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INVESTIGATION OF THE AGRICULTURAL RESOURCES IN  
SRI LANKA, 29040  
----- ( ) -----

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SRI LANKA MINISTRY OF AGRICULTURE AND LANDS.

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A N N E X U R E A

A N N E X U R E B - Map of Sri Lanka

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## I. INTRODUCTION:

The first sets of bulk LANDSAT 1 imagery were received in August, 1975. The lower half of the Image frame bearing ID number 1234-04233 (of 14th March, 1973) was found suitable for investigative purposes. Subsequently, image frame bearing ID number 2339-04151 (LANDSAT 2 image of 27th December, 1975) was received on 2nd April, 1976. This too was found suitable for investigation purposes. All other bulk imagery received had a very high percentage of cloud cover obscuring the land area and, hence, could not be used for the investigation.

At the commencement of the project, a small team was formed within the Surveyor General's Department (which is under the Administration of the Ministry of Agriculture & Lands) to gather experience on the processing and interpretation of LANDSAT imagery. This team consisted of officers performing Topographic, Geodetic, Engineering and Revenue types of surveys. Many of these officers are trained in processing and interpretation of aerial photography and are currently performing such tasks. The facilities of the Air Survey Branch were utilised for this purpose.

Our officers did not have special practical experience in the technique of processing LANDSAT data. Nor did we possess any special equipment for this purpose. Due to the scarcity of foreign exchange available to the Government, it was decided to perform the investigation, at least at the preliminary stages, using facilities available in the Surveyor General's Department.

The series of experiments described in the subsequent sections starting with the simplest experiment of projecting the 70 mm. transparencies utilising an ordinary projector to the use of precision photogrammetric equipment and interpretation techniques were mainly intended to give the team the much needed experience in processing and interpreting LANDSAT imagery. They have provided the team with a systematic process of gaining experience and learning more about this type of imagery, through practical exercises, continuous discussions and reading of reference material. This aim was achieved, and now more personnel are developing an interest in this investigation, and learning about the possible applications and future developments. Many lectures, seminars and on-the-job sessions were conducted.

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## II. Techniques and description of Experiments.

- LANDSAT DATA : - (a) Bulk 70 mm. negative transparencies of the Trincomalee frame (ID 1234 - 04233 of 14th March, 1973) of Bands 4, 5, 6 and 7. This frame covers a N-E Section of Sri Lanka with Trincomalee at the centre.
- (b) Bulk 70 mm. positive and negative transparencies of the Colombo frame (ID 2339-04151 of 27th December, 1975) - Bands 4, 5, 7. This frame covers a S-W Section of Sri Lanka with Colombo at the Centre.

### Experiment No. 1.

Each 70 mm. negative was projected on to a smooth wall through a Durst projector. A base map on the scale of 8 miles to 1 inch ( 1 : 506,880) was placed firmly on the wall. By adjusting the image distance, the scale of the projected LANDSAT image was made to agree with the base. Good agreement was achieved, when the Trinco scene was used. Local agreement could be obtained, with the Colombo scene.

### Experiment No. 2.

The Wild photogrammetric Rectifier E4 was used for this experiment. The size of the negative carrier of this instrument is 230 mm. x 230 mm. The 70 mm. transparencies were accommodated on this carrier through a window by masking the extra space with a thin black paper. The image was then projected on to the easel, without any tilts being introduced. The scale was adjusted to fit the relevant section of the base map of scale 1:506,880 (road map of Sri Lanka). The base map was then removed and photographic printing paper (AVIPHOT semi-matt) was placed on the easel and exposed. By this procedure a photo print of the LANDSAT image on the scale of 1:506,880 was produced. Other bands were also enlarged in the same manner. These prints were used for interpretation.

