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UTILITY OF SOME IMAGE ENHANCEMENT TECHNIQUES FOR RECONNAISSANCE SOIL MAPPING - A CASE STUDY FROM SOUTHERN INDIA

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ABSTRACT

The study deals with the evaluation of some image enhancement techniques, namely, colour slicing, ratioing, ratio-stretching, contrast stretching both linear and non-linear which were applied to Landsat MSS digital data for reconnaissance soil mapping through monoscopic interpretation approach in part of Anantapur district of Andhra Pradesh. The results demonstrate that the linear-stretched data appears to be the best in terms of ease and accuracy of soilscape boundary delineation with comparatively less field check as not only all the soilscape units could be mapped accurately but also a few sub-units within black and red soil patches, which otherwise would have been mapped as single unit, could be seperated out. The colour-sliced data has been rated next to linear-stretched data in terms of offering contrast for soilscape boundary delineation. Amongst the ratios obtained, only 4/5 output has yielded information on drainage pattern. Non-linear stretched data could afford accurate delineation of moderately to severely eroded lands and rock outcrops.

I. INTRODUCTION

While interpreting Landsat MSS data, either visually or by digital analysis, we often come across with the data having relatively poor overall tonal/colour contrast. It may be due to a variety of factors including highly reflective/absorptive terrain, presence of thick vegetation cover, adverse meteorological conditions over the terrain, etc. The poor tonal/colour contrast associated with the data obscures subtle tonal/colour variations which may be related directly or indirectly to various features of interest thereby making them indiscernible. In order to fully utilise the total information content of the data, several image enhancement techniques, namely, density slicing/ level slicing, spatial filtering-both high and low pass, textural analysis, pseudo colour compositing, band ratioing, contrast stretching - both linear and non-linear, image addition/substraction, etc. have been developed in the recent past to bring out these subtle tonal/colour variations that are otherwise obscured. The present study was aimed at evaluating the utility of a few image enhancement techniques viz., colour slicing, ratioing, ratio-stretching and contrast stretching - both linear and non-linear for reconnaissance soil mapping in a hard rock terrain covering part of Anantapur district of Andhra Pradesh. The area falls in the Landsat scene with path-row numbers 155-050 that was acquired on 10th February, 1973.

II. METHODOLOGY

The Landsat MSS digital data in the form of computer compatible tape (CCT) was used as input to the Bendix Multispectral Data Analysis System (M-DAS) for carrying out following enhancements:

A. COLOUR SLICING

Initially, the area was displayed on display unit (colour monitor) of M-DAS in each spectral band seperately and the band giving relatively better contrast was chosen for enhancement. The contrast was further improved by changing 'offset' and 'gain'. After achieving desired contrast the colour slicing programme (CSP) was run.

B. RATIOING AND RATIO-STRETCHING

The ratioing was performed by taking the ratio of the brightness values (digital counts) in two spectral bands. In the present study ratios of band 4 to 5, 5 to 6, 6 to 7 and 7 to 4 were obtained through 'RATIOING' programme. The resultant brightness values were not sufficient enough to yield optimum contrast for interpretation, hence, these values were stretched to full dynamic range of the film through 'LINEAR STRETCH' programme.

C. LINEAR STRETCHING

In the test area, the brightness values were in the range of 0 to 66 only. These values were stretched to entire photographic range (0-255 gray values) by defining minimum and maximum values in all the four bands after taking histogram of the data which were input to 'LINEAR STRETCH' programme. The minimum and maximum values defined in bands 4, 5, 6 and 7 were 27-48, 25-62, 23-66 and 15-28, respectively.

D. NON-LINEAR STRETCHING

Similar procedure was followed for non-linear stretching also except for only a narrow band (18-60) representing eroded lands and rock outcrops, black and red soils in the small subset (0. to 66) of total brightness range was enhanced. After running the programmes for different enhancements the output data were filmed on an optronics system and B&W and colour outputs were generated on 1:250,000 scale.

III. RESULTS AND DISCUSSION

In order to assess the utility of outputs obtained from aforesaid enhancements, these were compared with the original (unenhanced) Landsat MSS false colour composite of the same area for reconnaissance soil mapping by interpreting them monoscopically which was supported by limited field check. The soil map prepared from unenhanced data (Fig.1a and 1b) is presented as Fig-2 and its legend as Table-1.

