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Paper A 13

INTERPRETATION OF ERTS-MSS IMAGES OF A SAVANNA AREA IN EASTERN COLUMBIA

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Introduction

One of the objectives of CIAF's ERTS proposal nr SR 305 was to make an extrapolation of existing soil maps into unmapped areas, of the Llanos Orientales of Colombia. The first image received (nr 1086-14201 - 4, 5, 6 and 7) had no recovery with the area for which ground truth exists. It had recovery with the area requested but only with the part intended for extrapolation. Nevertheless interpretation of the image was started and while the investigation was in progress, we received new images which did cover the sample area requested (nr 1088-14320 - 4, 5, 6 and 7). Interpretation of these new images and confrontation of this interpretation with groundtruth confirmed the validity of most of the delineations made in the preliminary interpretation.

Interpretations were made according to the conventional photointerpretation technique called "Physiographic analysis" developed by Buringh, 1960 and in use at ITC and CIAF. Most usefull were the green and infrared images, the information from which was pooled. Samples of 1/60000 aereal photographs were interpreted from both areas. Extrapolation of information was done via existing soil map to ERTS image and photoimage. The interpretation of the unknown area on ERTS was verified by the interpretation of aerial photo samples. (see methods) and applying the knowledge gained by interpreting AP's of the existing soil map.

Most units delineated in the existing reconnaissance soil map at a scale of 1:250000 could be recognized and delineated in the ERTS image. With repetitive coverage the results would no doubt have been even better.

Methods

The interpretation of the ERTS images was carried out on blow ups at a scale of app. 1:500.000 of the green and infrared channels. (The blue channel was of a much lower quality due to haze, while the red channel did not supply any information not available with better contrast on the infrared, for our purposes).

We tried two methods for pooling the information of both channels. The images were fused by means of the mirrorstereoscope and delineations were made according to patterns visible in the joint image. In the second approach an interpretation was made on the green channel image transferring the transparent overlay to the infrared one, in order to bring infrared derived detail into the map.

It was found that the use of a stereoscope though accurate, was very tiresome mainly due to the difficulty of fusing images which show the same objects in very contrasting tones.

The interpretations were carried out notwithstanding the fact that no real stereoscopy is to be obtained according to the conventional photointerpretation technique called "Physiographic analysis" described by Buringh (1960) and in use at ITC and CIAF. Applying this technique, one tries to establish which processes like alluvial sedimentation, aeolian sedimentation, etc., have formed or are forming the landsurface under consideration. Subsequently an interpretation is made which is based on knowledge concerning the relation between soil formation and the abovementioned processes. Some lines are very obvious, others can only be drawn when there is additional local knowledge.

Of both the area with and without groundtruth a strip of aerial photographs of 1:60.000 scale was interpreted. For the data flow in the extrapolation see scheme.

The derived maps were consequently enlarged to a scale of 1:320.000 with the sole purpose of facilitating comparison with the existing soil map at 1:250.000. It is recognized that enlargement of interpretation beyond the scale of the original base is generally unsatisfactory since errors are magnified.

Description of Units

General

Since the Meta river flows in a fault line there is a strong contrast between the area studied S. of the Meta river and the landscape N. of this river which have not been object of intensive study on ERTS so far. The main object was the high plain (A) a very old alluvial surface with some aeolian influence divided into various units: the well drained level part (Aa), the poorly drained part (As), the undulating part (Ao) the dissected part (Ac) the minor drainageways (Ae) and the major drainageways (Av). Most of these units could be distinguished.

Of the floodplain of the Meta river (V) the main subdivision (Vb) with the high inundation hazard was present, occasionally including remnants of terraces (T) with a very low position (Tv). Relatively cumbersome proved some minor patches of aeolian influence within the flood plain related to extensive aeolian plain N. of the Meta river (E). On this landscape the subdivisions (Em) dunes, (Es) poorly drained aeolian plain and (Er) better drainaged patches within the level aeolian plain, occurred. Of these only (Em) could be identified with certainty especially if the influence transgressed into the high plains.

Unit: Aa

Occurrence: Anywhere in the level high plains S. of the Meta river wherever these plains are neither poorly drained, nor dissected.

