Improvement of Bird Prevention Strategy Based on Big Data Mining

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Abstract. This paper takes the bird damage situation of transmission lines in Y city of Henan province over the years as the research object, and adopts the method of data mining to conduct big data analysis of transmission line towers in Y city, so as to carry out targeted precise prevention and control of bird damage. Through the calculation of the correlation coefficient, we can find that the related factors of bird damage are: the arrangement of the tower insulator, the distance between the tower and the river, the height of the tower. In this paper, the characteristics of month, time, region and river basin of bird pest in Y City are analysed, and some laws beneficial to actual production are found. Combining the characteristics of various anti-bird devices at the current stage, it puts forward two new bird proof measures of 35kV "up" type pole tower innovatively, which has been proved to be effective in practice. Y City’s new idea of precise prevention and control of bird damage, has reference and reference significance for the prevention and control of bird damage in power grid.

1. Introduction

Large area scattered transmission lines are inevitably affected by both natural environment and human factors, which are very easy to cause trips and failures, and this will have a great impact on the safe operation of the whole power grid system. The improvement of ecological environment has created favorable conditions for the survival and reproduction of birds. At the same time, with the continuous growth of the power grid, the intersection of birds and overhead transmission lines are increasing day by day, and the number of overhead transmission line failures caused by birds is also increasing significantly. Operation experience and statistical data at home and abroad for many years show that bird damage has seriously threatened the safe operation of transmission lines, and the bird damage is only inferior to lightning stroke and external force damage [1-6]

For a long time, many scholars at home and abroad have carried out a series of observation, statistics and analysis work on bird related fault of transmission line, carried out theoretical and experimental research, and proposed and applied bird prevention measures for different fault types. Burnham J and Sundararajan R [7-8] respectively described the commonly used anti-bird harm measures in foreign countries according to the different types of bird body short circuit, impact, defecation, bird manure pollution flashover and so on. Li Hong et al. [9] described the specific application results of eight measures commonly used in Huizhou area, including sound bird drive, bird stinger prevention, windmill bird drive and bird insulator prevention. Guo Kailu et al. [10] observed the quantitative data such as the number of bird's nests and the number of insulators polluted by bird droppings after taking measures, and gave the effect of bird stab proof, bird box proof and bird baffle
proof on the middle phase of 220 kV line. Zhang Dongyang et al. [11] proposed a device combining sound, light and ultrasound to drive birds in multiple ways, so as to achieve the random broadcast of driving signals and overcome the adaptability of birds.

In this paper, the bird damage situation of transmission lines in Y city of Henan province over the years is studied and relevant data is extracted by data mining method. Combined with the living habits of birds, according to the characteristics of the line tower itself and the surrounding environment, the characteristic model of the tower is established, and through the analysis of the bird damage data over the years and the calculation of the correlation coefficient, the strong correlation factors of the bird damage are obtained: the arrangement of the tower insulator, the distance between the tower and the river, the height of the tower. In this paper, the comprehensive bird prevention strategy is formulated. Two new bird prevention measures of 35kV "up" type pole and tower are put forward innovatively, which are of reference and reference significance for bird prevention and control of power grid.

2. Data Sources

The data in this paper comes from the following three parts.

One is the data of bird composition and living habits of different birds in Y City, including the characteristic data of water source, forest, plain, crop planting structure, etc. This part of data is obtained by reading the literature and combining the data provided by bird research experts, and then is compared with the field observation data of operators.

The second is the bird damage data of Y City from 1985 to 2017, including the time of all tripping accidents, reclosing conditions, phase sequence, tower type, insulator arrangement, etc., as well as the bird nest, bird manure and bird habitat recorded by the operation and maintenance personnel in recent years.

The third is the information data of transmission line tower characteristics and surrounding environment characteristics of Y City. Part of these data are from the transmission line archives of State Grid Corporation of China, and other parts of them are from field investigation.

3. Data Mining Process

3.1. Data cleaning

Data cleaning is the last procedure to find and correct identifiable errors in data files, including checking data consistency, handling invalid and missing values.

During the collection and arrangement of bird damage records, it was found that 19 lines names and tower numbers did not correspond to the names and tower numbers of existing operating lines. In order to avoid the influence of error information on characteristic factors, the failure information was replaced by looking up the line change information table over the years.

