the virulence of the virus, tissue affinity, route of infection, poultry species, age and immune status (4, 12).

ND is a highly contagious viral disease that can be seen in nearly all domestic and wild bird species, affecting more than 250 bird species worldwide (2). It causes serious economic losses and epidemiological threats in the poultry industry with its high morbidity and mortality rate (1, 8). The creation of active surveillance systems, rationalizing fast, effective, and reliable prevention strategies in disease control, is necessitated by the disease's high death rate (6, 13).

It has been reported that the first outbreaks of ND were seen on the Indonesian island of Java in 1926, followed by the British town of Newcastle upon Tyne, where it was first described (3). Except for Oceania countries, ND is widespread in most of the countries worldwide (11).

Fighting epidemics like Newcastle disease is an important task in terms of ensuring food security and nutrition, for strengthening national economies. Combating outbreaks is one of the most basic research areas of epidemiology (26). Although the history of epidemiology is very old, recently geographic information systems (GIS) has become an innovative and important component of many researches in the field of epidemiology. The widespread use of GIS in epidemiology has also led to an increase in spatial epidemiology research (17).

With the development of GIS, the importance of spatial analysis studies has increased. Prevention measures can be adopted by identifying unusually high-risk areas with disease mapping. Furthermore, creating a reliable disease risk map allows for better resource consideration and risk assessment (18).

On visualizing the data instead of tables and graphs using thematic maps with GIS the decision-making units easily determine the regions that need to be taken precautions. In this sense, GIS remains the most useful application in basic disease mapping (23, 25).

ND is one of the most important poultry diseases in the world. The large number of birds affected by the disease has a serious economic impact on the poultry industry. The aim of this study is to determine spatial and seasonal the distribution of ND in Turkey by conducting a registry-based study, to guide the eradication following development of control programs against the disease. In addition, it is to produce maps by using Geographic Information Systems (GIS) and to guide in determining the areas that need to be taken precautions.

Materials and Methods

The material for the study consisted of ND outbreak data between 2017-2019, publicly published in the World Animal Health Information System (WAHIS) database and Provincial level shapefile (.shp extension) data.

Statistical analysis: The Kolmogorov–Smirnov and Shapiro–Wilk tests for normality of data was done and the Levene test for homogeneity of variances to determine whether to use parametric or non-parametric statistical tests before performing the statistical analysis. As the parametric test assumptions are violated, the Kruskal Wallis test was utilized to test the difference between groups. For the significant differences, multiple comparison tests were utilized as a post hoc approach. A probability value of less than 0.05 was considered significant, unless otherwise noted.

SPSS 14.01 (License No: 9869264) was used for statistical analysis. Distribution of ND, according to geographical regions, seasons and years were evaluated.

Geographical analysis: Thematic maps were needed to determine ND sensative regions in Turkey. In this respect, a database based on Geographic Information Systems (GIS) was created and firstly, the area to be studied was determined. As the study area, Turkey which is located in the northern hemisphere, between 36-42° north latitude and 26-45° east longitude, was targeted. Provincial level shapefile (.shp extension) data were used to be used in GIS software for spatial analysis and mapping of outputs. The shapefile format is a digital vector storage format for storing geometric location and associated attribute information. In order for the shapefile format to be displayed in CBS software, shp, .shx and .dbf file formats must be in the same folder. Here we used, the GIS program QGIS™ 3.6 was used to visualize the spatial data of the ND outbreaks.

Results

ND recorded a total of 220 (100%) outbreaks, 81 (36.82%) in 2017, 99 (45.00%) in 2018, and 40 (18.18%) in 2019. The highest number of outbreaks were seen in 2018, and the lowest was in 2019. When the number of cases in ND outbreaks was evaluated, a total of 88372 cases were identified, as 15823 (17.91%) in 2017, 66015 (74.70%) in 2018, and 6534 (7.39%) in 2019. When the number of deaths was examined, a total of 75436 deaths were identified, 9519 (12.62%) in 2017, 60298 (79.93) in 2018, and 5619 (7.45%) in 2019. As a result of the comparisons according to the years, there was no statistically significant difference ($P>0.05$) in terms of the number of outbreaks, cases and deaths (Table 1).

