# Comprehensive Geochemical Evaluation of Land Quality in Strawberry Plant Area and Geoscience Suggestions in Chengde

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**Abstract.** Strawberry Plant Area in Chengde is located in the Jingcheng Golden Tour Corridor. The main plantings in the area are strawberries, however in recent years, there have been problems such as insufficient supply of surrounding land and specialization of pesticide formulations. In this study, through testing and analysis of 30 nutrients and total metal elements, 7 efficient statuses of elements, pH and soil organic matter in surface soil samples, status of soil nutrients, soil environment and soil quality are comprehensive evaluated in the region. Based on the complete water quality analysis of irrigation water, the directional fertilization formula for the Quaternary accumulation area and the geological suggestion for the replacement of other high-quality soil for melioration are put forward to provide support for the sustainable development of Strawberry Plant Area.

## 1 Introduction

Strawberry has a very high nutritional value. Each 100g of fresh fruit pulp contains about 60-120 mg of vitamin C, which is more than 10 times higher than that of apples and grapes [1,2]. The pulp contains a lot of nutrients including sugar, protein, organic acid, pectin, and trace elements necessary for the human body such as calcium, phosphorus, ferrum, potassium, zinc, and chromium [3]. The Strawberry Plant Area in Qijia, Longhua County, Chengde City is located in the Jingcheng Golden Tour Corridor. The area spans 1 km from east to west and 2.8 km from north to south. The overall plan is 1.7 km2 (2560 Mu). The Wuliehe River is located in the west of the area and runs through. This survey involves the whole area of Strawberry Plant Area and the vast area in the south, with an area of 4.06 km2 (6084 Mu). The main plantings in the area are three types of characteristic agriculture including strawberry, economic forest begonia fruit, Chinese medicinal material yellow chrysanthemum.

A total of 45 surface soil samples were collected in this survey, with an average sampling density of 11 points per square kilometre. 32 types of elements are analysed including N, P, K, Mn, Mo, Zn, Cu, Se, Ge, B, soil organic matter (SOM), Cd, Cr, As, Hg, Ni, Pb, Sb, Sn, Co, V, Ti, Na, Al, TFe, F, Ca, Mg, S, Cl, Si, pH, and 7 types of element efficient statuses are also analysed including alkaline hydrolysis of nitrogen, available phosphorus, available potassium, available boron, available molybdenum, available ferrum, available manganese. At the same time, 2 samples of irrigation water were collected for complete water quality analysis. The soil quality of strawberry cultivation is mainly analysed, to put forward suggestions for comprehensive utilization of facility agriculture concentrated areas.

## 2 The status of land use

According to the latest third national land survey, there are 12 types of land use in the area (Figure 1). The area is 3050943.11 m2 of arable land, 33053.58 m2 of garden, 297832.09 m2 of woodland, 2388.32 m2 of grassland, 5673.69. m2 of Shangfu land, 168010.4 m2 of residential land, 18353.51 m2 of public land, 65298.15 m2 of other land, 280.39 m2 of special land, 162162.39 m2 of transportation land, 252927.48 m2 of water area, respectively. The area is mainly arable land, accounting for as high as 75.2%.

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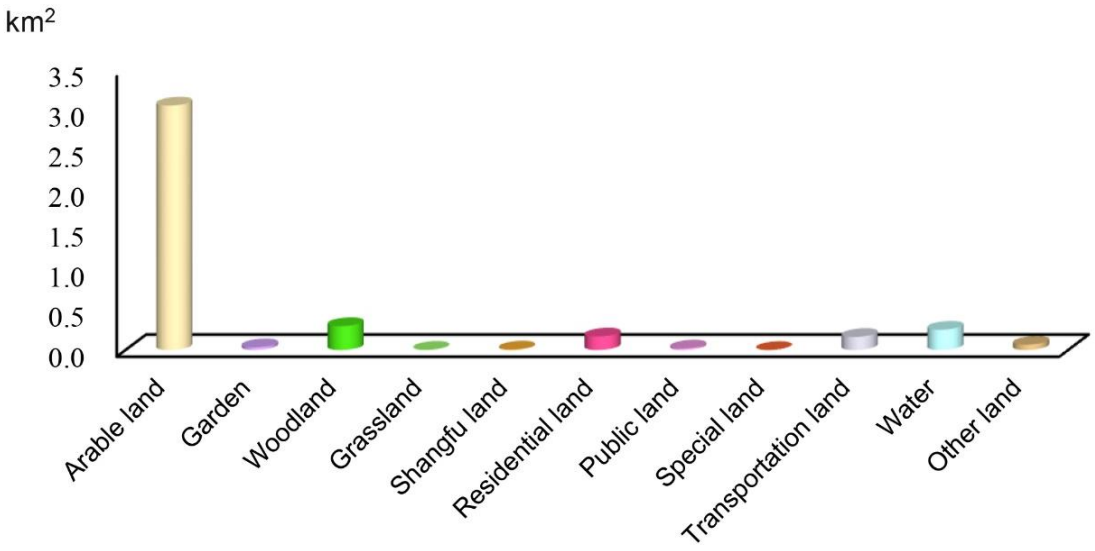



