黄土高原重点治理区
资源与环境系列研究

晋西黄土高原地区遥感应用研究

STUDY OF REMOTE SENSING APPLICATION IN
THE LOESS PLATEAU OF WESTERN SHANXI PROVINCE

赵 济 高起江 主编

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Study of Remote Sensing Application
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内 容 简 介

本论文集为国家“七五”科技攻关项目“遥感技术开发”的子课题“黄土高原遥感调查”中的山西西部遥感调查研究结果。内容包括卫星遥感信息源的适用性评价、信息提取、土地利用、草场、森林、土地类型、土地资源评价、土壤侵蚀等系列图件编制方法，以及晋西黄土高原环境资源的地学分析和区域开发问题探讨等。本文集可供遥感应用、农业、林业、土地、水土保持、地学等方面的科学研究工作者及有关高校师生参考。

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《晋西黄土高原地区遥感应用研究》

序

黄土高原地区具有发展农、林、牧业的有利条件，矿产资源丰富，煤炭、铝土等都居全国重要地位，能源资源尤为丰富，为本区开发提供了良好的物质基础。另一方面，这里又是生态环境十分脆弱的地区，特别是晋、陕、蒙黄河峡谷两侧（约8万平方公里的重点治理区），地形破碎，沟壑纵横，水土流失严重，为经济建设带来了困难。

长期以来，为了研究和改善黄土高原地区的生态环境，我国老一辈科学家，风餐露宿，跋山涉水，对黄土高原的形成和水土流失规律以及泥沙对黄河下游的影响等问题，进行了大量的科学考察与综合治理研究试验工作，为今天深入研究和治理黄土高原积累了丰富的科学资料。为了进一步查明黄土高原资源与环境现状，研究环境恶化的症结，为区域开发和宏观决策提供科学依据，国家计委决定，“七五”期间采用航天、航空遥感技术与地面调查结合的方法，在黄土高原重点治理区，进行全面的资源与环境遥感调查。通过近五年的工作，编制了8万多平方公里的土地利用、土壤侵蚀、土地资源、森林及草场类型等1∶5万、1∶10万比例尺的系列图件，取得了全面系统的资源数据，为各级政府规划与开发提供了科学依据。

“黄土高原重点治理区资源与环境系列研究”是在完成上述任务的基础上所进行的技术方法与区域开发研究的总结。这次研究在以下几个方面做了有益的探索：

1. 在地形破碎的黄土丘陵区，应用遥感技术进行大面积资源与环境遥感调查和系列制图，使我国遥感技术进一步系统化、实用化了。

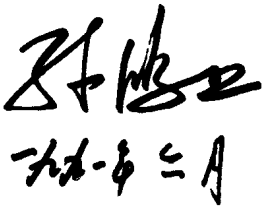
2. 在查清资源的基础上，对区域开发中存在的问题，通过典型分析，提出了一些符合实际的评价意见。

3. 在遥感侵蚀制图方面，通过遥感影象分析，将侵蚀类型与侵蚀强度组合形式反映在图上，采用多种自然因子综合分析研究，取得了一些新进展。

4. 通过多时相遥感图象对比与毛乌素沙地东南缘的动态分析，提出了治理风沙的具体设想。

黄土高原遥感调查与制图研究成果是在国家计委、国家科委支持下，由中国科学院主持，国家教委、林业部、国家测绘总局、农牧渔业部参加主持完成的。它不仅是各部门大协作的成果，也是近百名科技人员，历时五年辛勤劳动的结晶。

经济建设必须依靠科学技术，科学技术一定要面向经济建设。我国幅员辽阔，关系国计民生的资源环境问题众多，这正是地球科学工作者的用武之地，相信会有更多的优秀成果涌现出来，为国民经济建设做出更大贡献。



INTRODUCTION

BACKGROUND

According to the National Seventh Five-year Plan, the serial thematic mapping by using remote sensing technique in the key management area of the Loess Plateau was focused on three parts in terms of different geographical locations which are called the north part, the east part and the west part. The key management area, located along the middle reaches of the Yellow River, includes the north part of Shaanxi Province, the western Shanxi province and the southern Inner Mongolia. It is a typical region where occurs the serious soil erosion, excessive plantation plowing and ecological environment deterioration. Our studied area is located in the east part including twelve counties of the western Shanxi Province (Xingxian, Linxian, Fangshan, Lishi, Zhongyang, LiuLin, Shilou, Yonghe, Daning, Jixian, Xiangning, Hejin), where soil erosion is severely. The purpose of this project is to investigate the local natural resources, to study soil erosion and to compile the serial thematic maps. By using Landsat TM imageries as the major information source and by combining these with Landsat MSS imageries, color infrared airphotos and field survey, we achieved six kinds of thematic maps of each county with the scale of 1 : 100, 000, such as Landuse Map, Grassland Type Map, Soil Erosion Map, Forest Distribution Map, Land Type Map and Land Resources Map.