Between 2017 and 2019, the first outbreak was reported in Samsun and Ordu provinces and subsequently, the infection was spread to 47 provinces of Turkey, probably as a result of movements of infected poultry from the infected farms. While the highest number of outbreaks were reported in Samsun in total, no outbreaks were reported in 34 provinces (Figure 1).

When the outbreak data were evaluated according to geographical regions, the highest number of outbreaks, cases and deaths were determined in the Black Sea region. The least number of ND outbreaks was reported in The Southeastern Anatolia and The Marmara Region on these dates. As a result of the comparisons according to the regions, there was a statistically significant difference ($P<0.05$) in the number of outbreaks, but there was no statistically significant difference ($P>0.05$) in terms of cases and deaths (Table 1). On the other hand the outbreak data were evaluated according to seasons, the highest number of outbreaks, cases and deaths were determined in spring season. The least number of ND outbreaks was reported in autumn season. As a result of the comparisons according to the seasons, there was a statistically significant difference ($P<0.05$) in the number of deaths, but there was no statistically significant difference ($P>0.05$) in terms of outbreaks and cases (Table 1). The peak month of Newcastle disease was in May, the lowest month was October (Figure 2).

When the number of cases between 2017-2019 was evaluated, it was seen that the highest number of cases was in Samsun in 2017, Bartın in 2018 and Yozgat in 2019. According to the case and death numbers reported in Turkey between these dates, the case-fatality rates are calculated. It is determined that the highest case-fatality rate is in the province of Bitlis and Rize in 2017 (100%), in the province of Çankırı, Erzurum and Hatay in 2018 (100%), in the province of Trabzon in 2019 (100%), the number of cases

in these provinces is not very high. When we evaluate the Newcastle cases and deaths, cases were seen in 33 provinces in 2017 and no cases were observed in 48 provinces. While cases were seen in all six geographical regions of Turkey, no cases were reported in the Marmara region. It was determined that the case-fatality rate was very high in six provinces where the outbreak was seen (Figure 3). In 2018, cases were seen in 34 provinces and no cases were seen in 47 provinces. The outbreak was seen in all regions of Turkey. Case-fatality rates were calculated to be high in many provinces (Figure 4). In 2019, cases were seen in 24 provinces and no cases were seen in 57 provinces. While the cases decreased considerably in 2019, case-fatality rates remained high (Figure 5).

Discussion and Conclusion

Evaluation of the spatial and seasonal distribution of Newcastle disease is critical for continued surveillance of the disease, as it is located on the main transit route for migratory birds in Turkey, Europe and Asia, and the simultaneous different seasonal characteristics. In this study, ND was evaluated according to spatial and seasonal.

When the disease is examined spatially, 36 outbreaks were seen in 8 provinces in 2017, 59 outbreaks in 11 provinces in 2018 and 16 outbreaks in 8 provinces in 2019 in the Black Sea region. When the Black Sea region was evaluated in detail, it was determined that the area where the outbreaks were intense was the province of Samsun. Similarly, in the study conducted in previous years on ND status in Turkey, it was reported that the disease is common in Samsun province, which is located in the Black Sea Region (16). As a result, it has been determined that the Black Sea Region is the region with the highest number of outbreaks for all years. It is thought that giving

priority to this area with the measures to be taken will contribute to the eradication of the disease.

When the number of deaths was evaluated, it was determined that the area that caused the most deaths in 2017 and 2018 was in the provinces of Samsun and Bartın in the Black Sea Region, but the area that caused the most deaths in 2019 was in Yozgat, which is in the Central Anatolia region. When the number of provinces affected by the outbreak in Turkey was examined, it was determined that there were 33 provinces in 2017, 34 provinces in 2018 and 24 provinces in 2019. In a study conducted in previous years, it was reported that the number of provinces affected by the outbreak was 48 in 2013 and 20 in 2014 (16). In this context, it cannot be said that the number of affected provinces has decreased consistently over the years and that active surveillance systems have yielded results.