**Fig. 1.** Distribution map of land use status

## 3 Characteristics of Eco- Geological Conditions

### 3.1 Topography and landform conditions

Strawberry Plant Area is located in the valley area of the Wuliehe River Basin in Longhua County, with an elevation ranging between 561m and 841m. There are high mountains on both sides and low river valley in the middle. The topography is undulating, and typical river valley landscapes are developed (Figure 2 left). It is an important concentration area of agriculture, ecology and life (Figure 2 right).

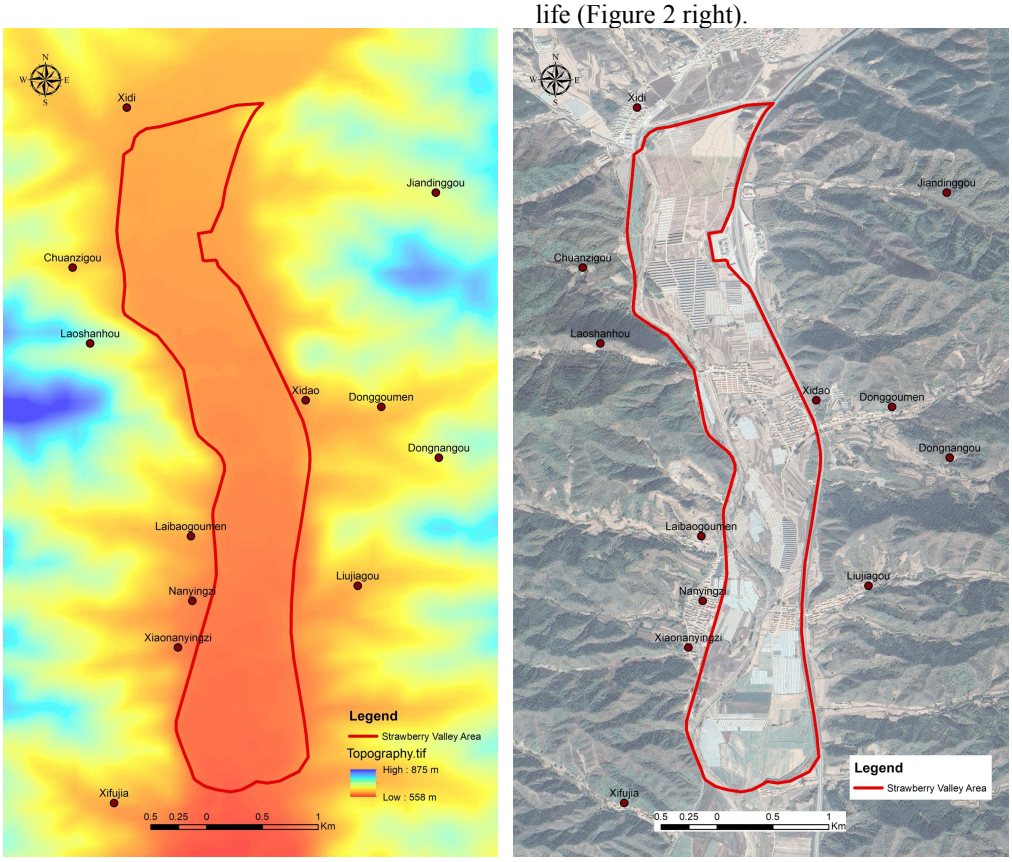



**Fig. 2.** Topographic map of Strawberry Plant Area (left) and current situation map (right)

### 3.2 Eco-geological conditions

The main types of geological formation in this area are loose accumulation of Quaternary, including aeolian loess, fluvial sand and gravel [4,5]. The bedrock is mainly composed of late Jurassic (J3G) and Late Triassic (T3Q) medium-fine-coarse biotite monzonitic granites, Neoarchean (Ar3Sgn) potash feldspathic gneiss (the original rock is monzonitic granite), and Paleoproterozoic (Pt1Dηδo) quartz monzodiorite (Fig.3).