A comparison of colour-sliced data (Fig-3) with the original data reveals that within black soil patch in the south-west of Urvakonda which has been mapped as G24 representing association of Typic Chromusterts and Vertic Ustochrepts, individual sub-groups of the association could be seperated out easily. Typic Chromusterts appears as light blue colour and the latter as bright green colour.

The G21 unit in the south of Mid Penner reservoir representing Typic/Lithic Ustorthents and Typic Ustochrepts with occasional rock outcrops is relatively more clear. The boundary of G24 unit in the south-west of Kuderu could be refined with the help of colour-sliced data. The river alluvium (A) could be easily seperated out from adjacent black soils (G24 unit). Besides, a patch of rock outcrop in the south of Mid Penner reservoir is also very clear.

Contrastingly, all the basic dykes (B), small valleys (G3) and residual hill complex on Dharwar Metasediments appear as bright green colour - same as of G24 unit thereby making their delineation relatively difficult.

Amongst ratioed data, only 4/5 data (Fig-4) has yielded some additional information over unenhanced data. However, many of the soilscape boundaries, namely, of G21, G22, G3 and G25 got merged on this data. The drainage pattern has come out very clearly. Besides, the boundary of G24 unit in the south-west of Kuderu could be refined. Black soils stand out as medium gray to dark gray tone in light gray toned background. The moderately deep black soils (Vertic Ustochrepts) could be delineated as pure unit since they appear as white to light gray tone. However, the boundary between Typic Pellusterts and Typic Chromusterts which is clear a colour-sliced data is not so sharp on this data. On the output of 5/6 (Fig-5) except for water bodies and a few drainage channels none of the features is discernible. Similarly, 7/4 data (Fig-6) is having very poor contrast. Furthermore, false colour composite prepared from 4/5, 5/6 and 7/4 of ratio-cum-stretched data - a B&W sample of which is given here as Fig-7 has not yielded any additional information over 4/5 data.

On non-linear stretched data (Fig-8), only moderately to severely eroded lands and granite-gneiss rock outcrops have been brought out very clearly as purple and white colour, respectively. Like ratioed data, here also, mapping unit G23 and G24, alluvium (A), waterbody (Mid Penner reservoir) and residual hill complex (D) are spectrally almost similar except that the waterbody and G24 unit have smooth texture whereas others exhibit coarser texture. Besides, small, low and bare hillocks within the red soil patch in the south-west of Urvakonda are easily seperable from them which could not be achieved on afore-mentioned enhanced data.

Lastly, the linear stretched data (Fig-9) has yielded maximum contrast amongst the soilscape units, consequently, most of the soilscape units could be delineated with greater certainity and accuracy with comparatively less field check. The stricking feature of this data has been its ability to bring out small, low and bare hills within the red soil patch in the south-west of Urvakonda more clearly as compared to non-linear stretched data. The hillocks appear as white colour and red soils as dark yellowish brown colour. In addition, alluvium (A), G22 unit representing mostly rock outcrops with shallow red soils with lithic contact, valleys (G3) and a patch of rock outcrop in the south of Mid Penner reservoir are very conspicuous. However, the oundary between G23 and G24 unit which is very sharp on colour-sliced data is not so on this data.

IV. CONCLUSION

The study has clearly demonstrated the utility of some image enhancement techniques like colour-slicing, ratioing, ratio-stretching, and contrast stretching both linear and non-linear for reconnaissance soil mapping in a hard rock terrain. Amongst the techniques used in this study, contrast stretching appears to be the best followed by colour slicing. The remaining three techniques are of only limited use. The utility of other image enhancement techniques like high-pass and low-pass filtering, histogram equalisation, pseudo colour composition, image addition/substraction, etc., may be tried in different type of terrains alongwith those used *in this study to verify and substantiate the finds and to evaluate the utility of these techniques.*

