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Image Atlas in Forest Health Protection 2001

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Image Atlas in Forest Health Protection

(Report of the APEC Project)

2001

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Institute of Remote Sensing Applications, Chinese Academy of Sciences

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General Center for Forest Pest Control of Zhejiang Province
General Center for Forest Pest Control of Liaoning Province

Image Atlas in Forest Health Protection

(Report of the APEC Project)

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Preface

Since 20's in last century, airborne remote sensing has been used in forest resource inventory and monitoring. Ever since 1972, civilian Earth observation satellites of different origin and construction have been circling our planet and reporting regularly on its land and ocean surfaces. Remote sensing techniques are now used for innumerable practical and scientific tasks, and make significant contributions to our understanding of the manifold processes that take place on our home planet.

Forest insects and diseases have long been a serious kind of disaster and cause great damage every year. Remote sensing has the capacity of large scale data acquisition, and can be used in the monitoring of forest disease and insects. Our project is to probe into the techniques for remote sensing applications in forest disease and insect monitoring. The study has been carried out in northeastern China, central eastern China and southern China, and has gained great success. It has demonstrated that Landsat TM data can be used in monitoring and assessing damages caused by pine caterpillars in stand level. Videography and high resolution data such as IKONOS data can even be used to detect individual trees hampered by diseases and insects. Images and maps of various type used in our project are compiled into this atlas, and they can be a good demonstration of remote sensing potentials in forest protection.

It is to be hoped that this work will have a widespread readership, broaden interest in the possible uses of remote sensing, and enhance awareness of what China is capable of doing. To mitigate damages by forest insects and diseases through remote sensing is our final goal.

Wu Honggan

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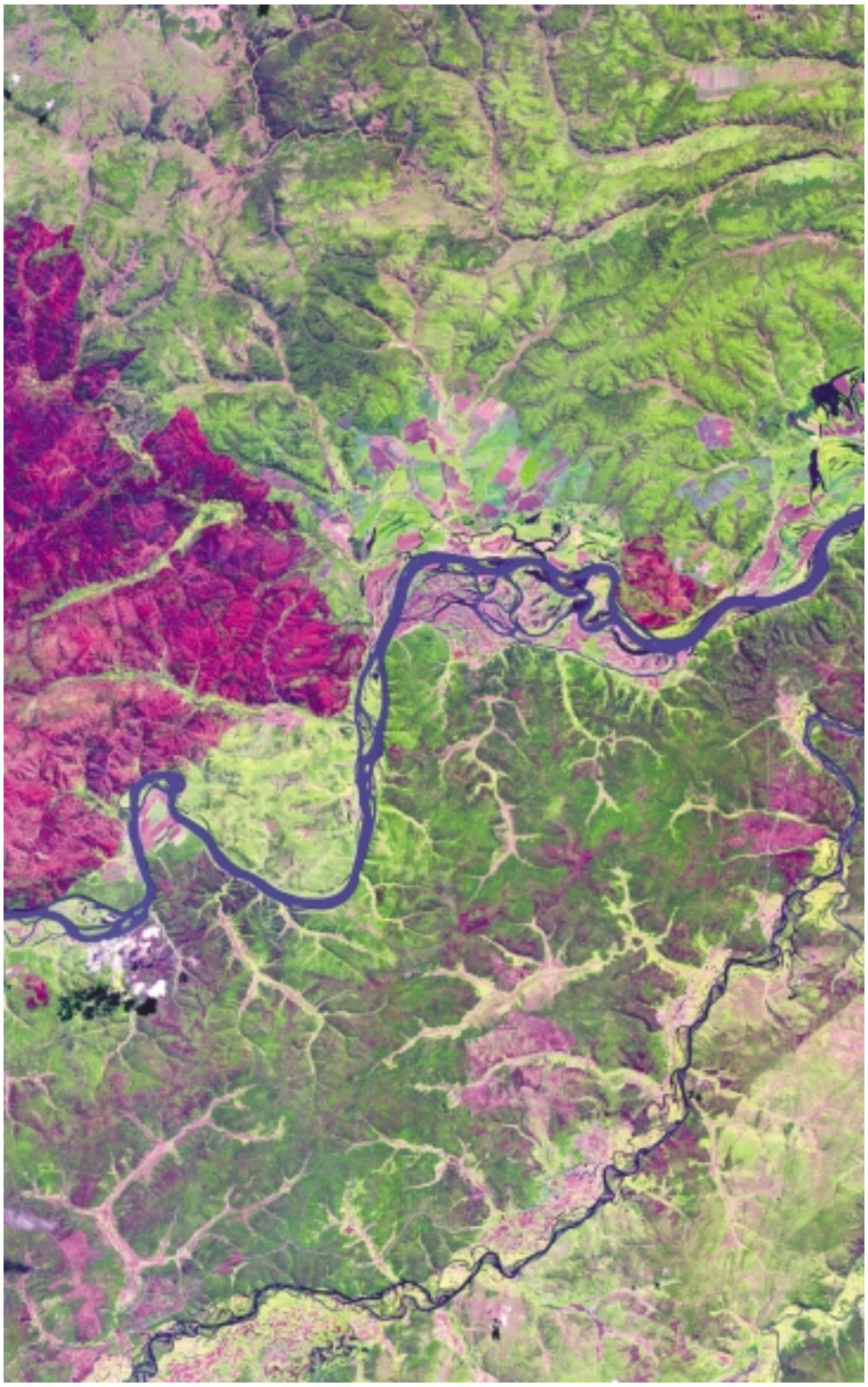

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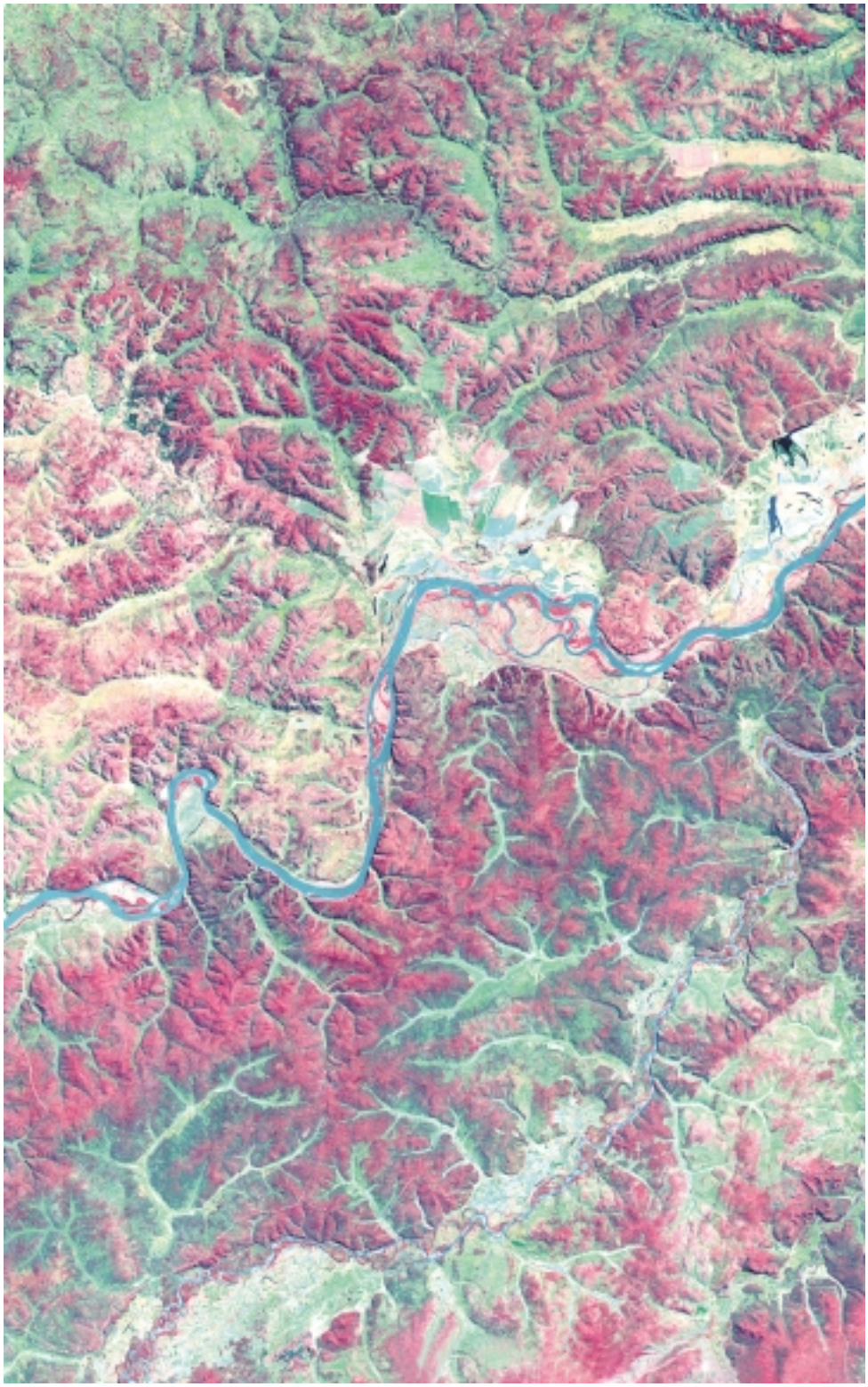

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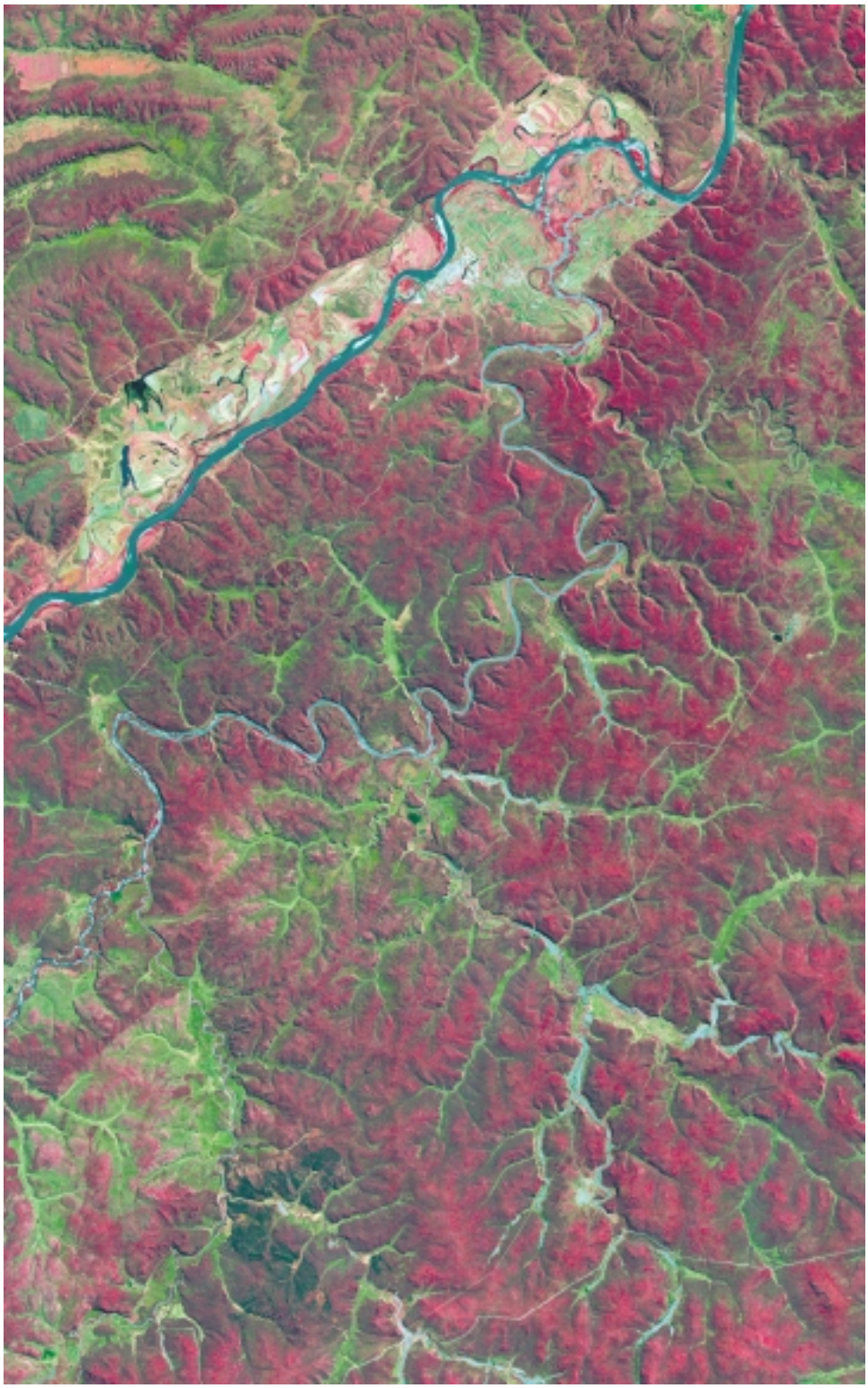

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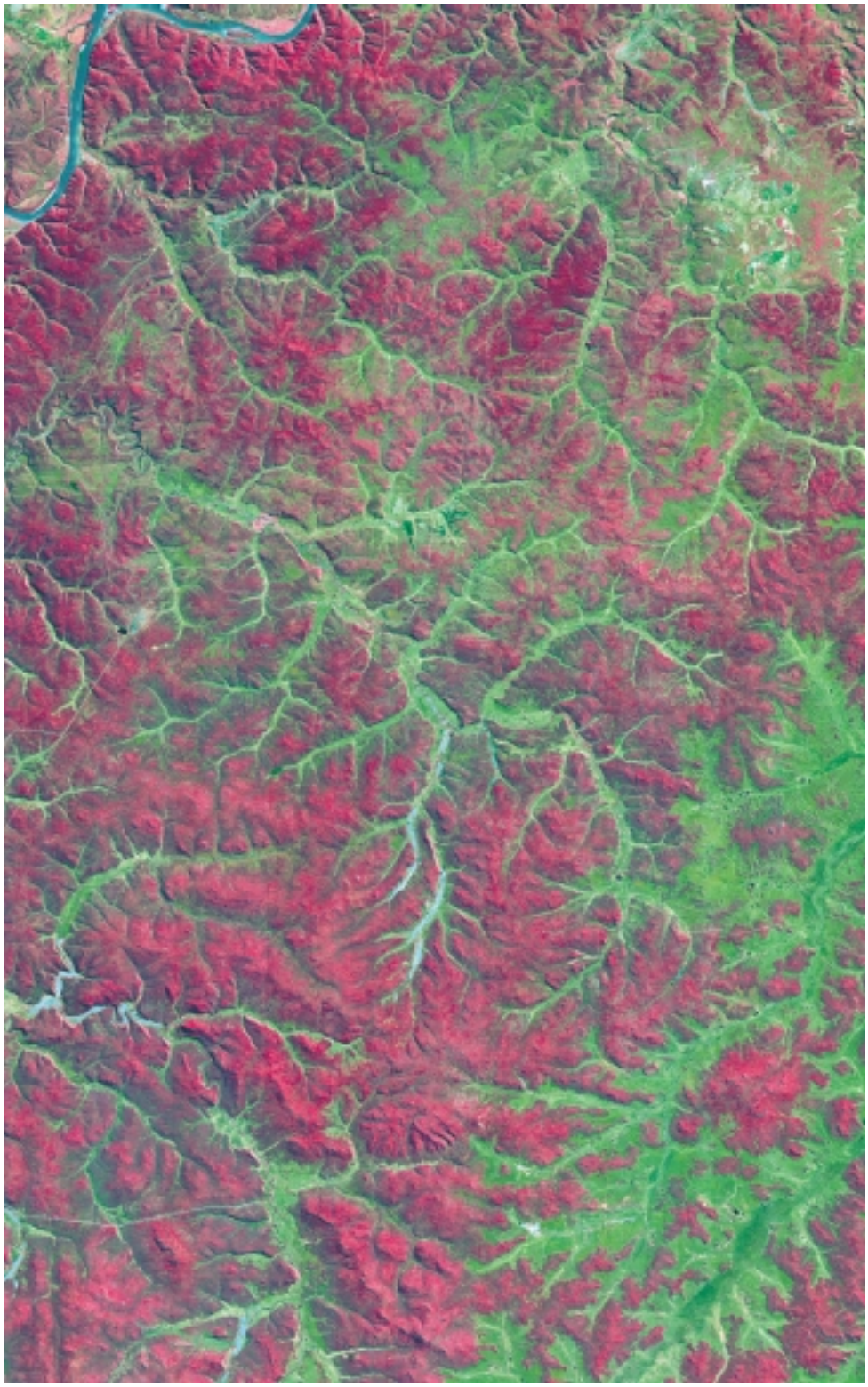

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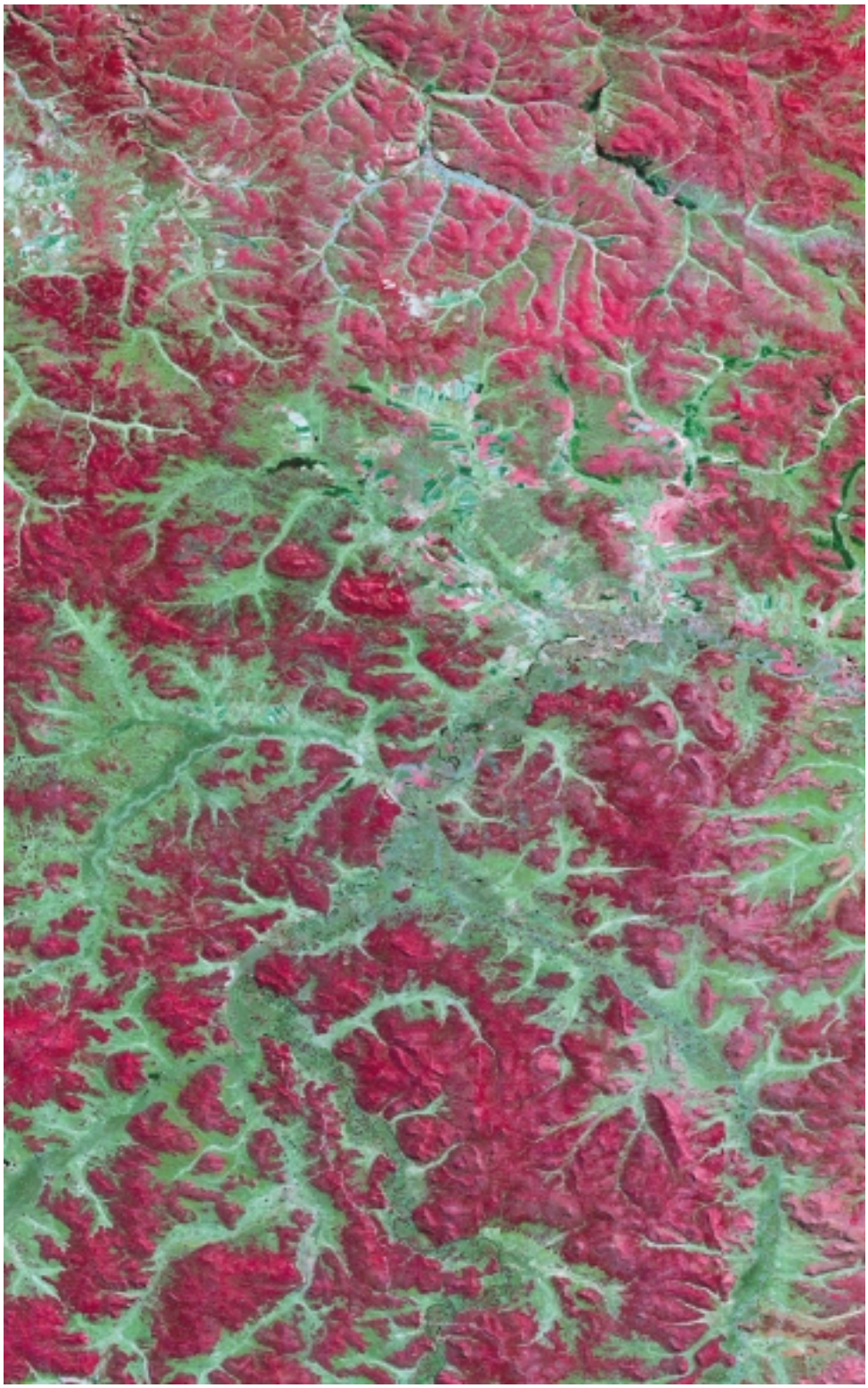