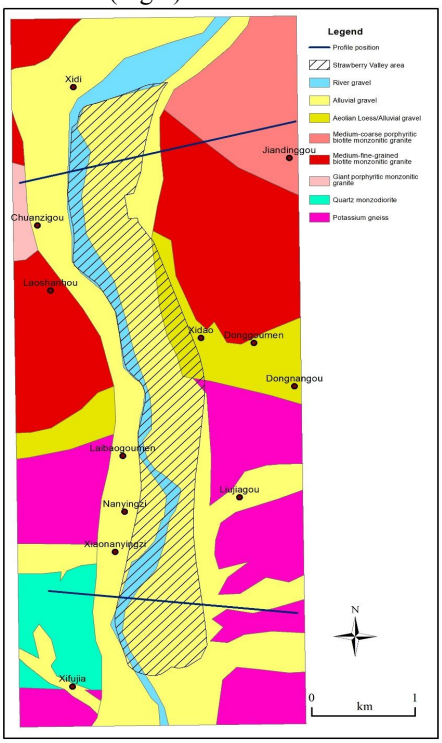



**Fig. 3.** Eco-geological map of Strawberry Plant Area

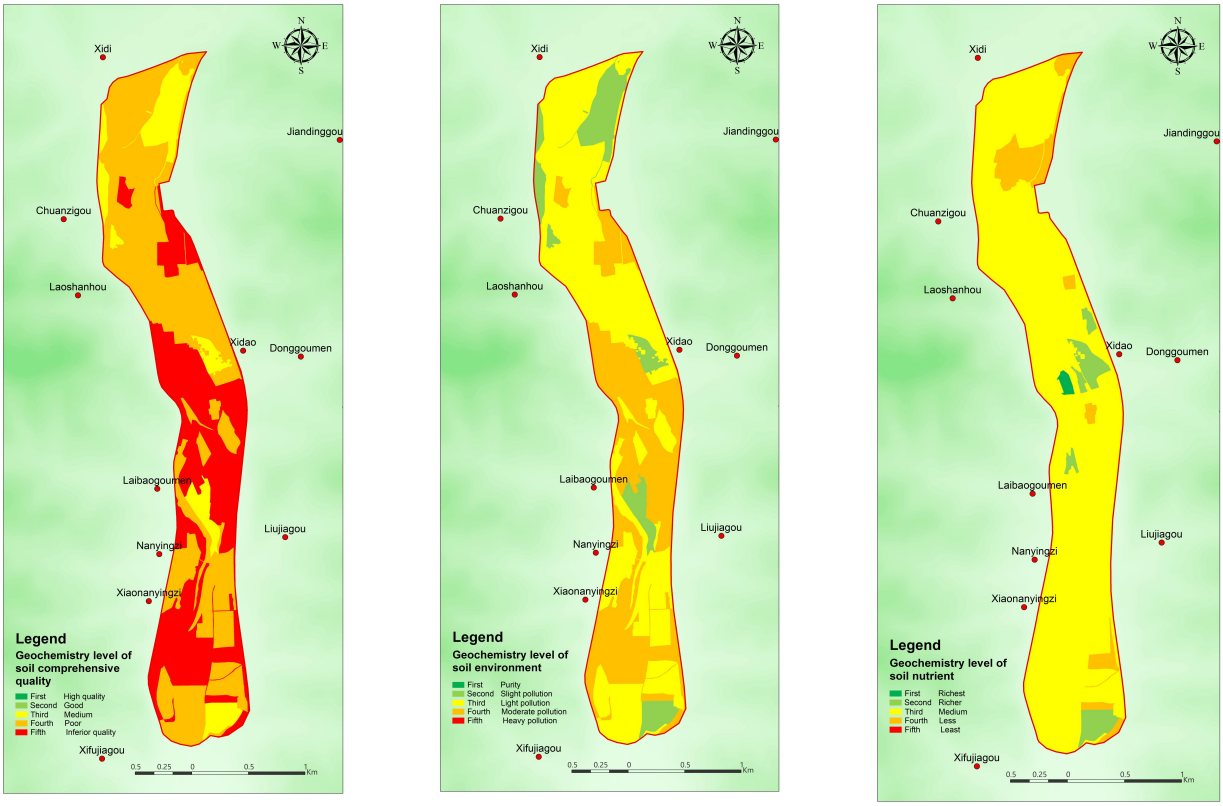
## 4 Analysis and discussion

### 4.1 Comprehensive evaluation of land quality

According to Land Quality Geochemical Evaluation Standards (DZ/T 0295-2016) [6], in the Strawberry Plant Area, the evaluation grade of land quality is fourth-class, covering an area of 2,148,280.88 m2, accounting for 53% of the total area（fig.4a）. The evaluation grade of soil environment is mainly third-class, with a risk of slight pollution (fig. 4b). The evaluation grade of soil nutrient is mainly third-class, covering an area of 3,542108.09 m2, accounting for 87.3% (fig.4c). The evaluation results of these soil quality are mainly due to the poor soil conditions, with the texture dominated by gravel soil, and nutrients easily leached in partial area. The statistics of various comprehensive soil indexes are shown in Table 1.