At the same time, the characteristic data of more than 16000 foundation poles and towers of 35kV an above transmission lines under the jurisdiction of Y City transmission inspection office are not comprehensive, so the field survey is carried out to supplement the data. This part is mainly to calibrate and supplement the topography, distance from the tower to the village and distance from the tower to the river.

3.2. Data analysis

Because of the different functions of transmission line towers, according to the different voltage level, line path and crossing conditions, their heights are also different; and because of their wide distribution, the environment of each tower is also different. Considering all aspects comprehensively, the characteristic model of the tower can be summarized, including insulator arrangement, tower height, water source distance, village distance, landform and terrain, etc.

Analyzing bird damage data over the years to show the relationship between these factors and bird damage information. And through correlation coefficient analysis, the strong correlation among the above five characteristic factors was screened for further research.

(a) Relationship between bird damage and insulator arrangement of tower

According to statistics, all the bird damage tripping accidents in Y City over the years occurred on
suspension insulator strings, and no bird damage accident occurred on horizontal insulator strings, as shown in Fig 1.

(b) Relationship between bird damage and distance between tower and river.

There is a significant correlation between bird damage and the distance from the river. The frequency of bird damage poles and towers in the range of 0-3km away from the river is much higher than that in other areas, as shown in Fig.2. Among them, the proportion of bird damage in the range of 0-1km can reach about 50%.

Definition of Pearson correlation coefficient:

\[ \rho_{XY} = \frac{\text{Cov}(X, Y)}{\sqrt{\text{D}(X)} \sqrt{\text{D}(Y)}} \]

Where: the correlation coefficients of two random variables X and Y are recorded as \( \rho_{XY} \), \( E \) is the mathematical expectation or mean, \( D \) is the variance, and \( D \) is the standard deviation, \( \text{Cov}(X, Y) = E[(X - E(X))(Y - E(Y))] \), which is called the covariance of random variables X and Y.

Then the formula is reduced to:

\[ \rho_{XY} = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}} \]

Where: \( \bar{X} \), \( \bar{Y} \) is the average value of the sample.

\[ \text{Table 1. Calculation of correlation coefficient.} \]

| Pearson correlation | Bird pest | Distance from river | Tower height | Distance from village |
|---------------------|-----------|---------------------|--------------|----------------------|
| Bird pest           | 1.000     | 0.862               | 0.712        | 0.053                |
| Distance from river | 0.862     | 1.000               | 0.015766     | 0.001                |
| Tower height        | 0.712     | 0.005               | 1.000        | 0.098                |
| Distance from village| 0.853     | 0.001               | 0.098        | 1.000                |

The Pearson coefficient of the distance between the tower and the river and the bird damage is calculated. The result is shown in TABLE 1, and the value is 0.862. It can be seen that the correlation between them is close. Therefore, the characteristic factor of the distance from the river is the strong correlation factor of bird damage.

(c) Relationship between bird damage and calculated height of tower.

According to their different properties, transmission tower can be divided into linear tower and tension tower. Here, the call height and tension tower height are defined as the calculation height of statistical analysis. The distribution of bird damage and calculated height of tower is shown in Fig.3. The calculation of correlation coefficient is shown in TABLE 1 and the result is 0.712. Therefore, the calculated height of tower is a strong correlation factor of bird damage.

(d) Relationship between bird damage and distance between tower and village.

It can be seen directly from the figure that the distribution is relatively scattered and there is no exact rule to follow, which is shown in Fig.4. After the Pearson coefficient is calculated, the value is
shown in TABLE 1, which is 0.053, with low correlation. Therefore, the distance between the tower and the village is a weak correlation factor of bird damage, which will not be considered.

(e) The relationship between bird damage and topography.

As shown in Fig.5, the statistics of topography and geomorphology of the tower caused by bird damage show that the times of bird damage in farmland landform and mountain forest landform are the same, indicating that the topography and geomorphology are not directly related to bird damage. The topography and geomorphology are the weak correlation factors of bird damage, which will not be considered.

With the analysis of the above five points, it can be concluded that the strong correlation factors of bird damage are: the arrangement of tower insulator, the distance between tower and river, the calculation height of tower.

4. Bird activity law and comprehensive bird control strategy.

Bird damage has certain regularity, such as seasonality, timeliness, instantaneity, repeatability, etc. For the operation and maintenance of power grid, mastering the activity characteristics of birds related to power grid is the basic work of bird related fault prevention and control, which has important guiding significance for improving the effectiveness of bird related fault prevention and control.