RESEARCH APPROACH

1. The Department of Geography in Beijing Normal University (BNU) took charge of this project, the Institute of Remote Sensing for Agricultural Application of Shanxi Province (IRSAAS) and the Department of Geography of Yantai Teachers' College, Shandong Province, took part in the research. Beginning in April of 1987, the research study group of 25 members was established. The soil erosion map and image optical processing were completed by IRSAAS, and the rest of maps were complied by BNU.
2. In order to compile the serial thematic maps, the well organized field surveys were conducted. After investigation in the situs, a common recognition was achieved to the problems concerning the major land types, the characteristics of geomophology, the distribution of vegetation, the intensity and the types of soil erosion. Moreover, much attention was paid to the concepts, such as, line of gully edge, line of slope feet, line of demarcation and line of concentration. The clarification of these concepts was crucial for coordinating various thematic maps.
3. As for information sources used in the study, IRSAAS processed the Landsat TM im-

ageries, which consists of Sheet 126—33 (Baode), Sheet 126—34 (Suide) —both dated June 8, 1986, and Sheet 126—35 (Yanchang) —dated June 24, 1986. In addition, Landsat TM imageries were compounded with band 3, 4 and 5 on the scale of 1 : 100, 000. All imageries, except for a little part covered by clouds, met the needs of the study for their distinct pictures.

The color infrared air photos were taken by plane in Xingxian, the middle north part of the study region, with a scale of 1 : 60, 000, on August 19, 1987. These provided us benefit situation in serial thematic mapping, varied information overlapping and accuracy examining of TM image interpretation for Xingxian County.

Similarly, color infrared air-photos for Sanchuanhe River Basin with a scale of 1 : 20, 000 (taken in September 1989) also fairly benefited to the setting up of the interpretation symbols of TM imageries. Landsat MSS imageries with a scale of 1 : 100, 000 (compound with band 5, 6 and 7) were supplemental information source in Sanchuanhe River Basin.

4. During the study period, field survey were conducted four times with different purpose: In 1987, clarifying recognition through image interpretation symbols; In 1988, examining the TM imagery interpretation accuracy and making sure whether Landsat TM imagery with the scale of 1 : 100, 000 satisfied the preciseness required in cartography in Loess Plateau; In 1989, investigating along a complete route within whole area to examine the interpretation accuracy of the maps, to solve the problems of indoor interpretation works and to correct errors of interpretation pixels; In July, 1990, verifying the quality of the interpretation maps once more.

RESULTS

1. Completing six kinds of thematic maps with the scale of 1 : 100, 000, area data list and study reports.

2. Comparing different methods in image processing. The methodology study was focused on how to distinguish the confusing information and how to extract it (e. g. natural forest and date forest). To solve this problem, on TM digital imagery, we adopted method of equalization processing, Gauss Transformation, KL Transformation, TM 4/3+3/2+2/1 processing and data matching between TM and color infrared air photos, etc. Among them, good result of the enhancement of date forest information and vertical structural forest were achieved. It is very important to circumscribe the date forest distributive boundary along Yellow River in the western shanxi province by extracting the date forest information in imagery.

3. Experimental study on Land Resources Information System of small drainage basin. After choosing typical geomophological area, an experimental study in Water and Soil Conservation Management (WSCM) was conducted and the WSCM Information System was set up. The typical areas were located in Yangjiayu drainage basin of Liulin County and in Nangezhan Basin of Shilou County. By means of microcomputer Great Wall/286B, we ana-

lyzed on land slop, land type, land use, soil erosion and water and soil conservation management in small drainage basin. The maps of slop classification, maps of elevation in three dimension, maps of land resources planning as well as other data tables were completed as the results.

4. Based on the feedback theory as landscape optical model—realistic ground model—remote sensing map model, we set up the models of remote sensing geoanalysis in the western Shanxi Province through the process of information extraction and feedback of imagery—field—map—field—imagery. They were: remote sensing geoanalysis model of the gully edge line—slope feet line, geomodel of the material image color difference classification and elevation classification. These models had significantly helped to reveal the distribution characteristics of the geographical phenomena and the model recognition of remote sensing imagery.

5. In accordance with river rift distribution maps, on the scale of 1 : 500, 000, the distinct distribution pattern of river rifts was strongly influenced by the regional factors. That possessed great reference value which help to study special features of neotectonic movement in the Loess Plateau, and to recognize the development of river system and their effects to the historic and modern process of erosion. Moreover, the rift lines were regarded as the critical line to distinguish regions and to be a mark of water and soil conservation.

On the slope maps of six typical geomophological small drainage basins, compiled with topographical map on scale of 1 : 50, 000, we measured the areas of each class of slope. (a) The area of slope being higher than 25 degree, called dominant slope, took up 50% of whole area. The distribution of this slope class ranges from the more in the middle part of the study region to the less in the north and the south. (b) The area of slop class being lower than 15 degree, depended on the geomophological type, mainly distributed over the gully edge line. For example, above the rift line about 90% of this class of slop land is located over the gully edge line. Similarly, below the rift line the percentage of this class of slop land located over the gully edge line is much higher.