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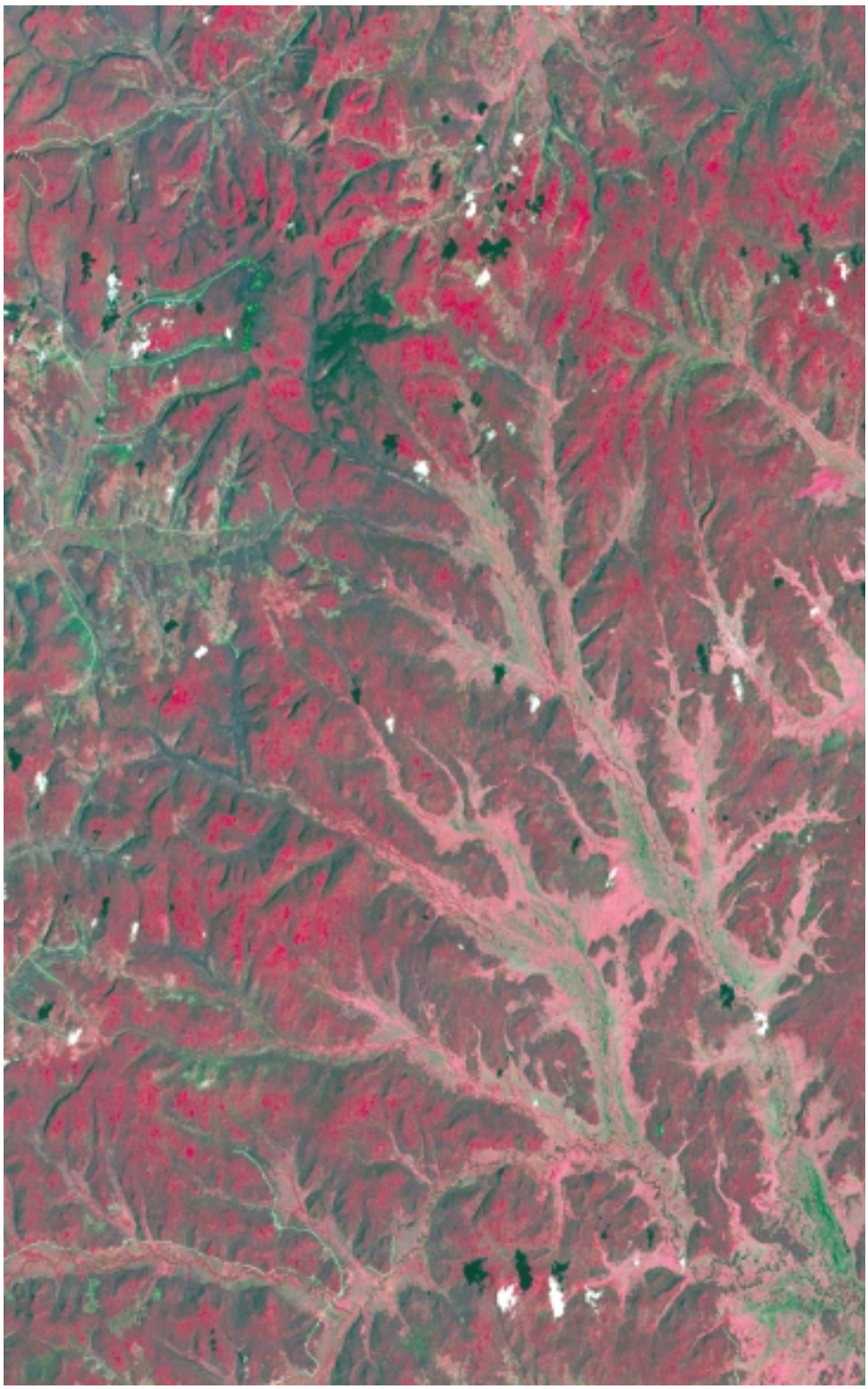
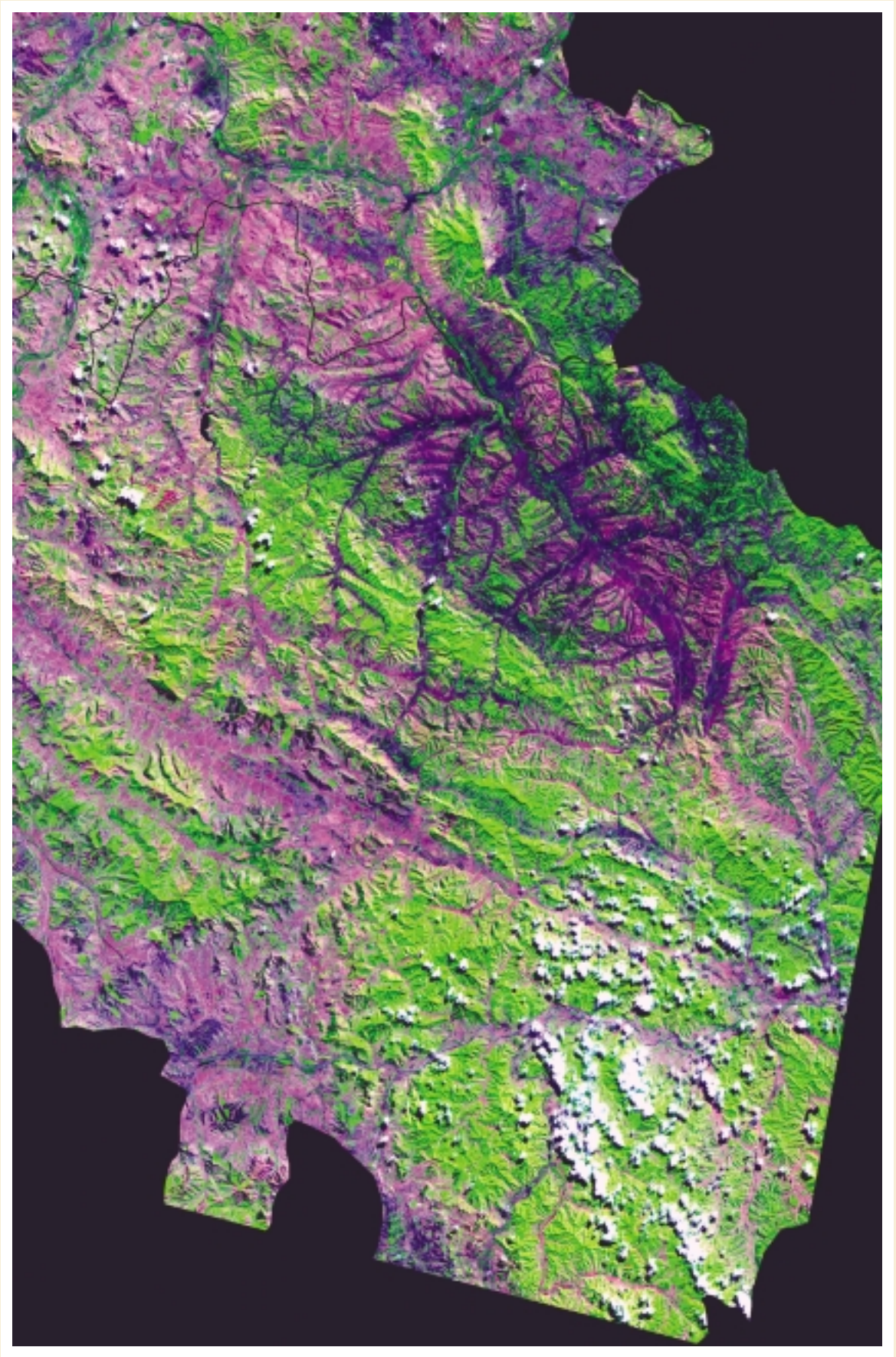


TM image in 1996

This group of images are situated at DaHingganling area of northreastern China, the center is about 124.6°E, 52.5°N. This area is the largest forested area of China with dahurian larch (*Larix gmelini*) as it dominant tree type, and dahurian larch caterpillar (*Dendrolimus superans*) is the main insect and disease type that intimidate forest health. In 1990, severe dahurian larch caterpillar (*Dendrolimus superans*) occurred in DaHingganling.

We choose five groups of images to analyze and compare the harm of dahurian larch caterpillar (*Dendrolimus superans*). In images of 1990, the green area represents the healthy forest, the deep purple and brown color represent the hazard area, the purple color represents bare land or area with no vegetation. In images of 1996, the red color represents healthy forest areas. By comparison between the two years, the hazard area can be seen clearly.

Images of damage by chinese-pine caterpillar in Liaoning Province



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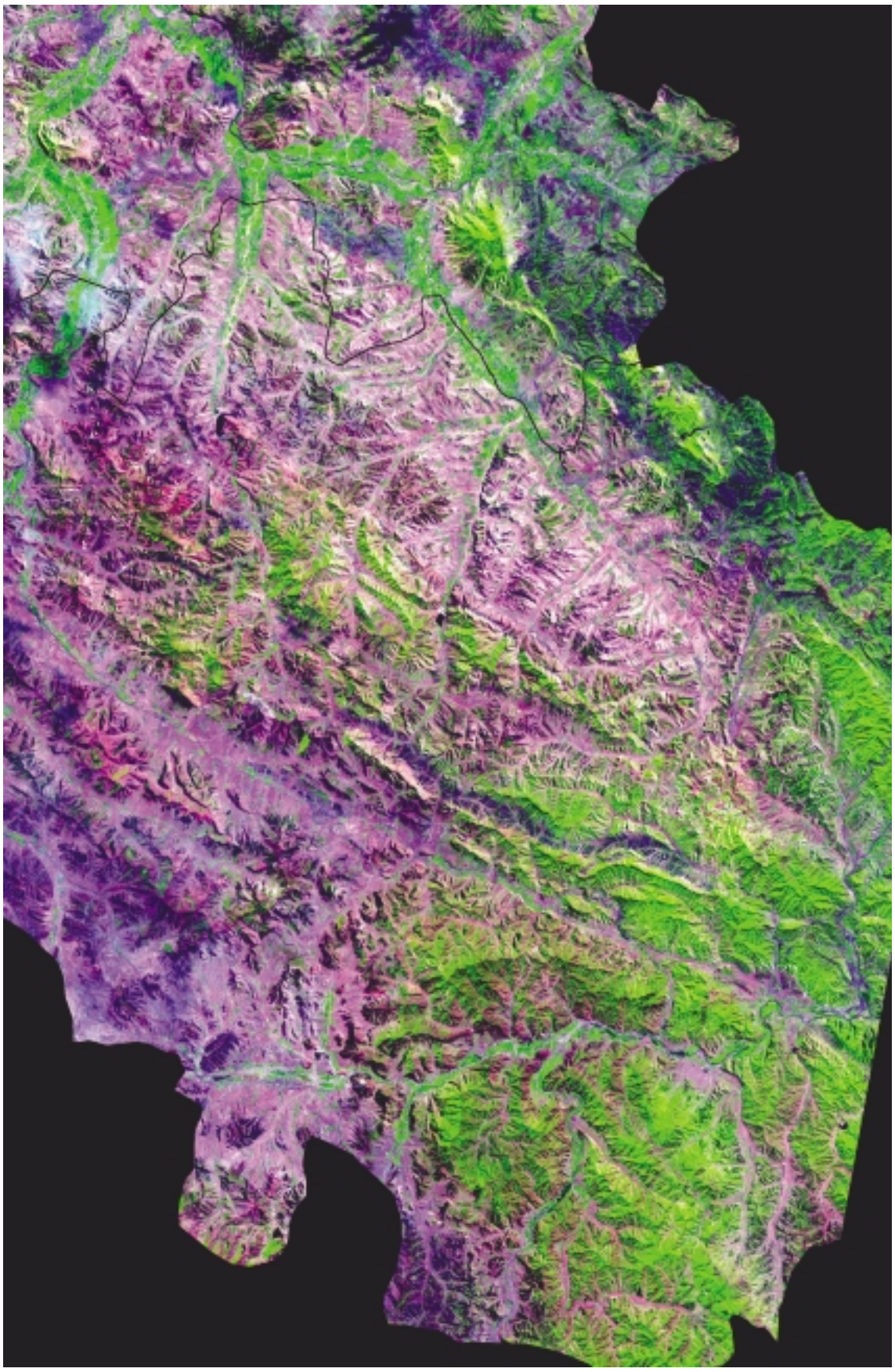

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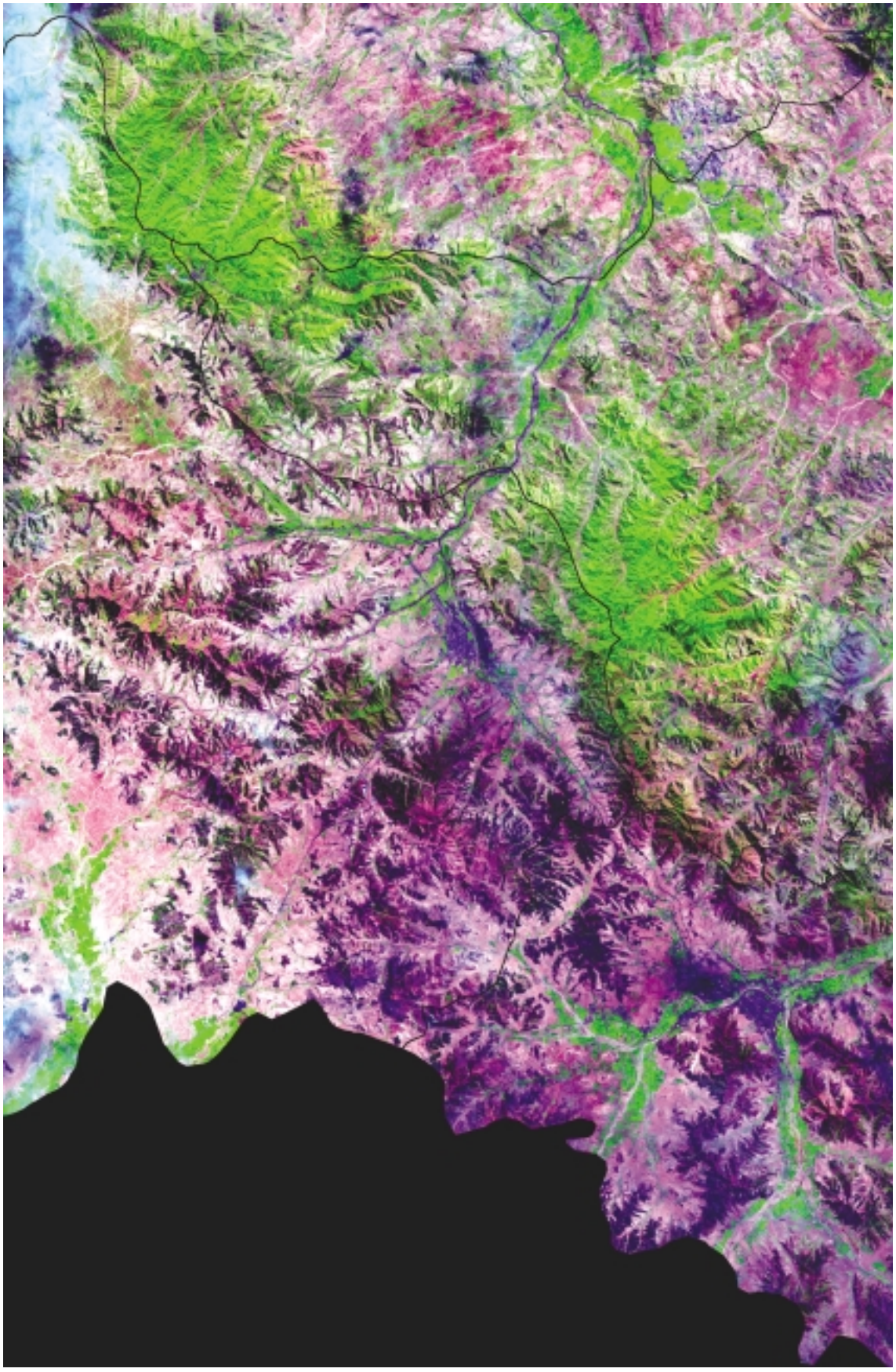

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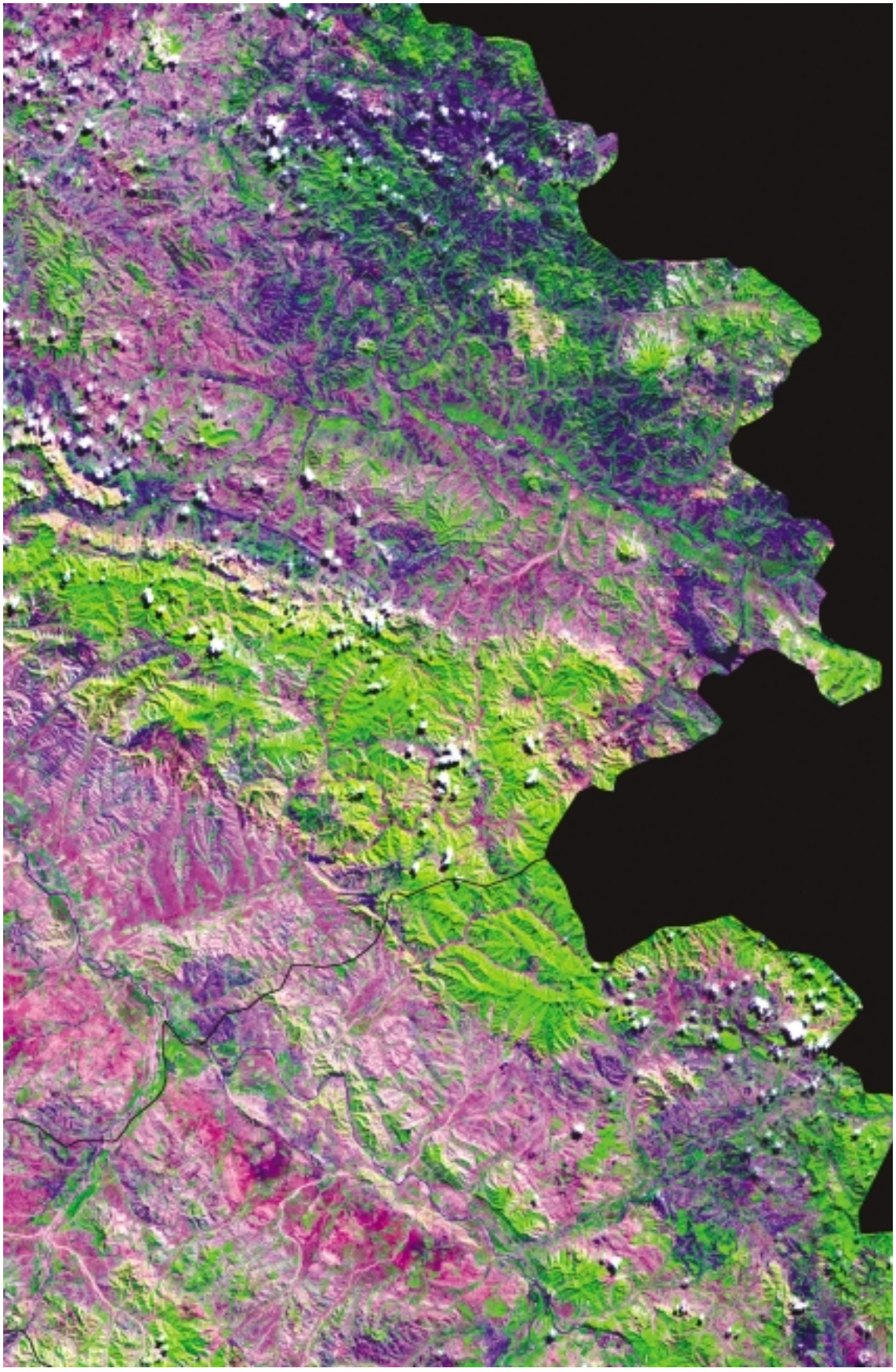