**Table 1.** Statistical Table of Comprehensive Soil Indexes in Strawberry Plant Area

| Level | Soil comprehensive quality | | Soil nutrient | | Soil environment | |
|---|---|---|---|---|---|---|
| | Area(km2) | Percentage(%) | Area(km2) | Percentage(%) | Area(km2) | Percentage(%) |
| First | 0 | 0 | 0.02 | 0.5 | 0 | 0 |
| Second | 0 | 0 | 0.18 | 4.5 | 0.47 | 11.6 |
| Third | 0.47 | 11.6 | 3.54 | 87.3 | 2.15 | 53.0 |
| Fourth | 2.15 | 53.0 | 0.31 | 7.8 | 1.44 | 35.5 |
| Fifth | 1.44 | 35.5 | 0 | 0 | 0 | 0 |




a) Soil comprehensive quality b) Soil environment c) Soil nutrient

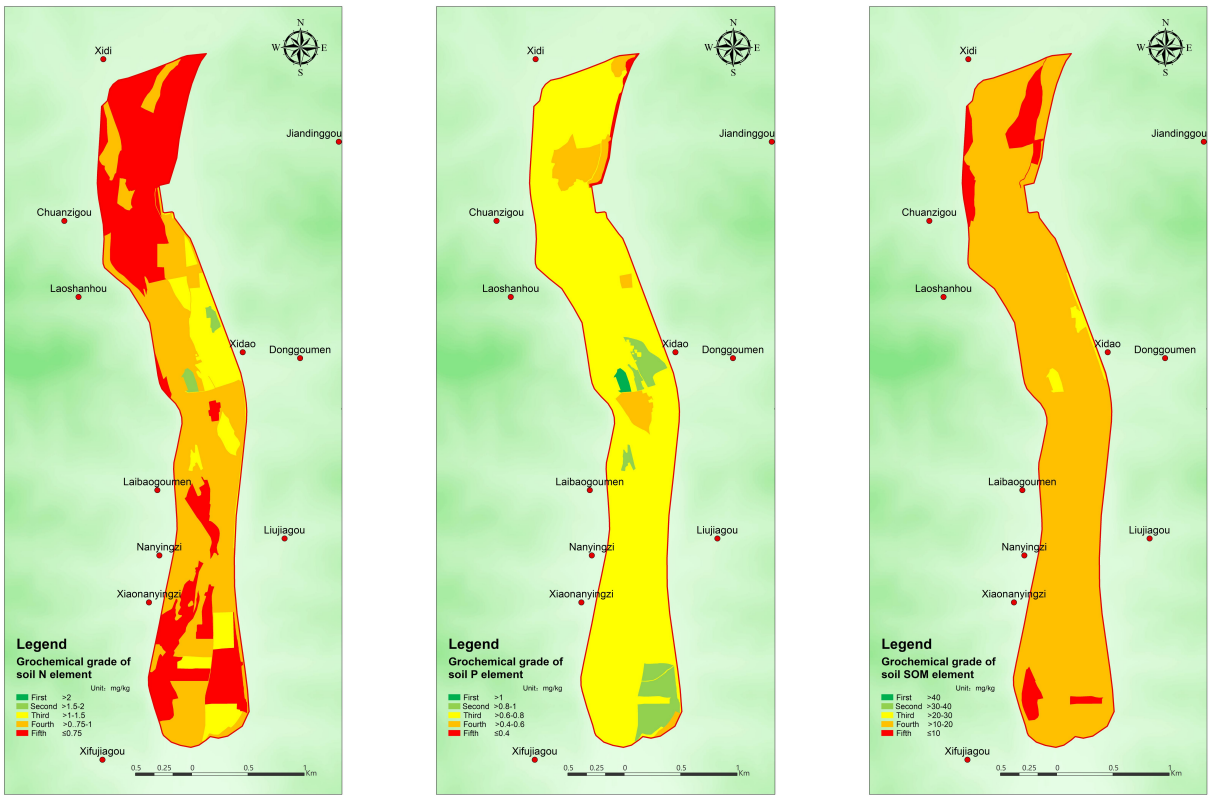
**Fig. 4.** Grade map of soil comprehensive quality, environment, nutrient in Strawberry Plant Area

