Investigation and Prediction of Soil and Water Loss in a Factory

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Abstract. According to the natural conditions of the project, the factors of soil and water loss during the construction of the project are analyzed, the investigation and prediction period, scope and prediction unit are divided according to the characteristics of the construction project, and the method of calculating the soil erosion modulus according to the formula is used to quantitatively investigate and predict the disturbance of the original geomorphology, the area of damaged soil and water conservation facilities, the possible soil erosion area and the amount of soil erosion.

1. Project profile
The geographical location of the project is located in Huangqiao (Town), northwest of Yingshang County, Fuyang City, Anhui Province, and the chemical concentration area of Yingshang Circular Economic Park, Fuyang City, about 8 kilometers from the county seat. Scale of Construction: 150 kt/year (27.5%) hydrogen peroxide (of which: 30,000 tons 27.5%, 60,000 tons 50%), 60 kt/year potassium sulfate, 60 kt/year polyaluminium chloride.

The geomorphologic type of the project area belongs to the plain area of northern Anhui, The project area is a warm temperate semi-humid monsoon climate, Annual mean temperature of 15°C, the accumulated temperature of≥ 10°C the whole year is 4743.6°C. Average annual precipitation 939.3 mm, Evaporation 1600mm .15 cm maximum freezing depth of soil. The project is located in the northern rocky mountains, Soil erosion is dominated by hydraulic erosion, Of micro - erosion, Allowable soil loss of 200t/km²·a. The project area does not belong to the national and provincial key soil erosion control areas, it does not involve soil and water conservation sensitive areas.

2. Analysis of the causes of soil and water loss
The main factors of soil erosion in the construction process include natural and human factors. Natural factors are potential factors that cause soil erosion, including rainfall factors, topographic factors, vegetation factors, soil corrosion resistance and erosion resistance; human factors refer to human activities that change the natural factors that cause soil erosion.

3. Investigation of soil loss
3.1. Survey module
According to the natural situation of the project area, the layout of the project and the construction characteristics, the scope of the investigation is defined as three investigation units: the factory area, the building concession area and the construction production living area. According to the requirements of the code, the predicted area of natural recovery period should be deducted from the building occupation, ground hardening and water surface area. The predicted area of soil erosion in this project is shown in Table 1.

Table 1. Survey of projected area tables

| Engineering Area                        | Survey area |
|-----------------------------------------|-------------|
|                                         | construction period | Natural recovery period |
| site area                               | 16.56       | 4.61       |
| Building concession area                | 0.09        |            |
| Construction and production of living areas | 0.74       | 0.74       |

3.2. Survey forecast period

The investigation period during the construction period of the project is from December 2016 to December 2018, 2 years.

Natural recovery period: this project belongs to semi-humid area north of Huaihe River for 3 years. From December 2018 to June 2020, the survey period is 1.5 years, and from July 2020 to December 2021, 1.5 years is the forecast period of soil erosion. The prediction period of soil erosion in each engineering unit is detailed in Table 2.

Table 2. Summary of forecast periods for soil erosion survey.

| Forecasting units                          | Survey forecast period | Natural recovery period (years) |
|--------------------------------------------|------------------------|--------------------------------|
| site area                                  | 2, of which 0.33 hm² projected 2.4 per cent | Survey 1.5 years, forecast 1.1 years |
| Building concession area                   | 0.2                    |                                |
| Construction and production of living areas | 2.2                    | Survey 1.5 years, forecast 1.3 years |

3.3. Soil erosion modulus

3.3.1. Background value of soil erosion modulus. According to the above analysis results, the current soil erosion intensity in the project area is mild erosion. Considering the actual situation, the average annual soil erosion modulus is determined to be 180 t / (km²·a).

3.3.2. Soil erosion modulus after disturbance. The project has been completed, and the amount of soil and water loss may have been estimated by investigation method. The project has been completed, and the amount of soil and water loss may have been estimated by investigation method. The soil erosion modulus after disturbance is calculated according to the guidelines for measuring soil loss of production and construction projects.