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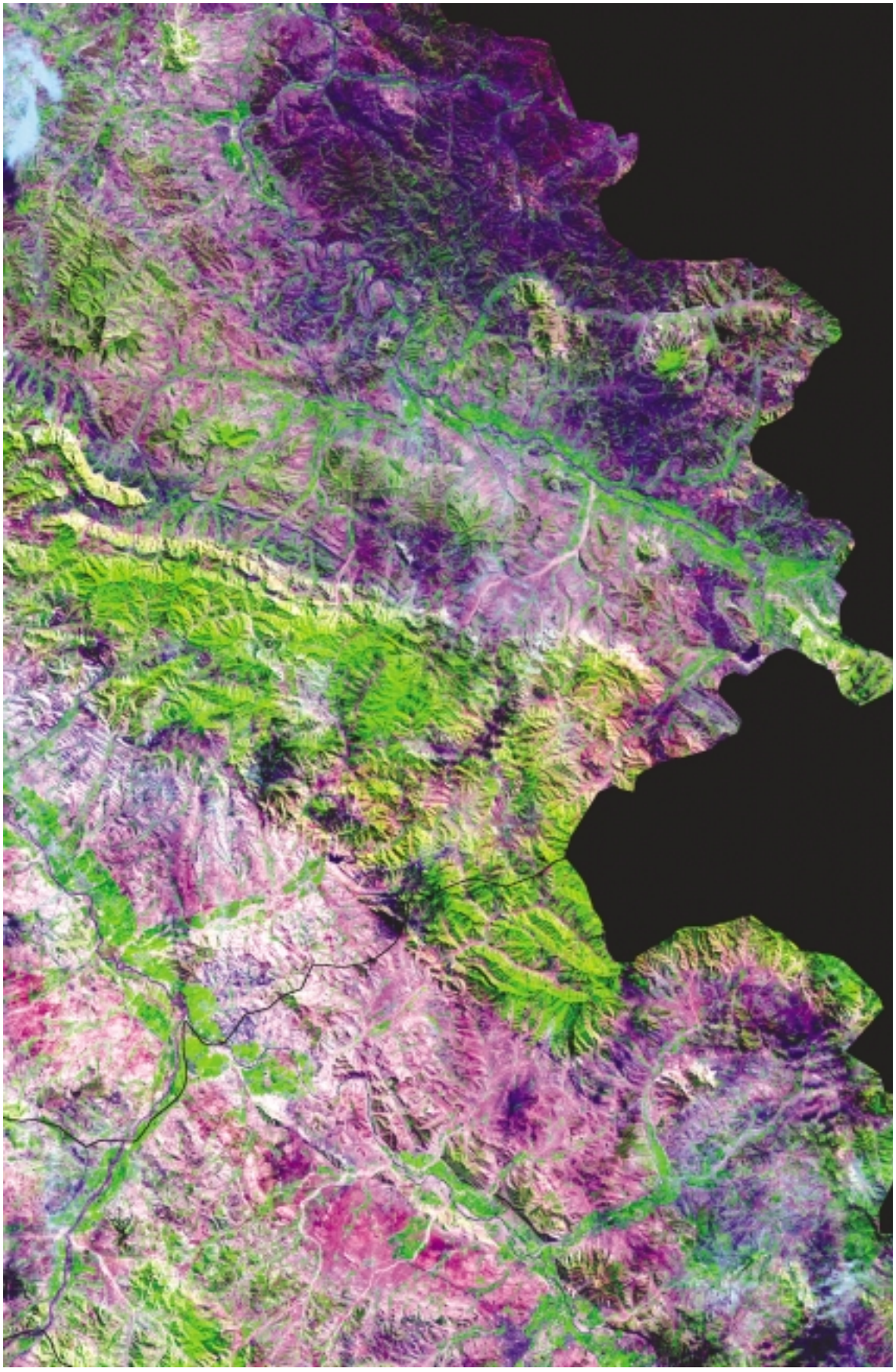

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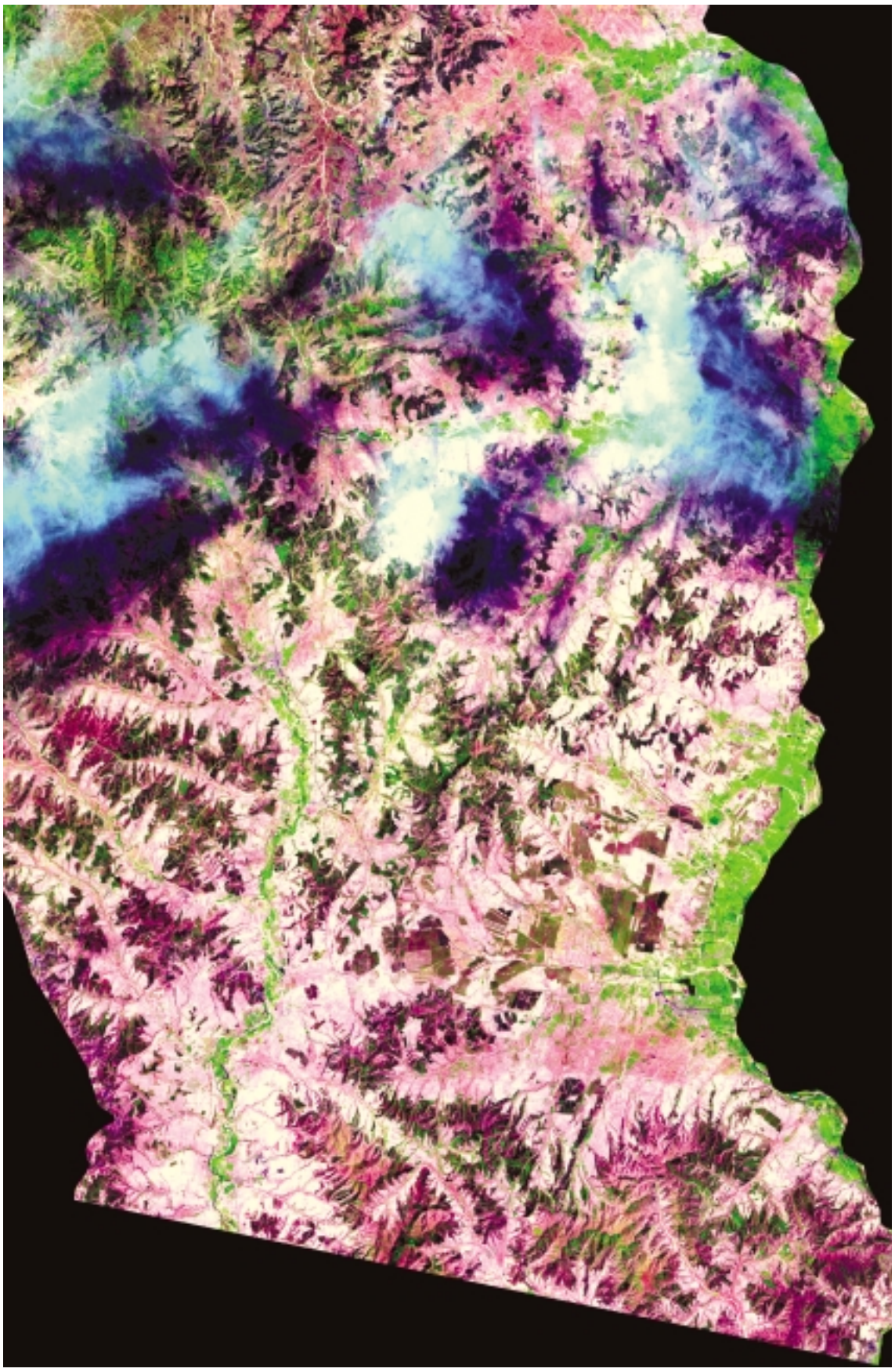

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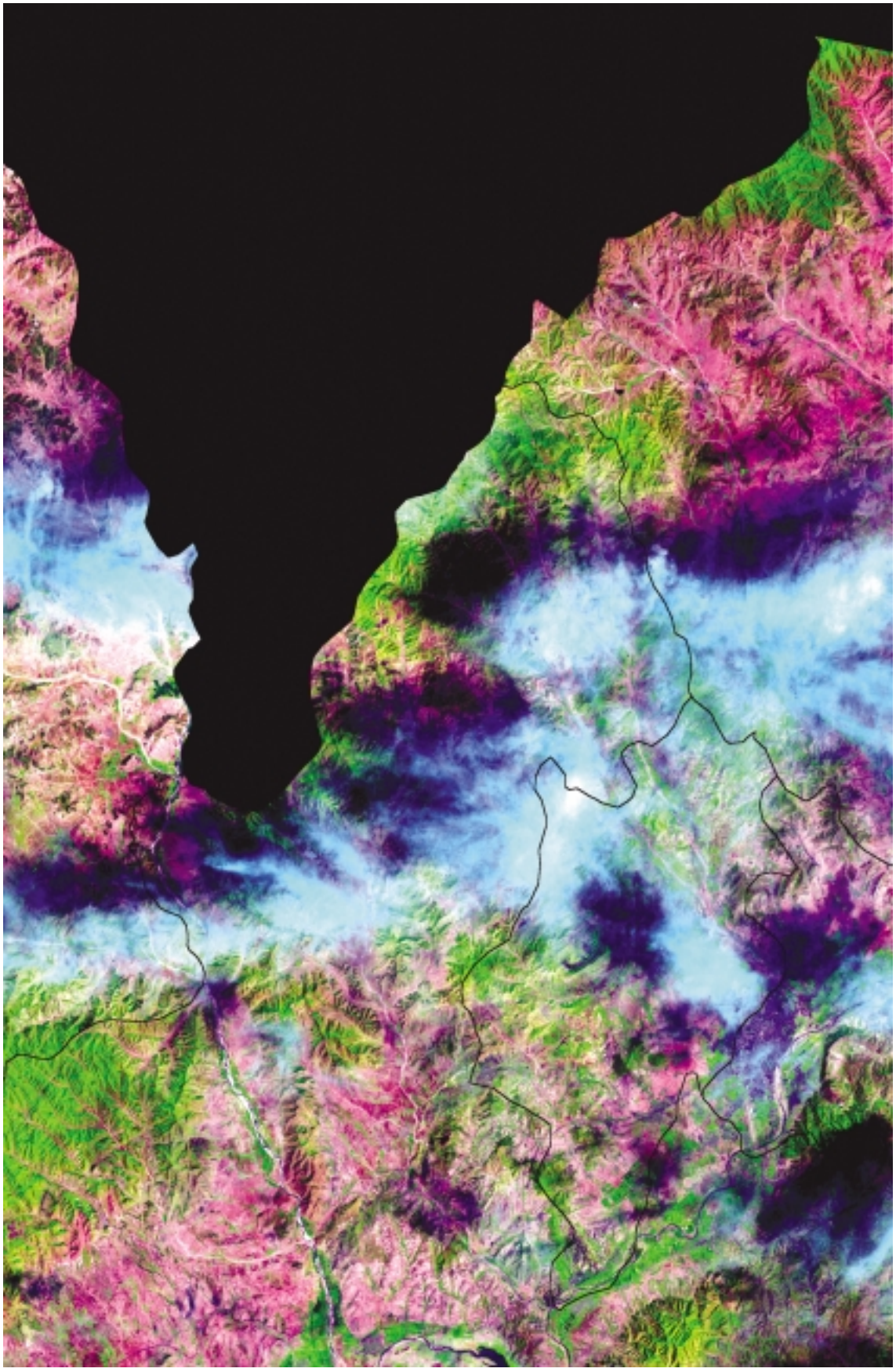

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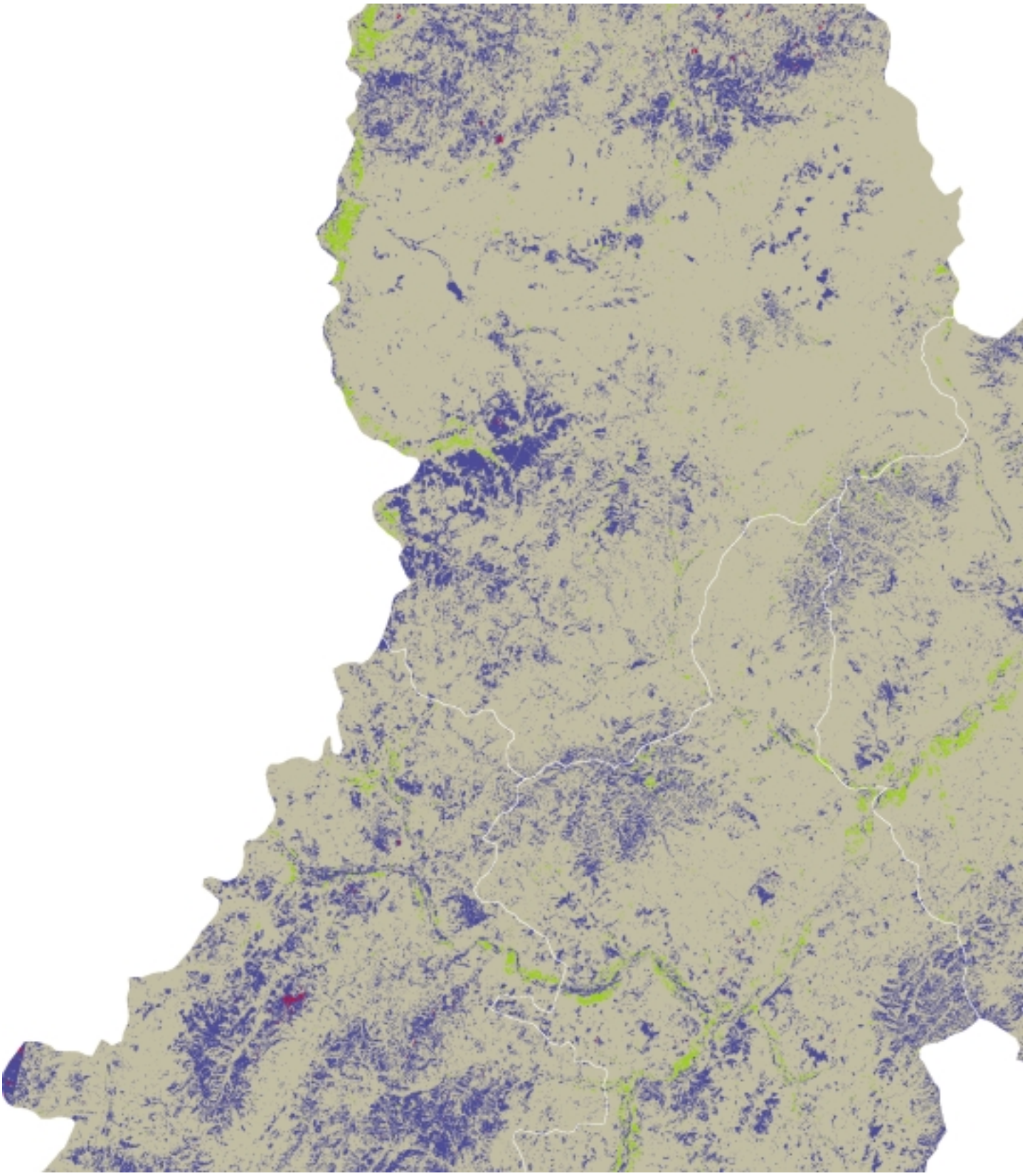
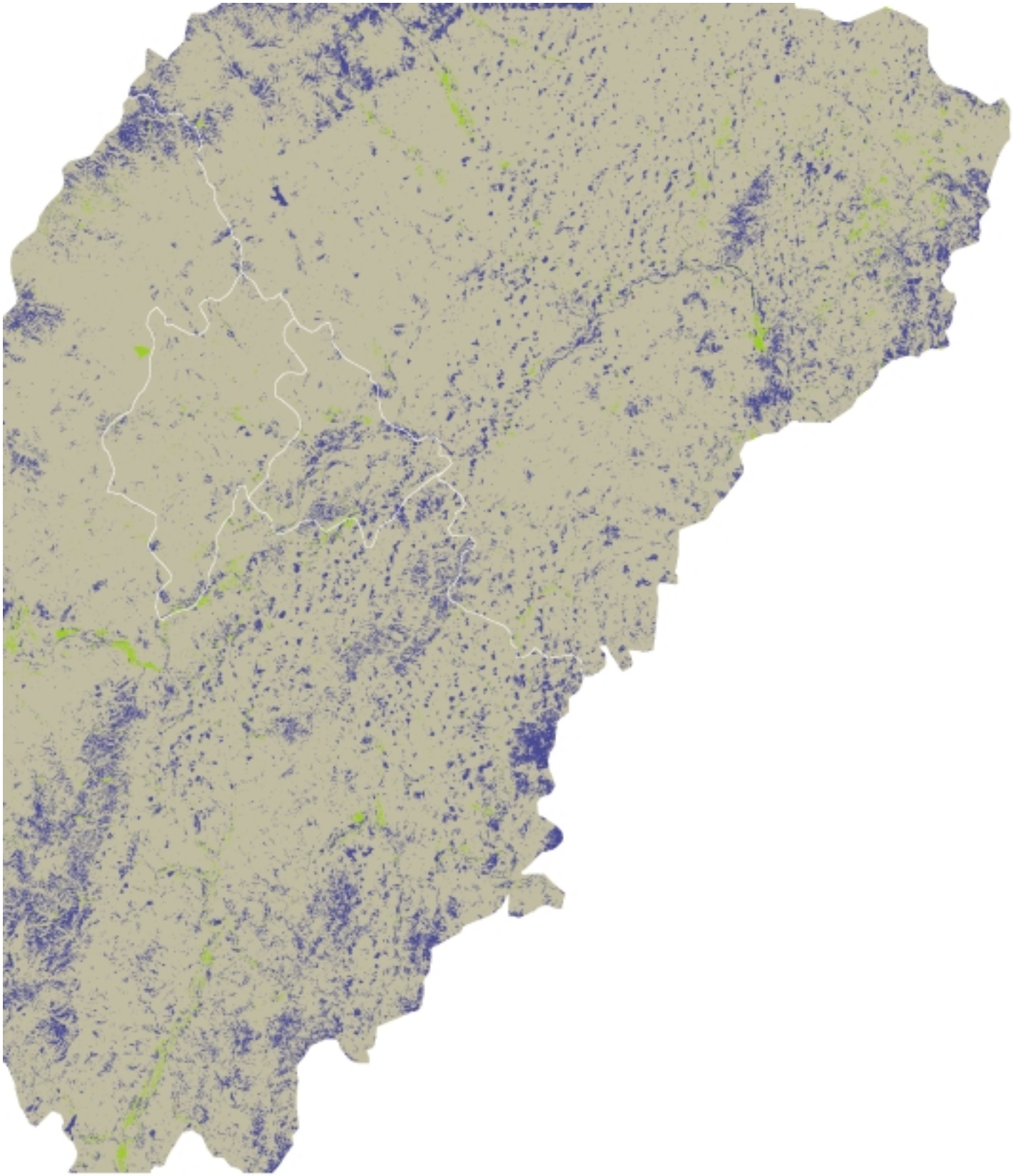


Vegetation change map of Chaoyang Region of Liaoning Province（Green— 2000 better than 1987，Pale—2000 much better than 1987, Blue—1987 better than 2000, Red—1987 much better than 2000）

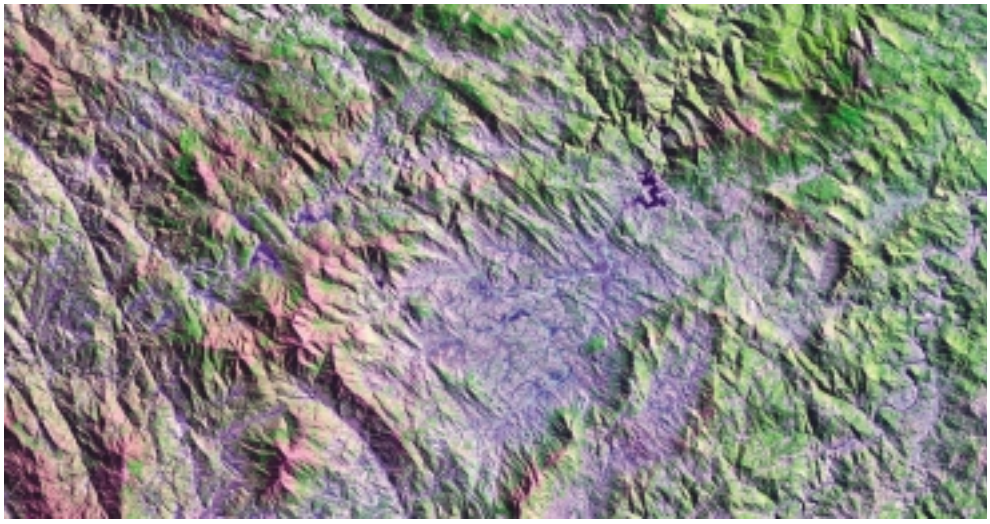


This group of images is situated in Chaoyang Region, Liaoning Province, Northeastern China, its center is about 120°E, 41°N, and chinese pine (*Pinus tabulae formis*) is one of its major tree types, and chinese-pine caterpillar (*Dendrolimus punctatus tabulaeformis*) is the major forest insect and disease type.

In 1987, heavy chinese-pine caterpillar (*Dendrolimus punctatus tabulaeformis*) hazard happened in the whole area and caused severe damage. In 2000, the weather was abnormally arid and has also impede greatly the growth and health of forest.

We choose five groups of images from two years to analyze and compare the forest health conditions. The green color represents healthy forest or vegetation, the gray green or gray blue represents the unhealthy forest. By comparison, the forest condition and trend of change can be clearly demonstrated, and it can be differentiated whether the forest insects and disease or other factors have caused the changes of forest quality. It has been proved that Landsat TM data can be used to accurately monitor the early hazard spot of chinese pine (*Pinus tabulae formis*), and it is an effective means of hazard protection and mitigation.

