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Research article

MECHANISM EXPLORATION AND QUANTITATIVE ANALYSIS OF SWINE ERYSIPELAS OUTBREAKS

Yuewu LIU[1], Jiaxi LIU[1], Yuhang LIU[1], Shengyong LIU[1], Chun LI[1*]

[1]Hunan Agricultural University, College of Information and Intelligence, Changsha, China.

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Swine erysipelas (SE) is a severe pig disease, resulting in considerable economic losses. So, preventing its outbreaks plays a key role. The great majority of pigs in Hunan Province, China are reared in intensive swine production areas on farms. Feeders' care degree is responsible for the adhesion of SE to the food and tools. Meteorological elements (ME) are responsible for the survival time of SE. In this work, we presented a difference equation model based on these two aspects. Five key ME are identified. The most optimal ME for SE outbreak is analyzed. The mechanism of SE outbreak is explored. This work may help farmers take measures against SE outbreaks in advance, and reduce the financial losses.

Keywords: swine erysipelas, meteorological elements, care degree, difference equation.

INTRODUCTION

Swine erysipelas caused by Erysipelothrix rhusiopathiae is one of the oldest recognized infectious diseases. This disease is characterized clinically by sudden death, arthritis, fever, and skin lesions. Up to 50% of pigs in intensive swine production areas are colonized with E. rhusiopathiae [1]. It is necessary to study the mechanism of SE outbreaks in order to control SE.

Swine erysipelas is caused by Erysipelothrix rhusiopathiae which is an ubiquitous bacteria, but many other factors are important in disease outbreaks [1,4]. We have listed the months with the highest number of SE cases each year (Table 1). They span over a period of four months. There is no preference for the peak month statistically each year. So, it is a challenge to predict SE.

Many biomathematicians studied the forecast models for some diseases. The SIR model is the classic deterministic model. Some scholars [2-3] used various trigonometric functions in the transmission rate coefficient to describe the seasonal change. However, the fixed amplitude and period for trigonometric functions may not fit the complex disease data in Table 1 with no apparent pattern. Qin et al. [5] used a zero-inflated

*Corresponding author: e-mail: li.chun@hunau.edu.cn

negative binomial regression model to evaluate the independent contribution of ME to SE transmission. Other statistical models which considered ME were studied [6-8]. Inspired by the previous works, we will consider ME, which really shows the seasonal change, into a deterministic model to explore the mechanism of SE outbreak.

Table 1. The month with the highest number of swine erysipelas cases each year from 2010 to 2015 in Hunan Province, China *

Year	Month with the highest number of cases each year	Number of cases
2010	October	654
2011	July	528
2012	August	3555
2013	September	2524
2014	August	954
2015	July	912

* Swine erysipelas cases data is downloaded from China's Ministry of Agriculture.

MATERIALS AND METHODS

Data sources

Numbers of SE cases each month from January, 2010 to December, 2015 in Hunan Province, China are downloaded on the web of China's Ministry of Agriculture. They are shown in Fig 1. We also get data of ME each month from 2010 to 2015 in Hunan Province on the web of National Climatic Data Center. These ME include 23 factors.

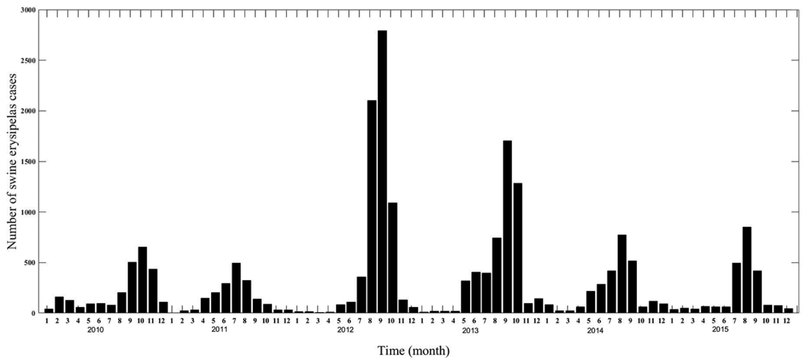

Figure 1. Corrected numbers of swine erysipelas cases.

Granger causality

After the first Granger causality test, nine ME were identified and listed in Table 2. Then, we carried on Granger causality test in each category further. Five key ME are identified and shown in bold in Table 2.

Table 2. Six categories, 9 meteorological elements [1] and 5 key meteorological elements [2]

Category	Meteorological element	Number
Atmospheric pressure	**Extreme minimum station pressure**, mean station pressure	2
Atmospheric temperature	**Mean minimum temperature**, mean maximum temperature, extreme minimum temperature, **average temperature**	4
Wind	None	0
Humidity	**Mean vapor pressure**	1
Rainfall	None	0
Sunshine	**Percentage of sunshine**, hours of sunshine	2

[1] 9 meteorological elements are identified at the first Granger causality test.
[2] 5 key meteorological elements are identified at the further Granger causality test and shown in bold.

Function for feeders' care degree

We define feeders' care degree as an indicator of how much attention feeders have for pigs. Logistic function is used as a characteristic curve for the development and psychometric assessment of measures [9]. As we know, the higher number of SE cases there is, the more attention feeders pay. So, we use the logistic function to describe the relationship between the feeders' care degree and the number of cases. It is given by

$$P(n)=\frac{K\cdot P_0}{P_0-\left(P_0-K\right)e^{-r\cdot n}} \tag{1}$$

where *n* is the number of SE cases, P_0 is the initial value of feeders' care degree with no SE case, *K* is the maximum value of feeders' care degree, *r* describes steepness of the Logistic growth rate of feeders' care degree.