Aspect: In the ERTS images both in the 5 and 7 channels a rather uniform grey if not disturbed by human influence or by burn patterns in various stages of regrowth. The unit is identified in this analysis more by its position around its characteristic drainage pattern and by the lack of those characteristics that identify adjacent contrasting units of the same or other landscapes.

On AP's the same aforementioned criteria apply, but in addition a typical pattern known as "rizamiento" occurs which consists of parallel erosion features on the long slopes toward the drainageways and a reticular pattern in the centres of the interfluves.

Soils: Well drained Oxisols (1)* (typic subgroup) in the high parts of the landscape, fine silty in the N. fine loamy and clayey in the S. The slopes are characterised by oxic haplorthents of course loamy textures.

Reliability: Though the drainage pattern of these units is rather characteristic transitions towards the Ao and Ac units, which are more dissected, are rather gradual. Often a slight difference in grey tone on the 7 channel image shows, but this is not uniformly so, especially since old burn patterns spoil this contrast. For the present interpretation the inclusion of a certain amount of Ao and Ac within Aa has to be taken for granted. Limits with the unit As are thought to be highly confiable due to its easy identification in channel 7, while the occurrence of small units of Em along rivers and streams is rather easily detected in the 5 channel, so that only minor contamination with these units is to be expected

Remarks: Repetitive ERTS coverage will facilitate a better separation of Aa from Ao and Ac. Images from the end of the dry season are expected to show maximum vegetation differences due to drainage conditions between the level and dissected areas.

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(1)* Under this heading we give the literal translation of the description of these units taken from pages 66, 67 and 68 of Vol. II of FAO,1966. No attempt has been made to update the classifications made according to Soil Classification 7th App., 1960. It may be mentioned that many authors consider the soils of this area to be Ultisols rather than Oxisols (Guerrero, 1971). This is probably due to the rejuvenation by volcanic ashes (Elbersen, 1972).

Unit: As

Occurrence: In the level high plains S. of the Meta river. In the larger interfluves wherever drainage is insufficient.

Aspect: On ERTS imagery channel 7 these areas are easily identified especially due to the peculiar aspect of the adjacent drainage ways. Since these courses grow into the poorly drained areas by a process of mass movement (as described by Goosen, 1972) the tips are very much enlarged in comparison to the gully downstream. These broad poorly drained tips devoid of arboreal vegetation show in a striking way on the infrared channel. The classification of the drainagesystem drawn on channel 5 into poorly drained tips and normal "esteros" on evidence from channel 7 forms the basis for the delineation of the As areas.

Other factors which aid in their identification are a slightly darker tone of the poorly drained interfluves as a whole and a higher incidence of burn patterns (the latter due to the fact that more dead vegetation is available for burns in these areas)

On AP's the same factors aforementioned occur but in addition the identification is greatly facilitated by the occurrence of solifluction rills locally called "escarceos".

Soils: Association of albaquox in the depressional parts with aeric and typic normaquox and the plinthic subgroup of the well drained oxisols in the higher parts.

Reliability: Taking into consideration the generalization due to the scale of the images, we may state that the mostly inferred limits of these areas are generally reliable. Within the poorly drained areas patches of better drained soils may occur (as indicated on the existing soil map and in the interpretation of the AP's) where according to Goosen (1972) whole blocks have moved in a catastrophic way over distances of hundred of meters due to instant liquifaction of the the subsurface layers, probably triggered by quakes. These inclusions cannot be predicted on the ERTS imagery and remain as impurities in the units.

Remarks: Repetitive coverage could include maximal contrast for the poorly drained zones if taken in extreme situations (dry and wet) Now boundaries are mostly inferred from the characteristics of the drainage pattern, only locally did tone differences help in the establishment of these limits.

Enlarged Gully head on AP

Solifluction rills of As contrast with "riza miento" of Aa on AP.

Unit Ae

Occurrence: As minor drainageways in the high plains S. of the Meta river.

Aspect: On ERTS imagery the 5 channel gives the most complete picture of the drainage pattern since both the gallery forest and the non arboreal vegetation of the poorly drained tips show up in contrasting dark tones. For the separation between poorly drained tips, essential for the delineation of As, and normal forested tips, we have to resort to the 7 channel where this difference shows in a very marked way (see description of Unit As): the gallery forest appears light grey while the poorly drained tips appear in a dark grey tone.

On AP's presence of absence of forest vegetation is the main basis for distinction of the two parts of the drainage system.