Images and maps of damage by pine caterpillar in Anhui Province



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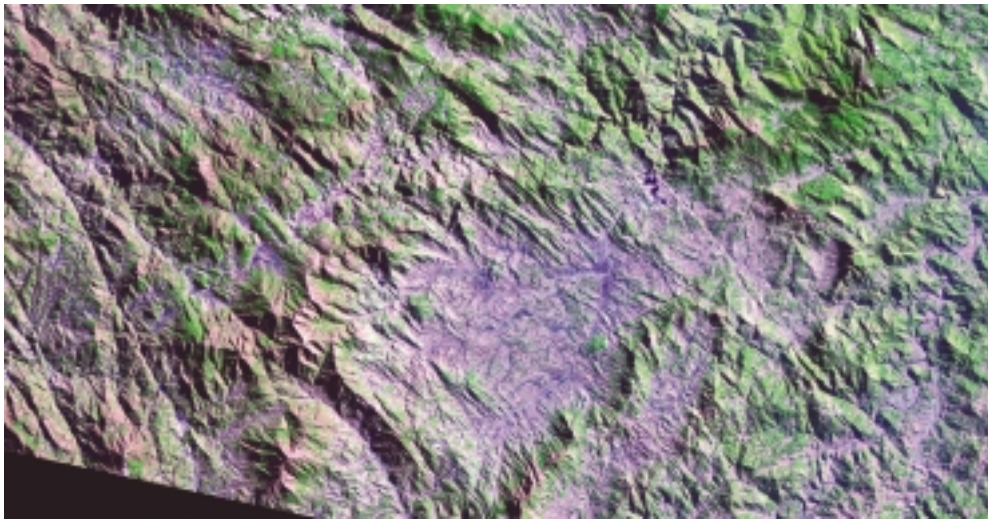

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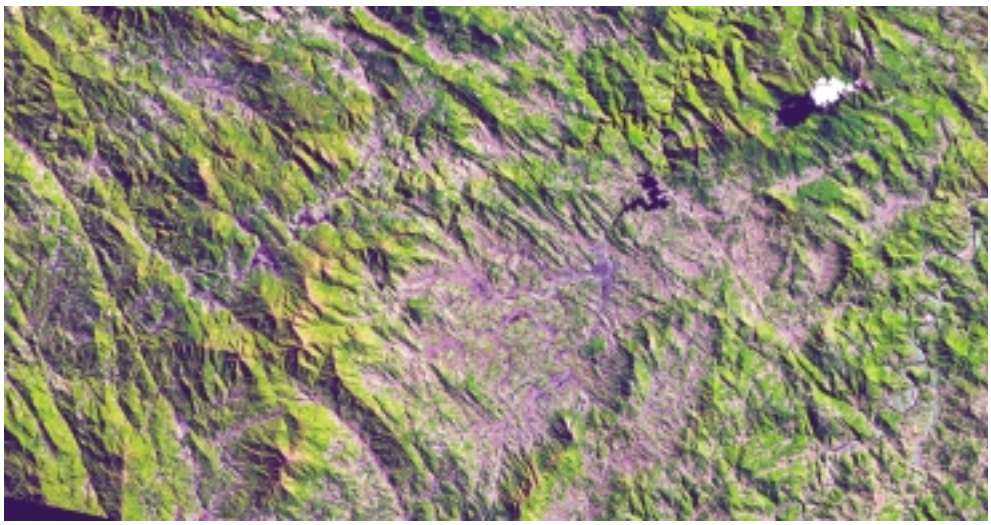

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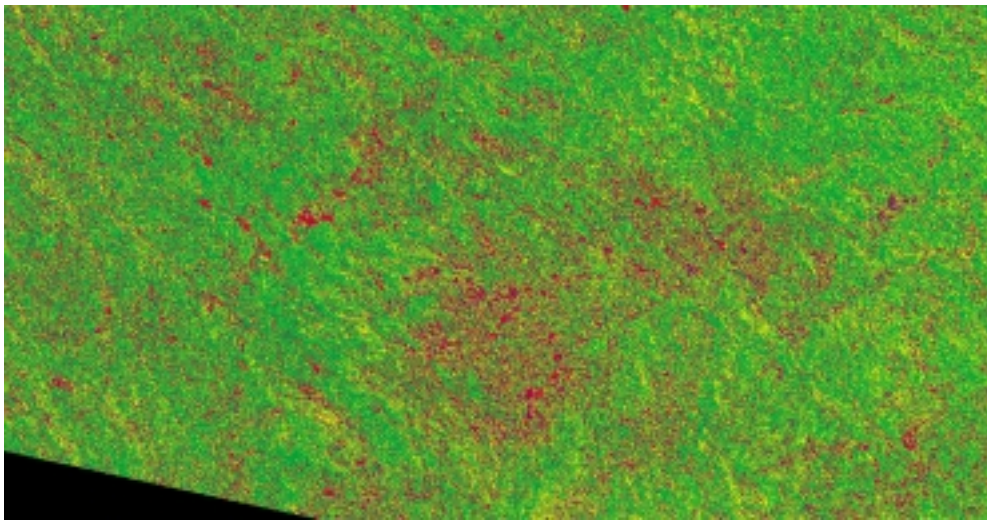
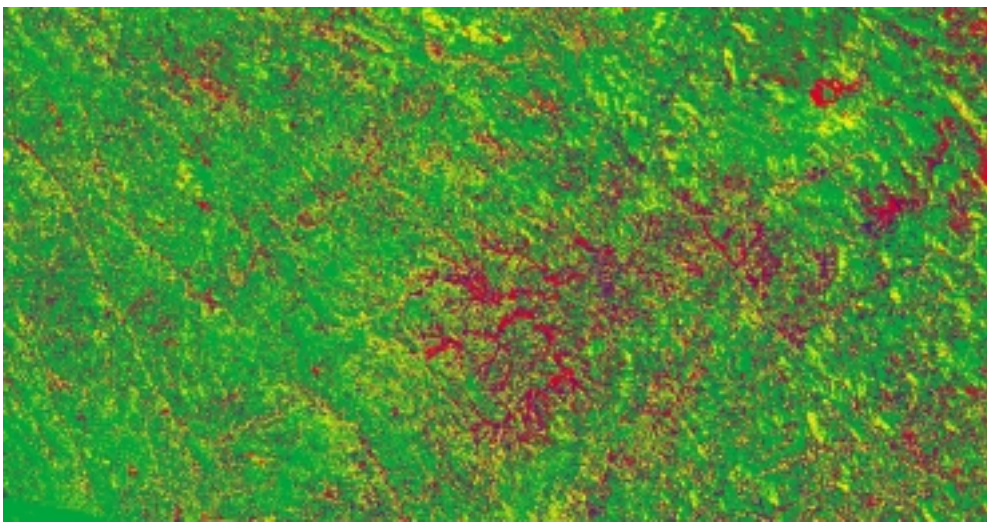


Green biomass change map based on single pixel in 1995 (Green color represents healthy forest， yellow color represents around 30 of needle loss percentage， blue color represents around 50 of needle loss percentage，red color represents larger than 70 of needle loss percentage in the forest area)



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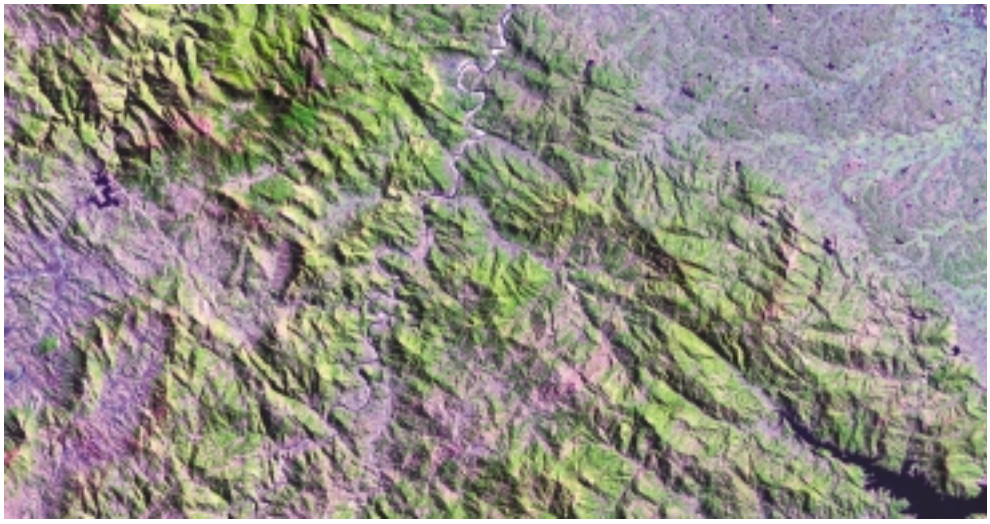

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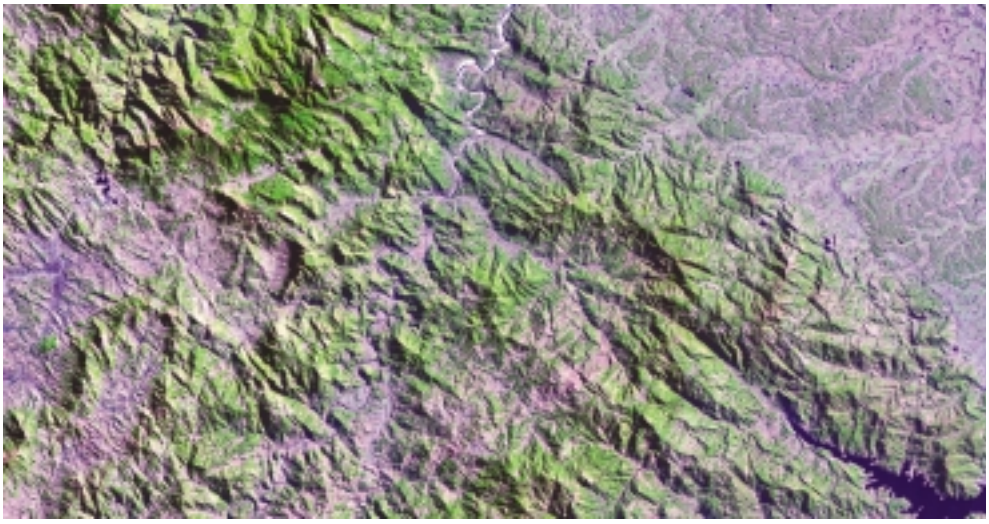

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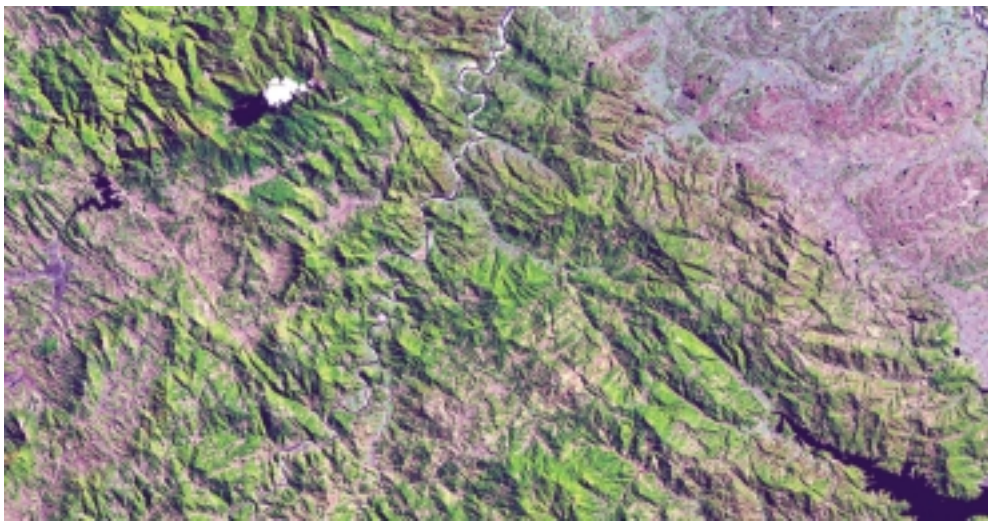

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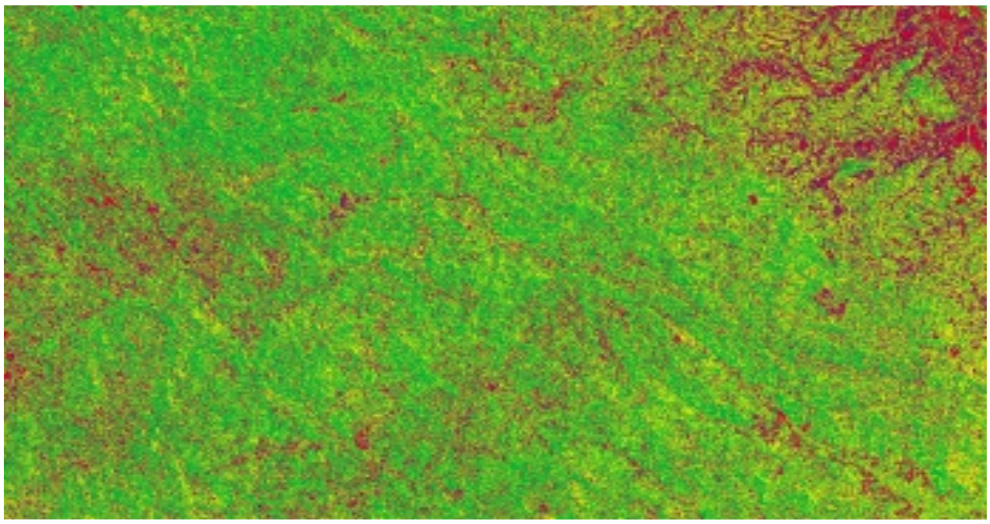

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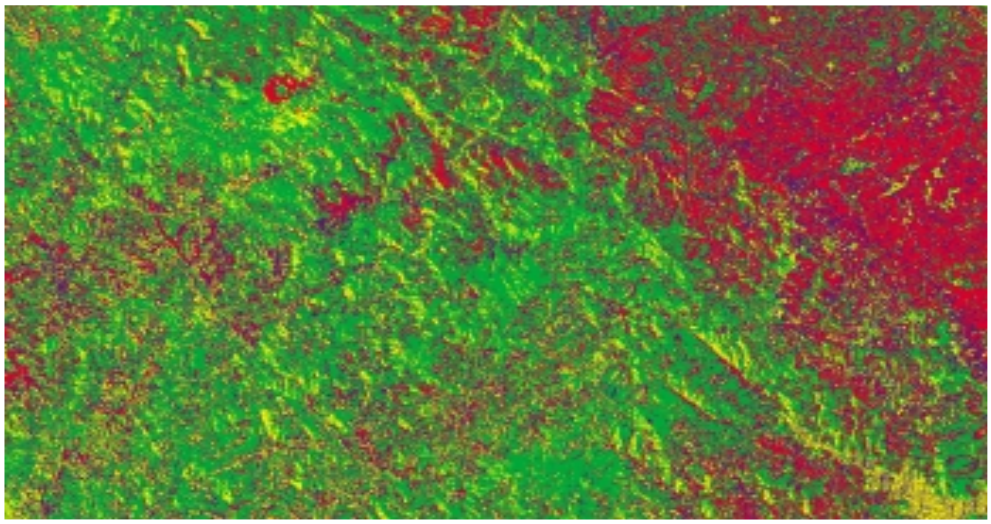

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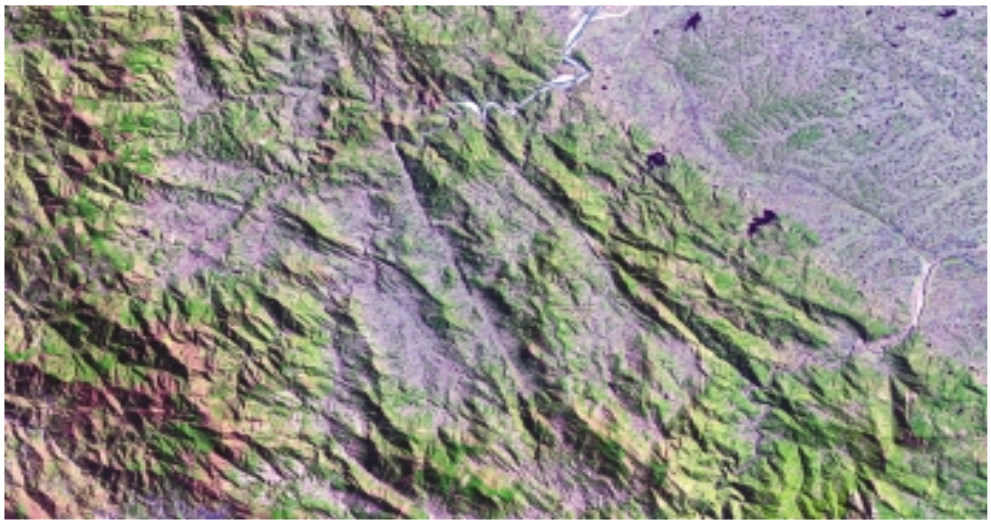

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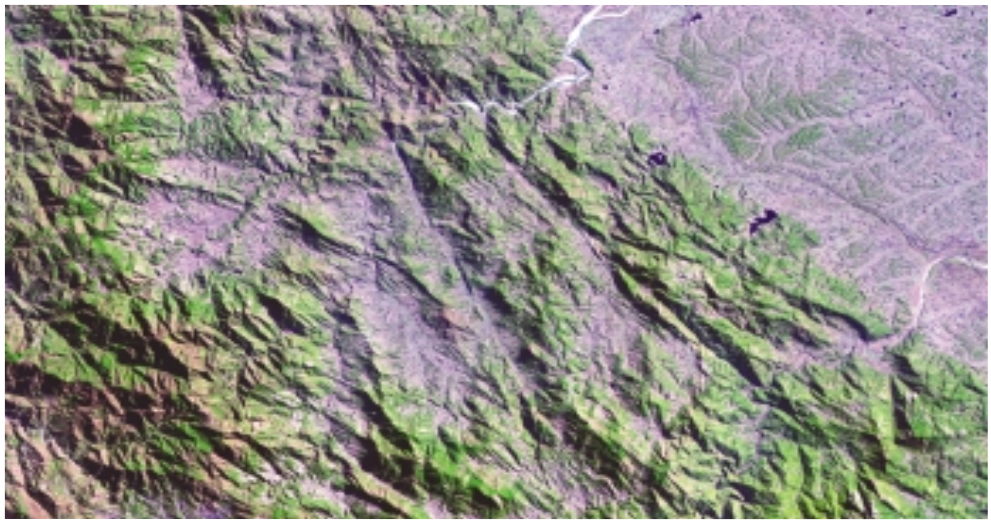

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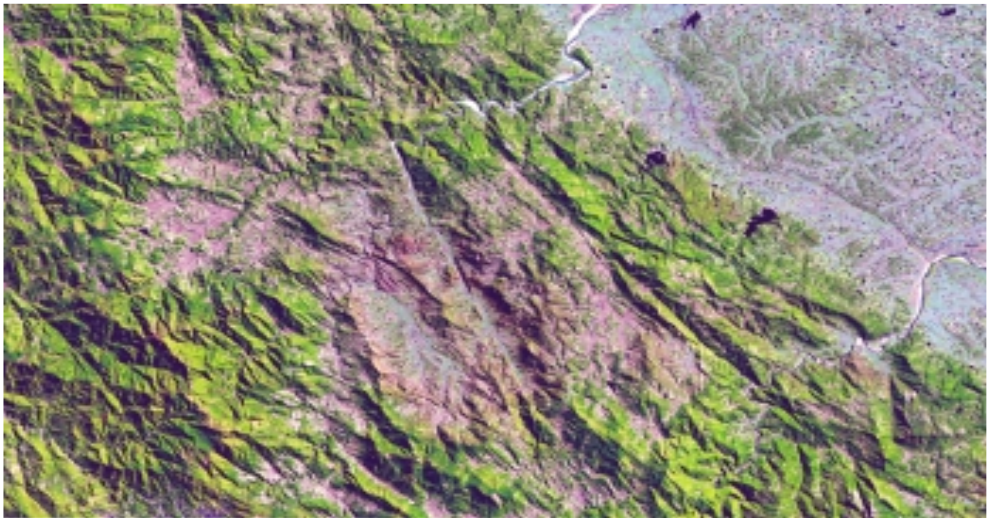

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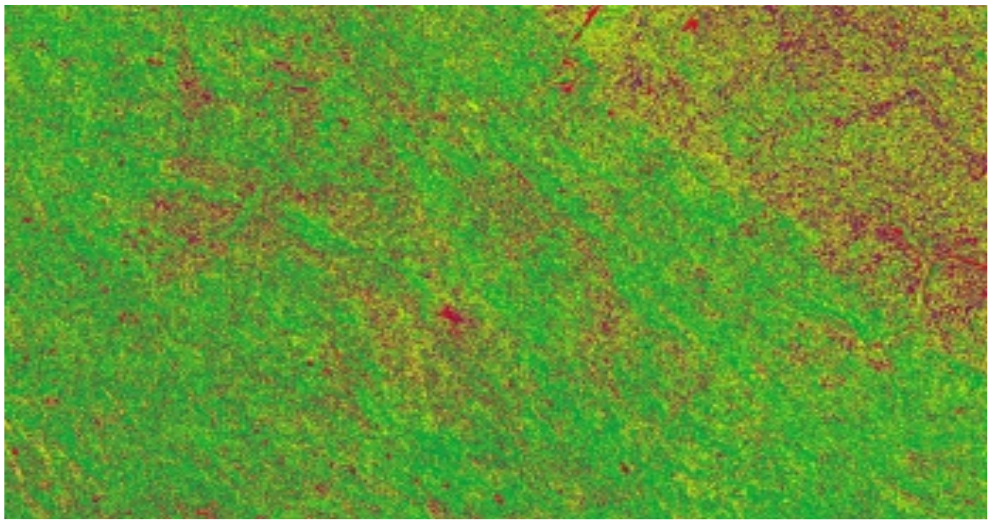

