capacities of the substation, equivalent load center is selected as the position for the to-be-built substation and substation capacity can be calculated by multiplying the overall selected loads by capacity-load ratio. In case a satisfying load point cannot be found, the load point is selected as a starting point for loop searches till all load points finish searching. Table 2 demonstrates substation capacity and coverage area.

Table 2. Substation capacity and coverage area

Substation	Covered load points	Overall loads (kw)	Capacity-load ratio	Substation capacity (kw)
No. 1	1, 2, 5, 6, 7, 10, 11, 12, 13, 19, 20, 22	216130989	1. 8	389035780. 2
No. 2	3, 4, 8, 9, 14, 15, 16, 21, 33	70675457	1. 8	127215822. 6
No. 3	17, 18, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32		1. 8	305878465. 8

Note: Load point 33 is added to No. 2 substation for which has a smaller capacity.

Substation locations of a county in Shaanxi Province are distributed as shown in Figure 2.

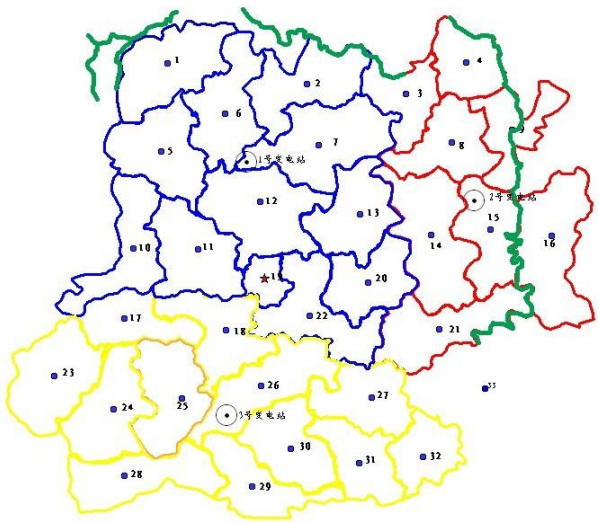

Figure 2. Substation locations and coverage area

In Figure 2, blue area is the coverage area for No. 1 substation containing 12 load points, red area is that for No. 2 substation covering 9 load points and yellow area is that for No. 3 substation covering 12 load points. It follows that substation distribution and coverage area are not only consistent with geographic information, but meet the actual demands for substation capacity.

6. CONCLUSIONS

Traditional methods are difficult to meet the actual demands in research on county-level substation sizing and siting. Therefore, this paper has gained good effects in practice by combining GIS platforms with the improved PSO algorithm. The research has come to the following conclusions:

(1) GIS platforms are introduced to the siting of county-level substations, because GIS can assist planners in avoiding geographic environments, including rivers, mountain lands and lakes, which are inconvenient to select substation locations;

(2) The improved PSO algorithm, with rapid computing speed, good global optimization capability and better comprehensive optimization capability than the traditional PSO algorithms, is applied to substation location. (3) GIS is used to manage special and attribute data needed for substation location planning, so that such data can be intuitively displayed to planners and the planning is more realistic.

This paper fully considers the effects of geographic factors on substation location by combining PSO algorithm and GIS database, which visualizes the planned locations, realizes a more scientific location and improves the location quality.

REFERENCES

[1] Wang Chengshan, Wei Haiyang, Xiao Jun, et al. "Two-phase optimal planning for substation locating and sizing," *Automation of Electric Power Systems*, vol. 29, nol. 4, pp. 62－66, 2005.

[2] Dai Hongwei, Yu Yinxin, Huang Chunhua, et al. "Optimal planning of distribution substation locations and sizes-model and algorithm," *International Journal of Electrical Power & Energy Systems*, vol. 18, no. 6, pp. 353－357, 1196.

[3] El-Gallad A., El-Hawary M., Sallam A., et al. "Swarm-intelligently trained neural network for power transformer protection," *Proceedings of Conference on Electrical and Computer Engineering*, Canada, 2001, pp. 265−269.

[4] Liu Ling, Yan Deng-jun, Gong Deng-cai, et al. "New method for short term load forecasting based on particle swarm optimization and fuzzy neural network," *Proceedings of the Chinese Society of Universities*, vol. 18, no. 3, pp. 47−50, 2006.

[5] Shi Biao, Li Yu-xia, Yu Xin-hua and Yan Wang. "Short-term load forecast based on modified particle swarm optimizer and back propagation neural network model," *Journal of Computer Applications*, vol. 29, no. 4, pp. 1036-1039, 2009.

[6] Omkar S. N., Mudigere D., Narayananaikg, et al. "Vector evaluated particle swarm optimization for multi-objective design optimization of composite structures," *Computers and Structures*, vol. 86, no. ½, pp. 1-14, 2008.

[7] Xu Tong-yu and Sun Yan-hui. "Substation locating and sizing in rural power system based on GIS and modified differential evolution algorithm," *Power System Protection and Control*, vol. 37, no. 22, 2009.