Soils: Humic normaquox or clayey or fine silty texture occupy the lowest parts of the esteros surrounded by albaquox especially in the N. part of the area surveyed.

Reliability: Due to the limitations of the scale of the material these areas could not be delineated. The interpretation had to be restricted to the representation of this unit as a symbol (drawn line for the normal esteros and dotted line for the poorly drained tips.) This representation is thought to be highly accurate. Check with AP's showed that only some very minor secondary gullies were missed.

Trident shapped "Estero" on AP, ERTS 5 and ERTS 7 respectively. Note that forested part is distinguishable in ERTS 7 as white line, ERTS 5 does not permit this distinction.

Unit: Ao and Ac

Occurrence: In the level high plains S. of the Meta river where an intricate drainage pattern has dissected the landscape.

Aspect: On ERTS these two units representing two fases of dissection could not be separated while limits of this combined unit with the unit Aa are difficult to trace exactly. Locally the Ao and Ac units show a lighter tone on both 5 and 7 channels which may be due to scarcer vegetation. In other areas however it has been observed that Ao/Ac shows a darker tone on the 7 channel than in adjacent Aa areas; in this case the darker color may be due to the presence of laterite crust fragments on the surface of the dissected areas This matter needs further investigation.
On AP's the units are easily separated in the stereoimage due to their different relief. In addition the absence of the "rizamiento" pattern characteristic of Aa serves as an easy guide for distinction,.

Soils: For Ao there is a dominance of oxic haplorthents on the slopes that grade through sapric tropepts to the typic well drained oxisols of the hillocks. Entic and sapric tropepts occur around the outcrops of indurated plintite gravel.

In Ac sapric tropepts with a hardened plintite gravel layer close to the surface are dominant alternating with oxic haplorthents. Depressions may have aeric plintic normaquepts.

Reliability: Since most limits are inferred from characteristics of the drainagepattern which in turn does change gradually, a lot of inclusions of Aa will occur. Tone differences of these areas with Aa though locally helpfull are not consistent and need further investigation.

Remarks: Here too repetitive coverage may turn out to be usefull since in extreme situations of drought vegetation differences between these areas and Aa will be more marked

Unit Av

Occurrence: As major drainageways in the high plains S. of the Meta river.

Aspect: On ERTS imagery these show up very clearly both in the 5 and 7 channels. The gallery forest shows, just as for the unit Ae, dark on channel 5 and light on channel 7. The watercourses meandering within these small floodplains show well on the 7 channel. The major ones show their complete streambed while the minor ones, the channel of which is partly obscured by vegetation show as a "string of pearls". The latter probably due to the fact that the small units of water are less than the minimum picture element and consequently show up enlarged. Most streambeds could probable be reconstructed completely, within this unit Av, but for cartographic reasons no attempt was made, to show them.

On AP's these units are identified by their level topography and characteristic galery forest.

Soils: Humic normaquox of clayey textures that limit with aquic tropepts and with well drained psammentic oxisols.

Reliability: Comparing AP's we may conclude that this unit is accurately delineated. Since the vegetation is the factor on which the galery forest-boundary has been shifted slightly due to burns.

Unit Vb

Occurrence: In the valleys of the main rivers [illegible]g the streambed.

Aspect: On ERTS imagery this unit shows a [illegible]er light tone on the channel 7 and a rather dark one or [illegible]nel 5. On the latter channel the tone is variable accor[illegible]o the occurrence of forest or shrub. A difference which does not show up in the 7 channel.

On aerial photographs this unit is easily separated in the stereoimage due to its position, flat topography and the ocurrence of numerous small streamchannels. The color tone and texture indicative of shrub and forest respectively serve as an added guide.

Soils: Entisols and entic tropepts on point bars and levees; aeric normaquepts are dominant in the low parts with humic subgroups in the depressions.

Reliability: At certain places in the alluvial plain there exists a certain aeolian influence (Es and Er). These units were not detected on the ERTS imagery so that the unit indicated as Vb on the map may contain units of Es and Er.

In the aforementioned areas with aeolian influence the escarpment separating the unit from adjacent better drained areas is poorly expressed resulting in low contrast on the images and consequently inaccurate boundaries.

Remarks: With repeated ERTS coverage it is quite well possible that the delineation of Vb from Er can be improved especially if coverage includes high flood situations.