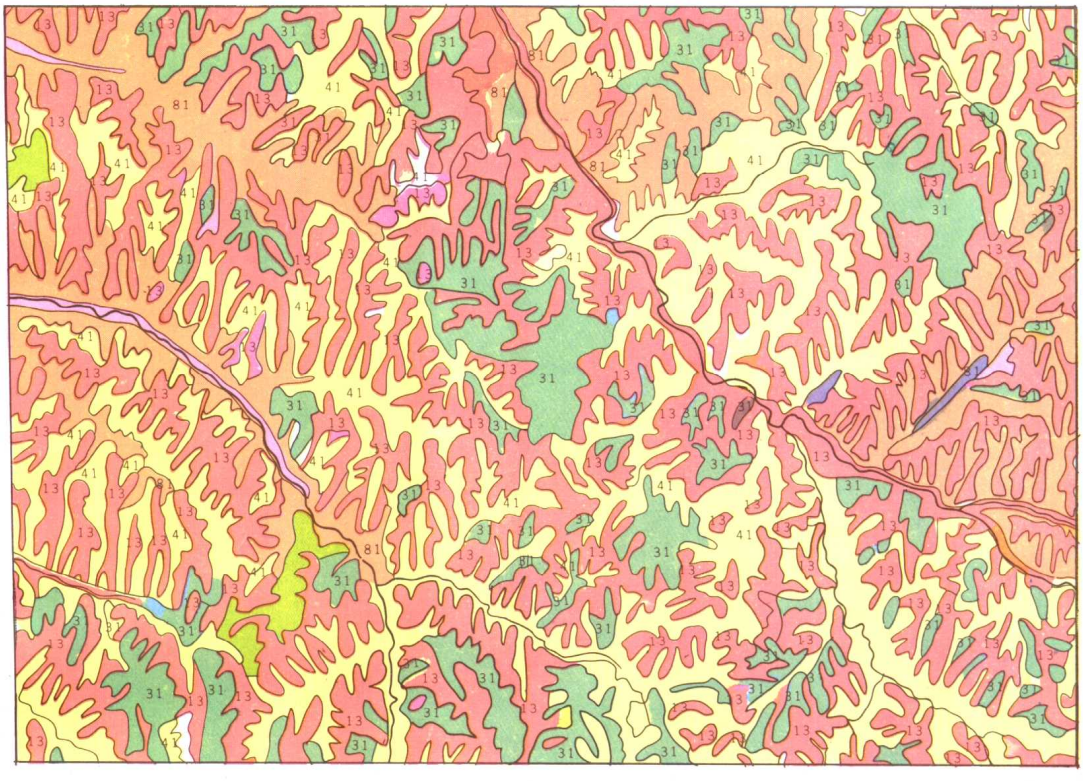
6. By using Landsat TM imageries and color infrared air photos, we undertook a full study on landslide. Consequently, the Distribution Map of Landslide Types and Regional Assessment of Landslide Danger, both on the scale of 1 : 400, 000, were complicated. A package of software on the analysis system of regional landslide was carride out, as well as, the data of the landslide area and of the whole study area were submitted. The results show that there are three strips of large sale landslide developing separately in the counties of Xingxian, Linxian and Xiangning. This discovery has benefited greatly to the prevention of regional landslide.

7. As for population inhabitant distribution characteristics, two sheets of topographical maps, scaled on 1 : 50,000 in the south part and north part of loess area were selected. The analysis shows that in the south 50% of people live above the line of gully edge, however, in the north 70% of people live below the line of gully edge. Comparing with the farmland

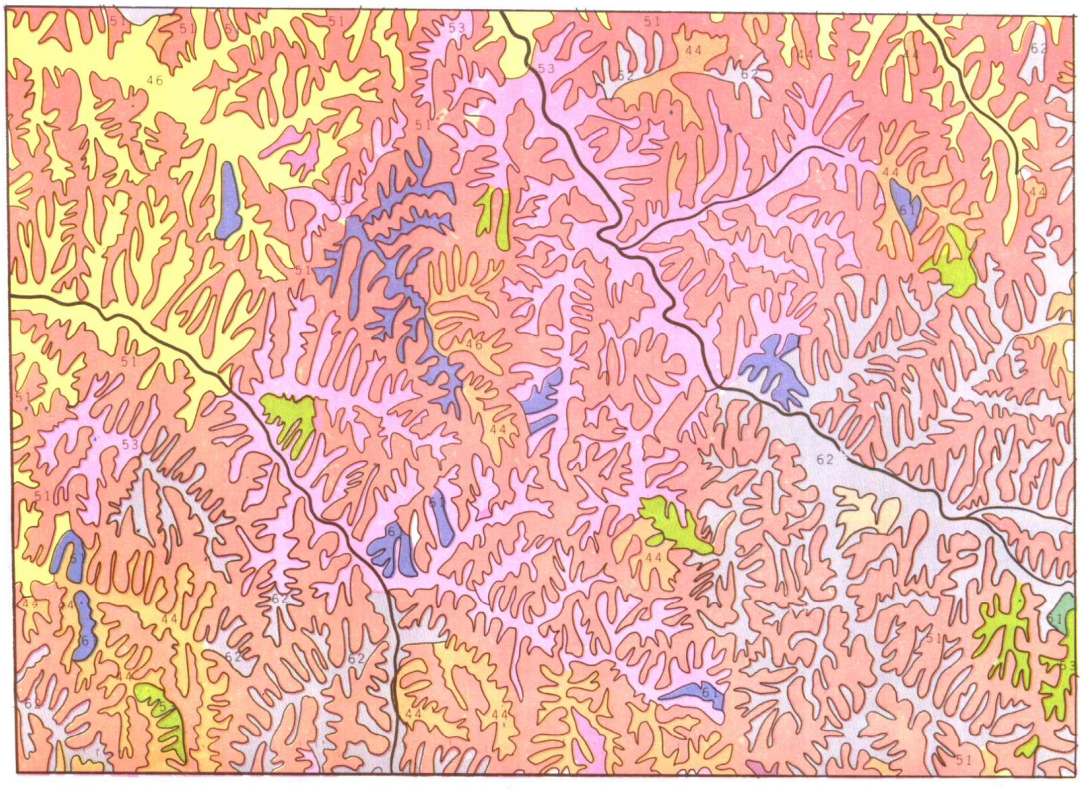
distribution pattern, we discovered that the situation of separation between human and land, water and land is main factors influence landuse and population capabilities.