V. ACKNOWLEDGEMENTS

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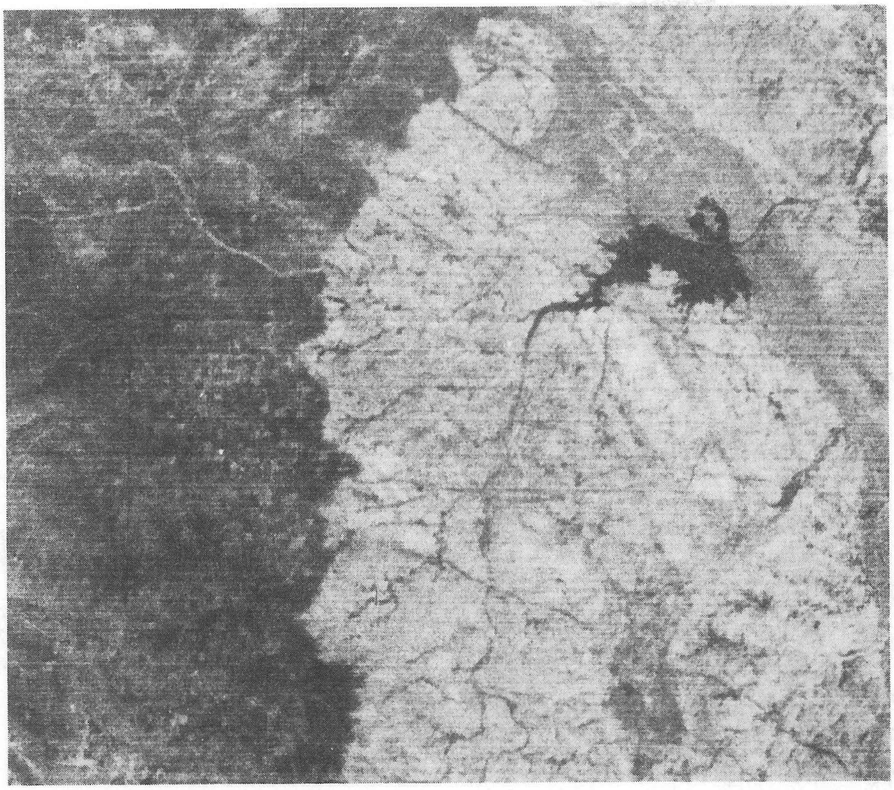