Unit Tv

Occurrence: As small units (terrace remnants) within the Meta floodplain mostly adjacent to the escarpment of the high plain.

Aspect: On ERTS imagery of channel 7 these units show up as dark colored patches within the light grey tones of the galery forest of unit Vb. They contain many open waterbodies. In the channel 5 they cannot be distinguished.

The dark color of these units is probably due to the poor internal drainage of its soils which are mostly of a heavy texture.
On AP's these terrace remains are characterized by a lower probably denser shrub vegetation which contrasts with the higher gallery forest of unit Vb.

Soils: The lagoons of this unit are surrounded by typic normaquepts and aeric humaquepts of clayey textures; aeric plinthic normaquepts characterize some levees an borders of escarpments, while the albaquox ocupy those parts of the terrace that suffered aeolian influence.

Reliability Comparison with the existing soil map shows that some units appear strikingly clear in the ERTS image while others can only be inferred with difficulty from the open waterbodies. The aforementioned aeolian influence which is difficult to distinguish from Vb makes errors in delineation of certain units probable.

Remarks: ERTS coverage from a high flood situation would probably make the delineation of these units more accurate.

Unit Em

Occurrence: Small patches of longitudinal dunes, blown out from the major rivers and occurring on the S. river shores either in the floodplain or invading the high plain.

Aspect: On ERTS imagery especially in the 5 channel these dunes show up as light colored elongated patterns with a clear NE-SW orientation. The poorly drained areas between the dunes are easily identified on the 7 channel, where they show up as dark colored streaks. The 5 channel shows the depressions as well due to vegetation differences though with less contrast. On AP's the same features outlined above together with the characteristic relief visible in the stereoimage serve to identify this unit.

Soils: Ultic and typic quarzipsamments on the dunes that grade through aquic haplorthents to humic normaquepts of coarse loamy texture in the depressions.

The transitions towards the solifluction rills have aeric plinthic normaquepts.

Reliability: Though one unit identified in the sample strip of AP's was missed in the ERTS interpretation, we are rather confident that most major units have been identified and properly delineated, since the units generally have a strong contrast with their surroundings and a predictable position.

Unit Er

Occurrence: Within the eolian plain mainly N. of the river Meta in better drainage positions along drainageways and escarpments

Aspect: In the eolian plain N. of the river Meta these units show up as light colored strips along drainageways on the 7 channel ERTS image. In the small patches S. of the Meta river this unit could not be identified in the Es patches which as a whole are difficult to recognize within the floodplain.

On AP's they are identified by their position within the aeolian plain and by their lack of solifluction rills.

Soils: Typic tropepts of fine silty texture that change towards the drainage ways into the typic subgroups of the well drained oxisols of fine loamy texture. Towards the aeolian plain aeric plinthic normaquepts appear.

Reliability: For the area S. of the Meta very low. The area N. of the Meta where these units have a major extension looks more promising as far as the identification and delimitation of these units is concerned.

Unit: Es

Occurrence: As level poorly drained plains mainly N. of the Meta river.

Aspect: On ERTS imagery N. of the Meta river these areas are distinguished by a dark mottled tone in the 7 channel to a lesser extent this mottling can be observed in the 5 channel too. The small patches that occur S. from the Meta river mainly within the floodplain are not easy to identify and very difficult to separate from unit Tv. After consulting the existing soil map, identification is possible but delineation of minor patches without this aid seems troublesome. In the AP's these units are easily recognized due to the occurrence of "escarceos" (solifluction rills). Confusion between Es and As does not occur since both units have very different positions.

Soils: Dominance of albaquox with fine loamy and clayey textures in the level parts; transitions towards dunes include oxic haplorthents. In areas with a slight slope towards drainage ways aeric and aeric plinthic normaquepts are found. Very seldomly found are the plinthic subgroups of the well drained oxisols.

Reliability: The small patches occurring S. of the Meta river cannot easily be identified and consequently occur as inclusions in unit Vb. Confusion with Tv is also possible.

Remark: ERTS coverage for high flood situations could help in solving the identification problems.