4.1. Analysis of bird activities

(a) Month rule

The distribution is shown in Fig.6. It can be seen from the figure that the period from December to February is the high incidence period of bird damage, which is the active period of bird reproduction and migration and the key period of bird damage prevention.

(b) Time period rule

Fig.7 shows the statistics of bird injury trip accidents over the years. It can be seen that the period from 8:00 p.m. to 8:00 a.m. the next day is the period of high bird injury trip, accounting for 79%.

(c) Regional rule

According to statistics, bird damage failures have occurred in nine counties and regions, which are significantly concentrated in the west of urban Y, as shown in Fig.8. This area is the intersection of mountains and rivers, which makes the birds rich in resources, many species, and large populations. The passage of migratory birds also makes birds have a greater impact on transmission lines.
According to the layout statistics of the main rivers in Y City, the river statistical chart of bird damage fault is shown in Fig.9. There are many and large shoals in the above basins, which are most suitable for bird activities.

### 4.2. Discussion on comprehensive bird control measures

At present, the measures to prevent bird damage are mainly divided into three categories: drive, block and drain. Anti-bird devices mainly include: anti bird stab, anti-bird baffle, anti-bird box, anti-bird needle board, anti-bird cover, artificial bird nest, bird perch, windmill type bird alarm, etc.

The bird proof device shall not have any hidden danger which may affect the safe and stable operation of the line, shall not affect the maintenance and repair of the line as much as possible, and shall be easy to install and fix. In general, single protection is unable to effectively prevent all kinds of bird damage. A variety of anti-bird equipment should be reasonably configured according to the actual needs, such as the combination of bird box, bird baffle and bird sting, the combination of bird guard, bird guard, bird thorn and bird baffle.

Aiming at the 35-kV pole tower, a bell is used as a bird-proofing tool in practice, in order to make the sound of the bird's wings sway through the sound of the wind to achieve the effects of frightening and driving birds away. In addition, a new type of bird stab prevention mechanism, which is "main stab + auxiliary stab", can be adopted. The bird thorn is composed of main thorn, auxiliary thorn, fixed block and fixed base plate. The main thorn is installed on the fixed block of bird thorn, and the auxiliary thorn is arranged on the main thorn. The fixed base plate can be U-shaped and L-shaped and fixed on the tower material by bolts and nuts. The main thorns are longer and less, mainly preventing large birds from perching on poles and towers; the auxiliary thorns are more, with different lengths and angles, mainly preventing small birds from nesting between the main thorns. The design drawings of U-shaped and L-shaped bird sting are shown in Fig.10 and Fig.11.

![Figure 10. design of U-shaped new bird sting prevention](image1)

![Figure 11. L-shaped new bird sting prevention design](image2)

The strategy of bird prevention combined with "drive, block and release" has been preliminarily formulated and implemented: the 220kV line is mainly for bird stab prevention, supplemented by bird baffle and bird perch; the 110kV line is mainly for bird cover and bird baffle, supplemented by bird stab prevention. From October 2016 to October 2017, the transmission lines under the jurisdiction of the transmission operation and inspection office tripped six times due to bird damage; from October 2017 to October 2018, there was no bird damage trip accident on 220kV lines under the jurisdiction of the transmission operation and inspection office; only one bird damage trip occurred on 110kV lines, a year-on-year decrease of 80%.

In the aspect of bird proof device improvement, two new bird proof measures of 35kV "up" type tower are put forward, which have been proved to be effective in practice.

### 5. Conclusion

In this paper, the bird damage of transmission lines in Y City of Henan Province is taken as the research object, and the trip data of bird damage from 1985 to 2017 and the trace information of bird activity found and recorded in the actual production line patrol in recent years are sorted out, aiming to explore the relationship between the living habits of birds and the characteristics of transmission lines and towers, and to implement the precise prevention and control of bird damage.
By using the method of data mining, the relationship between the living habits of birds and the characteristics of transmission line tower is mined. Based on the statistical analysis of the data of bird damage trip of transmission line over the years, the reasons of bird damage trip are analysed in depth according to the strong correlation factors of tower height, insulator arrangement, distance from the river and so on. Combined with practical experience, comprehensive bird prevention strategies should be formulated to different tower types as far as possible. In the actual production, two kinds of bird proof measures for 35kV "up" type tower are put forward innovatively, with remarkable results. It has greatly reduced the risk of the company's transmission line tripping due to bird damage, greatly reduced the company's operating cost, and saved human, financial and material resources.

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