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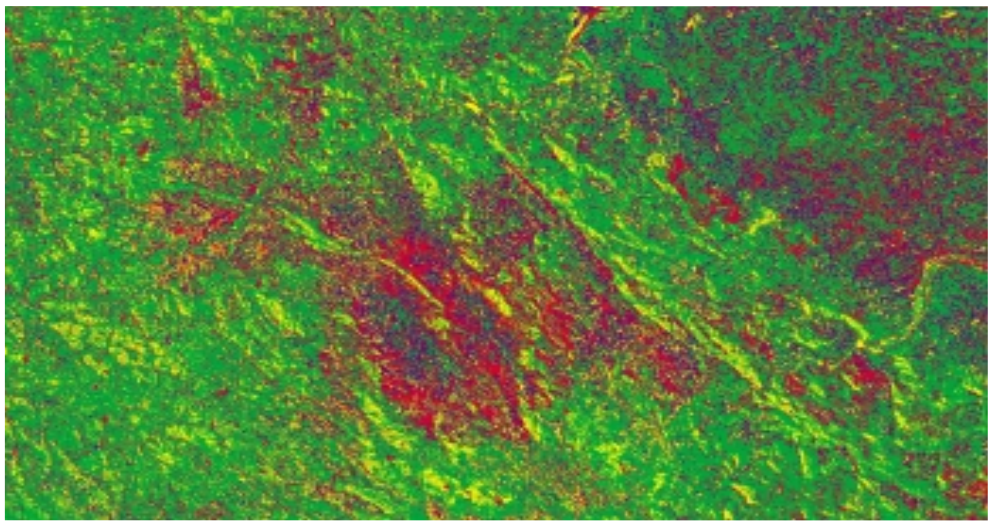

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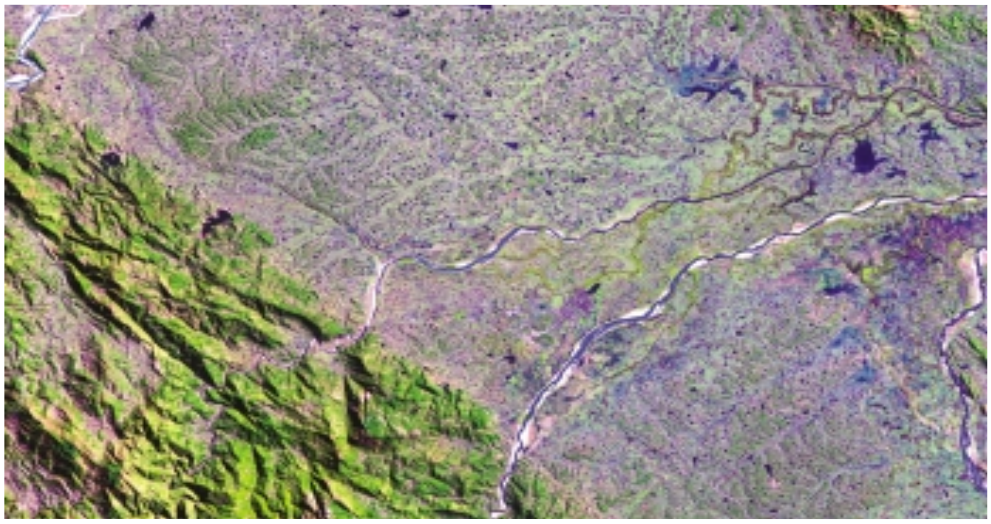

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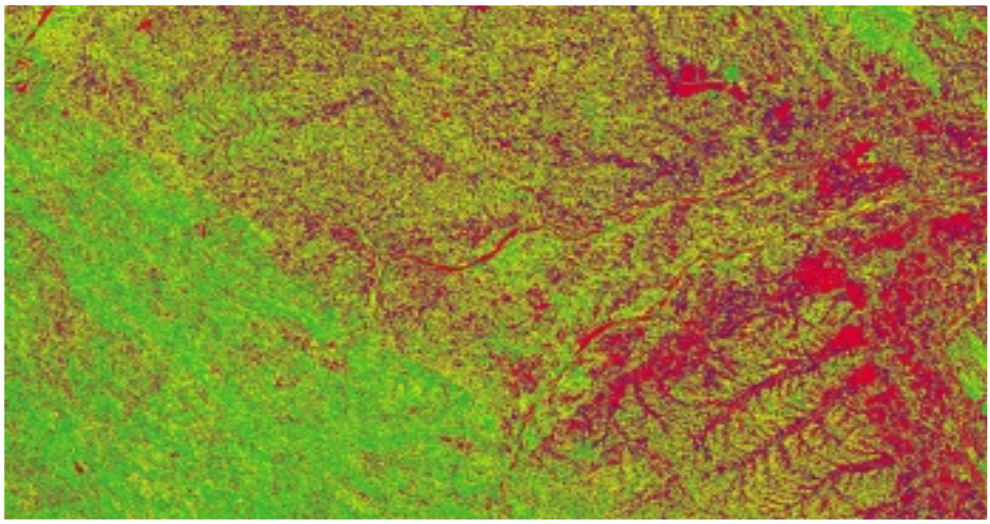

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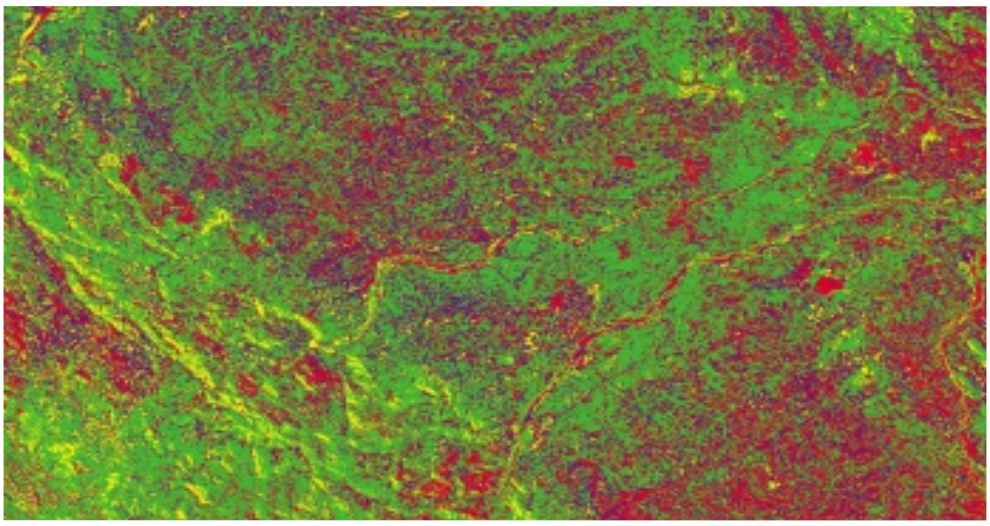

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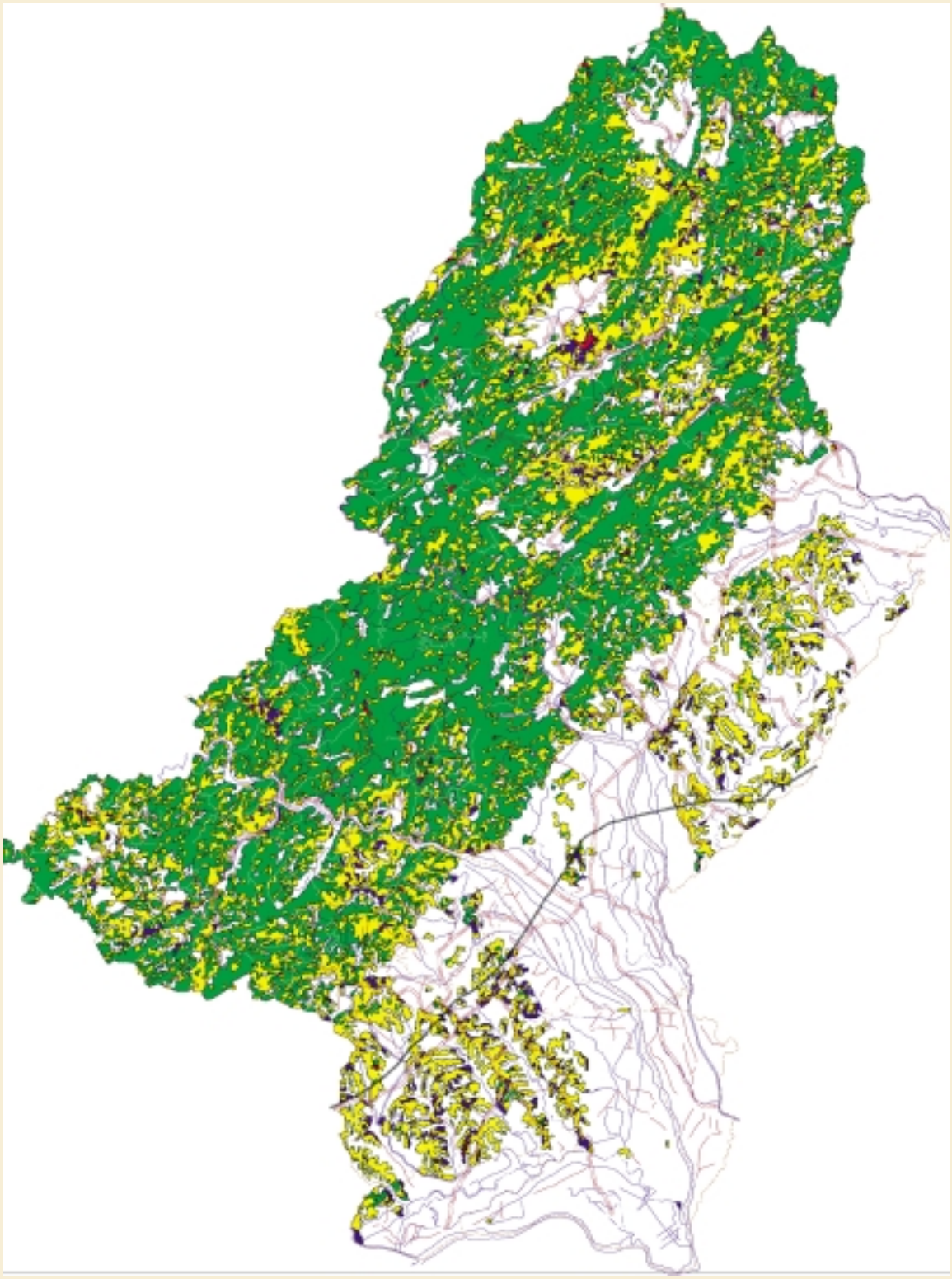
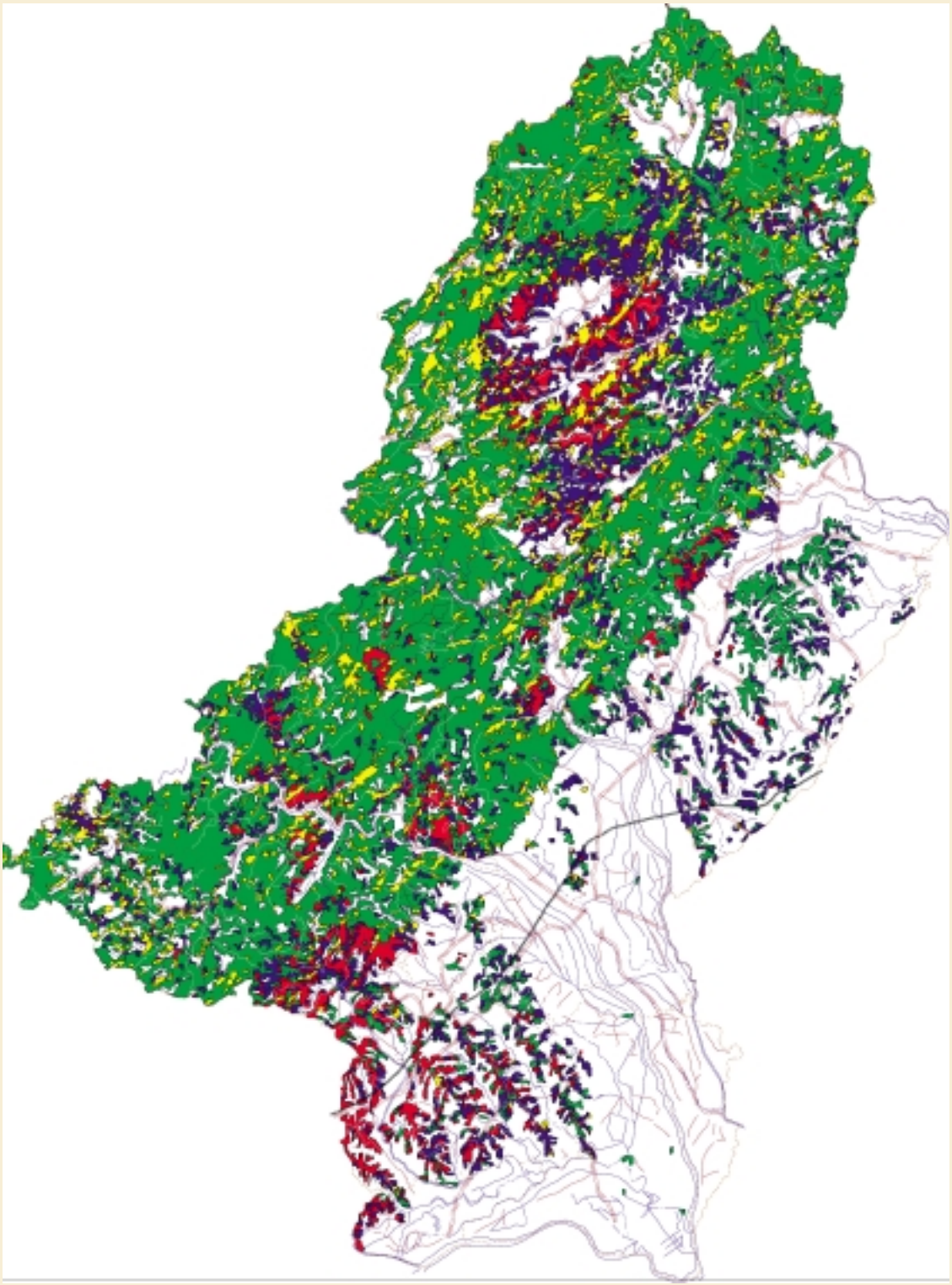


Forest health change map of Qianshan County of Anhui Province in 1995 (Green — healthy forest, Yellow — around 30 of needle loss percentage, Blue—around 50 of needle loss percentage, Red— Larger than 70 of needle loss percentage)

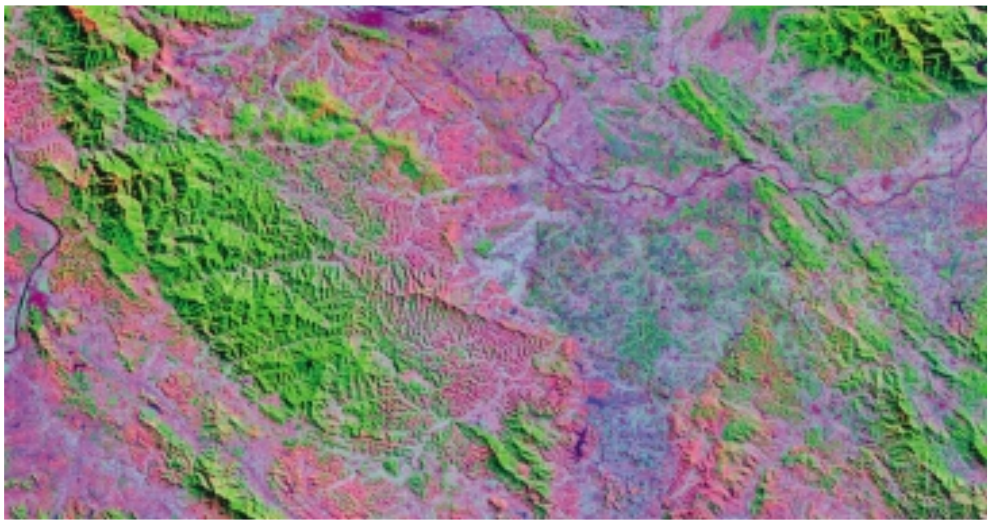


Forest health change map of Qianshan County of Anhui Province in 1996 (Green — healthy forest, Yellow — around 30 of needle loss percentage, Blue—around 50 of needle loss percentage, Red— Larger than 70 of needle loss percentage)

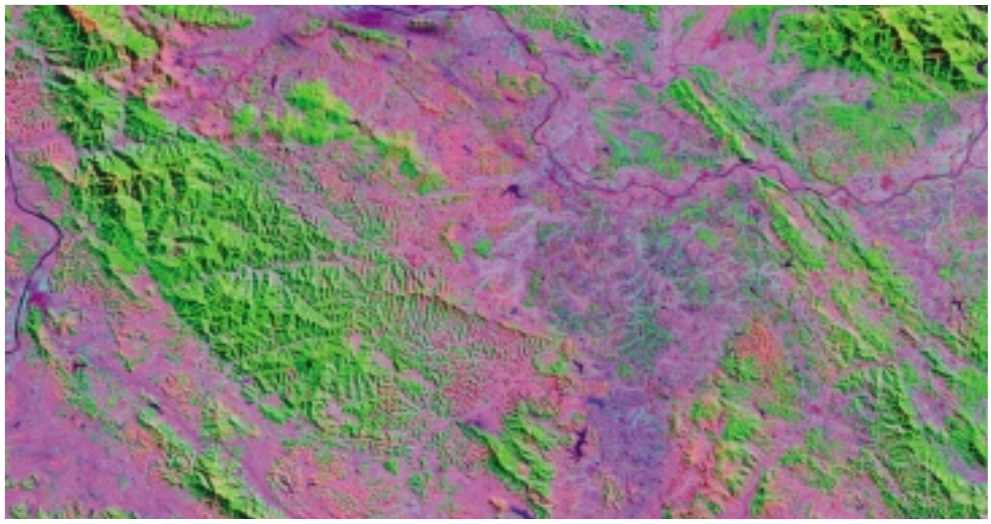
This group of images is situated at western Anhui Province, Central China, the center point is about 116.5°E, 30.6°N. It belongs to the subtropical climate, mason pine (*Pinus massoniana*) is its pioneering tree type of forest cultivation and dominate the forest type. Mason pine caterpillar(*Dendrolimus punctatus*) usually happened two or three generations each year, and led to large areas of damage, it's the most serious forest insect and diseases in this area.

We choose four groups of images of three continuous years to analyze and compare the change of forest quality. In the composite image, the green color represent the healthy forest. In 1996, Mason pine caterpillar (*Dendrolimus punctatus*) happened in large areas and caused great damage, the red brown color represents areas with quality changes by forest insects or other factors. By comparing the images, the early hazard area of 1995 can be clearly detected, and it's the central area with most serious damage in 1996. It can be demonstrated that TM data can be used in the monitoring and assessment of mason pine caterpillars(*Dendrolimus punctatus*) in Anhui. Through long term monitoring, the goal of early forecasting can be achieved.

