Research on Lightning Hazard Grid Map of Taiwan Power Transmission Lines from 2015 to 2020

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I. Research Background

In this study, TPRI （Taiwan Power Research Institute） measured the CG（Cloud to Ground, CG） lightning current data (≧1kA) in Taiwan in 2015~2020. GFD(Ground Flash Density, GFD） distribution maps in Taiwan have been established, based on three different lightning current levels, including CG≧5kA, ≧10kA, and ≧20kA, respectively. The "GFD distribution maps" in Taiwan clearly show the distribution of lightning hazards in various regions of Taiwan, which can be used to design lightning protection for outdoor power facilities and buildings. In addition, we calculate the lightning current of the back flashover and shielding failure flashover for the power transmission lines and use the numerical analysis and natural breaks classification of MapInfo to establish the "The GFD distribution maps for Taipower Transmission Network," distinguishing the type of lightning hazard and identifying the most serious hazard level of the transmission towers. The results can be used to improve lightning protection and effectiveness measurements.

II. Research results

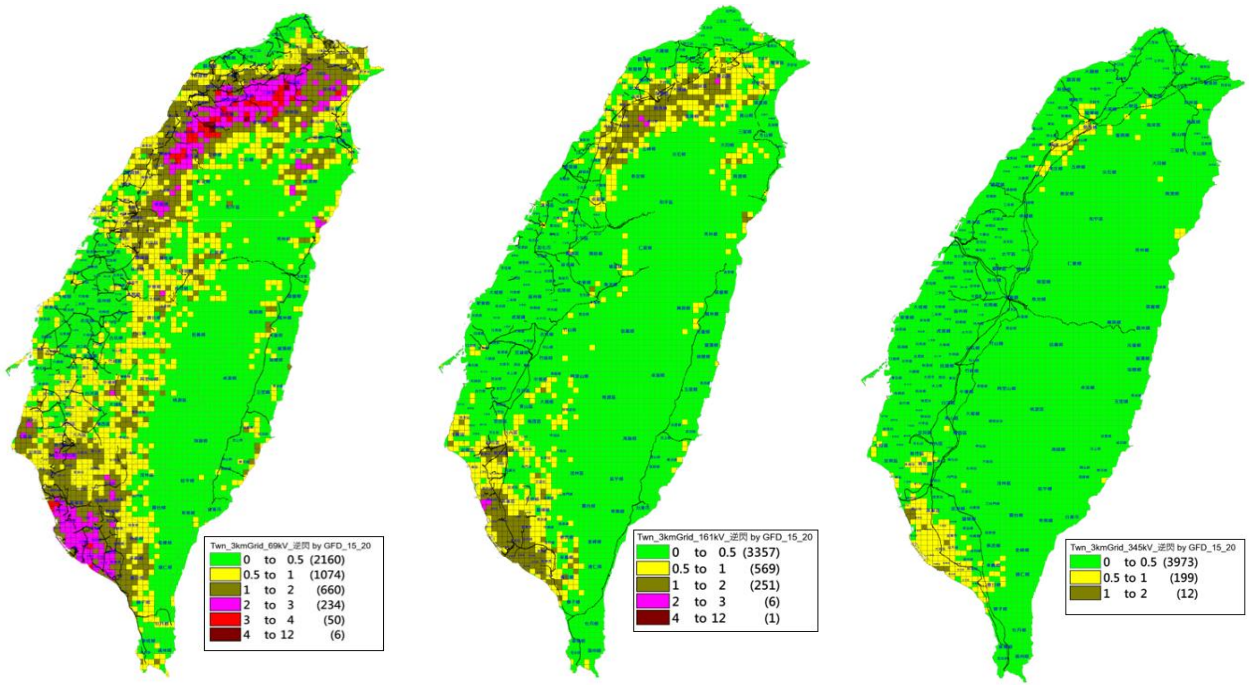
The 13 lightning detection stations of TPC（Taiwan Power Company） are distributed throughout Taiwan to form a lightning detection network, detecting all thundercloud discharge phenomena on Taiwan's main island and adjacent sea areas, as shown in Figure 1. The electromagnetic radiation signals are generated by the discharge in CC（Cloud to Cloud, CC） and CG（Cloud to Ground, CG）, and then via the TPC's internal communication E1 circuit to transmit the electromagnetic pulse signals to the computer room of the Department of Communication of TPC. Subsequently, an optical fiber network is used to transmit signals to the lightning data processing server of TPRI in the Shulin area. According to each detection station's GPS time synchronization signal, cross-location and lightning current parameter calculations are carried out for the same lightning data. The real-time lightning information after positioning and calculation is transmitted to the CDCCs under the Department of Power Dispatch, ADCCs under the Department of Power Transmission, and TPRI of TPC through the network for related applications such as lightning hazard prevention research.