8. From the series study on " Investigation—Assessment—Management" of the natural resources in Fangshan County, we completed the study that approaches on applied engineering system of Loess Plateau by remote sensing. Also, we successfully transformed the investigation and assessment result, both concerning resources and environment, to the management and operated developing program. A land resources oriented planning model which coordinately developed resources and environment in poverty mountainous area of Fangshan County was put forward. An adjustment program of landuse structure which took the fundamental farmland construction as the core work and took integrated developing of farm-forest-pasture as agriculture development direction was posed. All of those developing programs got the high appraisal from the local government.

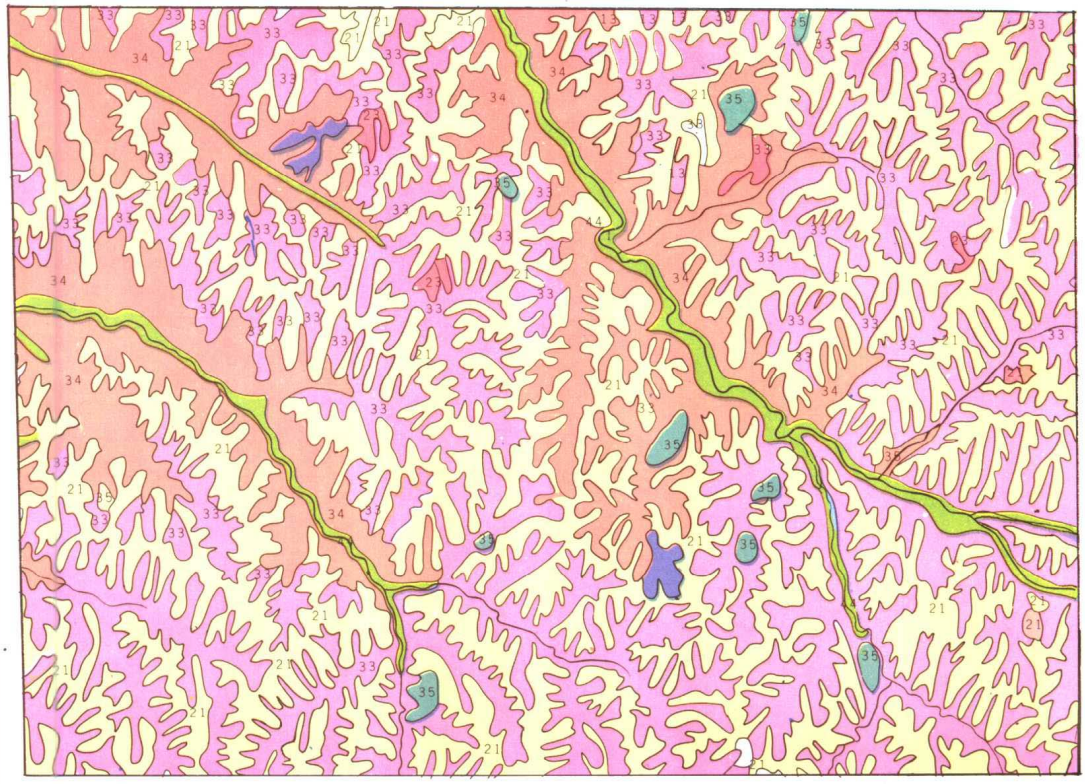
9. According to the study result of natural resources distribution characteristics as " Difference from east to west and changing from south to north", we raised magnificent developing and management programs for the whole area. This plan suggested that the local government should built up three economic belts from west to the east and two major industrial centers. The three economic belts are: the west economic belt of husbandry and fruit on loess area; the middle economic belt of farm-husbandry, and water conservative forest on loess area; the east economic belt of forest and husbandry on loess area and rocky region. The two major industrial centers include the north center of local mine base on loess hilly area, the south center of hybroelectricity, aluminum smelting and integrated agriculture.