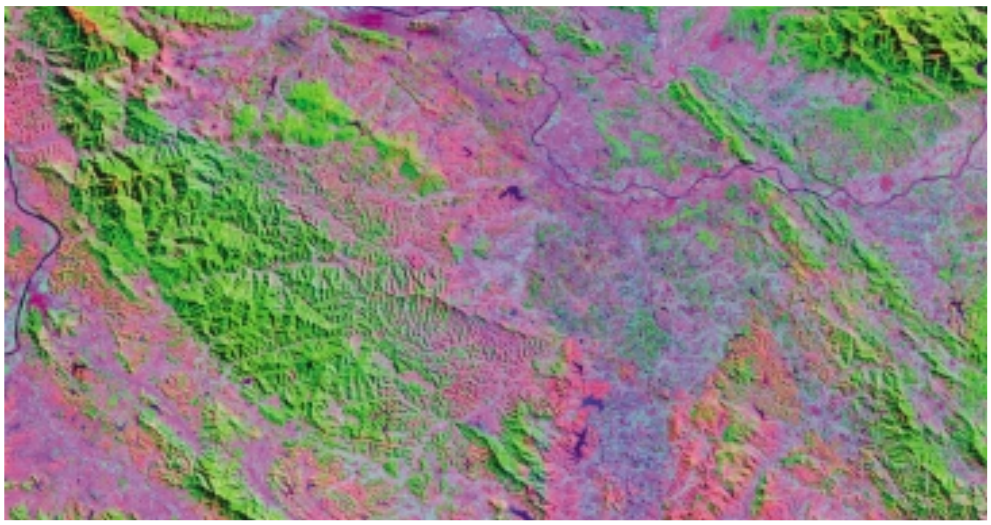
Images and maps of damage by pine caterpillar in Zhejiang Province



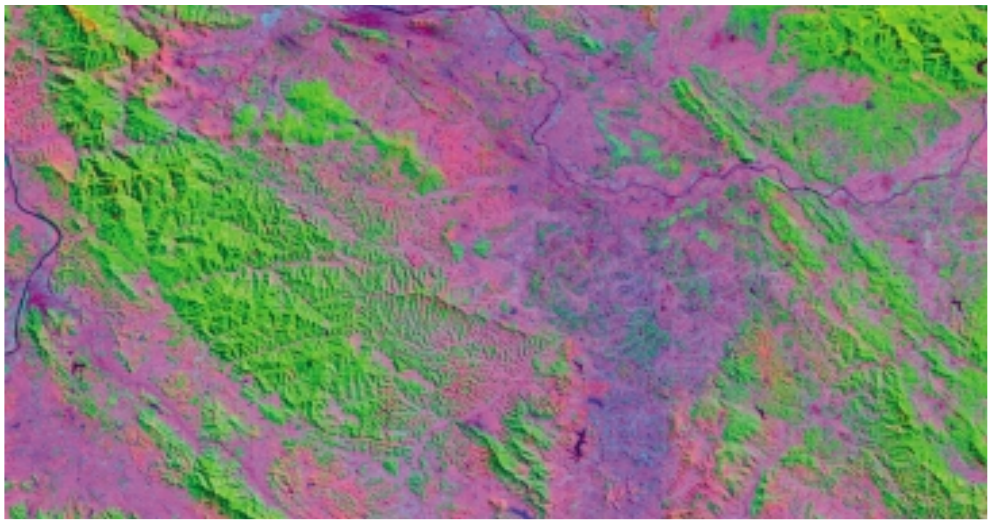
TM image in 1986



TM image in 1988



TM image in 1989



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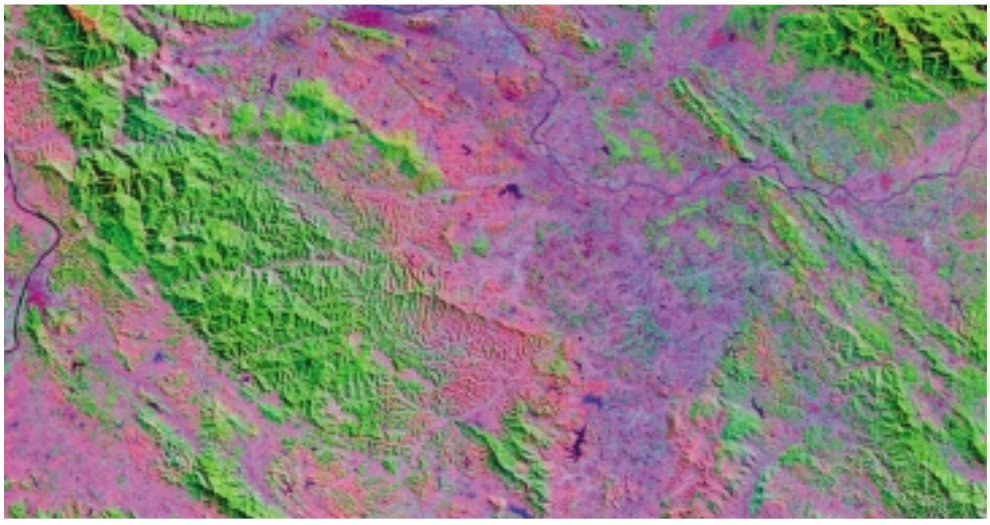

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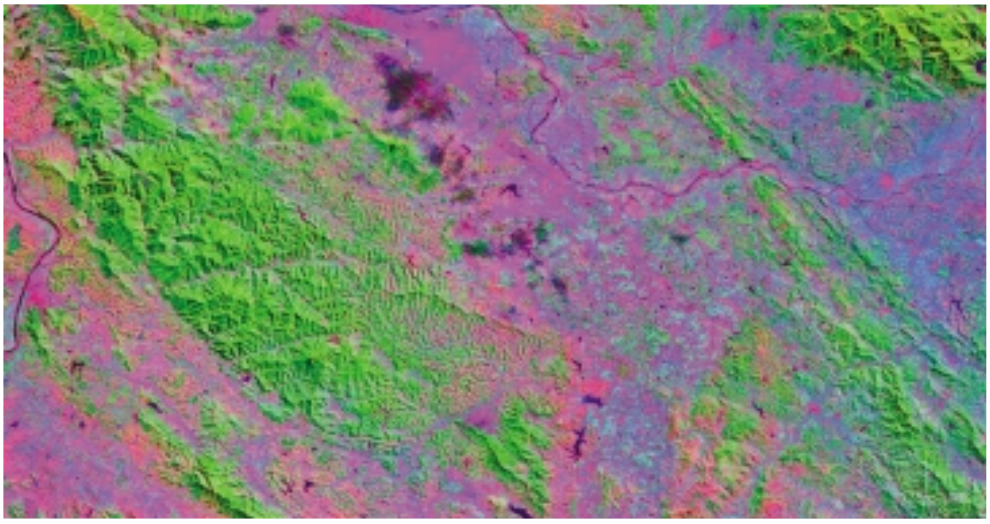

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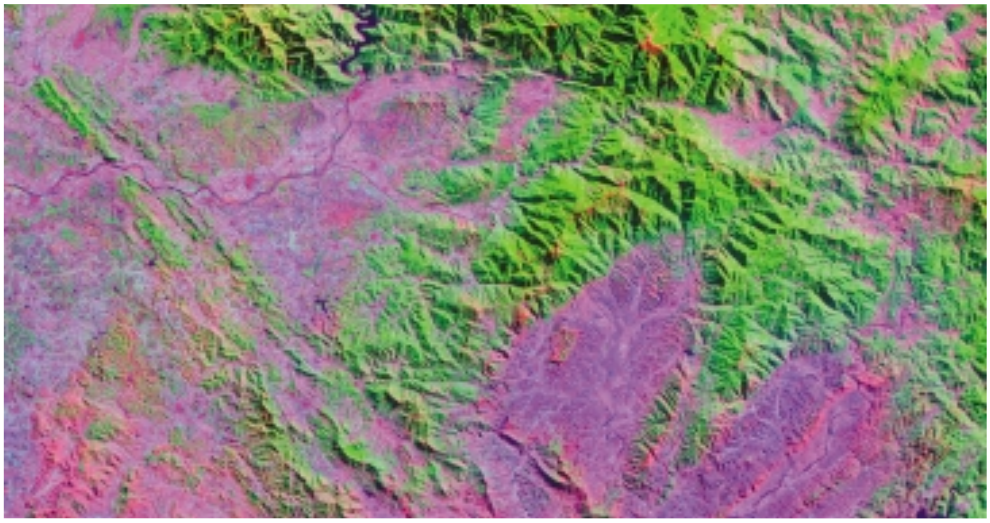
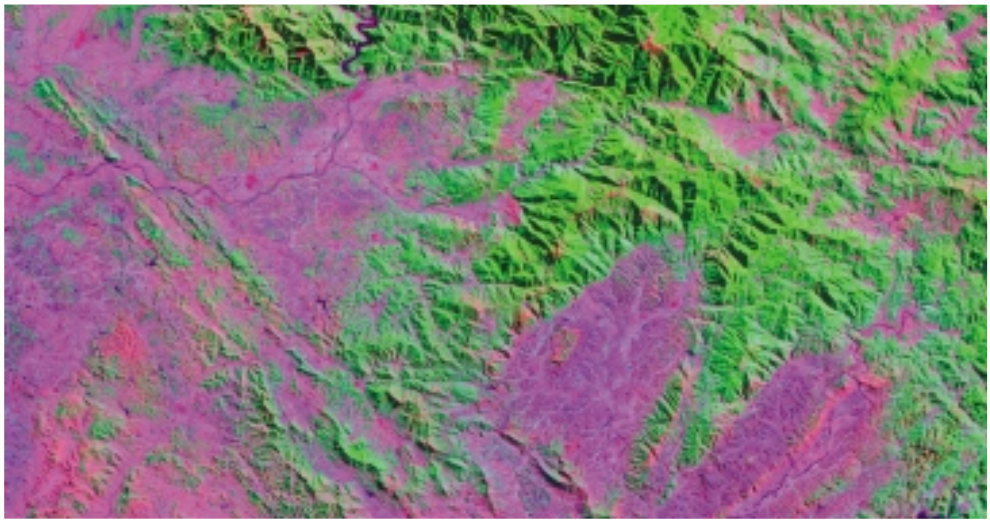
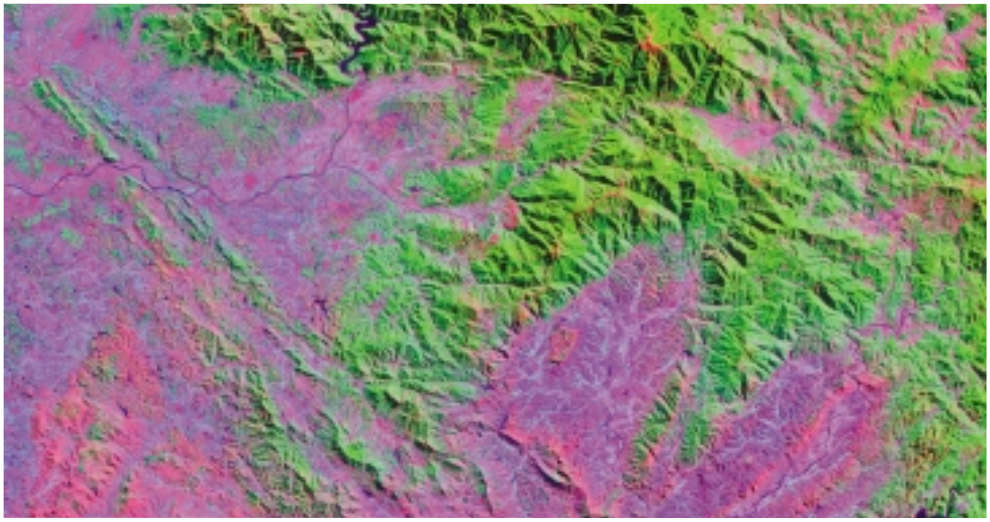


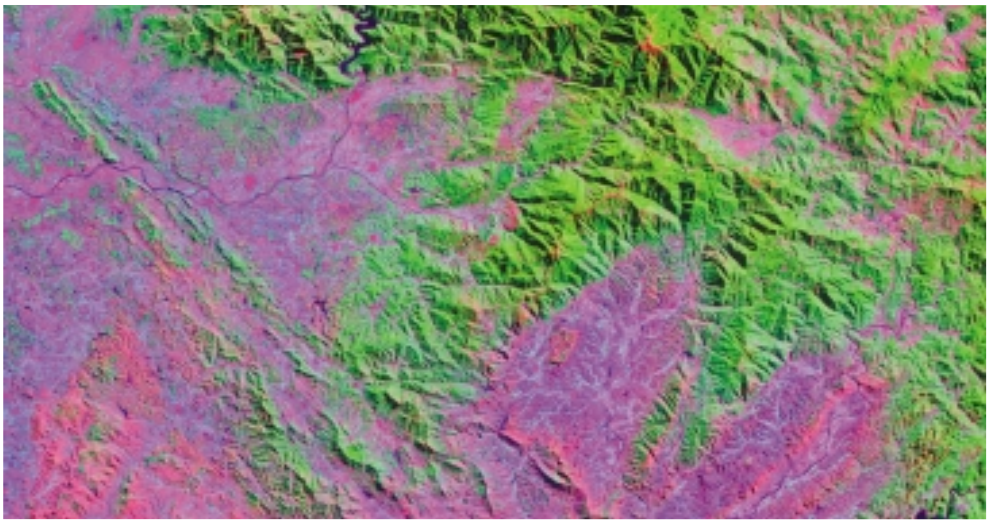
TM image in 1986



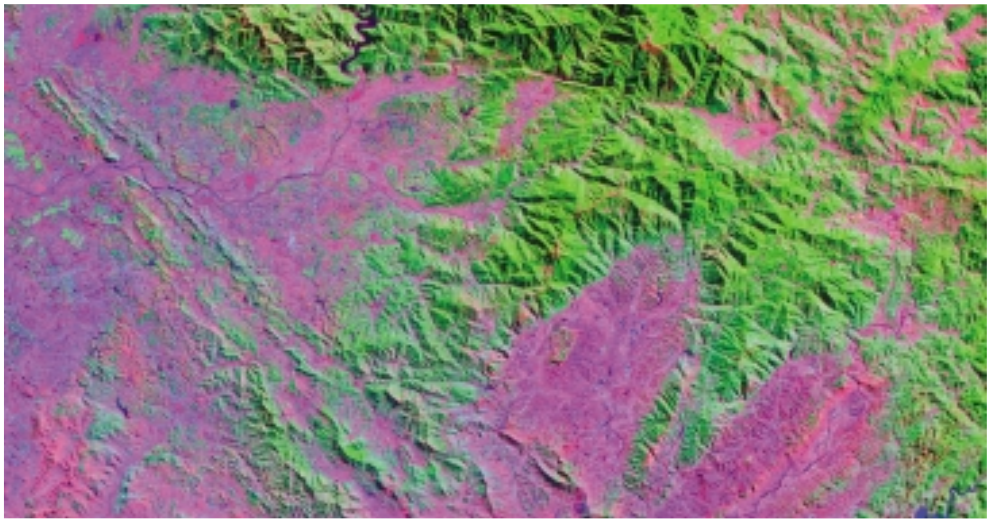
TM image in 1988



TM image in 1989



TM image in 1991



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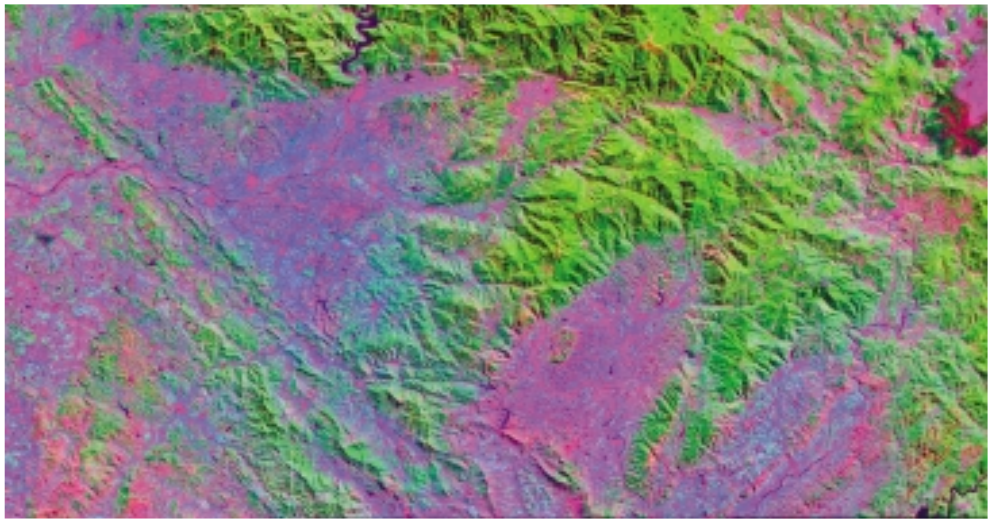
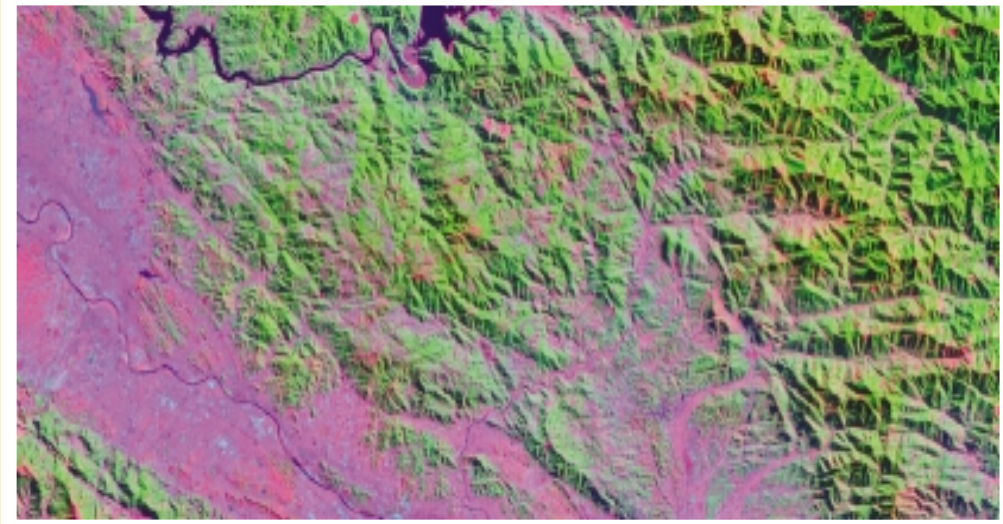
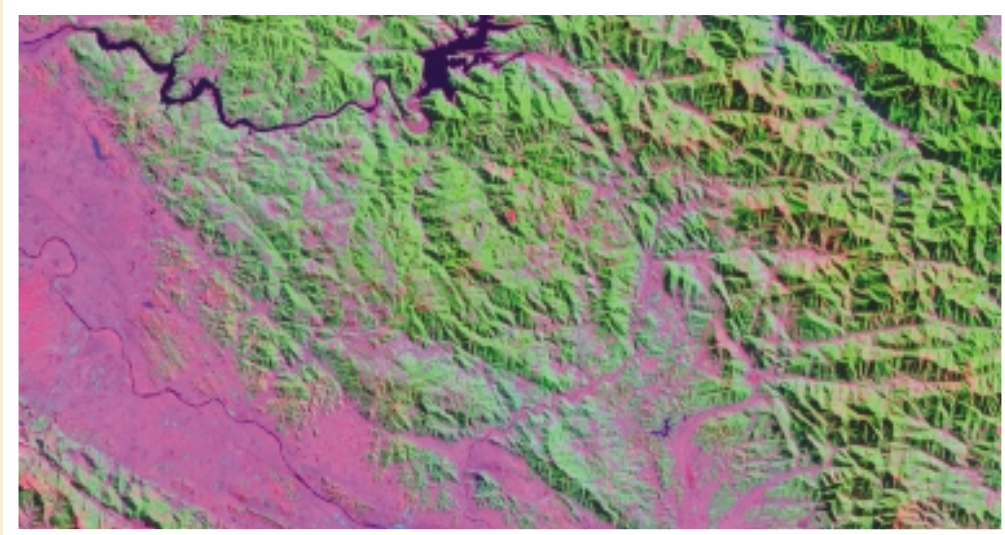