Function for the vitality of swine erysipelas

The more suitable the meteorological condition is, the longer SE survives. Five key ME are denoted by $\chi=\left(x_1,x_2,\cdots,x_5\right)$. We denote that SE has the strongest activity $1/\sqrt{a_0}$ under the most suitable meteorological condition $\chi_0=\left(x0_1,x0_2,\cdots,x0_5\right)$. The activity $f(\chi,t)$ of SE is constructed as follows:

$$f(\chi,t)=\frac{1}{\sqrt{a0+\sum_{i=1}^{5}a_i\left(x_i(t)-x0_i\right)^2}} \tag{2}$$

Difference equation model

Firstly, we show how number of cases in this month affects the next month in Fig. 2.

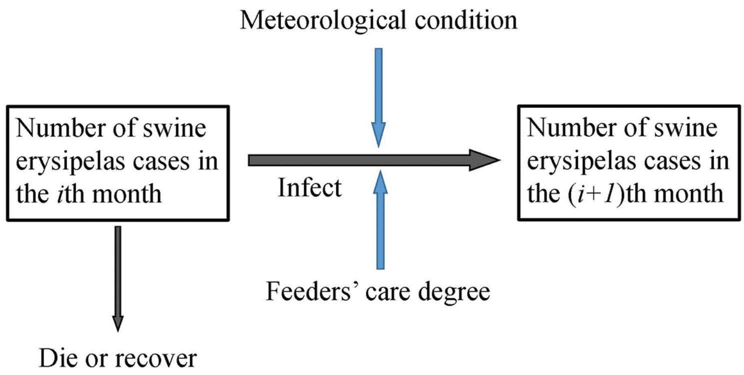

Figure 2. Flow diagram of number evolution of SE cases between two adjacent months.

Based on Fig. 2, we present the difference equation model as follows:

$$N(t+1) = \frac{f(\chi, t)}{P(N(t))} N(t) - d \cdot N(t) \tag{3}$$

where $N(t)$ is number of SE cases at t-th month. d is the ratio of death or recovery cases to the total cases in a month.

Identification of model parameters

The optimization problem with a regularization term [10-11] is given as:

$$\min_{\theta_1 \le \theta \le \theta_2} J(\theta) = \left\| n(\theta) - n^{(data)} \right\|_2 + \lambda \left\| \theta \right\|_2 \tag{4}$$

where θ is the parameter vector, θ_1 and θ_2 are the lower and upper bounds of θ, respectively. $n(\theta)$ and $n^{(data)}$ are the simulated value and epidemic data, respectively. $\lambda \left\| \theta \right\|_2$ is the regularization term, and the weight coefficient λ is set to 0.1.

RESULTS

Comparisons between the simulation results and epidemic data

We use data of SE cases and five key ME for the first five years to fit model (3). Data for the last year is used to test the model. Parameters are identified by Eq. (4) and listed in Table 3.

Table 3. Parameter values optimized by the Tikhonov regularization method (4).

Parameter	Value	Parameter	Value	Parameter	Value
a_0	38.76	a_1	3.50 x 10^{-18}	$x0_1$	1.65 x 10^{-12}
K	3.80	a_2	64.89	$x0_2$	0.73
P_0	0.08	a_3	17.74	$x0_3$	2.07 x 10^{-15}
r	3.13 x 10^{-4}	a_4	47.29	$x0_4$	1
d	0.67	a_5	1.60 x 10^{-14}	$x0_5$	2.97 x 10^{-12}

We can see that the error between the collected data and the fitted data in Fig. 3A is relatively small, and the predicted values are consistent with the collected data in Fig. 3B.

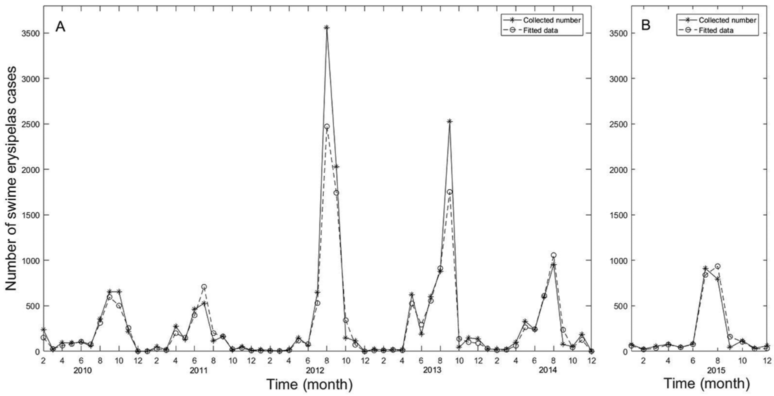

Figure 3. Fitting from 2010 to 2014 **(A)** and predicting for 2015 **(B)**.

Reduced model

In Table 3, $a_1, x0_1, x0_3, a_5, x0_5$ are very close to their lower bound 0. $x0_4$ is very close to its upper bound 1. S0, let $a_1\!=\!0, x0_1\!=\!0, x0_3\!=\!0, a_5\!=\!0, x0_5\!=\!0, x0_4\!=\!1$ to get the reduced model.

Elasticity values for all parameters are shown in Fig. 4.

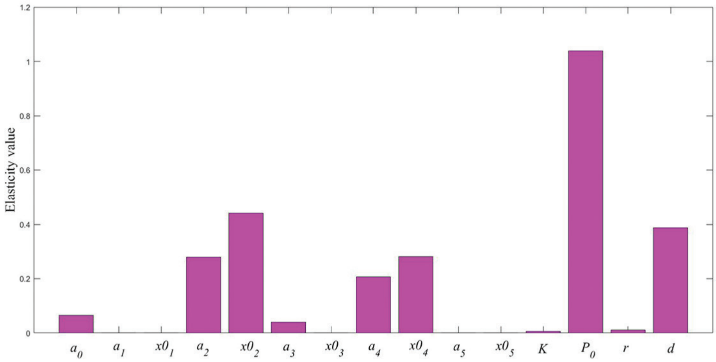

Figure 4. Elasticity analysis of parameters.