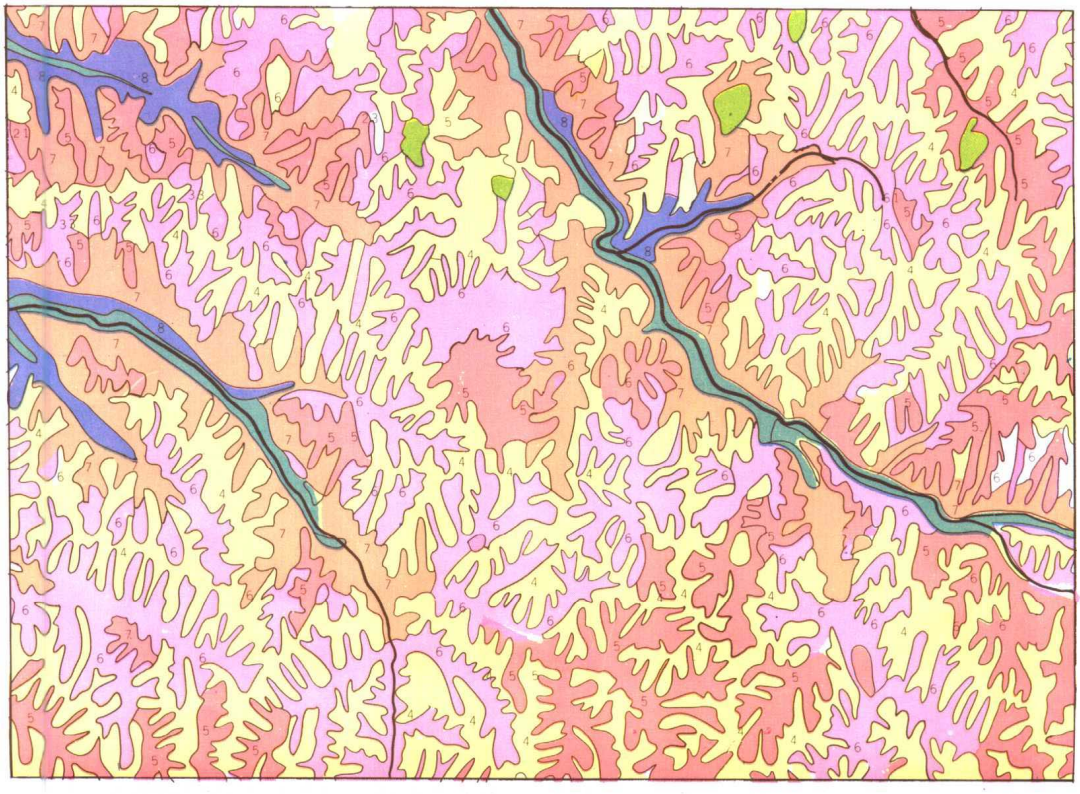
彩图1　土地利用图(局部)



彩图2　土壤侵蚀图(局部)