Fig.1a - Unenhanced data band-5 image

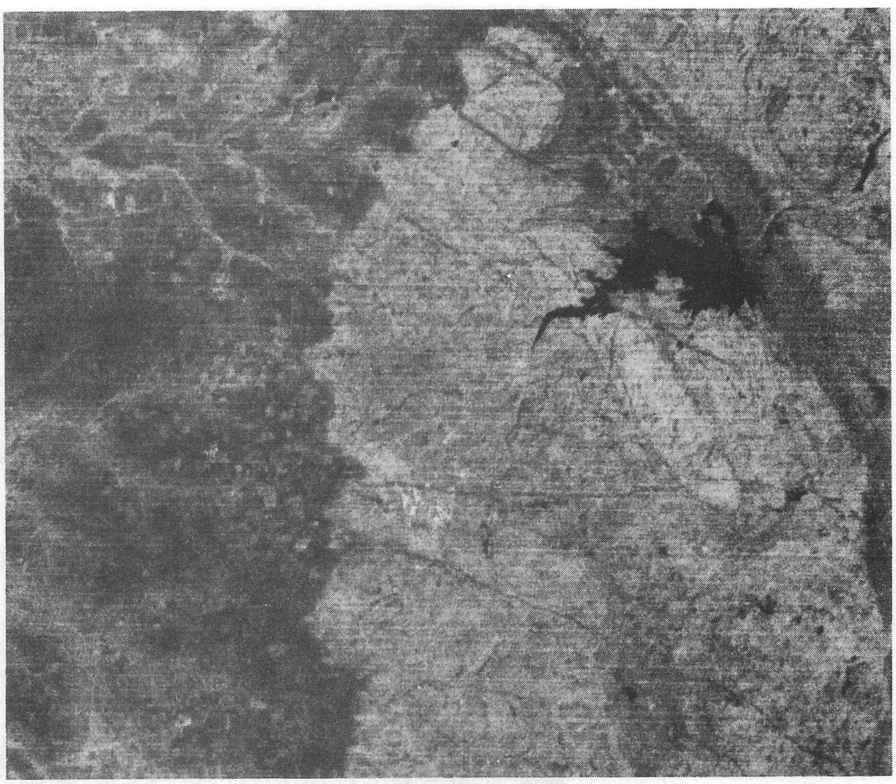

Fig.1b - Unenhanced data band-7 image

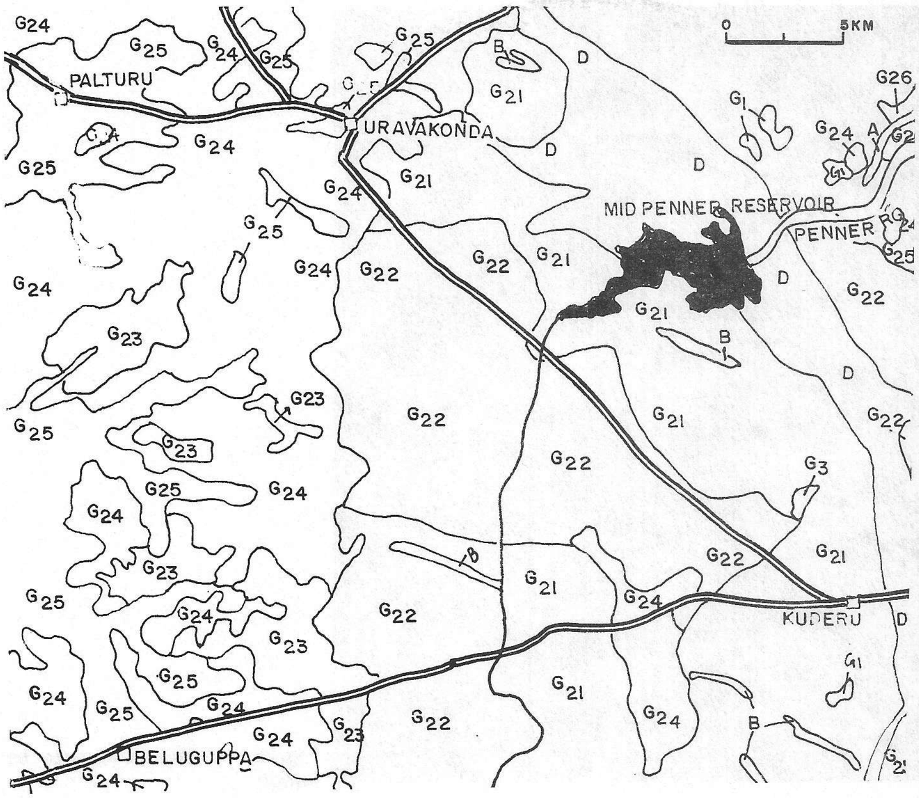

Fig.2 - Soil map of part of the study area prepared from unenhanced data. Area coverage - Lat.14°40'0" to 15°0'30" Long.77°6' to 77° 27' (For legend refer Table-1)