Conclusion

Resuming we may state that most of the important units of an existing 1:250,000 reconnaissance soil map could be extrapolated successfully into an unknown similar area using ERTS imagery in conjunction with sample strips of aerial photography. In those cases where delineations were insatisfactory it is to be expected that repeated ERTS coverage could improve the results. The resulting map shows sufficient detail to justify a publication scale of 1:500.000. It can be classified as a soil map which is in between exploratory and schematic. With repeated ERTS coverage and some field work it may be improved to a soil map which classifies in between exploratory and reconnaissance. Since these maps are usefull in the first stages of planning in remote undeveloped areas it is stressed that the application of conventional photointerpretation techniques (physiographic analysis) on ERTS imagery can yield significant practical results especially in the developing countries.

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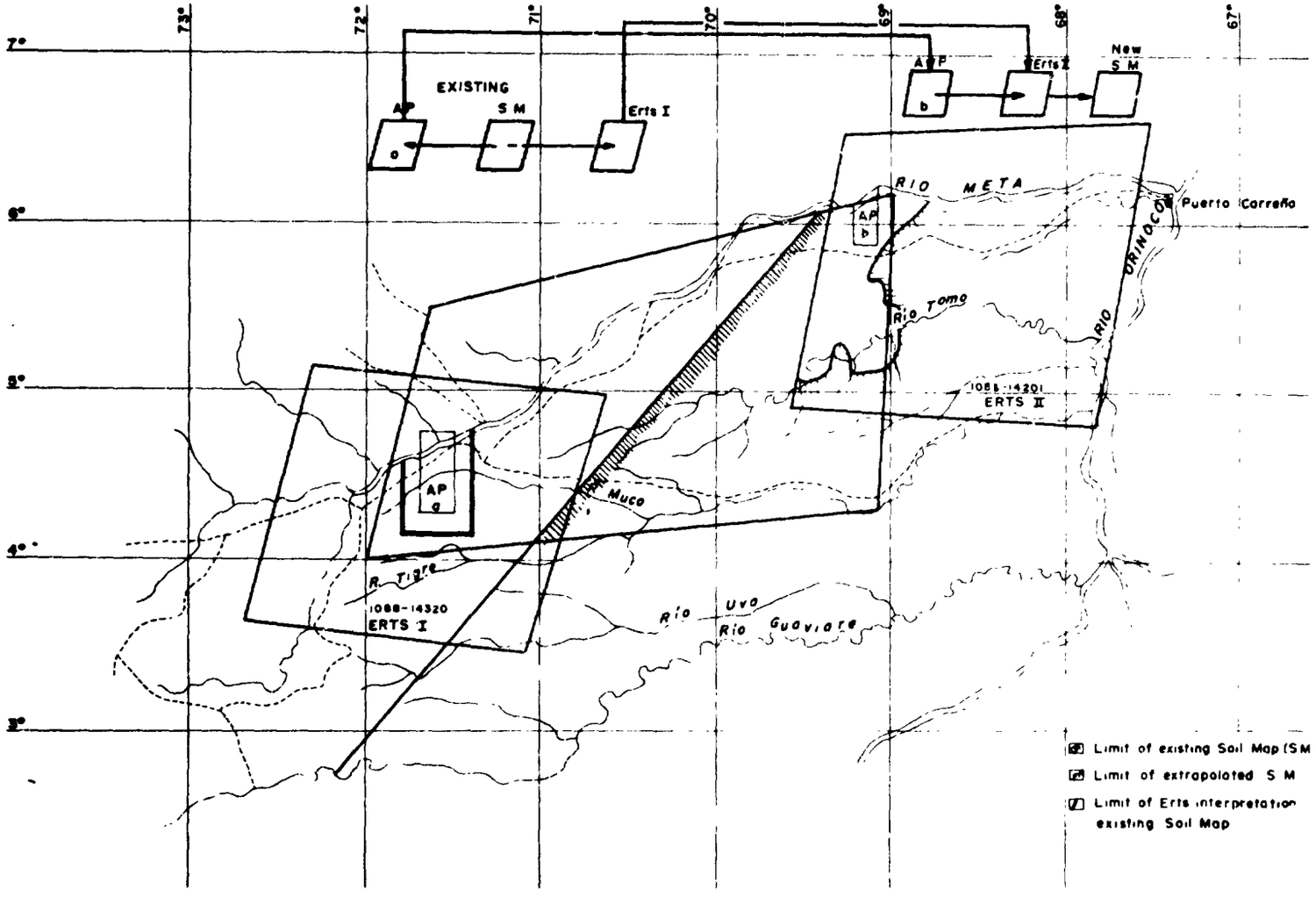
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a
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b
Rio Tomo
RIO
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AP
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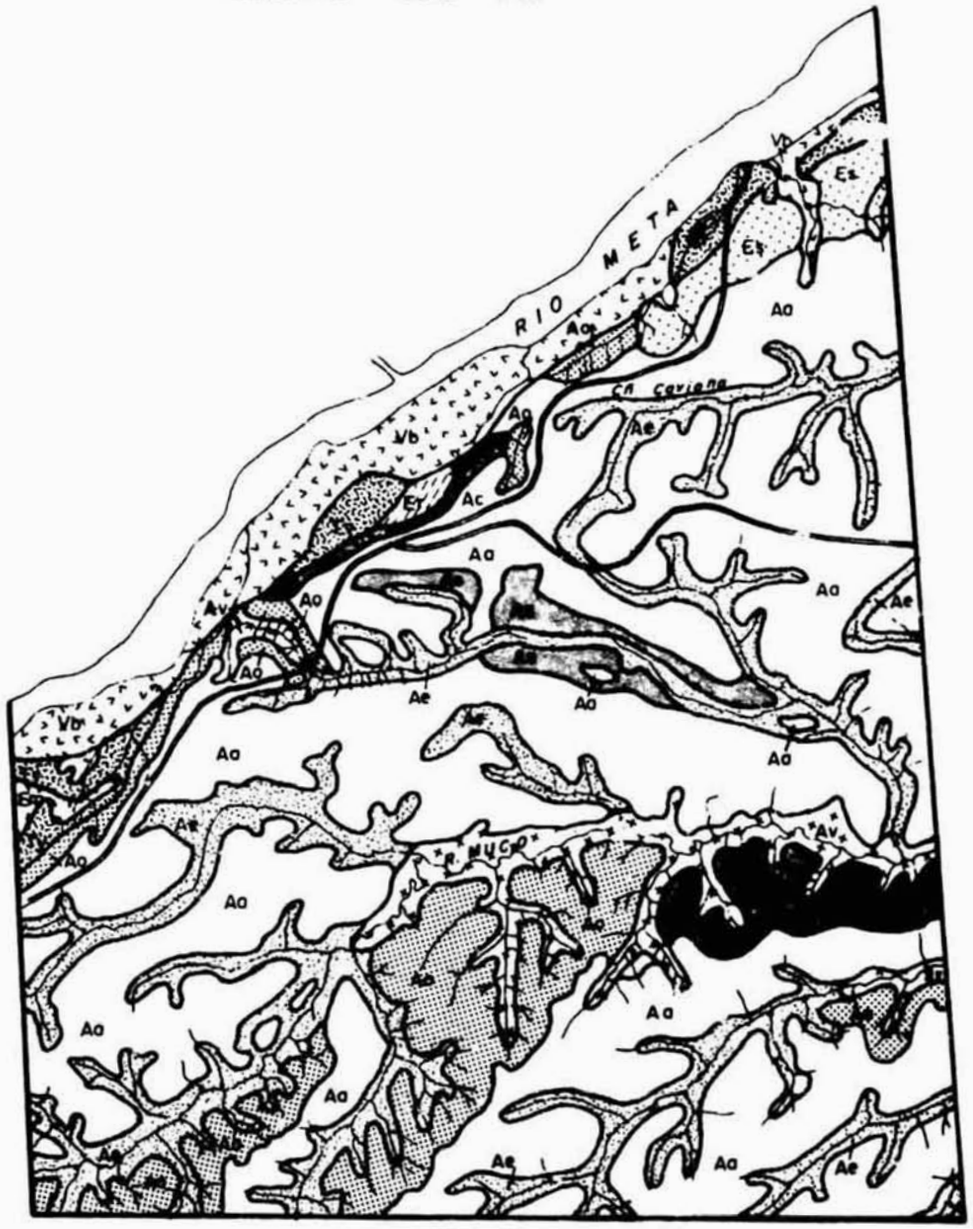
ERTS I
Rio Uva
Rio Guaviare
7°
6°
5°
4°
3°
73°
72°
71°
70°
69°
68°
67°
Limit of existing Soil Map (SM
Limit of extrapolated S M
Limit of Erts interpretation
existing Soil Map