$f(\chi,t)$ are shown in Fig. 5A. $P(N(t))$ is shown in Fig.5B. $f(\chi,t)N(t)$ is shown in Fig. 5C. $f(\chi,t)N(t)/P(N(t))$ shown in Fig. 5D. $f(\chi,t)N(t)/P(N(t)) - dN(t)$ is shown in Fig. 5E.

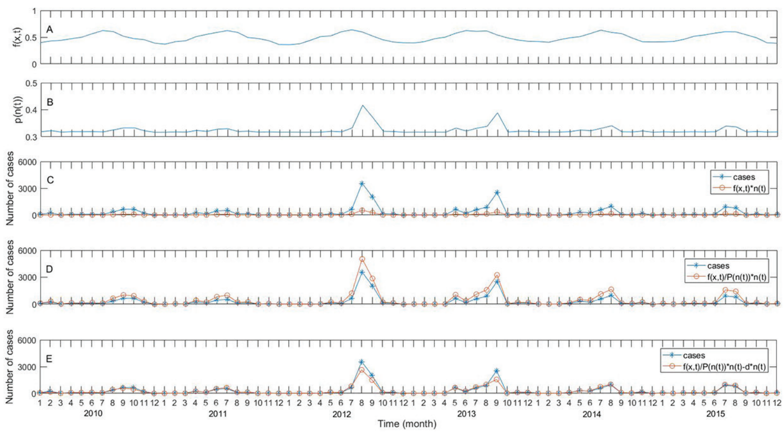

Figure 5. f(x, t), P(n(t)), f(x, t)n(t), f(x,t) P (n(t))n(t) and f(x,t) P (n(t))n(t)−d•n(t) for January, 2010 to December, 2015 in Hunan Province. f(x, t) is the activity function of SE, n(t) is the number of SE cases, P(n(t)) is the feeders' care degree.

Reliability of the reduced model

Method 1. We use data for the first four years to fit the reduced model. Data for the last two years is used to test the model. Results are shown in Fig. 6. The reduced model works well.

Method 2. We use data from 2011 to 2014 to fit the reduced model. Data for 2015 is used to test the model. The reduced model works well too (Fig. 7).

Method 3. We use data for the first three years to fit the reduced model. Data for the last three years is used to test the model. The reduced model works well (Fig. 8).

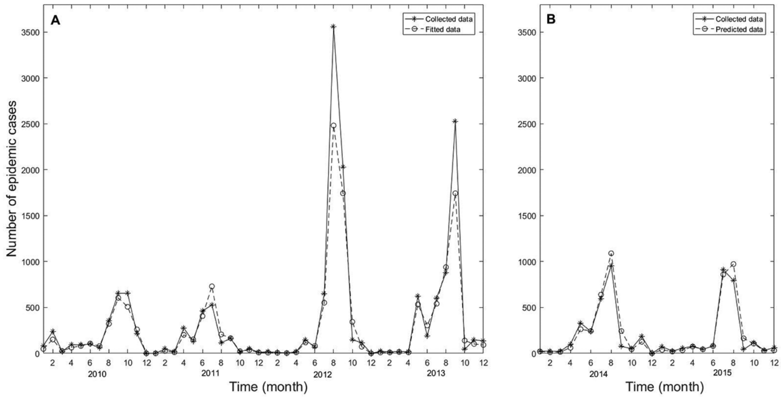

Figure 6. Fitting from 2010 to 2013 (**A**) and predicting from 2014 to 2015 (**B**).

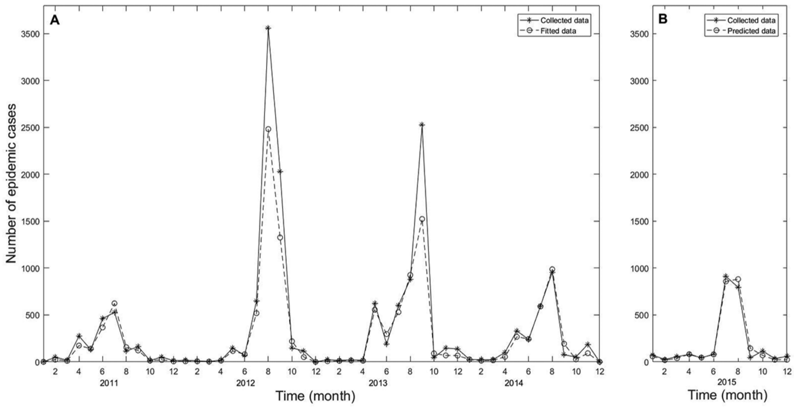

Figure 7. Fitting from 2011 to 2014 (**A**) and predicting for 2015 (**B**).

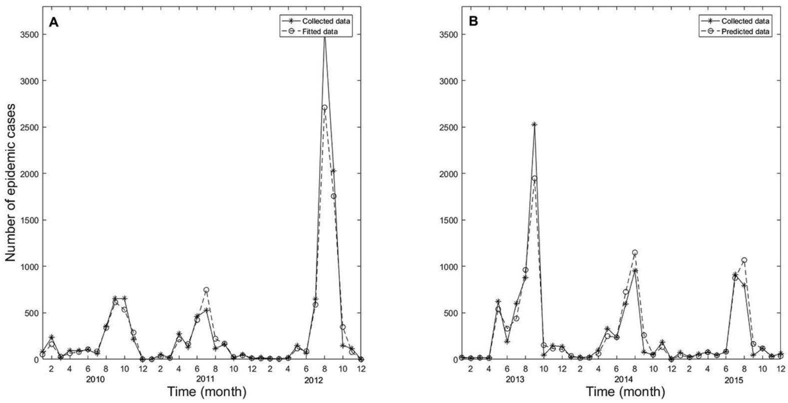

Figure 8. Fitting from 2010 to 2012 (**A**) and predicting from 2013 to 2015 (**B**).