### 4.2 Comprehensive Geochemical Status of Soil Nutrients

The Strawberry Plant Area is obviously deficient in N, less P and rich in K [7]. The evaluation grade of N element is mainly fourth-class (Fig.5a), with a content of between 0.75 and 1.0 mg/kg, and covering an area of 1,881,54.56 m2, accounting for 46.4%. The evaluation grade of P element is mainly third-class (Fig.5b), with a content of between 0.6 and 0.8 mg/kg, and covering an area of 3,461,169.42 m2, accounting for 85.3%. There is mainly rich in K element, with the first-class area of 3,485,987.69 m2, accounting for 85.9%, and the rest as second-class. The evaluation grade of SOM is mainly fourth-class (Fig.5c), with a content between 10 mg/kg and 20 mg/kg, and with an area of 3,727,788.35 m2, accounting for 91.9%. The statistics of individual indexes of soil nutrients are shown in Table 2.

**Table 2.** Statistical Table of Individual Indexes of Soil Nutrients in Strawberry Plant Area

| Level | N | | P | | K | | SOM | |
|---|---|---|---|---|---|---|---|---|
| | Area (km2) | Percentage (%) | Area (km2) | Percentage (%) | Area (km2) | Percentage (%) | Area (km2) | Percentage (%) |
| First | 0 | 0 | 0.02 | 0.5 | 3.49 | 85.9 | 0 | 0 |
| Second | 0.04 | 0.8 | 0.26 | 6.4 | 0.57 | 14.1 | 0 | 0 |
| Third | 0.54 | 13.3 | 3.46 | 85.3 | 0 | 0 | 0.05 | 1.3 |
| Fourth | 1.88 | 46.4 | 0.29 | 7.1 | 0 | 0 | 3.73 | 91.9 |
| Fifth | 1.60 | 39.4 | 0.03 | 0.7 | 0 | 0 | 0.28 | 6.8 |




a) N b) P c) SOM

**Fig. 5.** Geochemical grade map of soil N, P, SOM in Strawberry Plant Area

### 4.3 Soil single element geochemical grade status

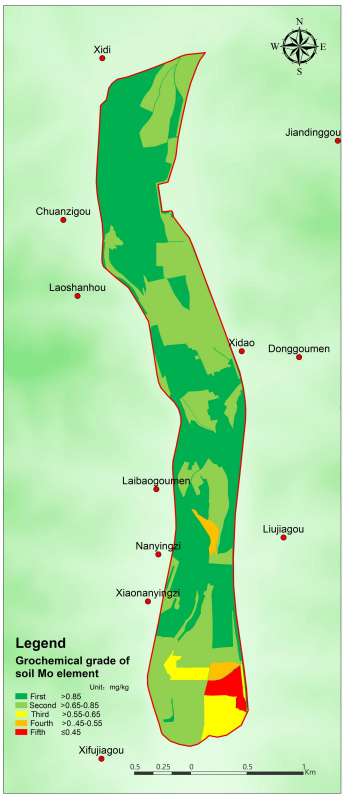
The soil in this area is rich in trace beneficial elements such as molybdenum (Mo, Fig.6a), manganese (Mn, Fig.6b), zinc (Zn, Fig.6c), ferrum (Fe, Fig.6d), magnesium (Mg, Fig.6e), and calcium (Ca, Fig.6f). The soil trace elements reach the medium and rich level, namely second-class and above. Only the first-class of Mo element accounts for more than 50%, and that of other elements account for less than 5%. The statistics of indexes of single soil nutrient elements are shown in Table 3.