### Experiment No. 3.

When the prints resulting from Experiment No. 2 was used for interpretation, grey scale variations from band to band were noticed as the printing was done for best enhancement of detail. Hence,

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it was felt that the interpreter may be misled by attempting to compare grey tones in different bands when they were not really matched in intensity. However, these prints were successfully used for visual interpretation of individual bands. Tone matching of the prints of the different bands of this frame were achieved by visual judgement comparing the resulting grey levels on the Grey Scale of band 5 with the grey scales of the other bands. These were used further for interpretation and preparation of grey scale maps of different bands and then an attempt was made to combine these maps onto a composite interpretation. This was an attempt to perform manual multispectral (compressed) signature evaluation by assigning arbitrary code values to the consecutive grey tones. This attempt was not very successful due to the restriction of having to use the only available transparency material (tracing paper) and the subsequent difficulty of combining the overlay composite. However, the separation & evaluation of about 15 different homogeneous spectral signature (manual) areas were seen and their extents calculated. No conclusion could be drawn due to the fact that this scene was about 3 years old (Trinco scene (a) ) and much change has occurred in this area. In addition, the season of acquisition of this image complicated any further attempts at detailed interpretation especially of areas covered by seasonal or shifting crops. It is felt that this technique can be used to develop manual spectral signatures by using good quality overlay transparencies to develop the composite. Upto six tone-matched grey levels may be used. But the use of four grey tones is likely to be sufficient.

#### Experiment No.4.

##### Processing of imagery for precise photogrammetric plotting.

Contact size diapositives were obtained on 9" x 9" sensitised glass plates. The images of all 4 bands were symmetrically positioned on the same glass diapositive. This was used on the Precision Photogrammetric plotter Wild A7 for monocular plotting.

##### Photogrammetric plotting .

The glass diapositive containing the 4 images of Frame ID 1234-04233 were placed on the left projector. The scaling was done using 4 prominent points (from the 1:253,440 topographical map sheet of Sri Lanka covering this region) visible on the LANDSAT image. The matching of these 4 points to the base map placed on the plotting table was achieved by changing the projection distance and using the suitable gear-ratio on the plotting table pantograph. Good agreement of all



of all/  
4 points were possible. Now, other features visible on the LANDSAT image were plotted on a Garbelon (transparency) sheet placed over the base map. All sea coast boundaries, water bodies, visible parts of roads, railways etc., were plotted. All major features showed agreement locally. There were minor variations of overland water-surface boundaries. This is to be expected as such water surface areas change according to the season and rainfall.

Subsequently, more detailed plotting revealed, that in certain instances, the LANDSAT imagery could be used for revision of maps of this scale, through local fitting of the imagery to the base map detail.

Experiment No.5. - Scene ID 2339 - 04151: 27th December, 1975 - LANDSAT 2. COLOMBO FRAME.

(a) Processing:- Utilising the Zeiss SEG V or the Wild E4 Photogrammetric Rectifier/Enlarger, the 70 mm. bulk LANDSAT imagery were enlarged approximately three times and printed onto sensitised glass plates (diapositives) normally used in standard photogrammetric practice. No rectification was attempted.

(b) Photogrammetric Plotting :- The size of the resulting diapositives were 7" x 7".

The Wild A7 (1st order Universal photogrammetric plotter) was adaptable to this plate size. Hence, this instrument was utilised for subsequent experiments. The following procedure was adopted :-

Two identical glass diapositives of Band 7 (positive) were mounted on the two projectors to attempt convenient binocular plotting. Principal distance setting = 150 mm. was used. The matching (or simulated orientation) of the two images were done with suitable base setting and adjusting the orientation elements of the right projector keeping the left projector at zero. Only the rotation of the image about the Z-axis (kappa) gave proper matching.

Plotting was performed on the scale of 1:253,440, using different pairs of images on the left and right projectors as follows :-

<u>Left</u>	<u>Right</u>
7 +ve	5 +ve
4 +ve	5 +ve
4 +ve	4 -ve
7 +ve	7 -ve
4 -ve	5 -ve
7 +ve	4 +ve

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This procedure attempted to achieve additive and subtractive combinations for plotting on photogrammetric instruments. The most suitable combination was found to be the positives of 2 separate bands. This enabled convenient (less eye strain) binocular viewing and the availability of additional details enhanced in the different bands. However, the combination of positives with negatives were very confusing to the operator and did not yield any advantage. Even the use of two negatives led to confusion.