Method 4. We use data from 2011 to 2013 to fit the reduced model. Data from 2014 to 2015 is used to test the model. The reduced model works still well (Fig. 9).

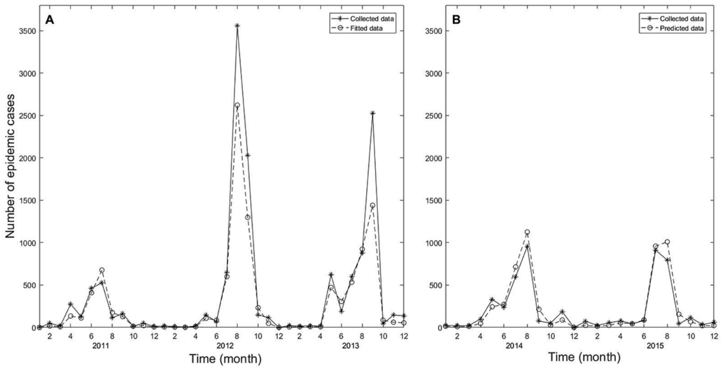

Figure 9. Fitting from 2011 to 2013 (**A**) and predicting from 2014 to 2015 (**B**).

Method 5. We use data from 2012 to 2014 to fit the reduced model. Data for 2015 is used to test the model. The reduced model works still well (Fig. 10).

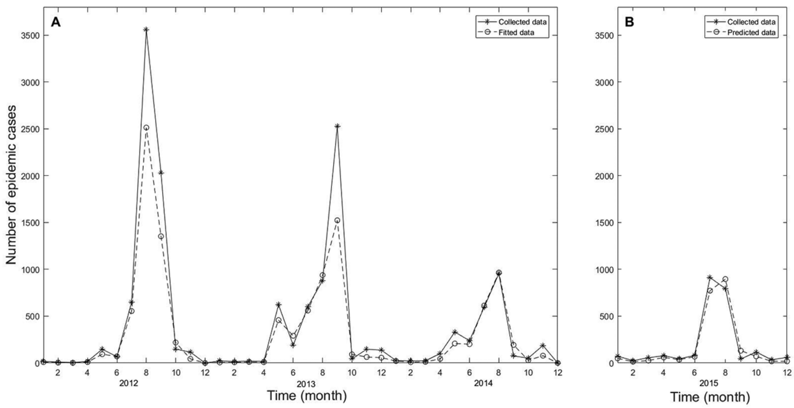

Figure 10. Fitting from 2012 to 2014 **(A)** and predicting for 2015 **(B)**.

DISCUSSION

Some measures, including extensive vaccination, preventive hygiene, etc., have been implemented in the last decade in China, but SE is still one of the most common porcine infectious diseases [12,13]. According to the report of China's Ministry of Agriculture, SE epidemic has a peak every year [13]. However, its peak month is not fixed (Fig. 1). Some clinical veterinarians generally believe that SE outbreak is related to meteorological elements, but details are not clear [4,13]. Qin et al. [4] found that there was a positive correlation between monthly mean maximum temperature and relative humidity and the number of cases. In our work, five key meteorological elements closely related to SE epidemic, including extreme minimum station pressure, mean minimum temperature, average temperature, mean vapor pressure, and percentage of sunshine, are identified by Granger causality. Results of these two methods are compared as follows. Monthly mean maximum temperature identified by Qin et al. [4] has close links with mean minimum temperature and average temperature identified by us because these three meteorological elements are all used to describe the atmospheric temperature. Relative humidity identified by Qin et al. [4] has close links with mean vapor pressure identified by us because these two meteorological elements are all used to describe the atmospheric humidity. Therefore, our method extends key meteorological elements presented by Qin et al. [4] and finds more key meteorological elements.

In Fig. 3B, our model works well to predict the SE epidemic outbreak in July and October, 2015. At the same time, it works well to predict the end of SE epidemic in September, 2015. On this point our model is superior to the previous works [4,14]. Moreover, in Fig. 6-10, reliability analysis of our model shows that our model has a good stability. Therefore, our model might be reasonable to simulate the number fluctuation of SE cases.

Based on sensitivity analysis of all parameters in Model (3) in Fig. 4, we conclude that three meteorological elements (i.e. percentage of sunshine, extreme minimum station pressure, mean vapor pressure) have more important effect on SE. The most suitable meteorological element values for the vitality of SE may be $x0_2 = 0.73, x0_3 = 0, x0_4 = 1$. Therefore, when these three meteorological elements are tending to these values, the activity of SE will hugely increase, and feeders may pay more attention on crushing SE outbreak. P_0 is the most sensitive to the number change of epidemic total cases for 2015. Therefore, we conclude that feeders should pay more attention on sterilizing tools and equipment even with no SE epidemic cases.