The evaluation grade of selenium (Se, Fig.6g), boron (B, Fig.6h), germanium (Ge, Fig.6i) and other elements in the soil are mainly fourth or fifth class, and the Se content is between 0.071 mg/kg and 0.19 mg/kg, which is lower than the selenium-rich land standard (with a content of more than 0.4 mg/kg) [6].

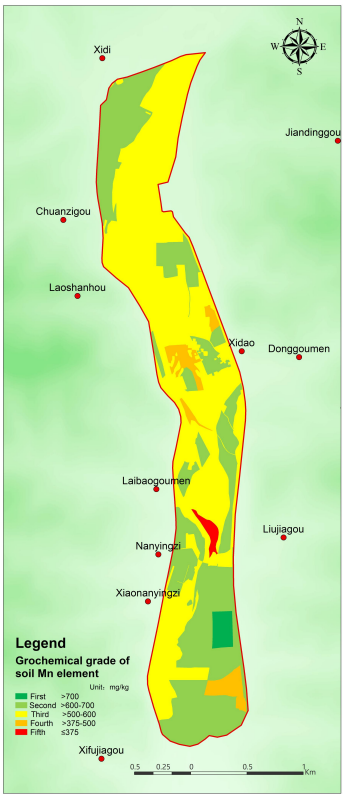
**Table 3.** Statistical Table of Indexes of Single Soil Nutrient Elements in Strawberry Plant Area

| Level | Se | | B | | Ge | |
|---|---|---|---|---|---|---|
| | Area(km2) | Percentage(%) | Area(km2) | Percentage(%) | Area(km2) | Percentage(%) |
| First | 0 | 0 | 0 | 0 | 0 | 0 |
| Second | 0 | 0 | 0 | 0 | 0 | 0 |
| Third | 33008.7 | 0.8 | 0 | 0 | 236545.5 | 5.8 |
| Fourth | 1713731.5 | 42.2 | 543558.1 | 13.4 | 3474926.4 | 85.7 |
| Fifth | 2310182.9 | 56.9 | 3513365.1 | 86.6 | 345451.1 | 8.5 |
| Level | Mo | | Mn | | Zn | |
| | Area(km2) | Percentage(%) | Area(km2) | Percentage(%) | Area(km2) | Percentage(%) |
| First | 2121960.4 | 52.3 | 0.06 | 1.4 | 0.17 | 4.1 |
| Second | 1638584.8 | 40.4 | 1.53 | 37.7 | 3.26 | 80.5 |
| Third | 169459 | 4.2 | 2.29 | 56.3 | 0.53 | 13.0 |
| Fourth | 58531.6 | 1.4 | 0.16 | 3.8 | 0.07 | 1.7 |
| Fifth | 68387.2 | 1.7 | 0.03 | 0.7 | 0.03 | 0.7 |
| Level | Fe | | Mg | | Ca | |
| | Area(km2) | Percentage(%) | Area(km2) | Percentage(%) | Area(km2) | Percentage(%) |

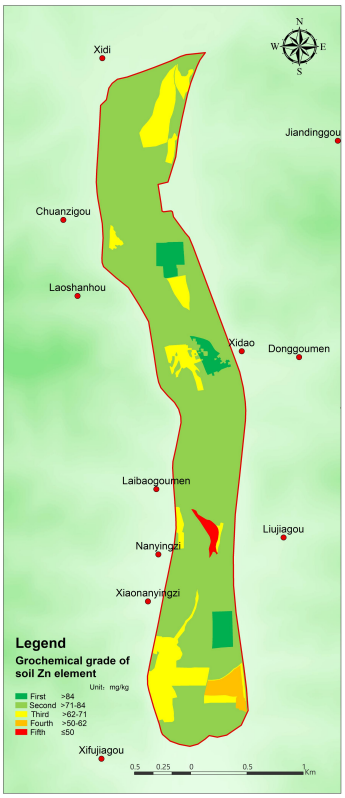
| | | | | | | |
|---|---|---|---|---|---|---|
| First | 0.06 | 1.4 | 0 | 0 | 0 | 0 |
| Second | 0.21 | 5.3 | 0.09 | 2.2 | 0.07 | 1.7 |
| Third | 2.49 | 61.3 | 2.99 | 73.6 | 3.96 | 97.6 |
| Fourth | 1.27 | 31.2 | 0.95 | 23.5 | 0.03 | 0.7 |
| Fifth | 0.03 | 0.7 | 0.03 | 0.7 | 0 | 0 |