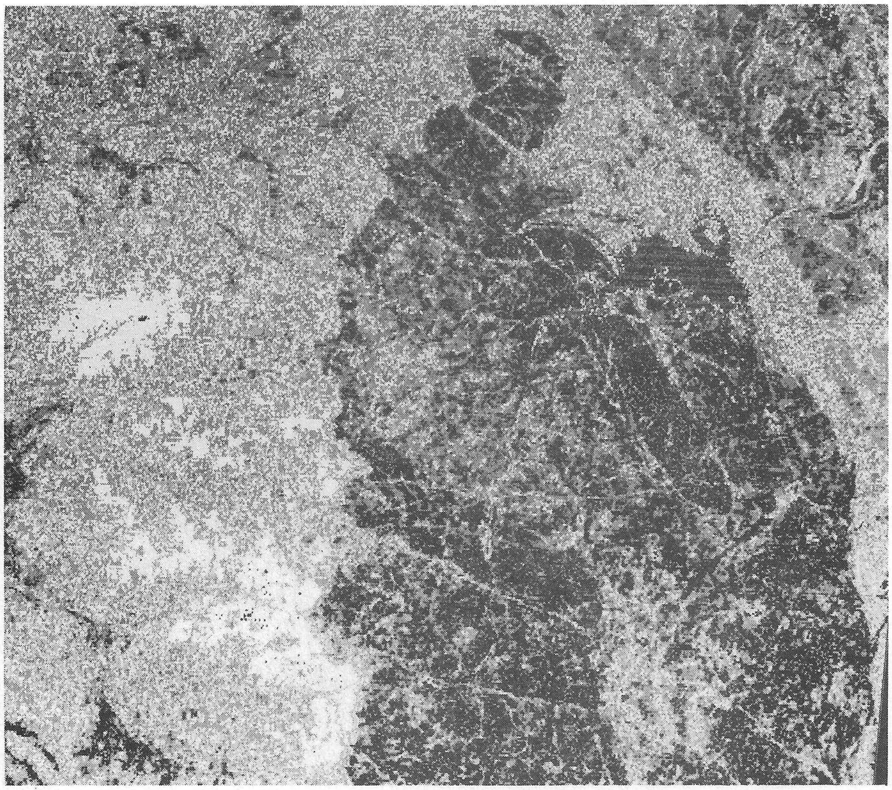

Fig.3 - B&W rendition of colour-sliced data

Table-1

SOIL MAP LEGEND

Mapping symbol	Landform and image characterestics and land use	Dominant soils	Erosion hazard
G	Soil-scapes from granite-gneiss		
G1	Hills, bare to thin vegetation cover	Mostly bare rocks with talus deposit on the lower slopes	Severe
G2	Pediplains		
G21	Gently sloping to undulating plains, light greenish yellow colour, cultivated	Typic/Lithic Ustorthents Typic Ustochrepts with occasional rock outcrops	Slight to moderate
G22	Undulating plains, yellowish green colour, coarse texture, cultivated in patches	Mostly rock outcrops with occasional skeletal, Lithic/ Paralithic Ustorthents	Moderate
G23	Nearly level to gently sloping plains,dark green colour, cultivated	Typic Pellusterts	Nil to slight
G24	Light green colour	Typic Chromusterts Vertic Ustochrepts	Slight to moderate
G25	Nearly level to gently sloping plains, yellow colour, cultivated	Typic Paleustalfs & Rhodustalfs with occasional rock outcrops	Slight
G26	Gently sloping plains, white colour wasteland	Skeletal, Lithic Ustorthents & Typic Ustipsamments with occasional rock outcrops	Moderate
G3	Valleys, cultivated	Vertic/Typic Ustochrepts Udic Haplustalfs	Nil to slight
B	Quartz reefs/basic dykes	None	-
D	Soilscapes on Dharwar Metasediments		
D	Residual hill complex	Mostly bare rocks with talus deposits on the lower slopes	Severe
A	Landscapes on Penner Alluvium		
A	Flood plain deposits, cultivated	Typic Ustifluvents Vertic Ustifluvents	Slight