Also in this study ND was evaluated seasonally. It has been reported that ND outbreaks occur throughout the year in Turkey and the area causing the most deaths in all seasons was the Black Sea region. Similarly, ND is said to occur throughout the year in the rural poultry populations in most countries. However, it has been reported by many authors that it is important in the seasonal incidence and severity of the disease (8). A study in Thailand reported that ND cases occur throughout the year, but the incidence peaks at the end of the season between February and April (22). Similarly, at the end of April, the highest number of outbreaks was observed in May (36, %16,36) Turkey.

Another study reported ND outbreaks in Mauritania throughout the year, particularly during the warm season starting in March (9). Similarly, ND outbreaks

were reported to be high in our country, especially in March (24, 10.91%), April (29, 13.18%), and May (36%, 16.36%) with the onset of hot seasons.

In different studies, it has been reported that ND outbreaks are more common in winter (7) and hot and dry season (September-November) and hot humid season (January-March) (24). A review concluded that ND outbreaks are often associated with seasonal change, particularly at the onset of the rainy season, with cold and hot weather (19). In Turkey, the most outbreaks were seen in the spring (89, %40,45) and the least in the autumn (30, %13,63). When the literature is reviewed, it can be said that the ND outbreaks is not associated with a specific season, but rather with climatic stress periods.

With this research, the geographical distribution of the disease was examined, it was determined that the epidemics were intense in the Black Sea region and the least number of epidemics was observed in the Marmara region and Southeastern Anatolia. In addition, with the maps created using geographic information systems, the areas where the disease is seen are shown on the map. It has been tried to show that besides standard methodological approaches, spatial mapping can be used to gather information about the places where the disease occurs and can be useful in identifying priority areas where precautions should be taken. As a result, the importance of a systematic approach has emerged before, during and after the eradication program. It has also been concluded that the improvement of prevention and control strategies for ND in endemic countries is necessary (14).

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Ethical Statement

This study does not present any ethical concerns.

Conflict of Interest

The authors declared that there is no conflict of interest.

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315 **Table 1**. Newcastle Outbreaks, Cases, Deaths Poultry by Years, Geographical Regions

316 and Seasons.

	Outbreaks			Cases			Deaths		
	n	**%**	**Med(Min - Max)**	**n**	**%**	**Med(Min - Max)**	**n**	**%**	**Med(Min - Max)**
Year									
2017	81	36.82	1(1-4)	15823	17.91	125(8-2200)	9519	12.62	70(3-1400)
2018	99	45	1(1-6)	66015	74.7	100(2-51122)	60298	79.93	85(2-48035)
2019	40	18.18	1(1-2)	6534	7.39	80(6-849)	5619	7.45	68(4-766)
p		0.164			0.427			0.788	
Region									
Mediterranean	24	10.91	1(1-2) [ab]	3158	3.57	100(8-543)	2107	2.79	60(3-520)
Eastern	22	10	1(1-3) [ab]	3317	3.75	123(2-744)	2750	3.65	80(2-714)
Aegean	21	9.55	1(1-2) [b]	4221	4.78	120(8-1369)	2983	3.95	59(8-840)
Southeastern	2	0.91	1(1-1) [b]	760	0.86	380(320-440)	558	0.74	279(168-390)
Central Anatolia	38	17.27	1(1-2) [b]	10684	12.09	114.5(4-2200)	7609	10.09	82.5(4-1400)
Black Sea	111	50.45	1(1-6) [a]	65501	74.12	97(4-51122)	58857	78.02	74.5(3-48035)
Marmara	2	0.91	1(1-1) [b]	731	0.83	365.5(20-711)	572	0.76	286(18-554)
p		**0.01**			0.683			0.721	
Season									
Spring	89	40.45	1(1-4)	66709	75.49	88(2-51122)	58345	77.34	45(2-48035) [b]
Winter	63	28.64	1(1-6)	11986	13.56	131.5(5-1820)	9442	12.52	100(3-1390) [a]
Autumn	30	13.64	1(1-3)	4495	5.09	120(16-744)	3539	4.69	79(11-714) [ab]
Summer	38	17.27	1(1-6)	5182	5.86	103(4-861)	4110	5.45	90(4-825) [ab]
p		0.669			0.199			**0.025**	

317 [a,b] Values within a column with different superscripts differ significantly at P<0.05