In Fig. 5C, $f(\chi,t)N(t)$ increases as the number of SE cases increases. However, its amplitude is significantly less than that of SE cases. Therefore, the activity function $f(\ ,t)$ of SE does not fully describe the number fluctuation of SE cases. We can see that $P(N(t))$ in Fig.5B roughly changes with the number of SE cases $N(t)$ in Fig.5C. Therefore, the infectivity of SE might rely on a combination of the activity of SE and feeders' care degree. $f(\chi,t)N(t)/P(N(t))$ is defined in Model (3). It roughly consists with the number of SE cases in Fig. 5D. Moreover, $f(\chi,t)N(t)/P(N(t)) - dN(t)$ in Fig. 5E is closer to the number of SE cases. Taken together, meteorological elements may affect the activity of SE. Moreover, feeders' care degree may affect the SE transmission. They have a combined effect in SE outbreak.

However, this study also has some limitations which should be noted. Firstly, we identify the key meteorological elements related to SE epidemic by Granger causality test. We declare that there are other methods to find key meteorological elements, and their results may vary somewhat. Secondly, our model is based on three factors:

meteorological elements, feeders' care degree and number of SE epidemic cases. Other potential socio-economic influence factors were not accounted for, such as a more effective vaccine [15], stricter breeding management system. These factors may reduce the accuracy of our model prediction. Lastly, $f(\chi,t)$ is constructed to describe the activity of SE based on our assumption. This function $f(\chi,t)$ is an approximation and it has some errors with the activity function of SE.

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Authors' contributions

YL conceived and designed the experiments and authored or reviewed drafts of the paper. JL and YL analysed the data. SL and CL prepared figures and tables. All authors read and approved the final manuscript.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ORCID iDs

Yuewu Liu https://orcid.org/0000-0003-1992-8776
Jiaxi Liu https://orcid.org/0009-0000-9375-7798
Yuhang Liu https://orcid.org/0009-0008-2318-0610
Shengyong Liu https://orcid.org/0000-0002-9970-8257
Chun Li https://orcid.org/0000-0002-1052-4305

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ISTRAŽIVANJE MEHANIZMA I KVANTITATIVNA ANALIZA *ERYSIPELAS* EPIDEMIJE KOD SVINJA

Yuewu LIU, Jiaxi LIU, Yuhang LIU, Shengyong LIU, Chun LI

Erysipelas svinja (SE) je teška bolest svinja koja rezultira značajnim ekonomskim gubicima. Stoga, sprečavanje epidemija igra ključnu ulogu. Velika većina svinja u provinciji Hunan, Kina, uzgaja se u područjima intenzivne proizvodnje svinja na farmama. Stepen brige o hranilicama je odgovoran za adheziju SE na hranu i alate. Meteorološki elementi (ME) su odgovorni za vreme preživljavanja SE. U ovom radu, predstavili smo model diferencijalne jednačine zasnovan na ova dva aspekta. Identifikovano je pet ključnih ME. Analizirali smo najoptimalnije ME za pojavu crvenog vetra svinja. Istraživan je i mehanizam pojave crvenog vetra svinja. Ova istraživanja mogu biti korisna u stočarstvu i sa ciljem da se preventivno preduzmu mere protiv epidemija SE i tako smanje finansijski gubici.

Supplementary files

Table 4. Cases of swine erysipelas in Hunan Province, China.

Year	Month	Cases of Swine Erysipelas	Year	Month	Cases of Swine Erysipelas
2015	12	60	2012	12	0
2015	11	33	2012	11	116
2015	10	117	2012	10	149
2015	9	43	2012	9	2030
2015	8	793	2012	8	3555
2015	7	912	2012	7	649
2015	6	81	2012	6	69
2015	5	43	2012	5	147
2015	4	78	2012	4	17
2015	3	56	2012	3	5
2015	2	25	2012	2	10
2015	1	73	2012	1	18
2014	12	0	2011	12	12
2014	11	187	2011	11	51
2014	10	52	2011	10	16
2014	9	75	2011	9	162
2014	8	954	2011	8	115
2014	7	21455	2011	7	528
2014	6	238	2011	6	461
2014	5	330	2011	5	130
2014	4	101	2011	4	275
2014	3	23	2011	3	17
2014	2	22	2011	2	49
2014	1	26	2011	1	1
2013	12	137	2010	12	0
2013	11	147	2010	11	215
2013	10	43	2010	10	654
2013	9	2524	2010	9	654
2013	8	882	2010	8	353
2013	7	602	2010	7	58
2013	6	190	2010	6	103
2013	5	621	2010	5	91
2013	4	17	2010	4	96
2013	3	19	2010	3	20
2013	2	16	2010	2	237
2013	1	22	2010	1	85

Table 5. Meteorological elements in Hunan Province, China. We take the following notation. **a1**: Average minimum temperature (one day), **a2**: Average maximum temperature (0.1 °C), **a3**: Daily precipitation >=0.1mm days (0.1m/s), **a4**: Sunshine percentage (0.1mm), **a5**: Sunshine duration (0.1 °C), **a6**: Maximum wind speed (bearing), **a7**: Wind direction of maximum wind speed (0.1 °C), **a8**: Maximum daily precipitation (0.1m/s), **a9**: Minimum relative humidity (1%), **a10**: Maximum wind speed (0.1 °C), **a11**: Wind direction for maximum wind speed (0.1 °C), **a12**: Extreme minimum Station Pressure (0.1 °C), **a13**: Extreme Minimum Temperature (0.1hPa), **a14**: Extreme maximum Station Pressure (0.1hPa), **a15**: Extreme maximum temperature (0.1hPa), **a16**: Precipitation anomaly percentage (1%), **a17**: Precipitation (0.1mm), **a18**: Average station air pressure (1%), **a19**: Average wind speed (0.1 hours), **a20**: Average temperature (1%), **a21**: Average temperature anomaly (0.1mm), **a22**: Average water vapor pressure (0.1m/s), **a23**: Mean relative humidity (orientation).