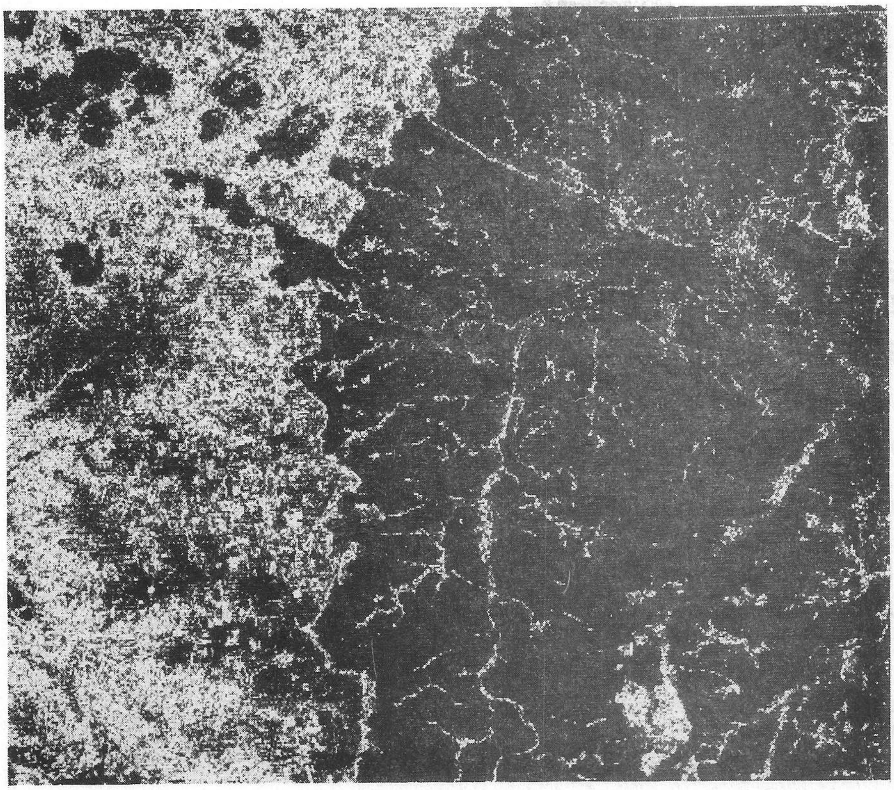

Fig.4 - Ratioed data - 4/5 image

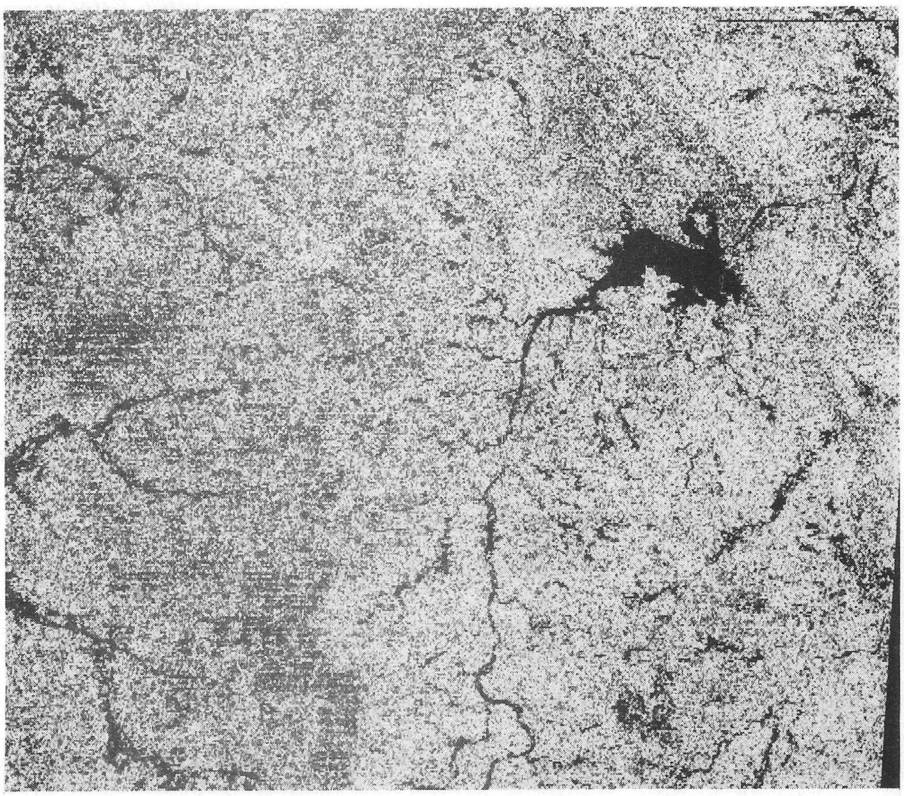

Fig.5 - Ratioed data - 5/6 image