Scaling :- Scaling was performed by changing the projection distance (Z-column). Two prominent points along the coast (N-S) were used for the preliminary scaling to 1:253,440. When this scale factor was checked with a third point near the Eastern end of the scene, there were significant differences amounting to about  $\frac{1}{4}$  inch on this scale (i.e. about one mile on the ground). Correction of this distortion was attempted by tilting the projector. There was slight improvement but this distortion could not be removed. This scaling experiment was repeated with Band 7 only (monocular) for the scene ID 1234 - 04233 of 14th March, 1973 and similar difficulties were encountered.

Therefore, it appears that bulk imagery can be used for revision of maps of this scale ( or even larger) only through local fitting of details or through localised scaling.

Experiment No.6 - Photogrammetric Plotting.

The scaling and plotting exercise as described in Experiment No.5 was repeated with the Trinco image (ID 1234 - 04233) using the Band 7 image only. Plotting was done on two scales ; i.e. 1:253,440 and 1:506,880. There was very good agreement between the LANDSAT plots and the corresponding scale maps. However, the water features on the extreme S-W corner of this LANDSAT scene showed discrepancies corresponding to about  $\frac{1}{2}$  mile on the ground. This image showed much better agreement with the base maps than the Colombo ( ID 2339 - 04151 ) image - vide experiment number 5.

NOTE : - These experiments were conducted on the BULK Landsat imagery. It is expected that rectification can improve the agreement slightly and that PRECISION processed products will yield even better planimetric accuracy.



Experiment No.8 -General Interpretation of a LANDSAT Frame  
over Trincomalee area -PURPOSE

The object of this study was to perform an interpretation of the Trincomalee Frame - JD No. E - 1234 - 04233 of 14th March 1973. About 60% of the land area within this frame is covered with cumulus cloud. Hence the area of study has been essentially confined to the southern half of the frame, which is free of cloud cover. The study itself is done on a very broad basis.

DATA :

Black and White tone - matched (visual) Imagery of Bands 4, 5, 6 & 7, printed on Kodak Semi-matte paper having an approximate scale of 1 : 500,000 were made available for the study.

The respective Exposure and Development times used in the visual tone-matching are as follows :

- Band 4 - 240 seconds and 120 seconds
- Band 5 - 900 seconds and 120 seconds
- Band 6 - 240 seconds and 120 seconds
- Band 7 - 240 seconds and 120 seconds.

A definite constraint in the study of this Frame was the non-availability of up-to-date Land-use maps and comparable aerial photographic coverage. However, the available aerial photographs of 1972 and 1974 were somewhat useful in this experiment.

Interpretations :-

BAND 4 : This Imagery is of a tone lighter in density (with an illusion of a misty cover over the entire land mass) than Band 5.

The roads and railway track are somewhat visible, and they could be satisfactorily traced out to a certain extent.

The water bodies and river courses are the same as they appear in Band 5, excepting that they are of a more subdued tone.

Along the near off-shore coastal length of the imagery is seen a light grey tonal variation which could be attributed to a relative variation in the depth of the sea.

BAND 5: As in the Colombo Frame (ID 2339-04151) the water bodies situated along the coast line have tones varying from white to dark-grey. It is worth mentioning that the body of water situated just north of Kantalai Tank ( located in the S.W. quadrant - outer edge of the large lop-sided 'L' shaped whitish pattern ) has a grey tone quite different to the black of the Kantalai Tank itself - (vide Annexure B - Map of Sri Lanka - for location). Comparison with the Band 7 image will also assist in the location of this feature. The same grey tone is seen covering the body of water ( Tambalagam Bay) west of Koddiiyar Bay (located in the S.E. quadrant ) though yet connected to it. The body of water west of Nuwara Wewa ( seen in the S.W. quadrant and located in a southwesterly direction as the second dark patch from the centre of this quadrant) has the same controversial grey tone and so has the water body west of Hurulu Wewa ( positioned as a dark patch in the south east quarter of the S.W. quadrant in a southerly direction). It is also observed that the Kaudulla tank ( positioned in a direction north of the Minneriya tank located at the very southern edge - in the south east section of the S.W. quadrant) is of a shade lighter than the Minneriya tank itself or any other water body. Are the tonal variations observed in these water bodies attributable to Soil conditions (Kaudulla and Minneriya tanks are located in Soils generally classified as Reddish Brown Earth ), depth of the water body, salinity, brackishness or due to a complexity of reasons ?