彩图3　土地类型图



彩图4　土地资源评价图

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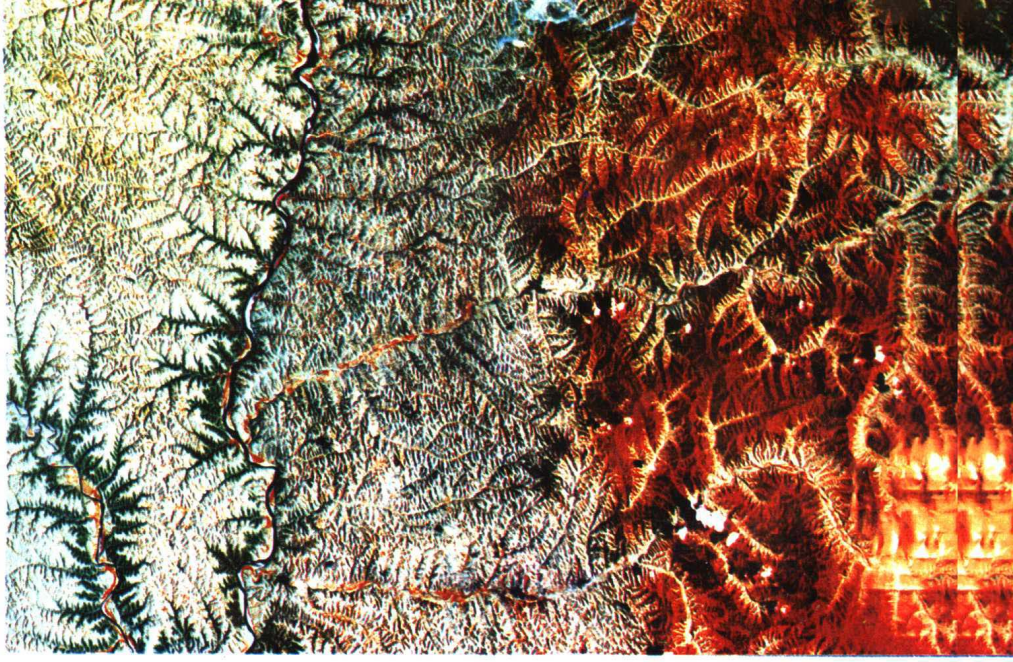
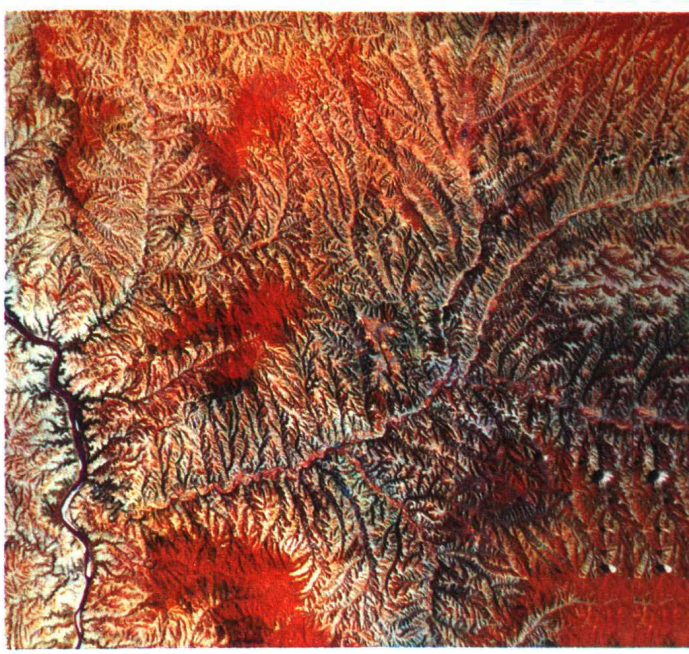
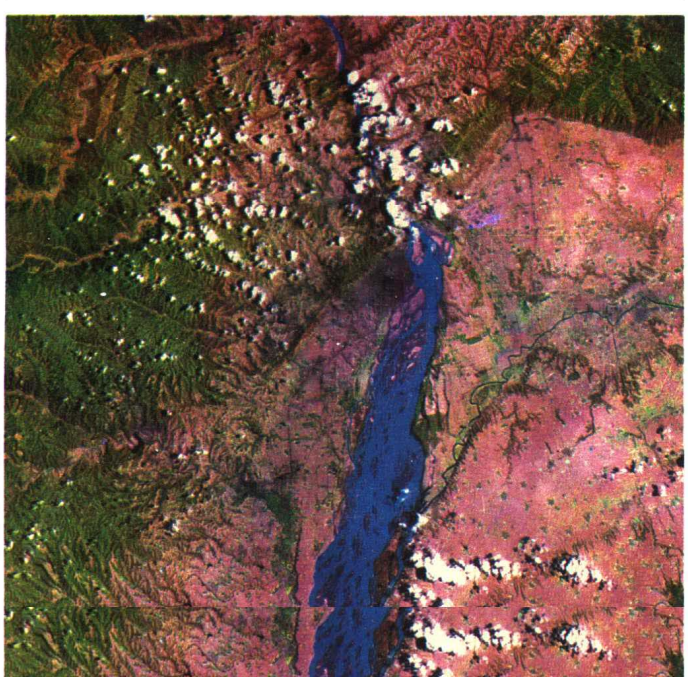
彩图5、6　TM2、3、4
标准合成片

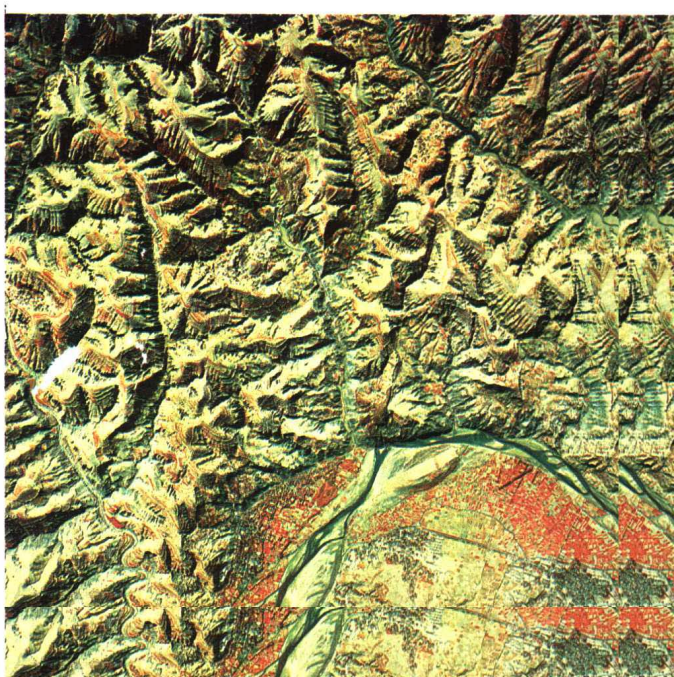
彩图7　TM3、4、5(B、R、G)合成片(河津)