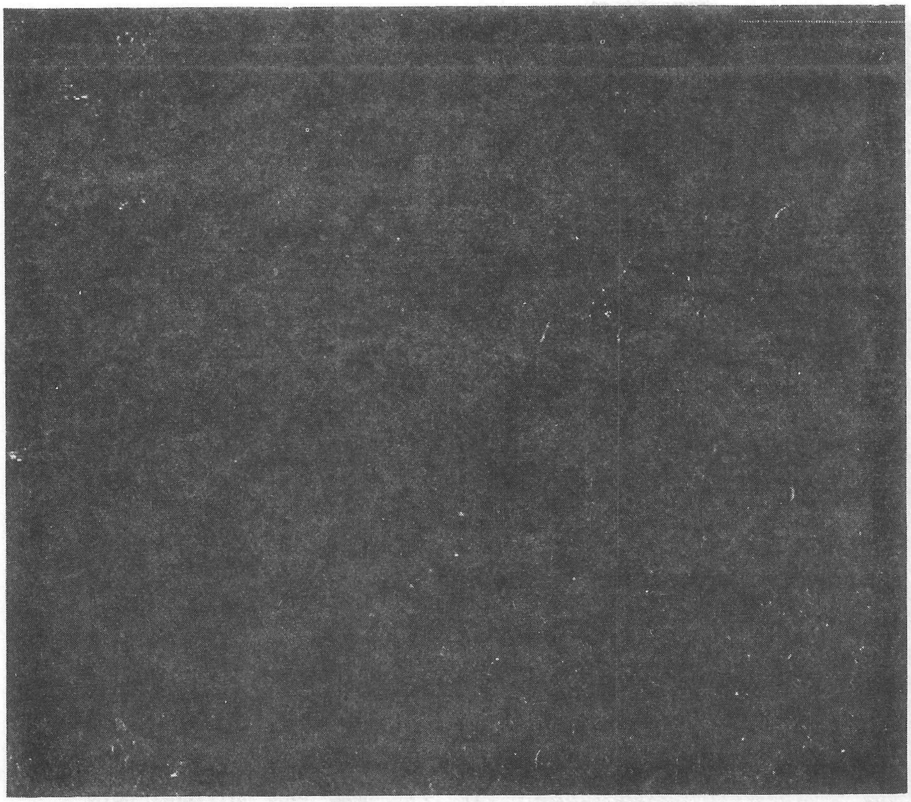

Fig.6 - Ratioed data - 7/4 image

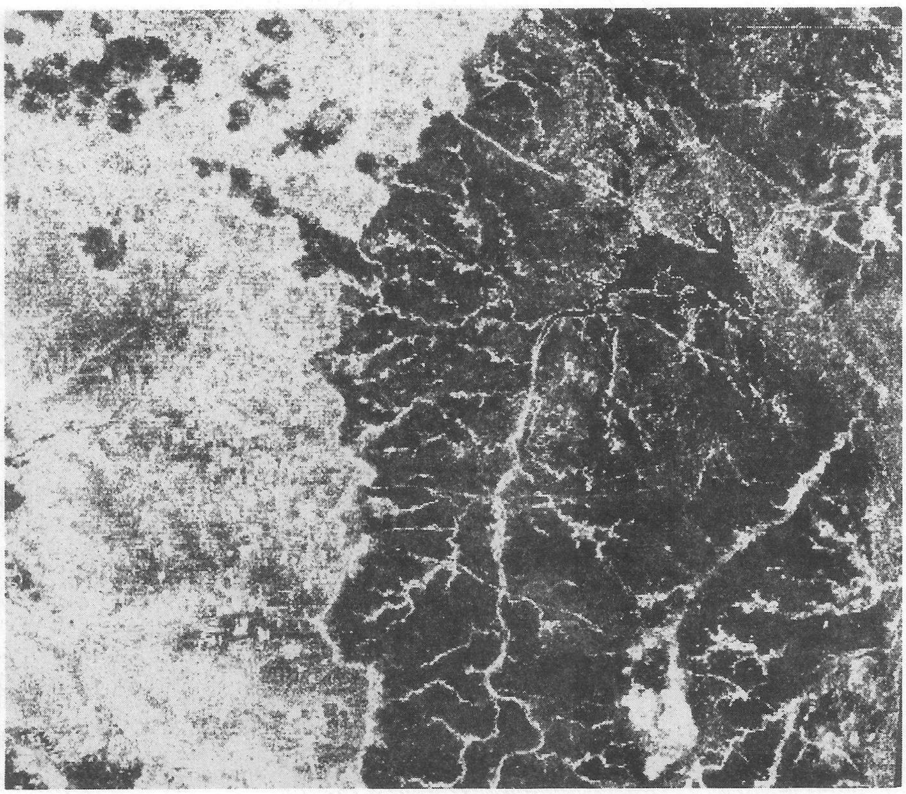

Fig.7 - Ratioed-cum-linear stretched data - 4/5 image