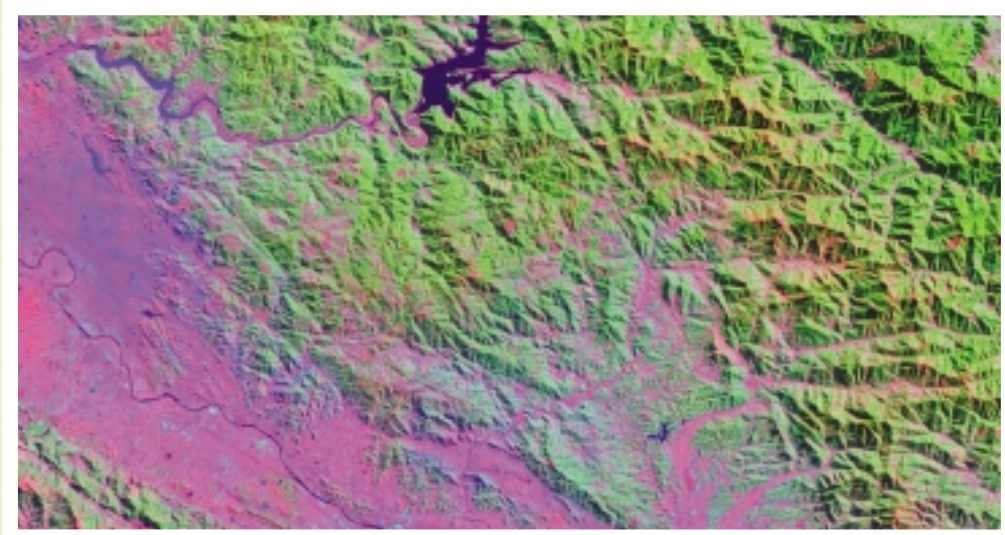
TM image in 1994



TM image in 1986



TM image in 1988



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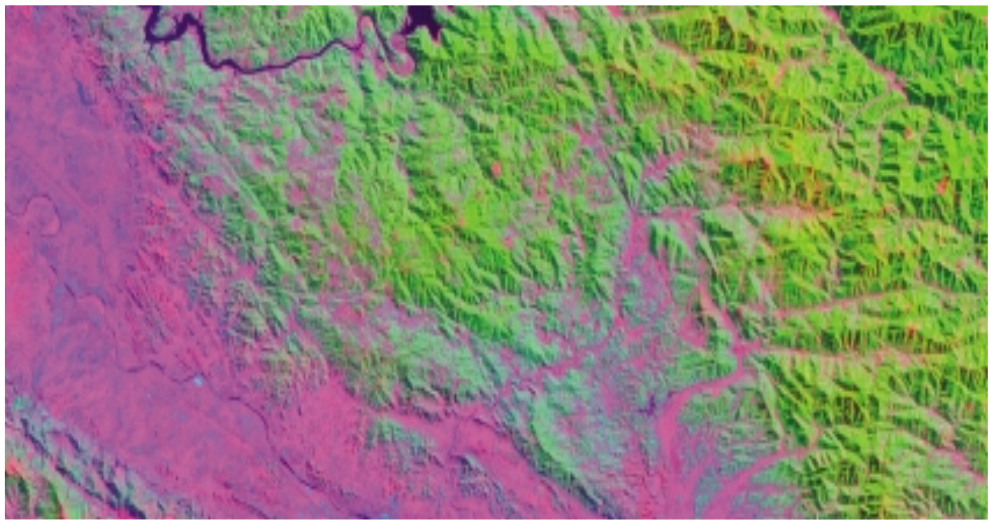
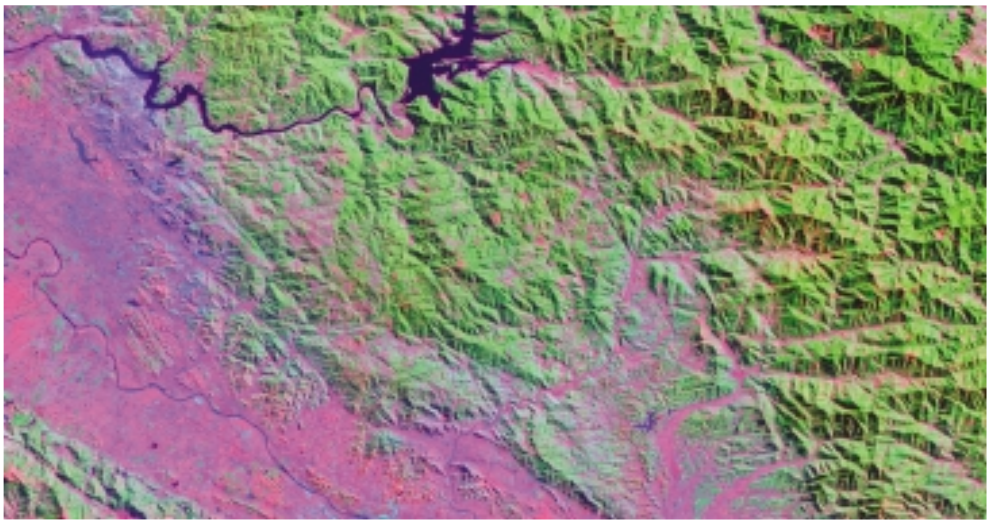
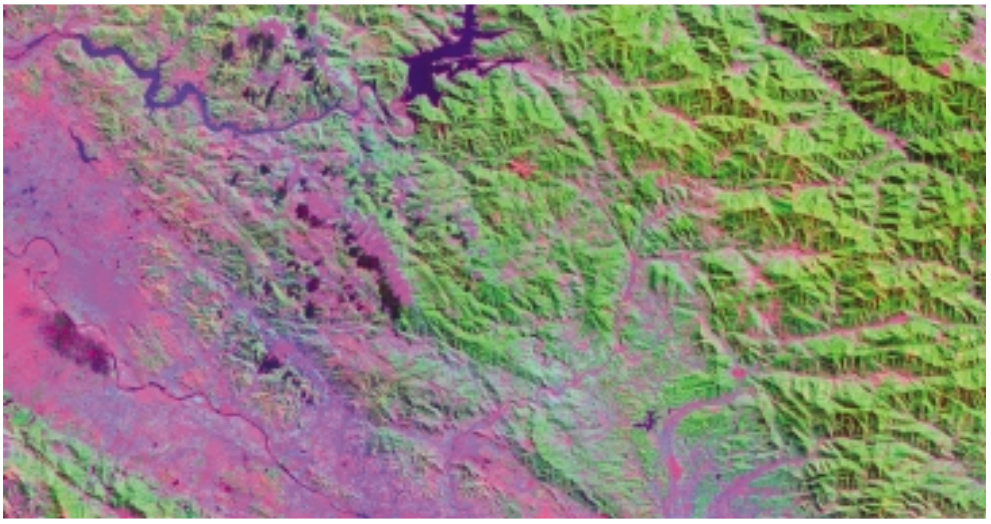


TM image in 1991



TM image in 1992



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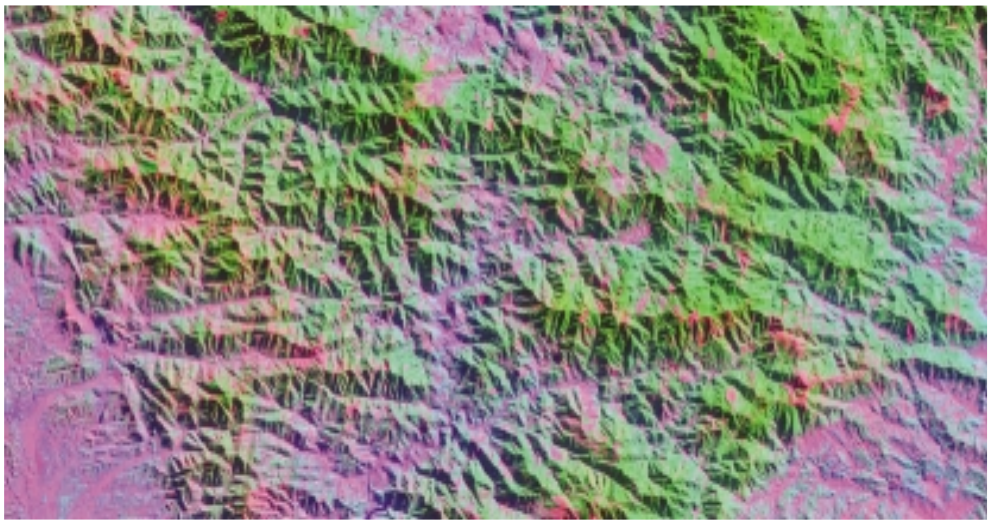

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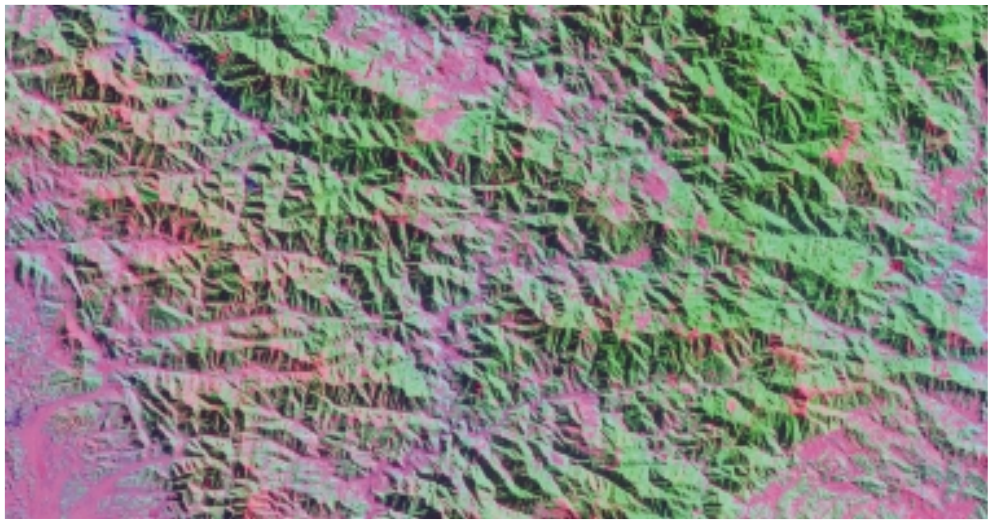

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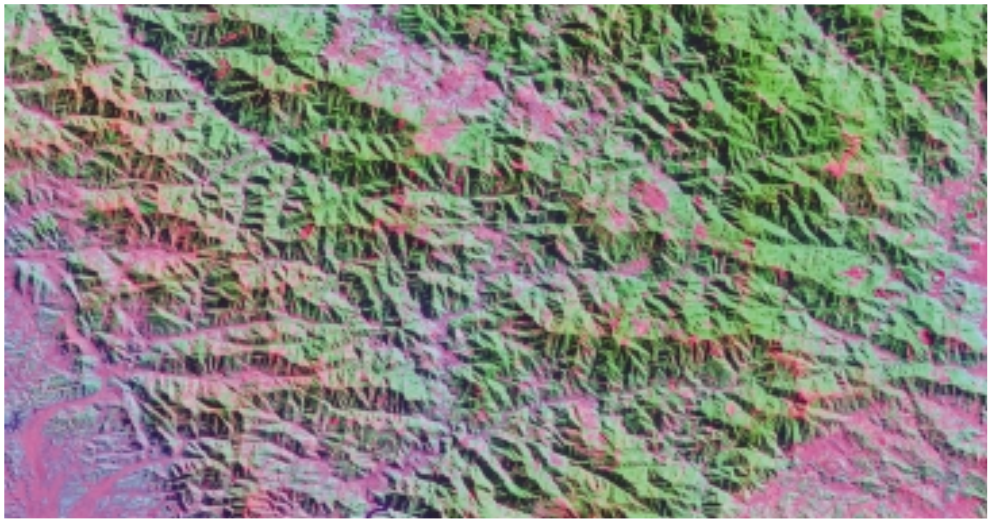
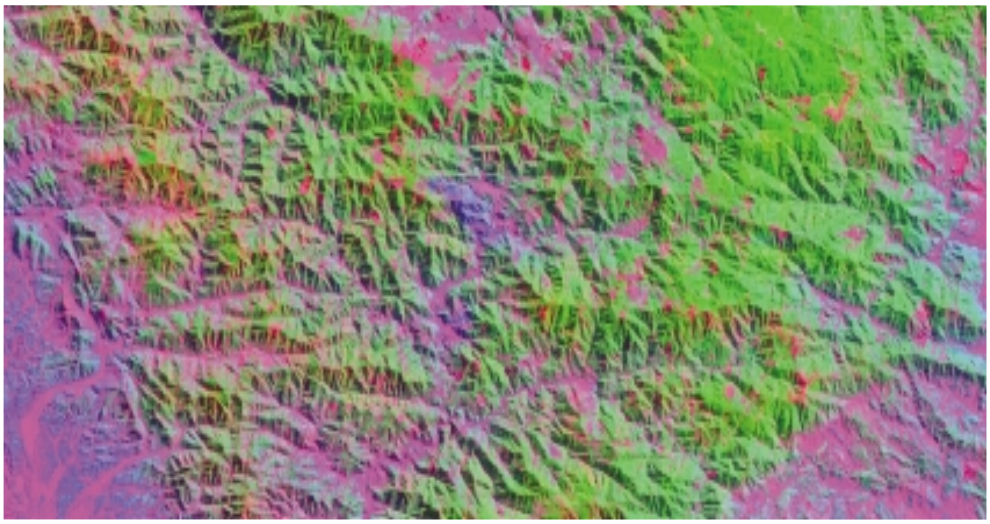
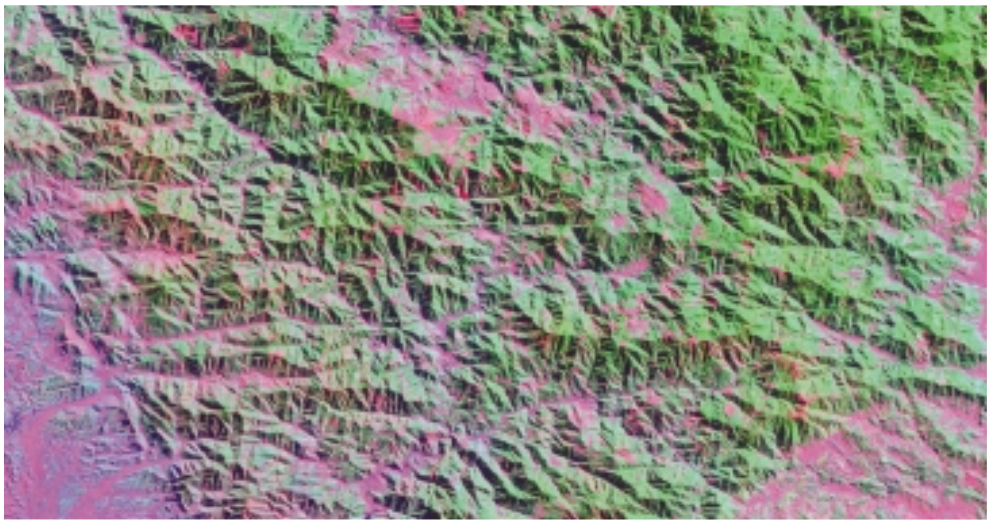


TM image in 1989



TM image in 1991



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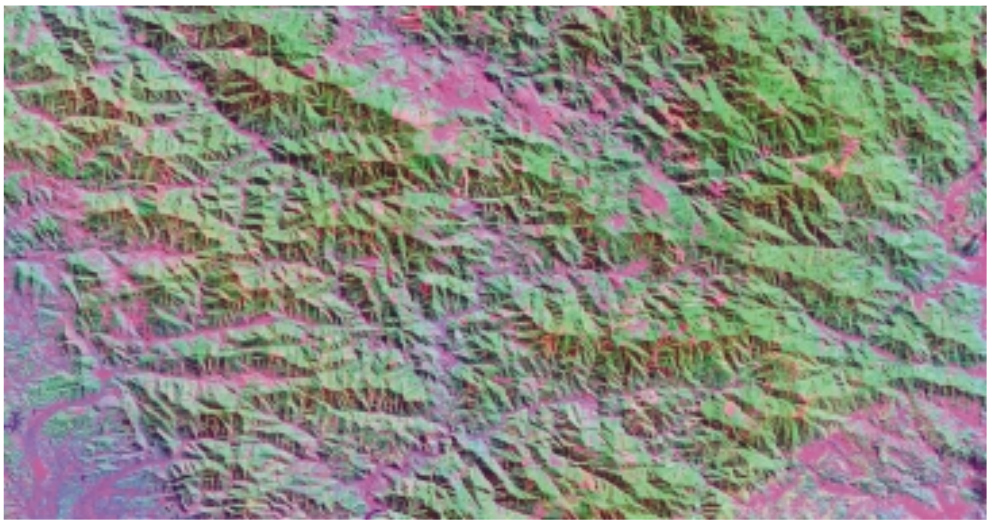
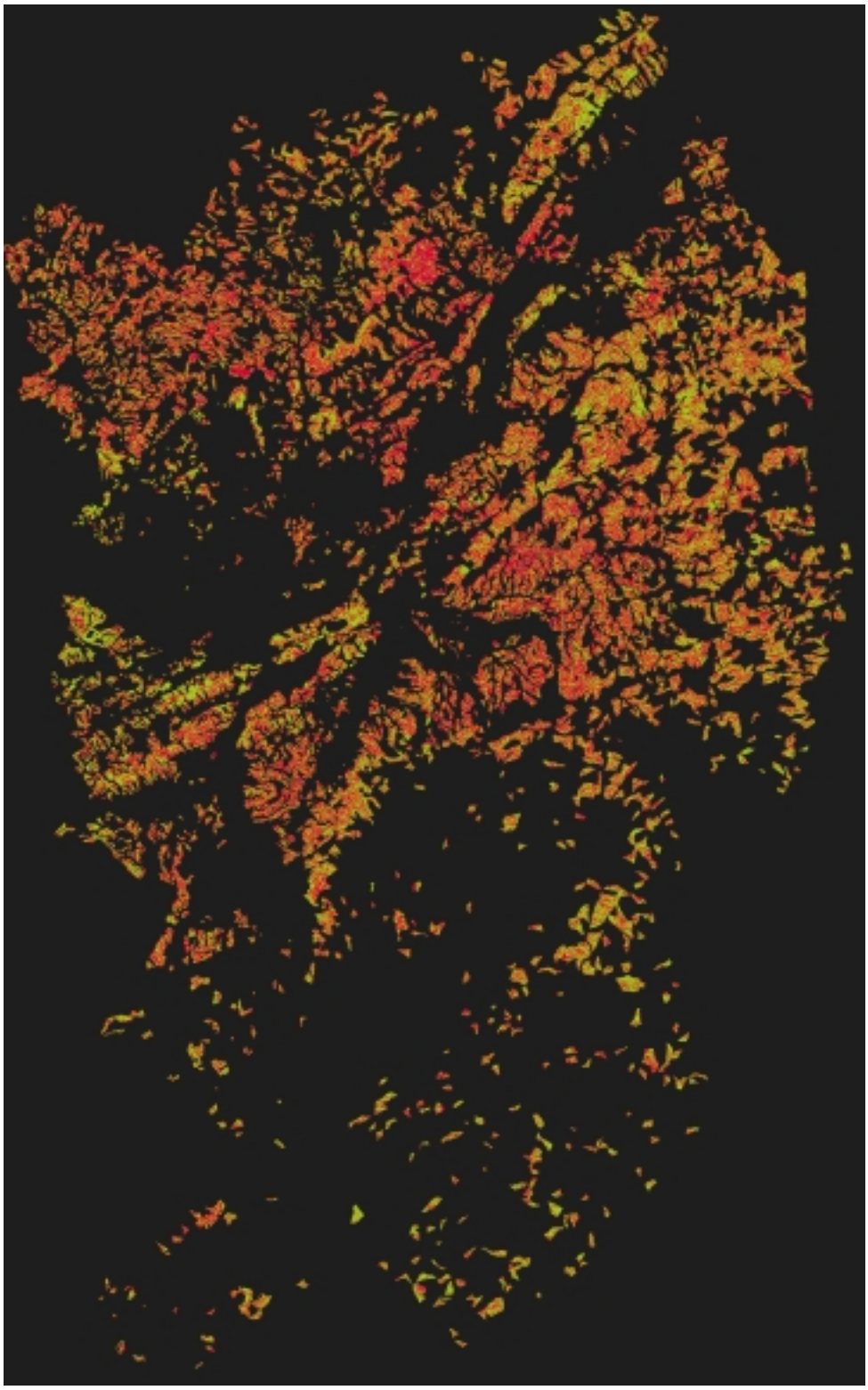
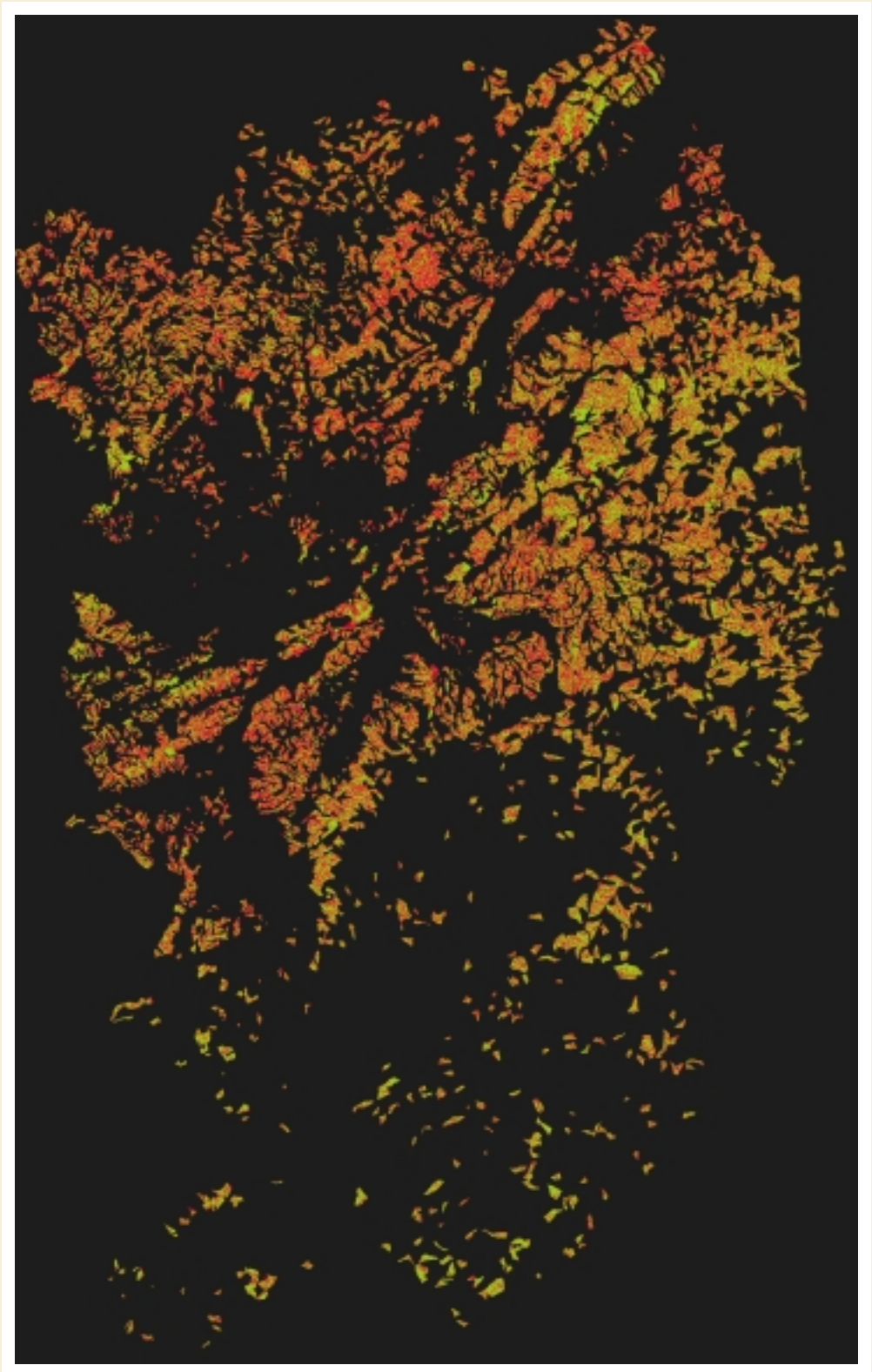