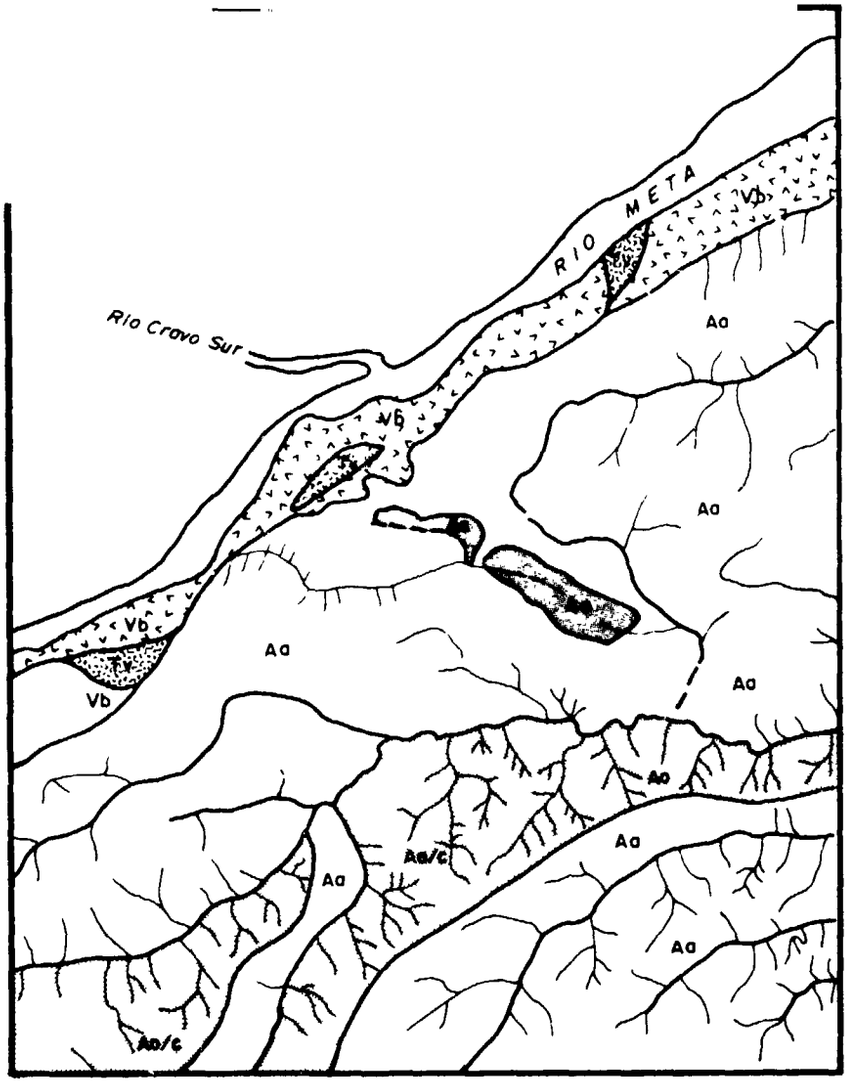
LEYENDA	LEGEND
Terrazas Aluviales	**Alluvial Terraces**
Tv Terrazas Bajas	Low Terraces
Llanura Eolica	**Aeolian Plain**
Em Medanos	Dunes
Es Llanura Eolica con "Escarceos" pobremente drenada	Aeolian Plain with "Escarceos" poorly drained
Er Rebordes de Caños y Barrancos bien a imperfectamente drenados	Borders of Streams and Escarpments well to imperfectly drained
Aluviones Recientes	**Recent Alluvium**
Vb Vegas bien a pobremente drenados con alto peligro de inundación	Floodplain well to poorly drained with a high inundation hazard
Altillanuras	**High Plains**
Aa Altillanura Plana bien y moderadamente bien drenada	Level High Plain well and moderately well drained
As Altillanura Plana moderadamente bien a pobremente drenada	Level High Plain moderately well to poorly drained
Ao Altillanura Ondulada	Undulating High Plain
Ac Altillanura Fuertemente Disectada	Strongly Dissected High Plain
Av Valles Coluvio Aluviales	Colluvial-Alluvial Valleys
Ae "Esteros" muy pobremente a imperfectamente drenados	"Esteros" very poorly to imperfectly drained
Rio o Caño	River or Stream
Límite de unidad	Unit boundary
Bancos	Banks
N Nubes y sombras de nubes	Clouds and cloud shadows