Soil erosion modulus after disturbance during construction period

\[
M_5 = R K_{\gamma_d} L_y S_y B E T A
\]
Soil erosion modulus after disturbance during natural recovery period

\[ M_z = RK_y L_y S_y B E T A \]  \hspace{2cm} (2)

\[ K_{yd} = NK \]  \hspace{2cm} (3)

Type:
K—Soil erodibility elicitor, Yingshang County 0.0042 t.hm^2.h/(hm^2.MJ.mm);
N—Increase coefficient of soil erodibility factor after surface tillage, dimensionless, take 2.13;
Kyd—Increase coefficient of soil erodibility factor after surface tillage, dimensionless, take Kyd =0.008946t.hm^2.h/(hm^2.MJ.mm);
R—Increase coefficient of soil erodibility factor after surface tillage, dimensionless, take 904.6mm, Calculated R=4327.4 MJ.mm/(hm^2.h);
Ly—Slope length factor, dimensionless, according to the actual situation of each district to take the average horizontal projection slope length calculation;
Sy—Slope factor, dimensionless, calculated according to the actual average slope of each district;
B—Vegetation cover factor, dimensionless, the original geomorphology of the project is grassland, after the implementation of surface vegetation will be destroyed, 0 per cent coverage, Vegetation cover factor \( B \) take 0.516;
E—Engineering measures factor, take 1;
T—Tillage measure factor, dimensionless, this project disturbed land type non-agricultural land, \( T \) take 1;
A—Horizontal projection area of computing unit, Calculation of soil erosion modulus \( A = 100 \text{hm}^2 \);
The calculation results of erosion modulus are detailed in Table 3.

**Table 3. Calculating Tables for Subdivisional Soil Erosion Modules.**

| Survey Projection Subdivision | site area | Construction and production of living areas | Building concession area |
|-------------------------------|-----------|------------------------------------------|-------------------------|
| Calculation of erosion modulus|           |                                          |                         |
| R                             | 4327.4    | 4327.4                                   | 4327.4                  |
| K                             | 0.0042    | 0.0042                                   | 0.0042                  |
| Kyd                           | 0.008946  | 0.008946                                 | 0.008946                |
| Ly                            | 1.3797    | 1.3601                                   | 0.866                   |
| Sy                            | 0.20359   | 0.20359                                  | 0.20359                 |
| B                             | 0.516     | 0.516                                    | 0.516                   |
| E                             | 1         | 1                                        | 1                       |
| T                             | 1         | 1                                        | 1                       |
| A                             | 100       | 100                                      | 100                     |
| construction period t/ (km^2-a)| 561.1083646| 553.1372665                           | 352.1923923            |
| Natural recovery period t/ (km^2-a)| 263.4311571| 259.6888575                           | 165.348541             |
3.4. Prediction of soil erosion

According to the prediction method of soil erosion, the investigation and prediction results of current soil erosion modulus and the soil erosion area of each construction unit, the possible amount of soil erosion caused by each district during the construction period and the natural recovery period is investigated and predicted respectively.

The prediction of soil erosion is calculated as follows:

\[
W = \sum_{j=1}^{3} \sum_{i=1}^{n} F_{ji} \times M_{ji} \times T_{ji} \tag{4}
\]

\[
\Delta W = \sum_{j=1}^{3} \sum_{i=1}^{n} F_{ji} \times \Delta M_{ji} \times T_{ji} \tag{5}
\]

Type: \( W \)—Soil loss from surface disturbance, t; \( \Delta W \)—New soil loss from surface disturbance, t;
\( F_{ji} \)—Survey Forecast Area of i Unit in j Period, km\(^2\);
\( M_{ji} \)—j Soil erosion modulus of i units during the period, t' (km\(^2\)-a);
\( \Delta M_{ji} \)—A new soil erosion modulus for a unit at a certain time, t' (km\(^2\)-a);
\( T_{ji} \)—Survey forecasting time of i unit in j period, a;
\( i \)—Survey forecasting units, \( i = 1, 2, 3, \ldots, n \);
\( j \)—Survey forecast period, \( j = 1, 2, 3 \), Refers to construction preparation period, construction period and natural recovery period

Through calculation, the total amount of soil erosion in the investigation stage is 215 t, of which the background loss is 77 t, the new loss is 138 t. The total amount of soil erosion is 215. The total amount of soil and water loss in the prediction stage is 22 t, of which the background loss is 16 t, the new loss is 6 t.