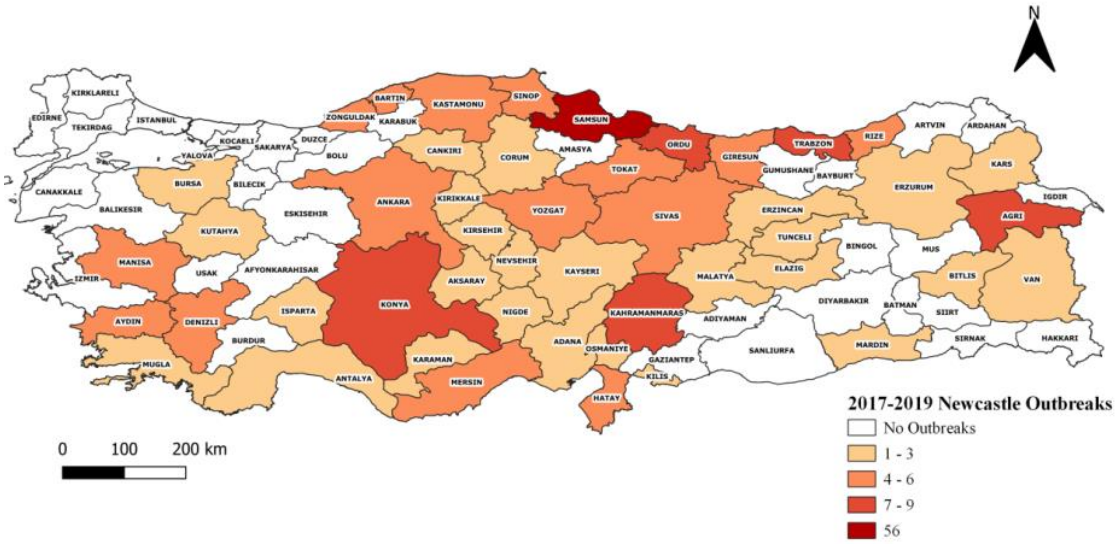


Figure 1. Map produced for Turkey according to Newcastle outbreaks between 2017-2019.

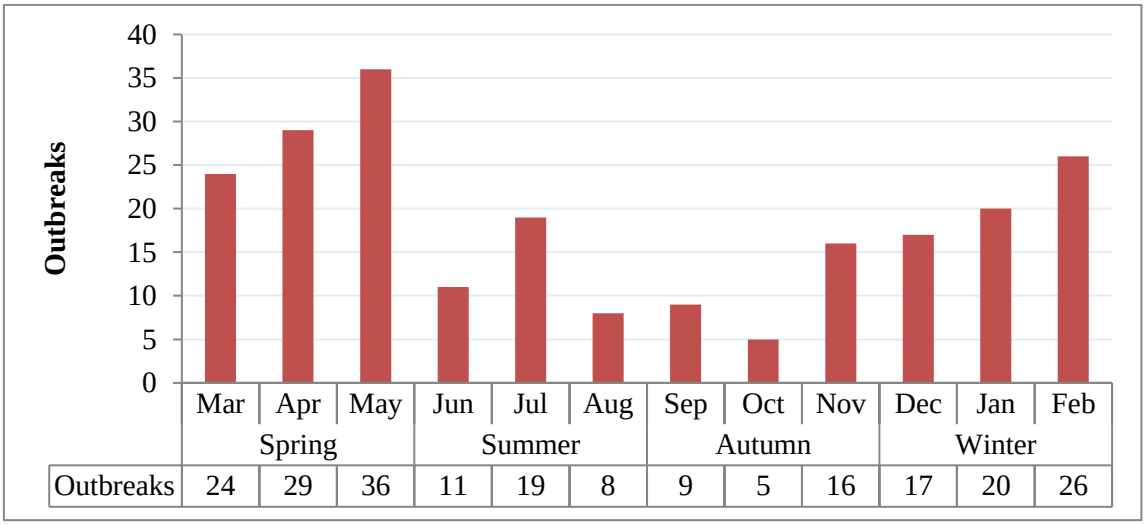
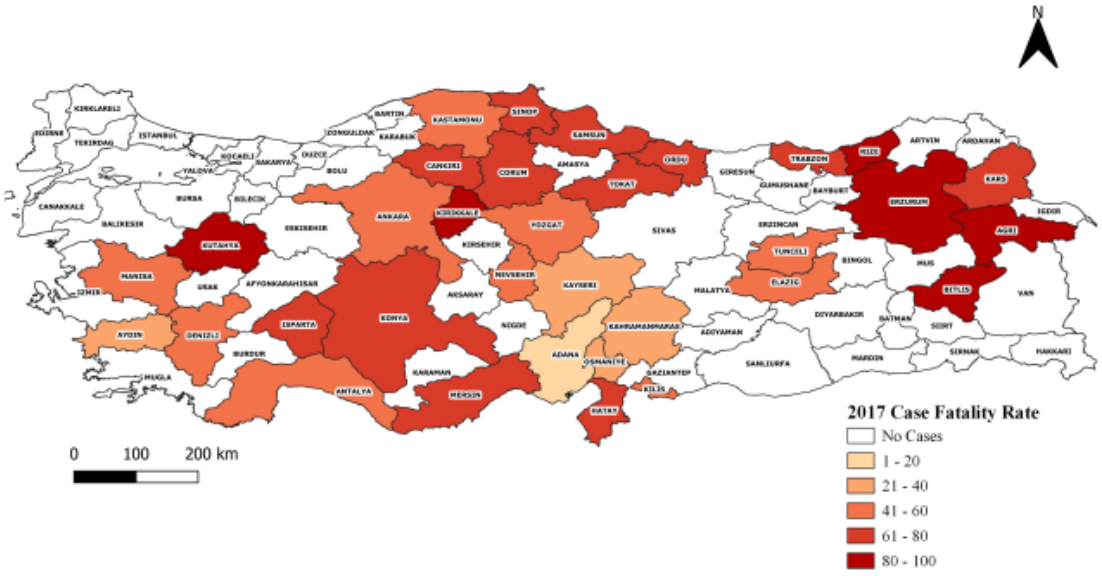