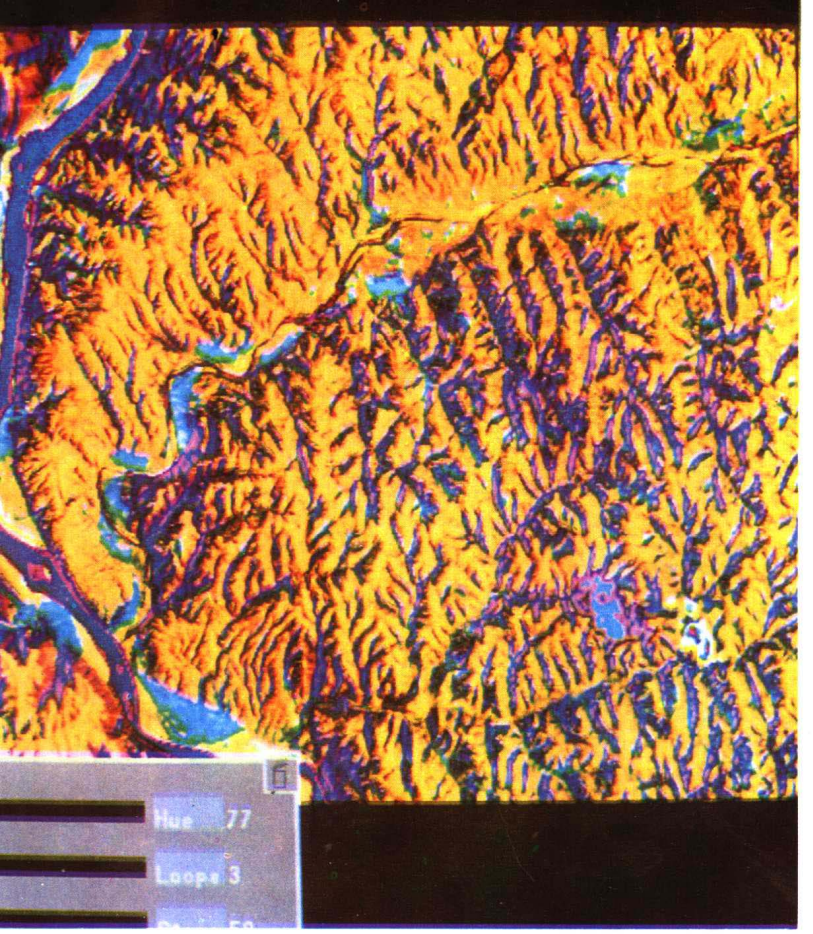
彩图8　离石县1:2万彩红外航片



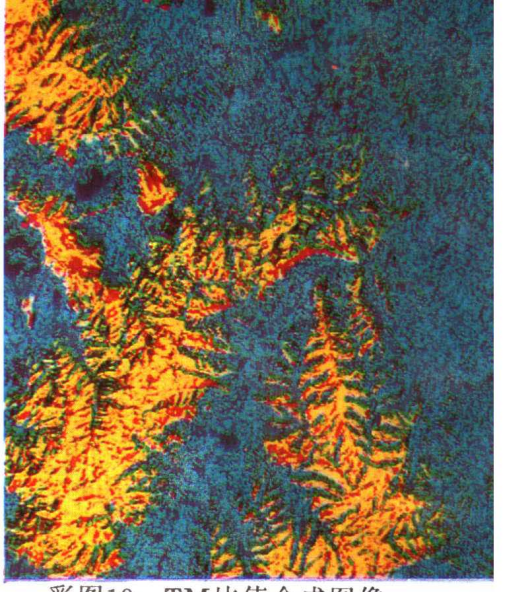








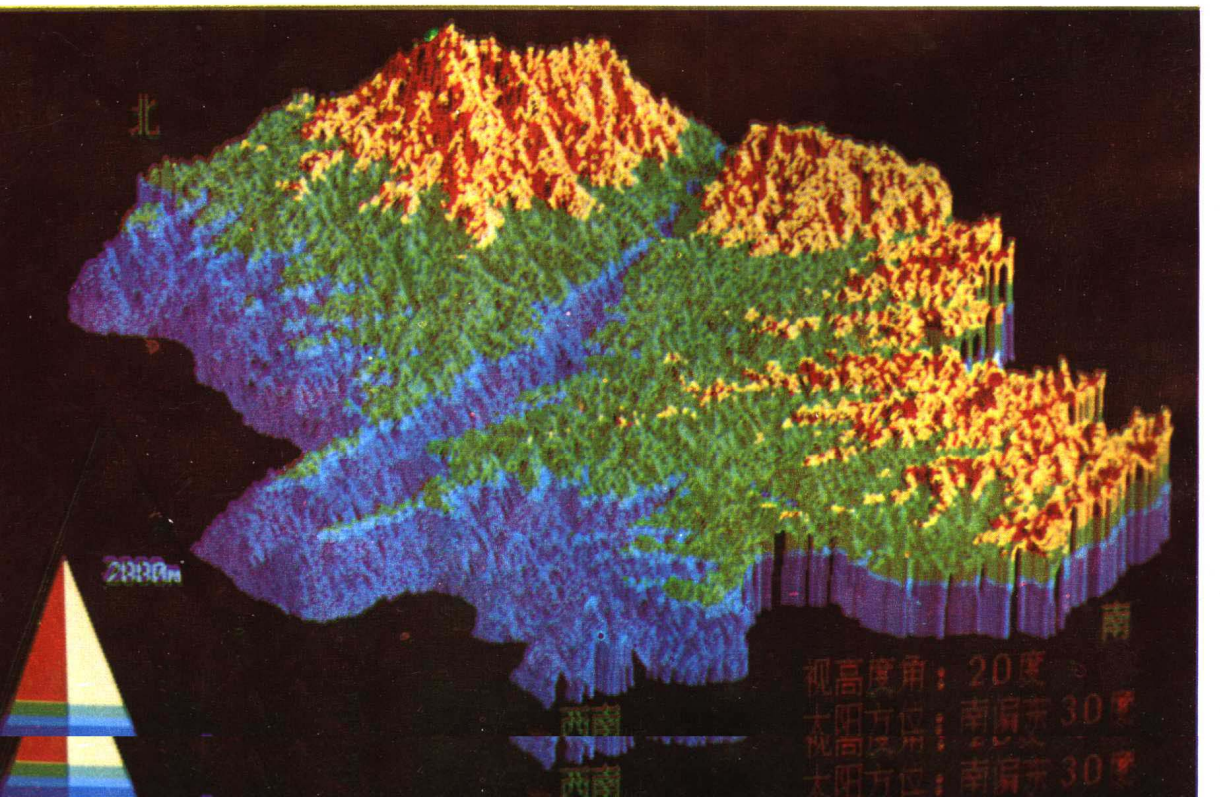
彩图9　伪彩色显示



彩图10　TM比值合成图像

彩图11　直方图均衡化

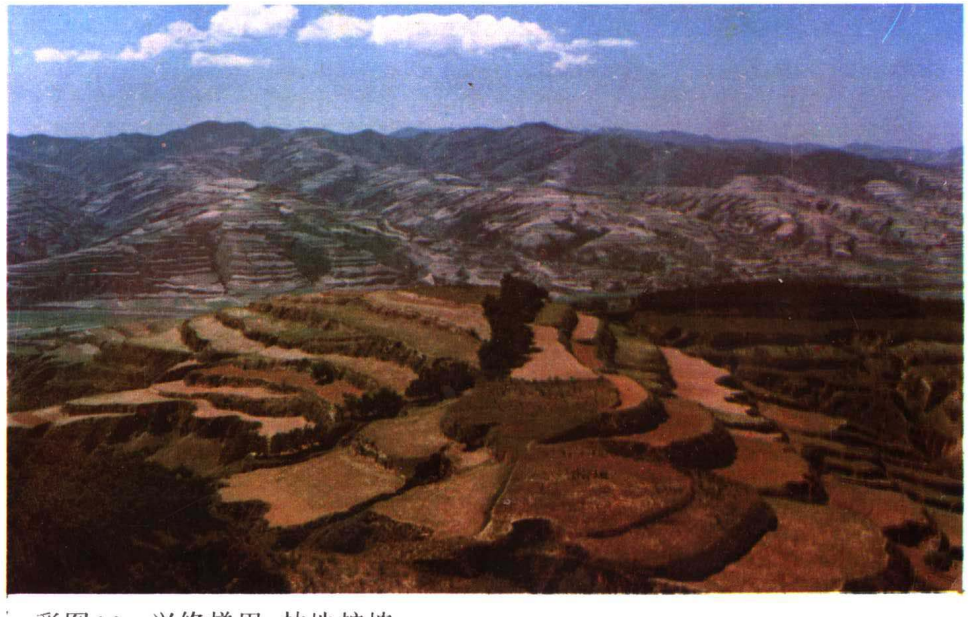
彩图12　柳林县GIS研究