4. Analysis of soil erosion hazards

The possible soil erosion hazards caused by this project are as follows:

1) The possible harm to the ecological environment of the project area

Construction of disturbed surface area 17.39 hm\(^2\). The engineering construction will disturb the surface geomorphology, damage the surface vegetation, destroy the natural balance of soil, and cause soil erosion.

2) Possible damage to land resources

The engineering construction destroyed the surface vegetation, exposed the soil, lost the effective protective layer of the topsoil, affected the soil water content, water permeability, corrosion resistance, erosion resistance and so on, resulting in the decrease of soil texture, the decrease of humus and organic matter content in the soil, the decrease of fertility and the deterioration of growth conditions.

3) Possible hazards to the project itself

Because the original structure of soil is destroyed during construction, if the protection is improper, soil erosion will occur, which will not only cause environmental damage, aggravate the harm of soil erosion, but also affect the construction progress and engineering safety.

4) Possible hazards to downstream and surrounding areas

If the excavations produced during the construction process are not protected and managed in time, the rainstorm runoff in the rainy season will carry a large amount of sediment into the river channels, ditches, farmland, silt ponds and reservoirs in the downstream areas, so as to reduce the flood discharge capacity of the river channels, reduce the reservoir volume and affect flood discharge and irrigation.
Therefore, it is necessary to formulate soil erosion prevention and control plan, strengthen soil and water conservation in the process of project construction, and control and improve soil erosion.

5. Fruit of Survey projections
(1) Through the investigation of soil erosion, the total disturbed land area of the project is 17.39hm².
(2) After investigation, the total amount of soil and water loss in this project is 237, of which the background loss is 93 t, the new loss is 144 t; and The total amount of soil and water loss caused by the construction period is 197 t, of which the background loss is 64 t, the new loss is 133, accounting for 92.36% of the total soil and water loss, so the construction period is set as the key monitoring period.
(3) The amount of new soil and water loss in the plant area during the construction period accounts for 91.67% of the total amount of new soil and water loss, the plant area is the key area of soil erosion, and soil erosion mainly occurs during the construction period, which is the key period of soil erosion prevention and control. The construction and production living area construction unit does not do the soil and water conservation measure engineering measure and the plant measure, also will be the monitoring key area.

6. Conclusions and guidance
In this paper, according to the natural environment of the project and the causes of soil and water loss in the construction process of the project, the prediction range of soil and water loss is determined as the disturbance area of each control zone, and the construction period is the key prediction period. The prediction results are basically consistent with the comparative analysis of the actual soil and water loss in satellite images. The investigation and prediction of soil and water loss itself defines the key areas and key periods of soil and water loss, which has certain guiding significance for the monitoring of soil and water conservation.

Through soil erosion investigation and prediction, the following guidance is put forward:
1) Construction, production and living areas should demolish temporary houses, add new engineering measures and greening measures, reduce possible soil erosion and improve the ecological environment of the project area.
2) Part of the greening effect in the plant area is not up to expectations, we should strengthen supplementary planting and replanting.
3) The southwest corner of the factory basketball court, canteen and other unbuilt areas to design soil and water conservation measures.
4) Do a good job of soil and water conservation monitoring, soil and water conservation facilities to strengthen maintenance work, strengthen acceptance work.

References
[1] <<Water and soil erosion control standards for production and construction projects>>(GB/T50434-2018);
[2] Guo Yuxin, Liu Guanghui. Prediction and Analysis of Soil and Water Loss in Jinling Reservoir Project [J]. Environmental Science Guide, 2015, 34 (4);
[3] <<Guidelines for measuring soil loss in production and construction projects>>(SL773-2018);
[4] <<Project Feasibility Study Report>> 2016.12.