Application of Remote Sensing Image in Soil & Water Conservation and Soil Erosion Survey

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Abstract: Remote sensing image is one new field in which remote sensing (RS) technique is applied. RS image, integrating multiple science and technologies including geography, computer science and cartography, is a new kind of map that not only consists the geographic information as the traditional map, but also is provided with RS characteristics such as true to life and real-time feature and abundant information. The RS image is more exact and visual. From the experiences of soil & water conservation and soil erosion survey, it is concluded that through RS image interpretation, combined with special maps, and image processing on computer, it is possible to determine soil erosion intensity highly precisely and process erosion classification block of the RS images highly efficiently. The thematic map could be prepared in a shorter period than manual processing. Along with development of soil & water conservation construction and RS technique, RS image will be widely applied in soil and water conservation.
Keywords: remote sensing image, soil & water conservation, soil erosion, application

1 The working procedures of remote sensing survey of soil erosion in henan province

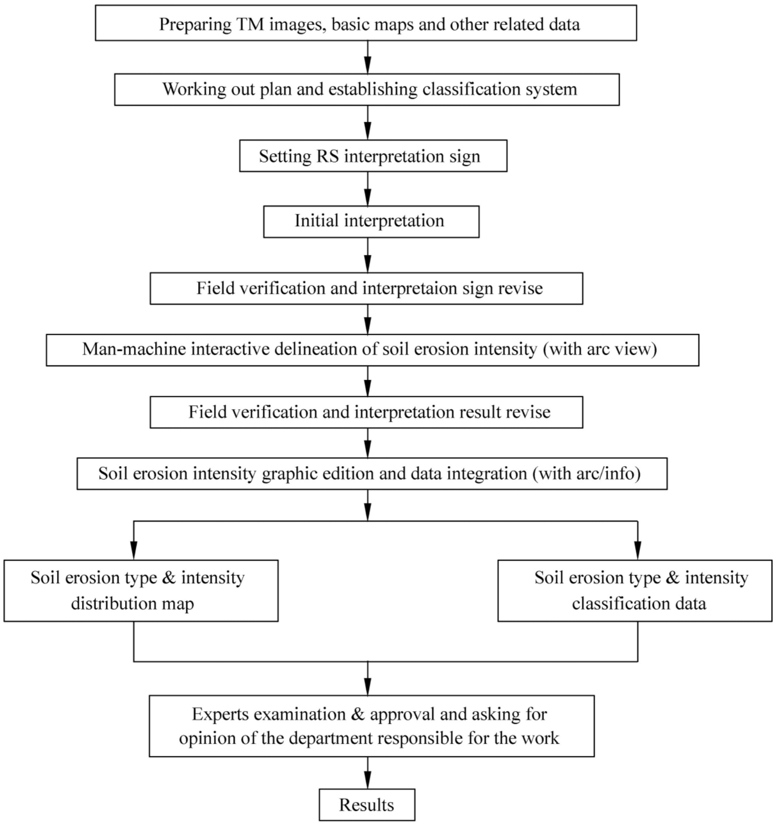
In "The National Ecological Environmental Planning" issued by State Council in1999, the set objective is that in 50 years the nation-wide soil erosion area should be basically improved, sloping farmland should be transformed to terrace and most of the improved areas should be turned into beautiful landscape. For the purpose of developing soil & water conservation in Henan province, the accurate information of the provincial soil erosion type, soil erosion intensity and distribution as well as recent development should be well known, so as to provide basic data to different level governments and departments concerned for comprehensive soil and water improvement, environmental evaluation, land improvement and disasters forecasting.

In 1999 and 2001, Henan Province conducted two RS survey. Soil erosion type, percentage of vegetation, slope and surface materials were analyzed, through man-machine interactive interpretation, in the light of TM remote sensing images, land utilization maps, topographic maps and lithologic maps, combined with necessary land survey data, and then soil erosion intensity grade was determined by means of direct determination, comparative analysis, correlation analysis and comprehensive analysis as well as other scientific methods, integrated with expert experiences, and finally soil intensity map was delineated on computer. The specific procedures are as follows:

2 Soil erosion classification system

Soil erosion is the result of interaction of all geographical factors. Soil erosion mapping involves kinds of erosion agent, mode, feature and underlying surface, etc. Therefore, a unified classification system is needed.

In Henan Province, soil erosion is mainly caused by water erosion, relating to four grades. The reference indexes for classification are shown in Table 1 and Table 2.



Flow Chart of RS Survey of Soil Erosion

Table 1 The standard for dividing soil erosion intensity

Classification	Average erosion modulus (t/(km^2 • a))	Average erosion thickness (mm/a)
Grade 1. slight erosion	<500	<0.37
Grade 2. light erosion	500—2,500	0.37—1.9
Grade 3. moderate erosion	2,500—5,000	1.9—3.7
Grade 4. heavy erosion	5,000—8,000	3.7—5.9

Table 2 Water erosion intensity classification index

Land type \ Surface slope		5°–8°	8°–15°	15°–25°	25°–35°	>35°
Vegetal coverage of non-crop land (%)	60–75		light			
	45–60					heavy
	30–45		moderate erosion		heavy	
	<30			heavy		
Sloping cropland		light	moderate			

3 Establishing RS soil erosion classification interpretation sign

The method for establishing RS soil erosion classification sign is to select typical sections with representative features such as geomorphy, lithologic character, vegetation and land utilization, using TM remote sensing images, land utilization maps and other related data and literal data. Combined with expert experiences, indoor predetermination of the selected sections is made and then field verification of the pre-determined results is conducted. After that according to the field verification result, by comparing TM remote sensing images with land utilization map, comprehensive analysis and qualitative description of different erosion grade are made, based on the difference of feature, tones, veins and image cell permutation, and then soil erosion classification interpretation sign is established.