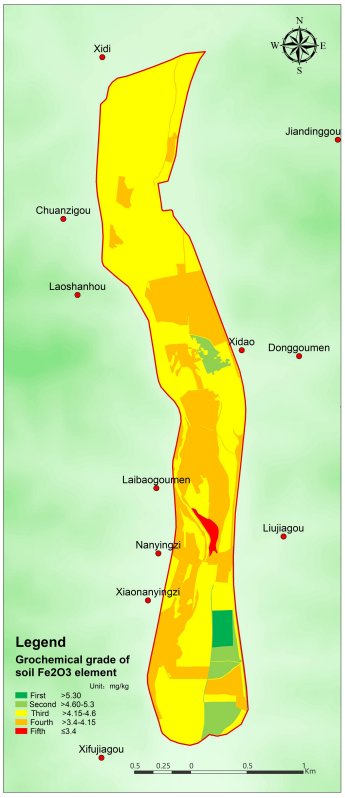

a) Mo



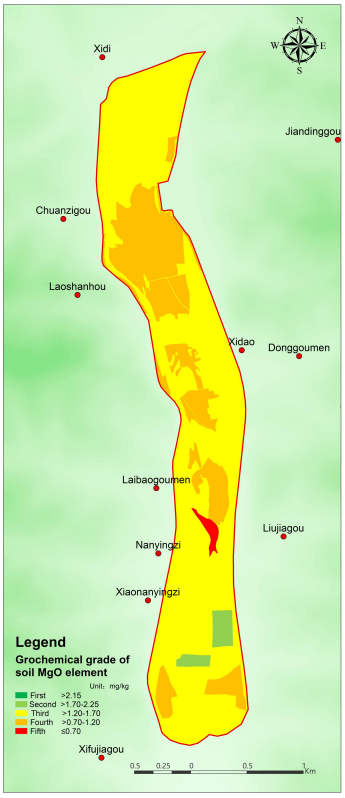

b) Mn



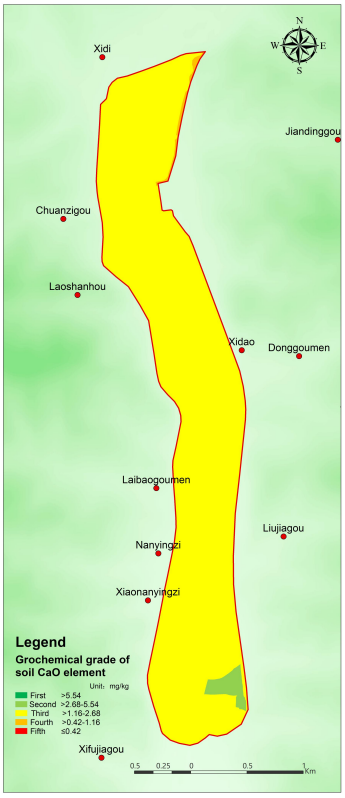

c) Zn



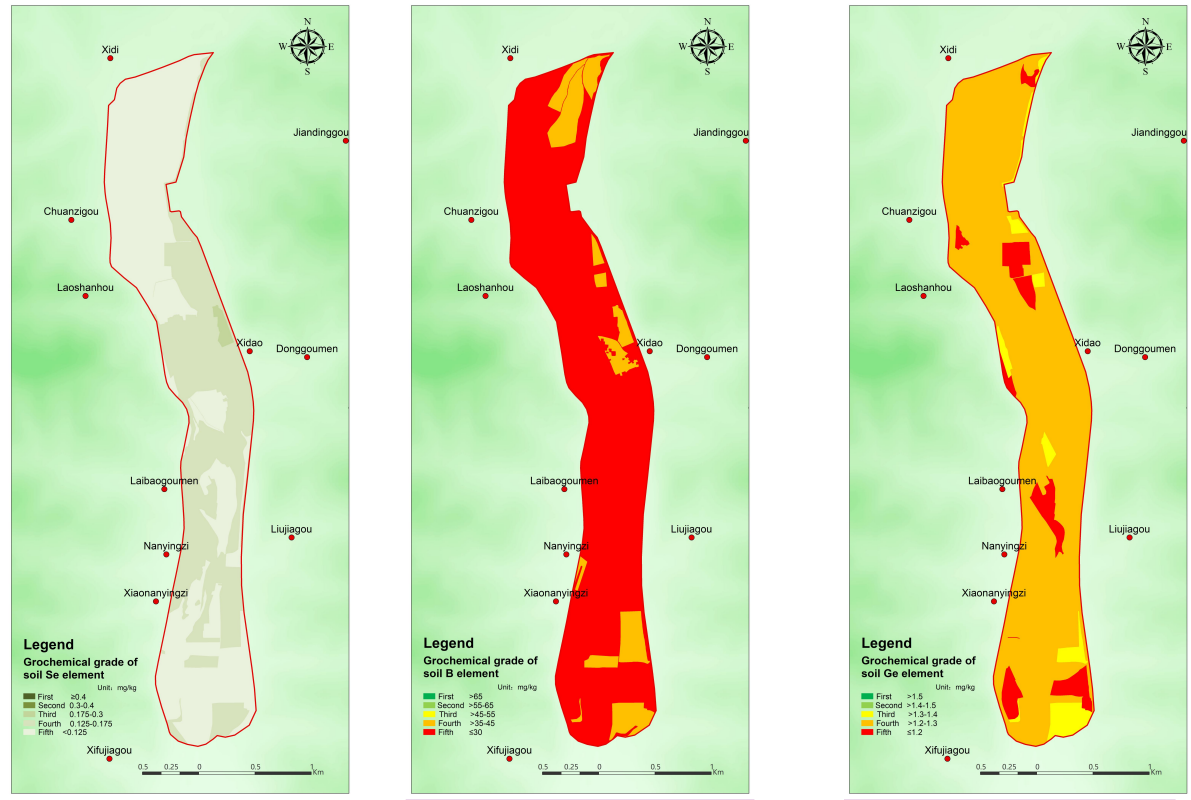

d) Fe




e) Mg




f) Ca




g) Se h) B i) Ge

**Fig. 6.** Geochemical grade map of soil nutrient elements in Strawberry Plant Area

## 5 Conclusions

1) Strawberries are plants that love K and P. The soils in the survey area generally have high potassium content, but the evaluation grade of effective potassium belongs to the third-class, and the content of phosphorus and nitrogen is uneven. It is recommended to adjust the formula fertilization structure according to the survey results. According to the needs of different elements for strawberry growth, it is recommended to use P+K fertilizer together. On the other hand, strawberry growth requires B and S elements, but these elements are in a lack status in this area. It is recommended that trace elements such as B and S should be fertilized in a targeted manner according to the characteristics of the soil background elements, while reducing the supply of rich elements in the soil such as Zn, to avoid excessive heavy metal elements or accumulated pollution caused by artificial fertilization.

2) Comparing the land quality between the southern area and the northern area, the absorption of trace elements in the soil during strawberry growth will lead to soil depletion. It is recommended to use the soil cultivation method in the strawberry planting area and use the crop rotation method for soil restoration in 3-5 years. Or according to the analysis of the characteristics of soil texture and nutrient content, most of the soil in the non-strawberry planting area is located on the dual structure of the river, and the soil is mainly a mixture of loamy soil and residual layer, with good nutrient texture, which can be used as a high-quality land resource concentration area for replacement of guest soil.