Figure 2. Newcastle Outbreaks by Seasonal in Turkey between 2017-2019.



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326 **Figure 3.** Map produced for Turkey according to Newcastle case fatality rates 2017.

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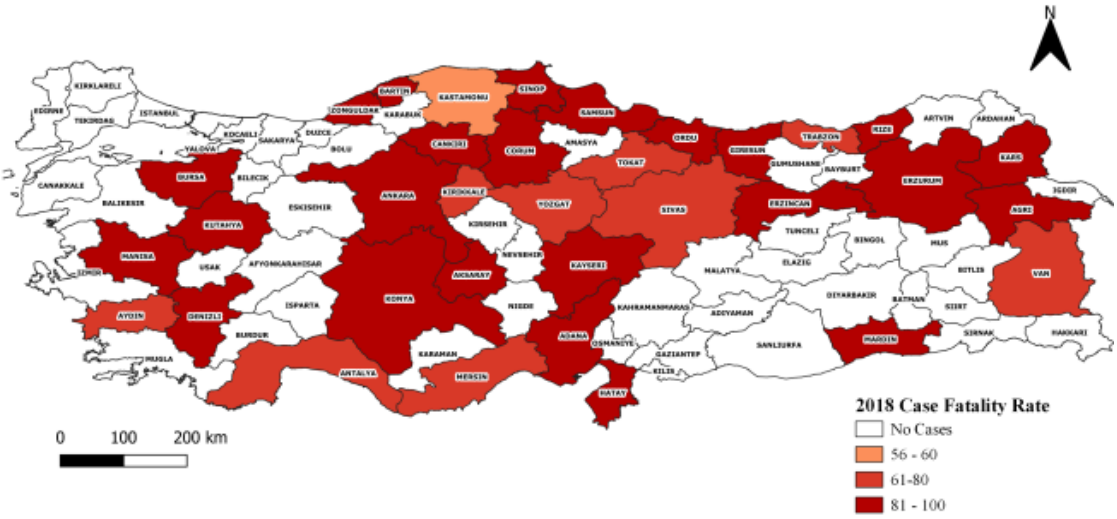

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329 **Figure 4.** Map produced for Turkey according to Newcastle case fatality rates 2018.

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332 **Figure 5.** Map produced for Turkey according to Newcastle case fatality rates 2019.