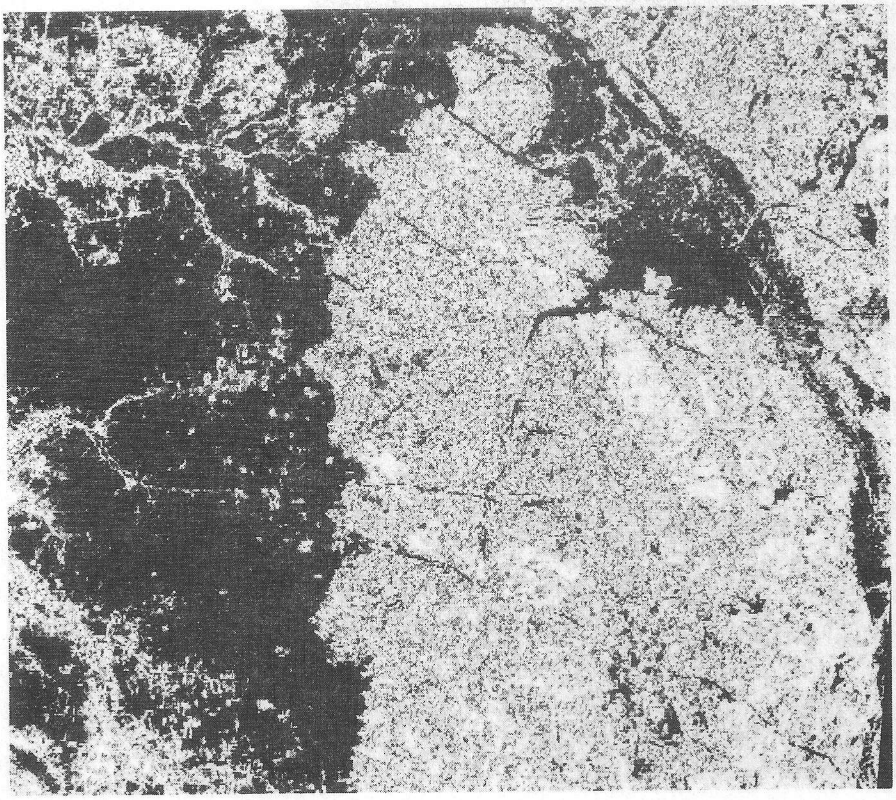

Fig.8 - B&W rendition of non-linear stretched data

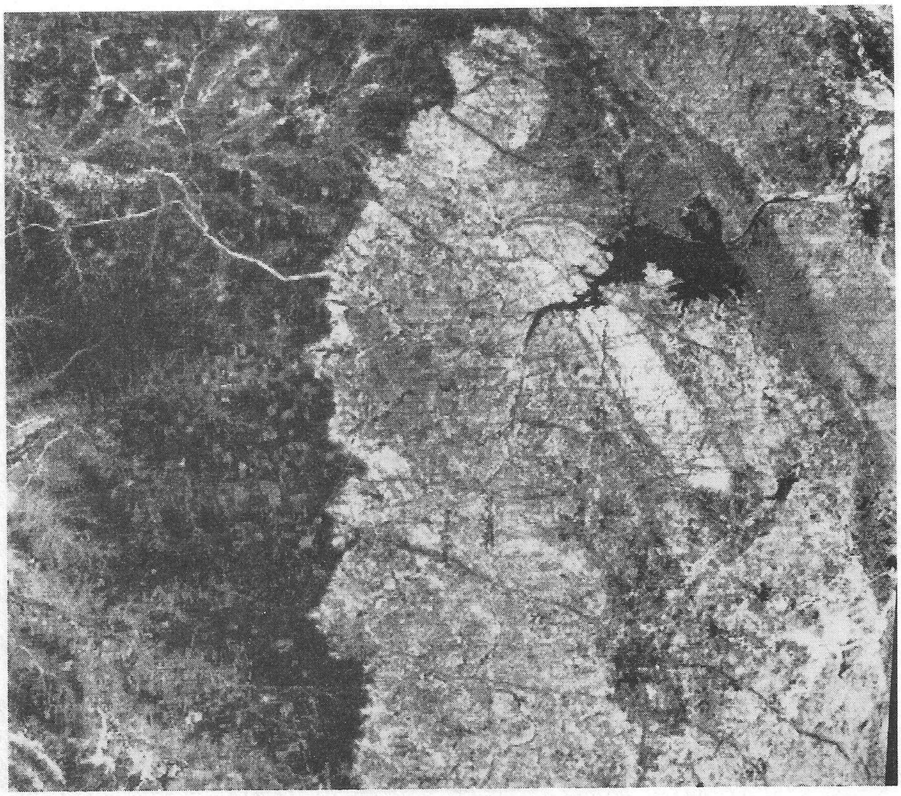

Fig.9 - B&W rendition of linear stretched data