Another noteworthy feature is the absence of the Allai Tank ( a water body located south of Koddiiyar Bay in the S.E. quadrant and between the first water body on the coast line and the Mahaweli Ganga, the water course leading into the Bay). Could it be that this water body which has a capacity of 8,400 acre feet and a surface cover of about 2/3 that of Kantalai tank ( capacity of 42,000 ac. ft. ) has lost its identity due to cloud cover or due to drought in the area ?

The road and railway leading southwards from Kantalai and the road proceeding eastwards from Kantalai ( to Kallar ) across the river and to the area of the development on the eastern coast is easily seen. The stretch of road and railtrack between Mankulam and Vavuniya ( located in the N.W. quadrant almost at the western edge of the frame ) could be identified fairly satisfactorily. The track about 10 miles west of



Kantalai Tank (S.W. quadrant) and proceeding in a south easterly direction to Alut Oya (a whitish geometrical shaped patch by the road) could be observed.

Of the landuse practices it could be said that the grey tone which is a shade lighter than the inland water bodies coincide with forested areas as seen on interpreted aerial photographs. The light-grey to white toned areas cover such land use patterns as Paddy, Homestead garden, Grassland, Land under development, Sugar Cane, and shifting cultivation - this was observed by completing a landuse interpretation on aerial photographs (1972 series) of 1:25,000 scale covering an identifiable light-grey to white toned area (Pankulam) on the Imagery - located in a north-westerly direction from Trincomalee, and making comparisons. An area of tonal and textural differences could be demarcated about 20 miles off shore, in the S.E. quadrant of the Imagery. Is this a rocky coral sub-surface? However, a section of it falls within the area demarcated as 'Submarine Exercise Area' in the Trincomalee Map Sheet (1:250,000 Scale - NC 44-15) published by the Army Map Service, Washington, D.C.

BAND 6 : This Band appears to be very similar to that of Band 7 excepting that the tonal contrast between the Forest and non-forested areas is a shade better.

The Mahaweli Ganga and other water bodies, as observed in Band 7, are visible in this Band too.

The direction of ridges are more clearly seen than on Band 7.  
Band 7:

On a closer study of this Band with a Hand lens it was revealed that other than the numerous water bodies the only river course that appeared in this Imagery was the Mahaweli Ganga (located in the S-E quadrant and flowing into the Koddiyar Bay) which has its origin in the hill country Wet Zone of Sri Lanka. The subsidiary streams of the Mahaweli, all of which have their origin in the Dry Zone area, suffer the same fate of obscurity as of about 20 other water courses. Even the Yan Oya, which has a basin coverage of 594 square miles is not visible. The Yan Oya, originating from the vicinity of Hurulu Wewa flows in a North Easterly direction. Is this an indication of the dryness prevailing, in the area? Observing the rainfall figures of a few stations, it could be reasonably called a dry spell for



this particular area.

	1972			1973		
	Oct.	Nov.	Dec.	Jan.	Feb.	March
Padawiya	11.96	10.24	11.46	3.86	0.92	0.47
Trinco	22.27	17.80	10.26	0.03	0.44	1.18
Allai	6.71	4.65	4.22	0.21	1.03	0.27

Hence the streams and rivers with dry-zone catchment areas are not visible on this image as they must have run-dry at this time of the season. However, the Mahaweli Main Course is flowing because its catchment areas are in the wet zone of the island. Its dry-zone tributaries appear to be dry.

Another feature of interest was that the mid-section of the Mahaweli Ganga appeared to be very faint. This is generarily a low-lying marshy area. It appears that at this low-lying marshy area, the flow is diffused into 2 or more streams and appears to join up northwards.