Year	Month	a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	a15	a16	a17	a18	a19	a20	a21	a22	a23
2010	**1**	44	107.75	12	19	627.75	76.25	6	141.75	26.75	127.5	6.25	9970.75	-11.75	10200.3	218	-38.75	462.75	10082.75	19.25	69.5	18.25	73.75	73
2010	**2**	59.75	126.25	9	21	650.75	86.5	8	111	20.25	143.75	8	9799.75	-7.5	10207.3	299	-65	287.25	10031.75	21.75	86.75	17.75	83.25	71.75
2010	**3**	88	170	16.75	30.25	1118.5	82	10.25	221.75	16.25	135.25	7	9881	0.75	10253.5	288.5	-7.25	1079.25	10031.5	23.25	121.75	15	95	67.5
2010	**4**	125.75	195.75	19.75	23.25	889.75	80.5	6	417.5	22.5	139	5.75	9869.5	46	10134.3	300.5	19.25	2124.5	10005.5	19.25	155.25	-15.25	131.25	74.75
2010	**5**	188	258.5	18.75	23.25	968.5	70.75	230.75	675.5	22.5	129	3.75	9834	151.5	10010.5	336.25	34.25	2539.5	9929.5	15.75	217.75	-0.5	195.25	76
2010	**6**	219.25	285.5	16.75	21.25	888.25	65.5	5.75	952.5	38.25	112	10.5	9838.75	174	9997.5	350.75	49.25	2912.25	9913.25	15.75	246.5	-6.75	240.75	78
2010	**7**	265.75	343	9.25	55.5	2359.25	88.5	10.75	576.25	40	162.75	11	9835	240.5	9949	365.75	-20	1209	9891.25	19.5	298	14.75	289.25	70.25
2010	**8**	254.5	344.75	8	65	2638.25	73.75	8.5	356	27.5	135.5	9.25	9843.25	196.5	9988.75	401.25	-26	906.75	9920	18.5	292.75	15.25	265.25	67
2010	**9**	220.25	286.5	14	31.75	1173.75	74.5	5.75	434	32.25	131.5	2.25	9868	150.5	10051.3	377.75	66.25	1243	9953.75	18.25	246.5	11.5	238.25	77.5
2010	**10**	149.5	219.25	11	32	1134	65	5.75	239.5	24.25	114.75	6.25	9908	72	10171	281.25	-2.25	836.5	10031.75	18.5	178	-4	152	74.75
2010	**11**	104	192	10	44.75	1437.25	69.75	5.75	124.25	18.5	117.75	6.25	9937	64.75	10168.8	268.25	-48	317.5	10056.5	14.25	140	13.5	109.75	71.5
2010	**12**	54	139	8.25	34.25	1100.75	72.5	5.75	393	17.5	123.75	5.5	9932	-14.25	10199.8	233.25	154	960.5	10047	17.75	89	12	79.5	70.75
2011	**1**	3.5	44.5	10.75	11.75	387	67.25	6.25	154.5	19.25	107.5	231	10032.8	-36	10223.5	96.75	-27.5	482.5	10134.5	19.25	20.75	-30.5	46.5	67
2011	**2**	54.75	136.75	8.25	22.75	709.5	73.25	6.5	97	23.75	118	6.75	9883.75	-9.5	10148.3	246	-66.5	303.25	10037.25	17.75	87.5	18.5	81.75	71.5
2011	**3**	75.75	147	15.5	22.25	821	82.75	5.75	162	14.25	148.25	5.5	9906.25	17.5	10207.3	245	-56.75	559.75	10070.5	17.5	104.75	-2	86.75	70
2011	**4**	149.75	233.75	13.75	30.75	1169.75	72.25	5.75	182	15.25	122.25	8	9863.5	55.5	10106.3	331.5	-66.25	588.25	9987	17	186	15.5	144.75	69.25
2011	**5**	182	279.75	9.5	42.5	1775.5	76.5	6.25	388.25	17.25	130.75	233	9816.25	124	10027	352.75	-46	1064.5	9942.5	19	224.5	6.25	175.75	66.25
2011	**6**	231.75	298.75	17	28.5	1183.25	61.5	227.5	643.5	38	104.5	9	9811.75	181.5	9972.25	360.25	18.75	2477.75	9884.5	16.25	258.25	5	258	78.25
2011	**7**	257.25	345.75	4.25	57.5	2437.5	80.5	11.75	100.25	27.75	133.5	11.25	9808.25	215.5	9922.5	391.25	-88.75	187.5	9876.5	19.5	296.75	13.5	256.75	63
2011	**8**	244.5	331.25	6.75	56.25	2288.75	74.75	10.25	301	26	137.75	8.5	9838.25	203.75	9969	379	-46.25	670.5	9906.25	19.5	281.25	3.75	252	68.25