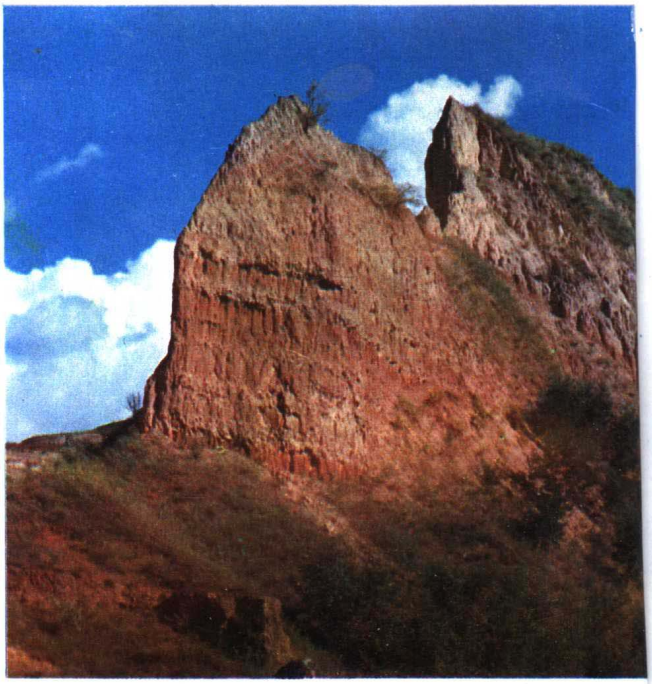
彩图13　大宁县太德塬沟头防护

彩图14　退耕还林

彩图15　山前水保林



彩图16　兴修梯田，林地护坡



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彩图17　梁状黄土丘陵

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资源与环境特征分析

土壤侵蚀分析

区域治理与开发