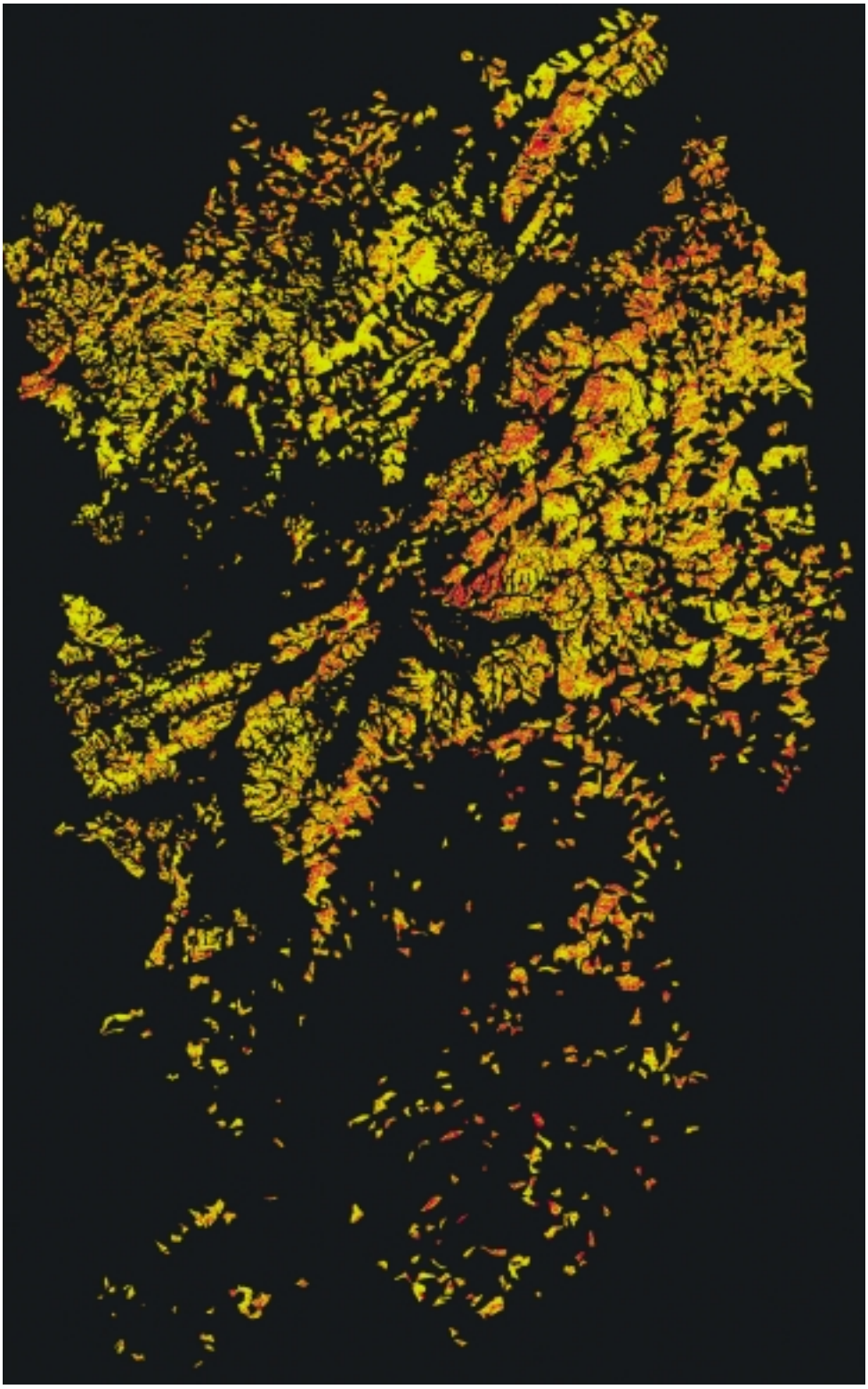
TM image in 1994



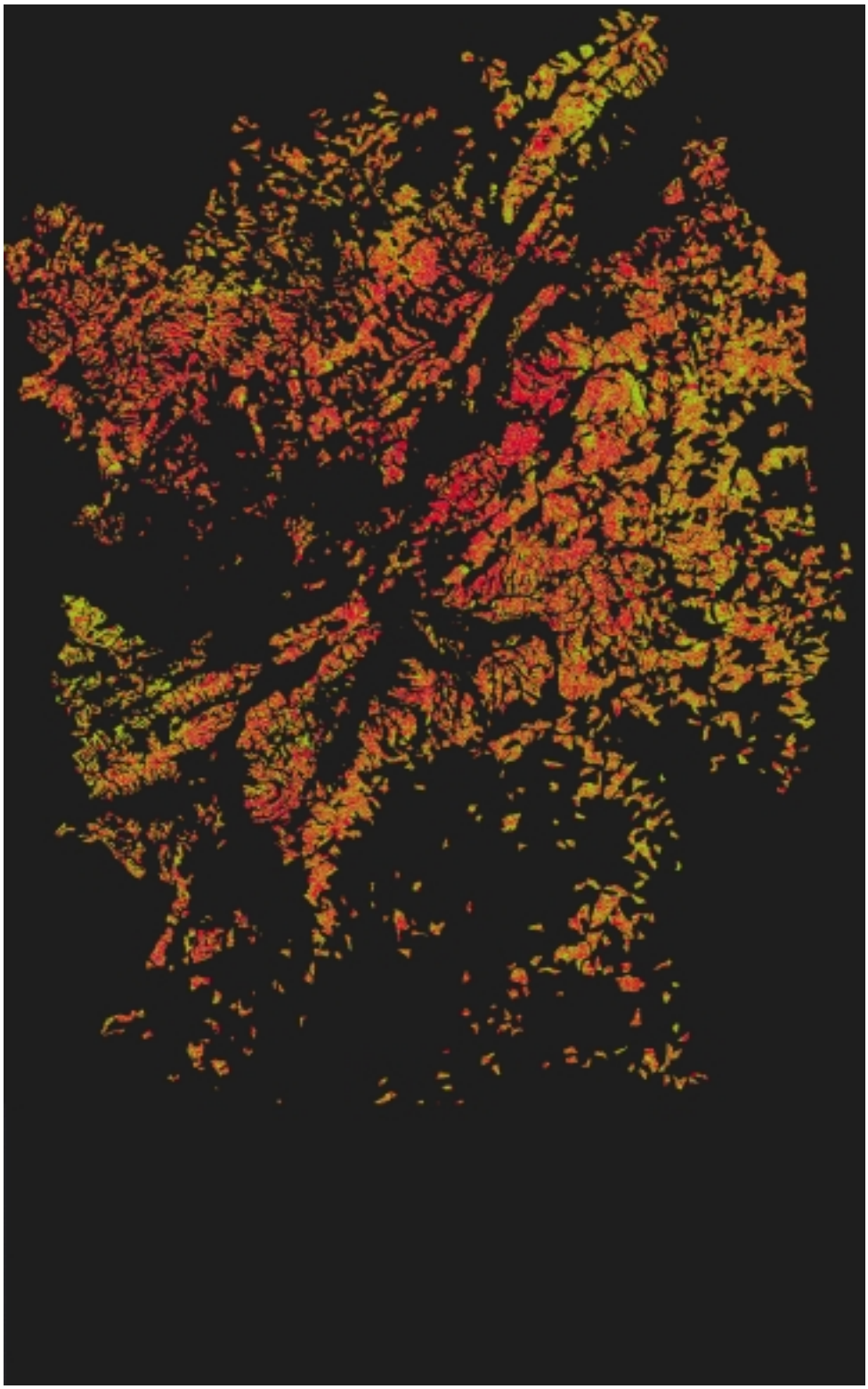
Forest health change map of Jiangshan County of Zhejiang Province in 1986（Green health forest，Yellow around 30 of needle loss percentage，Blue around 50 of needle loss percentage，Red Larger than 70 of needle loss percentage）



Forest health change map of Jiangshan County of Zhejiang Province in 1988（Green health forest，Yellow around 30 of needle loss percentage，Blue around 50 of needle loss percentage，Red Larger than 70 of needle loss percentage）



Forest health change map of Jiangshan County of Zhejiang Province in 1991（Green—health forest，Yellow—around 30 of needle loss percentage，Blue—around 50 of needle loss percentage，Red—Larger than 70 of needle loss percentage）



Forest health change map of Jiangshan County of Zhejiang Province in 1992（Green—health forest，Yellow—around 30 of needle loss percentage，Blue—around 50 of needle loss percentage，Red—Larger than 70 of needle loss percentage）

This group of images is situated at southwest Zhejiang Province, the center is about 118.5°E, 28.5°N. It has the subtropical climate with mason pine(*Pinus massoniana*) as the major tree type. Mason pine caterpillars(*Dendrolimus punctatus*) usually happened two or three generations and led to large areas of hazard and damage.

We choose four groups of images of six continuous years to analyze and compare the process of forest quality change. In the composite image, the green color represents the healthy forest, the red color represents the serious damage area of more than 70% needle loss, burnt area or clearcut area. The red orange color represents hazard areas with less than 50% needle loss. In 1992, large areas of mason pine caterpillars(*Dendrolimus punctatus*) happened and caused great damage. By comparing the continuous images, the direction of changes can be clearly seen. If the early pest spot can be monitored and measures can be carried out, the hazard loss can be lowered, and the forest resources can be protected.

In all, TM data has been successfully used in monitoring some defoliator in China.

Images of IKONOS

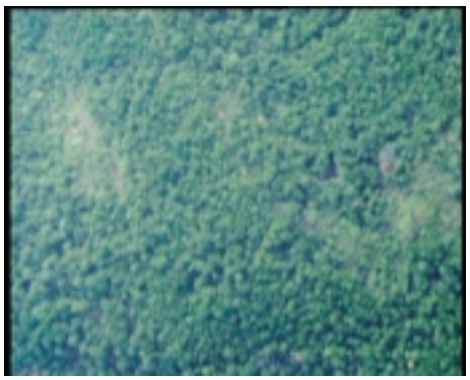
4-meter color image of IKONOS

1-meter panachromatic image of IKONOS

Merge image of IKONOS

This is a group of IKONOS test data. The four meter multi-spectral data can be used to distinguish individual trees, but their detailed information is very much limited. The one meter panchromatic data has rich information about individual trees, but has less spectral information. In the merged image of the two, the texture and spectral information has been effectively enhanced. The differences of tree types and tree conditions can be seen clearly, this means that this kind of data will play positive roles in monitoring forest insects and diseases.

Airborne video images and maps

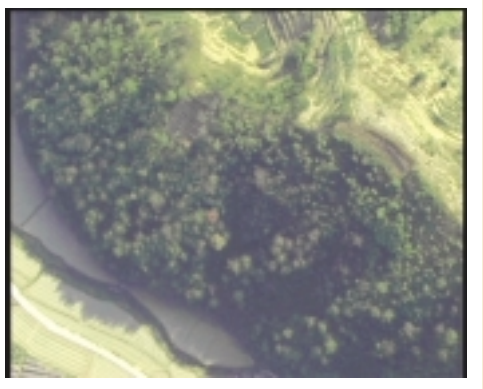


Individual dead trees in October(red)

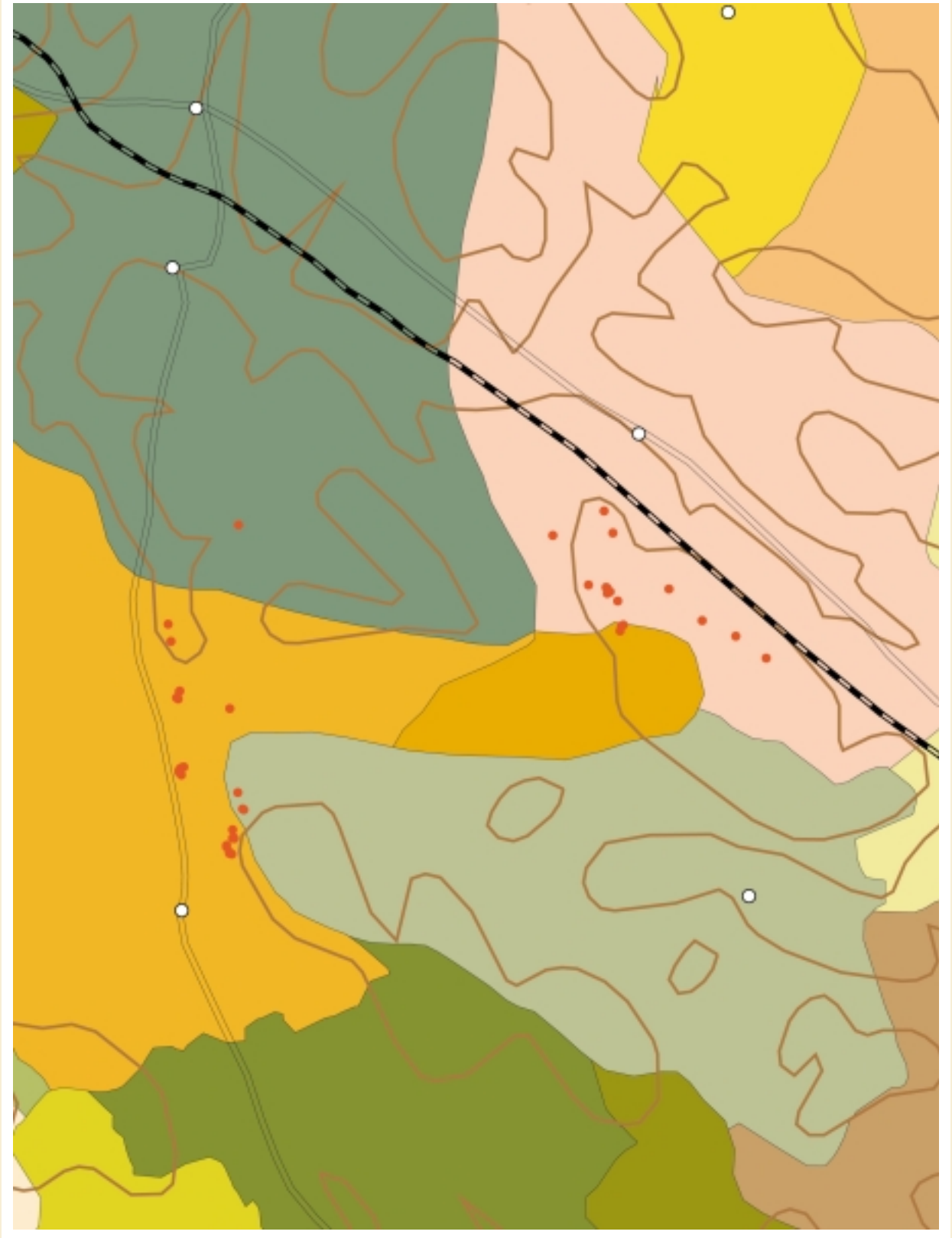
Dead trees on top of cliff in October (red)

Dead trees on barren grass slope in October (red)

A standing tree that is just dead in October (red)

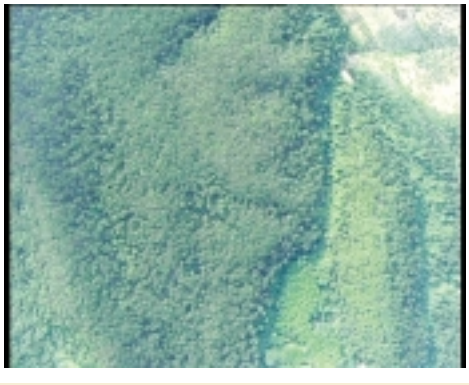


Distribution map of single dead trees and individual trees of change color in Huangshan City and Shexian County of Anhui Province in October 2001 (red point)



Distribution map of single dead trees and individual trees of change color in Jingde and Jixi County of Anhui Province in October 2001 (red point)

Distribution map of single dead trees and individual trees of change color in Ningguo County of Anhui Province in October 2001 (red point)

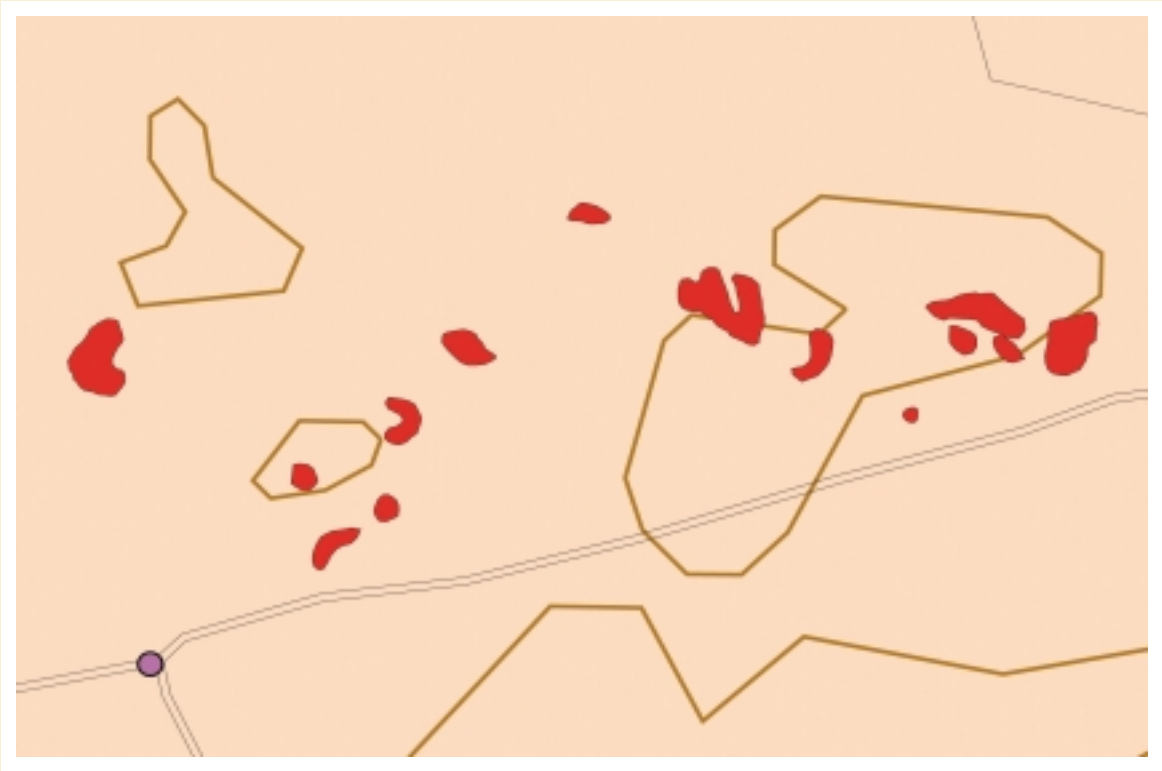


Stands with less than 30% defoliation
(yellow green region)

Stands with about 50% defoliation
(orange region)

Stands with about 70% defoliation
(brown region)

Stands with above 90% defoliation
(dark brown region)



Distribution map of disaster of Fusui County of Guangxi zhuang Autonomous Region in May 2001

Distribution map of disaster of Wuming County of Guangxi zhuang Autonomous Region in May 2001

This group is the result of videography. It is with two kinds of scales, one is in the stand scale and is used in the monitoring of pine caterpillars(*Dendrolimus punctatus*) , the other is in the individual tree scale and is used in the monitoring of Pine wood nematode disease (*Bursaphelenchus xylophilus* Nickle) . Videography plays imperative roles in monitoring dangerous forest insects and diseases. We have successfully applied it in Chinese Guangdong Province, Anhui Province and Guangxi Zhuang Autonomous Region in China.

Summary

Continuous growth of world population and economy has posed increasing pressure and influence to forest resources and ecology. Forest insects and diseases are also exhibiting a rising trend, the areas of hazard and damage continues to be high. One of the main reasons is the backward monitoring technology that cannot forecast and monitor the hazard effectively, and cannot control the hazard on time. Advancements of remote sensing, GIS and GPS technology has provided an effective means for monitoring and management of forest insects and diseases. Satellite, airborne multi-scale remote sensing data are effective tools in monitoring forest insects and diseases in different scale, and have played great role. With continuous development of technology, more effective methodology will come into being to monitor forest insects and diseases.

Acknowledgment

Thanks to the Committee on Trade and Investment , APEC, the Asia-Pacific Economic Cooperation Secretariat, and the Ministry of Foreign Trade & Economic Cooperation, PRC, they have provided full support for this project. Thanks to my colleagues Wu Jian, Shi Jin, Xue Zhennan, Chen Murong, Sun Yongping, Tian Yonglin, Zhou Jinsong, Zhang Peiyi, they have helped a lot in the compilation of this atlas.