2011	**9**	208.25	281.75	10.75	27.75	1019.25	64.75	231.5	248.75	31.25	115.75	7.25	9862.25	125.25	10071.3	357.75	-33	454.5	9960.75	18.75	237	2	210	71
2011	**10**	153.25	223.75	11.75	31.5	1117.75	56	6.25	297	22.25	106	6.25	9954.5	103	10118.3	303.75	23.5	1050.5	10032.75	16.25	181.75	-0.25	152.5	74.75
2011	**11**	127	207.75	6.75	38.75	1256	61.75	231	165.25	30	111.75	6.25	9943.5	51	10145.5	251.5	-29	437.75	10042.75	15.5	159.25	32.75	134.75	74.75
2011	**12**	48.5	103.75	7.75	22.25	716.75	58.75	2.5	73.25	18.25	109.25	2.25	10026.3	-3.25	10220.3	155	-58.75	161	10123	17	71.25	-5.75	61.5	62
2012	**1**	23.25	58.5	14.5	6.5	213.25	70.5	230.5	306.5	31.75	116.75	6	9963.5	-32.75	10170.5	128.25	17.25	840.25	10062.75	21.5	38	-13.25	60.25	75.5
2012	**2**	33.75	71.5	17.25	6.75	217.75	76.5	5.75	172.75	22	120.5	6	9905.75	-3.75	10137.5	139.75	-30.5	552.25	10029.25	24	49.5	-19.5	65	74.5
2012	**3**	77.75	136	19.25	16.75	613.5	78.75	6	341.5	12.75	130.5	6.5	9900	30.5	10102.5	273.5	23	1447.5	9996.75	22	102.25	-4.5	93.25	76.25
2012	**4**	155.25	234.25	17	28.75	1096.5	104	11.5	345	16.25	189.25	9	9758.5	92.75	10066.5	321.75	-11.75	1547.25	9921	22	187	16.5	155.5	72.75
2012	**5**	194	260.75	19.25	25.5	1065	98.25	6.5	536	30.75	171	10.25	9813	155.5	9955.25	336.75	30.5	2449	9899	21.25	221.5	3.25	209.5	80
2012	**6**	228.75	300.25	14.5	29	1199.25	70.5	5.75	463.5	32	118.5	9.5	9770.75	182.75	9941.25	354.75	-14.25	1729.5	9839	17.25	258.75	5.5	254.25	77.5
2012	**7**	257.5	335.75	11	58.25	2476.25	96.5	7.25	694.5	38.25	154.5	230.75	9784.25	231.5	9891.25	368	21.75	1807.75	9839.75	23.5	291.5	8.25	278.5	70.5
2012	**8**	244.5	324.25	8.5	44.75	1830.75	107.5	5.25	383.5	34.75	181	8.25	9789	201.25	9947.75	367	-11.25	1159.5	9863.25	22.5	277.25	-0.25	271.5	74
2012	**9**	201.75	281.25	11.25	39.75	1465	85.25	227.75	450	21.25	150.25	2	9857.75	146.75	10020.3	352	50.5	1066	9943.75	21	233.75	-1.25	204.5	72
2012	**10**	159.25	228.25	11.25	27.75	995.25	104.25	6	240.25	21.75	169.75	2	9924.75	103.5	10076.5	294.75	-12.25	750.5	9986.75	19.5	187.5	5.5	157.75	74.75
2012	**11**	93.75	150.5	14.75	23	728.75	88.5	6	402	26.25	147.5	6.25	9934.25	49.5	10100.8	231.25	114.75	1327	10005	21	117.5	-9	106.5	78
2012	**12**	37.25	88.25	16	20.25	653.5	76.75	5.75	195.5	24.75	139.5	5.25	9931.25	-20.75	10196.8	188	88.75	721.25	10048.75	22.75	58.25	-18.75	73	78.75
2013	**1**	31	98	11	22.25	731.75	75.5	5.5	58	23.75	134.75	6.5	9944	-29.5	10198.3	196	-65.5	226.75	10053.5	18.75	59	6.5	70	74.25
2013	**2**	54.25	107	16.25	9.75	305.5	78.75	5.5	143.75	40.5	134.75	7.5	9852.25	-16.5	10145.8	226	-35.25	552.75	10025.75	21.5	75.5	1.5	88.5	83.25
2013	**3**	109.25	202.25	14	30.75	1147.25	116	8.5	371.75	15.25	186.75	8	9845.75	31.25	10153	301	23.5	1476.75	9974.5	23.5	146.5	33.5	115.5	69.75
2013	**4**	138.75	223.75	15.5	28.5	1108.5	118.75	8	426.5	18.75	209.5	5.25	9815.25	66.25	10059.3	324.75	-5.75	1579	9940.25	21.75	174	-0.25	143.5	72.5
2013	**5**	193.25	277.25	17.75	31.25	1307.5	93.25	5	719	17.75	158.25	4.5	9781	145.25	9976.25	353.75	33	2530.5	9893	19.75	228	5.75	206.25	75.5
2013	**6**	233.5	314.25	10.5	48.25	2002.25	90.75	5	373	27	143	230	9774.25	171	9934.25	370.75	-36	1306.75	9857.5	19.5	268	11.75	259.75	74.75
2013	**7**	268	357	2.75	76.5	3235.75	94	10.5	142	28.75	146.5	10.75	9791.75	247.5	9891.25	390	-85.25	237	9845.25	24.75	308.75	23	259.75	59.5
2013	**8**	262.75	351.25	8.5	59	2369.5	114.25	3.75	541.75	24	186.5	6.75	9762.75	227	9936.75	401	11.5	1375.5	9853.25	26	300.25	21.5	260.75	64.25
2013	**9**	201	277.5	10.75	40.5	1470.25	104	5	702.75	27.75	172.5	230.25	9833	127.25	10044.3	349	190.5	1909.25	9933	22.5	232.75	-5.75	216.5	77.25
2013	**10**	157.5	243.5	5.5	44	1538	82.25	5.75	110.25	21	144	5.5	9911.25	102.75	10088	318	-78.75	181	9998.5	20.25	194	9.75	145.5	66.75