EXISTING SOIL MAP



ESCALA 1:250.000

ERTS INTERPRETACION EXISTING SOIL MAP



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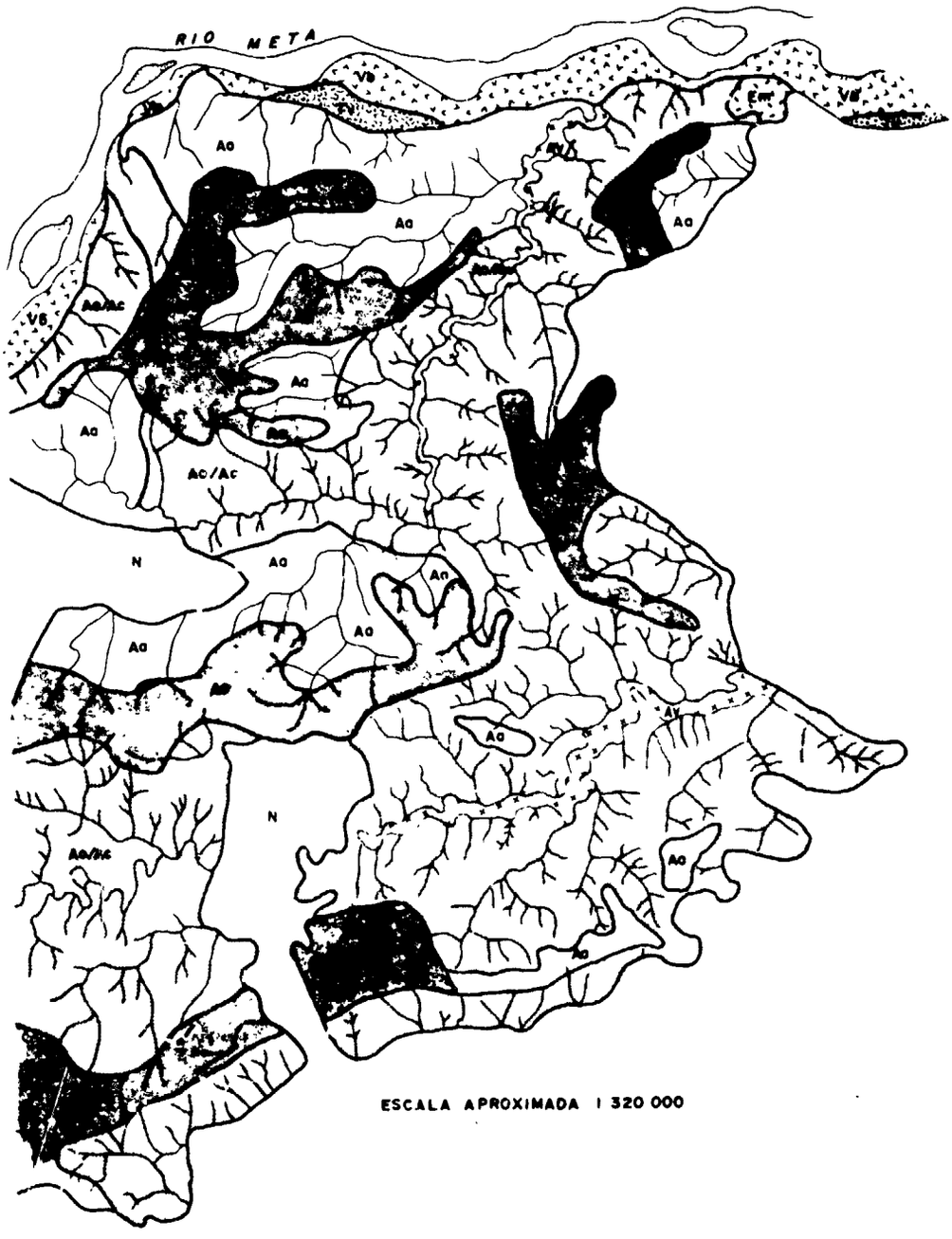
EXTRAPOLATED SOIL MAP



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