It should be noted that there are many factors which could cause soil erosion, especially abrupt disasters, the direct interpretation of “feature” and “tones” of RS images alone could not explain all the problems. Therefore in the process of interpretation of soil erosion intensity classification, on condition that a special factor plays the leading role, concrete problems should be analyzed concretely. For example, different effect of such factors as precipitation, lithology, topography, geology, loess and the ruins of fire should all be taken into account in the interpretation of RS images.

4 Soil erosion type and intensity images interpretation and processing

4.1 Soil erosion type and intensity images interpretation

The main contents of man-machine interpretation include soil erosion type and soil erosion intensity. The soil erosion classification is made according to soil erosion type and intensity classification system. Man-machine interactive interpretation includes following procedures: (1) Input city (prefecture) level and county (district) level image grid document block by block. (2) By means of the comprehensive processing capacity and hierachical data management function of Arc view software for grid document and vector document, TM image hierarchy and land use hierarchy are set up and new soil erosion data hierarchy is established, in the way of man-machine interaction, based on the interpretation signs such as tones (color), pattern, position, size, shadow, veins and topographical map, to decide indirect signs of soil erosion intensity including slope and vegetation and determine the attribute of image plots. The interpretation of soil erosion type and intensity of all the images should be done in this way. If one plot is decided having more than two attributes, it is suggested to add an arc and label by means of Arc view (The boundary should be strictly closed.). The attribute of the newly added label should also be defined. (3) After interpretation is over, the newly established hierarchy, arc and label documents should be stored , and derived in the format of *.SHP and then converted to Arc/info with the command of Shapearc for graphic edit.

4.2 Image processing

Since the image interpretation is made block by block, the graphs should be put together.

(1) The arc and label should be edited. First of all, the documents of Shape format should be converted to Coverage format document with “Shapearc” command, and then label document and arc document should be merged by means of Arcedit modulus, and all the documents should be closed. After that the arc document should be topologized with “Clean” command. Finally, the arc document and label document should be edited with “Arcedit”.

(2) Edit of hierarchy, arc and label document. In Arc/info, the already established erosion intensity classification attribute should be converted to User-ID and the superfluous ID should be deleted. At the same time, as the background hierarchy, the arc and label should be added with edit hierarchy by means of “put” command. And then, through “labelerr” and dangle label correction, the plots of image with same attribute should be merged by means of “dissolve” command and topologized finally.

4.3 Edges connection

Edges connection mainly includes connection of different images, namely, attributes connection and graphs connection. The attributes connection means connection of different erosion type and intensity classification, and the graphs connection means specific plot boundary lines connection.

The maps we adopted are prepared with each county as an element and data interpretation is also made on the basis of county. Since conditions of both sides of the administrative boundary line (county boundary or prefecture boundary) of the adjacent counties are basically same, and the soil erosion intensity is also almost similar, the plots should be closed with each other, moreover, the attributes of the plots should also be same. To make sure that the plots on both sides of the administrative boundary line are closed and the administrative boundary line is not used as the boundary line of the plots (In some cases, the attributes of plots are not same, and the administrative boundary line is taken as the boundary between the two plots. If a river is taken as the administrative boundary, then the administrative boundary might be taken as the boundary of the plots.), the edge connection between counties should be made first, and any plot error between administrative boundaries (including county boundary and prefecture boundary) should be corrected.

With the support of Arc/info software, city (prefecture) level graphic files should be connected with Append command. The number of connected maps depends on file quantity.

4.4 Data error detection and integration

After edge connection is corrected, the provincial and prefecture data should be integrated and error detection should be made. The major objective of error detection includes detection of dangle error, label error, illegal code error and administrative boundary line error. A. Detection of dangle error. Detection is made to find if any Dangle (unclosed Polygon) exists in the result Coverage and any Dangle should be deleted. B. Detection of label error. One plot should have only one label and the attribute value of the label should be a fixed numeric. If one plot has more than one label or dose not have a label, then label error detection is needed. After the correct label is found, the superfluous label should be deleted. If one plot has no label, it is recommended to check if the plot is necessary or not. If the plot is necessary, a label should be marked on the plot and given a correct attribute. If a plot is caused by tolerance and is not necessary, then the plot should be deleted. C. Detection of illegal code. The main objective of this operation is to check if the soil erosion attribute value or code of the plot is correct and consistent. If not, the error should be corrected. D. Detection of administrative boundary error. An administrative boundary line may be changed by a minor plot or operation mistake. If the change is minor, no correction should be made, otherwise, the boundary line should be corrected. After the above-mentioned error detection is over, the coverage data should be integrated and topologized on the basis of prefecture and province. Finally, the adjacent plots with same attributes should be merged to generate provincial, prefecture and county result data.

5 Conclusion

(1) Remote sensing TM image not only could provide geographical information as traditional map, but also could provide abundant information in time and is easy to read. Moreover, the TM image is prepared with computer in a short period, with higher precision. With the TM image, quantitative, qualitative and positioning processing and analysis on overall news is possible. The remote sensing TM image is the best supplementary tools and means in soil and water conservation.

(2) As GIS technique is used widely, digital images could be used as data source of geographical information system. Combination of GIS and digital image not only could provide us kinds of information indexes of all fields in different period, but also could make dynamic management of variable data, realize real-time remote monitoring of soil and water conservation and provide basis and reference for soil & water conservation in future.

(3) Compared with traditional visual interpretation and manual processing, the man-machine interpretation & analysis and image processing on computer needs less manpower, material and financial resources, increases scientific and technical application in soil & water conservation research as well as scientific and standardized management of soil & water conservation.

References

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