2013	**11**	109	185	8.75	39.25	1260	79.75	9.5	377.5	24.25	147	9.5	9917	32.5	10141.5	285	48.5	1065	10028.5	19.75	140.5	10.5	118.75	74.25
2013	**12**	45.25	126.75	3.75	40.25	1292.75	80.5	227	187	14.5	142	6	9931.5	-13	10157	216.25	-11.25	387	10057.25	19.5	80.75	4.75	64.25	61
2014	**1**	50.25	140.5	6.25	41.5	1367.5	63.5	12	89	13	109.5	7.5	9896.5	-3.5	10166	256.25	-63.25	242	10044.25	19.25	88.5	36	67.5	62.25
2014	**2**	40.5	88.25	14.75	14	446.5	84.75	6.25	223.5	31.5	134.5	5	9874.5	-37.75	10135.8	251.5	-2.5	804.75	10028.5	21.25	59.25	-14.75	78.5	81.75
2014	**3**	105	171.25	18.5	18.5	698	87.25	8.5	297.75	33.25	160.75	6	9834.5	39	10105	280.75	8.75	1354.5	9993	20.75	131.25	18.25	125.75	81.25
2014	**4**	153.5	220.25	14.75	20.25	793.25	81.75	10.5	258.5	27	128.75	3.75	9860	119.75	10029.8	296	-29.25	1185.25	9951.5	20.25	180.25	6	166.25	81.5
2014	**5**	186.75	258.25	18	24.25	1025.25	82.5	8.75	573.5	22.5	142.25	5.25	9804.5	130	10026.5	324	19	2244	9904.25	18.75	216.25	-6	207.75	80.75
2014	**6**	226	287.75	17	18.75	764.5	79.25	13.25	779.75	39	135.5	10.75	9790.5	202	9903.75	342.75	-10.25	1814.25	9857.25	18.5	251.25	-5	269.25	85.25
2014	**7**	247.5	328	13.5	50.25	2122.25	84.75	8.5	751.5	36.75	133	7.25	9789	218.75	9925	373.5	39.25	2097.25	9860	17.25	280.5	-5.25	298.75	80.75
2014	**8**	234	308.25	13	40.75	1648	79	233	594.25	39.5	132.25	13.75	9801.75	191.5	9959.5	371.5	4.25	1221.25	9882.25	18.5	263.5	-15.25	272.75	81
2014	**9**	214.5	289.75	9.25	38.5	1408	70.5	11	252.25	34.75	113.25	5.25	9842.5	172	10004.3	355.75	-1	629	9918.75	20.25	244.25	5.75	240.75	79.75
2014	**10**	170	259.5	6	50.75	1788.75	72.5	7.5	335.25	22.75	127.5	6.5	9909.5	127.25	10075.3	314.25	-19.75	672.5	9985.75	20.25	207.25	23	165.5	70
2014	**11**	114.75	165.5	15.25	18.75	600	77.5	6.25	367.25	26.25	135.25	2	9923.75	74.75	10109.3	223.5	47.75	1054.75	10021.5	20.25	135.25	5.25	117.25	77
2014	**12**	48.25	123	5.75	38.75	1245.75	75.75	226.75	76.75	15.5	129.75	6.25	9973.5	-5.75	10201.5	192	-65.5	155	10079.5	20.75	79.25	3.25	62.75	60.75
2015	**1**	52.75	116.75	11.5	22.75	750.5	80.75	9.25	69.25	22.5	138.5	5.5	9883.75	-6	10142	198.75	-59.75	264.25	10038.25	22	79.75	27.25	78	74.25
2015	**2**	62	125.25	15	22.75	721.25	87.5	10.25	318.25	24.75	145.25	7.5	9887.25	-8.5	10135	233.5	5.5	913	10005.5	22	88.75	14.75	89.75	78.5
2015	**3**	97.25	159	15	14.75	554.25	84.75	457	275.5	41.25	140.75	8.25	9815	31.25	10103.3	303	-28.25	883.5	9984	22.5	122.5	9.5	123.5	84.5
2015	**4**	141.25	225.5	14.5	33	1272	100.5	5.25	441.5	21	172.75	11.25	9756.75	69	10083	322.75	-38	1027	9936.5	25.75	176.5	2.25	158.75	78.25
2015	**5**	195	266.5	18	22	921.75	130.5	5.75	470.25	39.5	215.25	4.5	9787	117.75	9982.25	323	19.5	2271.25	9874.5	21.25	224.25	2	229.75	85
2015	**6**	229	299.75	14.75	32.5	1345	86.75	12.5	582.25	40.25	143.25	8.25	9778.25	176	9912.5	357.75	5	2173.5	9844	23	258	1.75	276.5	84.25
2015	**7**	230.75	303.25	12.25	31.5	1339	81.75	10	546.75	43.25	138	3.75	9775.25	186.5	9897.75	367	-5.5	1404	9845.25	22	260.75	-25	276.75	82.75
2015	**8**	234.25	316.75	10.5	48.75	1961.75	102.75	9	421.5	38	163.75	9	9798.75	202	9921	356.25	8.5	1278.75	9865.75	21.5	267.75	-11	274.75	79.75
2015	**9**	211.25	286	12.75	28.25	1030.75	82.75	7.5	366.25	31	138.25	230.5	9825.75	177.5	10001.3	335	49.5	1000.25	9916.5	20.75	240.75	2.25	240	81
2015	**10**	159.5	246.75	8	45.5	1610.25	103	6	476.5	26	172.75	5.75	9898.5	113	10094.8	297	39	1086	9975.5	21.5	195.5	11.25	170.5	76.75
2015	**11**	101.25	149.5	18.75	10.5	331.25	85	231.5	379.5	40	144.5	5.5	9892.75	24.5	10119.3	257.5	122.25	1611.75	10011	20.75	120.5	-9.5	130.75	90.5
2015	**12**	56	101.25	14.5	13.25	425.25	77.25	2.75	360	26	127	2.75	9956	-1.75	10150.3	155	120.75	944.25	10055.75	21.5	74.25	-1.75	86.25	83.5