III. Conclusion

The lightning data such as CG are collected by Total Lightning Detection System (TLDS) built by TPRI. The produced data of TLDS offers the relationship between lightning surge and transmission line; moreover, it can be used to build a variety of GFD distribution by using GIS software. The results can provide references for designing an effective lightning prevention method against lightning hazards. The 69kV, 161kV, and 345kV transmission lines for the Lightning Hazard Grid Map of back flashover and shielding failure flashover established in this case (as shown in Figure 2 and Figure 3), all of which are based on the voltage level, insulation strength, tower height, and upper phase of conductor height, overhead ground wire protection angle, ground inclination angle, and other parameters and refer to IEEE standard maximum lightning distance, maximum shielding failure current and other related formulas. Finally, the dangerous lightning current interval distribution and ground flash density are calculated.

Fig.1 Distribution map of TLS200 and LS7002 lightning detection stations of TPC

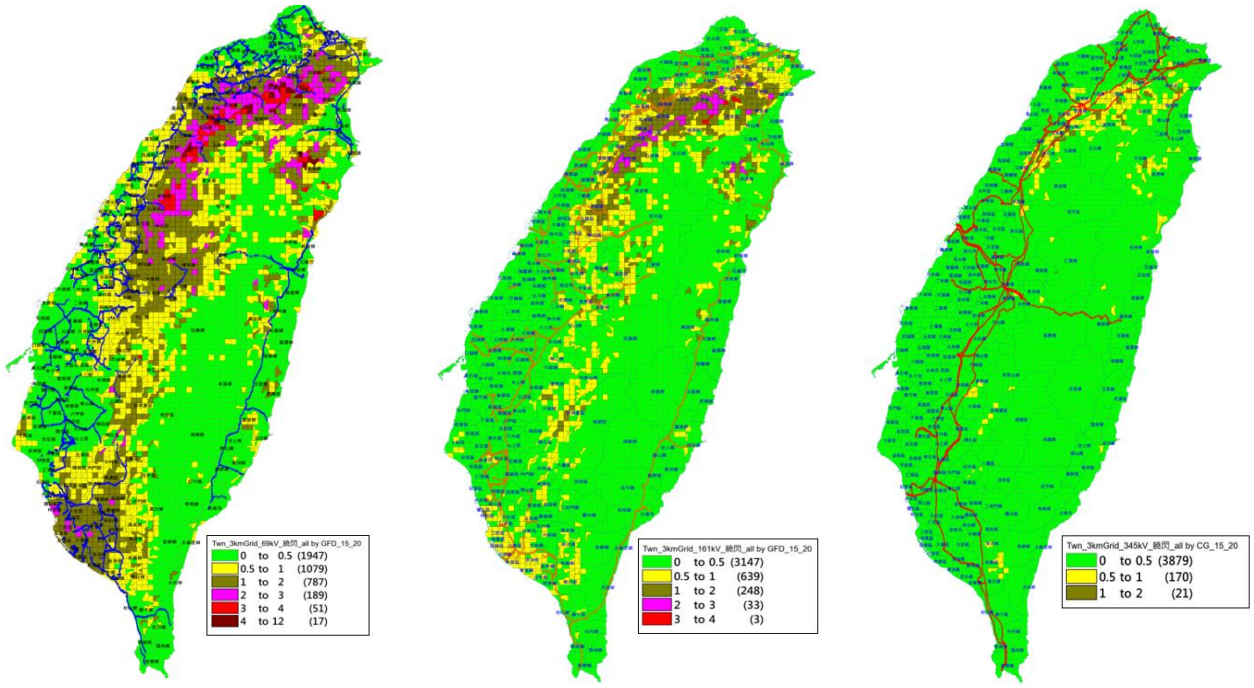
Source：this study



69kV 161kV 345kV

Fig.2 Lightning Hazard Grid Map of back flashover

Source：this study



69kV 161kV 345kV

Fig.3 Lightning Hazard Grid Map of shielding failure flashover

Source：this study