3) There is no heavy metal pollution in the land in the survey area, and the comprehensive evaluation results of the soil environment have no first-class (clean) and fifth-class (severely polluted). The evaluation grade of soil environment is mainly third class, accounting for more than 50%, which is greatly affected by the pH value. Therefore, it must be to pay attention on control of soil pH during the process of planting strawberry to maintain the balance of soil pH.

4) The content of Se, B, Ge and other elements in the soil in the survey area is lower than the enrichment standard. The Se content is between 0.076 mg/kg and 0.193 mg/kg, which is lower than the standard of selenium-enriched land (with a content of more than 0.4mg/kg), and the evaluation grade is fourth class (accounting for 45.6%) or fifth class (accounting for 52.8%). However, the evaluation grade as first class of the trace elements such as Fe, Zn, and Mn (rich grade) account for less than 5%, and only Mo element as rich grade accounts for more than 50%. Thus, the background content of beneficial elements in the soil is not high.

5) The floodplain in Strawberry Plant Area is generally less than 1m in soil layer that can be beneficial to farming. The lower part is a gravel layer, which has a poor ability of retaining water and fertilizer. On the other hand, the groundwater in floodplain is relatively shallow, and man-made fertilization will cause the nitrogen and phosphorus in the river to exceed the standard. Therefore, it is recommended to limit the floodplain area to the development scope of facility agriculture and set it as a buffer zone in the basin, that is, an ecological protection zone.

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