The absence of the Allai Tank (which is located just south of Koddigar Bay) is another interesting observations. Could this be the effect of a localised severe drought or has the permeability of the soil in this area anything to do with it? Or could it be completely obliterated by cloud and shadow? The latter does not seem to be the real answer, for a tracing prepared on the 1" 8 miles scale showing the Allai Tank with other Tanks superimposed on the Imagery indicated that all of the Allai Tank was not covered by cloud or cloud shadow.

The grey tinted areas, south of Koddigar Bay and East of the northern section of Mahaweli Ganga could be marshy land or water-logged paddy tracts (generally by March the paddy crop in this area has been reaped and the tract is left fallow). Due to the non-availability of concurrent aerial photography it has not been possible to determine the reason for this.

The very light grey toned areas coincide with the forested land which show as grey-toned in Band 5. The white toned patches scattered throughout the imagery appear to be extents of land devoid of any forest cover, developed land or grasslands.

SUMMARY :

From Band 7 could be extracted all water bodies and major water courses. Marshy areas including water-logged areas could be traced out. Directions of ridges are visible. Forest areas could be distinguished.

Band 6 gives almost the same features as Band 7.

Band 5 shows roads and railways. Developed areas, inclusive of grasslands, could be separated from the forested areas.

From Band 4, too, areas of development and grassland could be separated from the forested areas. Roads and Railways are not that clearly discernible.

III. Accomplishments :

The working group gained the much needed experience in processing and interpreting the Landsat data. Only two Landsat frames covering the North-Eastern and South-Western parts of Sri Lanka were studied. The other imagery received were in heavy cloud cover over the land area.

As described in the respective experiments, the Landsat findings were, wherever possible, verified with ground truth obtained from aerial photography or from available maps.

The Preliminary and organisation phases of the investigation have been completed. The analysis phase is continuing.

IV. Significant Results :

It is observed that Landsat data is easily adaptable to photogrammetric techniques. With such adaptations, revision of topographic or thematic maps can be performed at very little cost, compared to the methods adopted by us so far. Revision of Maps up to scale 1:100,000 (or better) can be performed. The Landsat image has definite advantages over the standard methods (inclusive of aerial photography) in areas of extensive development where the synoptic view of the Landsat image offers the required control in the form of distant mapped data in one frame.



#### V. Publications :

An abstract of a talk delivered of the Sri Lanka Astronomical Association is annexed.

#### VI. Problems :

Only two Landsat frames suitable for investigation were received during this period. This was mainly due to heavy cloud cover over Sri Lanka and our original specification of 20% for the cloud cover. This has now been raised to 50%.

The availability of sequential images through a cultivation season of even a single frame would have assisted in a clearer discrimination of rice fields from other land areas which appear similar in the one-time frames available. NASA has agreed to attempt sequential imaging of two selected frames.

The non-availability of equipment more suitable to Landsat image processing and analysis has hindered the investigation. Action is being taken to purchase a few inexpensive sets of selected equipment.

#### VII. Data Quality and Delivery :

The Bulk data analysed were of sufficiently good quality considering the scale and resolution. It is intended to obtain precision processed products, too, for further investigation.

Under the present arrangements, the delivery of data takes 1 to 2 months after acquisition. This is acceptable at this stage of the investigation. However, at the operational stages, faster delivery is desirable. It should be possible to make suitable arrangements for this in due course.

#### VIII. Recommendations :

It is recommended that this investigation be continued with more emphasis on interpretation in order to get accurate estimates of major agricultural crops in Sri Lanka. It is also recommended that wider coverage/<sup>at</sup> frequent intervals be obtained in order to complete the investigation and to obtain complete thematic mapping of Sri Lanka.



IX Conclusions :

It is intended to expand the already established data base to include Landsat photo-maps covering the entire Island. A complete inventory of the Agricultural Resources in Sri Lanka is to be prepared in the form of thematic overlays. Crop prediction is to be attempted. Successful implementation of these proposals on an operational basis will certainly be very useful to this Ministry in Agricultural Planning and Management.

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