MANAGEMENT OF NATURAL RESOURCES THROUGH AUTOMATIC CARTOGRAPHIC INVENTORY

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C.I. Yves GOURINARD
Francis CAMBOU

TYPE I PROGRESS REPORT
for Period Avril - December 1973
(n° 3)

January 1974
The following significant results were obtained:

- Accurate recognition of previously known ground features from ERTS imagery has been confirmed and a probable detection range for the major signatures can be given.

- Unidentified elements, however, must be decoded by means of the equal densitometric value zone method.

- Determining these zonings involves an analogical treatment of images using the color equidensity methods (pseudo-color), color composite and especially TEMPORAL COLOR COMPOSITE (repetitive superposition).

- After this analogical preparation, the digital equidensities can be processed by computer in the 4 MSS bands, according to a series of transfer operations from imagery and automatic cartography.
MAJOR PROBLEMS

The latest imagery from the ARNICA program for the period March - July, 1973 was not received until November, 1973.

The quality of the imagery varies considerably from region to region, due to frequent cloud cover, and repetitive information is available only for limited sections.

For the central part of the test-site (the Garonne Valley) which has a rather extensive experimental ground based network, there was no usable imagery throughout the entire program.

Research has therefore been directed towards the study of regions in which good repetitive information was obtained rather than on the sections and on the themes originally planned in which the ground truth information could not be treated because the corresponding simultaneous imagery was not provided.
Plot of data received on June - August 1973
Plot of data received on August - November 1973
LIST OF DATA RECEIVED
on June - August 1973

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ACCOMPLISHMENTS
DURING THE REPORTING PERIOD

A. Qualitative Studies

Research was carried out in two complementary directions:

- inventory of elementary signatures
  - biological (vegetation, agriculture, urbanization)
  - geographical (geology, hydrography, soils)
  - linked with event (meteorology, nivology, hydrology)

- geographical organization of signatures and determination of zones of equal densitometric value necessary for eventual computer processing.

This work has been written up in two publications. Cf. Type II Progress Report n° 2, Study by B. DONVILLE (Part II, Chapter 1, pp. 11-24) and Study by P. GOUAUX and D. LOUBET (Part II, Chapter 2, pp. 25-39).

B. Quantitative Studies

Since an example of complete integrated cartography has already been done (cf. automatic cartography of Fir forests in the Aran Valley, in the Type II Progress Report n° 1), this study concentrates on defining the exact methodological conditions of the various operations required in the chain of operations from ERTS imagery to the automatic mapping of natural resources.

Three stages have been completed:

- printout of the imagery after densitometric processing
definition of rules for precise referencing of the selection of samples on the imagery

definition of techniques for selecting representative samples based on successive levels of digital equidensity approaching ground truth with increasing accuracy.

A review of these methods can be found in the Type II Progress Report n° 2: a study by T. LE TOAN, M. MONCHANT (Part II, Chapter 3, pp. 40-54); T. LE TOAN, J.C. GUYADER, P. GOU-AUX (Part II, Chapter 4, pp. 55-70); T. LE TOAN, J.C. GUYADER, M. MONCHANT (Part II Chapter 5, pp. 71-82).

C. Ground Experiments

Reflectance measurement experiments on healthy and chlorotic deciduous samples as well as the study of experimental apparatus on articulated porticoes were carried out, but as there is not enough corresponding satellite imagery, this part of the ARNICA program has been basically organized for use in future ERTS B programs.
ACCOMPLISHMENTS PLANNED FOR NEXT PERIOD

The final phase of the ARNICA program will consist of developing the last experiments in order to make up the complete chain of operations leading from ERTS documents to their automatic cartographical processing.

In this perspective, and taking into account only the documents actually available, the final program includes 3 successive complementary aspects:

1 - Establishing a detection range for the principal elementary signatures and organizing "equal value zoning".

2 - Establishing analogical correspondence codes, using chromatic coding methods on a systematic basis
   . color equidensities (pseudo-color)
   . color-composite (very promising and economical results in the form of TEMPORAL COLOR COMPOSITES).

3 - Final development of the stages in the chain of operations for digital computer processing, using the analogical processing described above as a guide.
DISCUSSION
OF SIGNIFICANT RESULTS

1. AGRICULTURE / FORESTRY

A. Crop survey:
(Data 1241-10033)

In the alluvial zone of the Rhone, rice cultures under water can be distinguished from vine cultivation.
(Data 1243-10143
1352-10192)

The comparison of two successive states of agriculture in the Garonne Valley help distinguish major cultures by means of the temporal color composite, by associating the following three components into one document:

1243-10143 MSS 7
1352-10192 MSS 5
1352-10192 MSS 7

B. Timber survey:
(Data 1352-10183
1352-10192
1353-10244)

Deciduous and conifer can be distinguished clearly from other land use types when MSS 5 and MSS 7 are combined.

F. Water utilization:
(Data 1352-10201)

A very fine illustration of the irrigated zones of Aragon and Catalonia.
DISCUSSION
OF SIGNIFICANT RESULTS

2. LAND USE SURVEY and MAPPING

A. Land use classification
(Data 1228-10305 1352-10183
1241-10030 1352-10192
1242-10085 1352-10201
1242-10141 1353-10244
1243-10143 1443-10235)

All of the documents analyzed demonstrate that the land use elements are grouped together in homogeneous units, translated by a characteristic densitometric zoning of the elementary combinations defining each regional landscape.

Thus the treatment of data from unknown ground must be based on the analysis of these zones. An example of zoning is given in the Type II Progress Report n°2, Part II, Chapter 2: Study by P. GOUAUX and D. LOUBET, pp. 25 - 39.

B. Thematic mapping
(Data 1241-10030 1243-10143
1241-10035 1295-10025
1242-10085 1352-10183
1242-10141 1352-10193)

Especially clear results of thematic mapping of major land use types could be easily obtained from such documents.

E. Population density
(Data 1128-10305 1352-10183
1242-10141 1352-10193)

It has already been shown that the inventory of urban zones was directly obtainable from ERTS data. The references provided here show that this urban zoning can be interpreted in detail as follows: old city, recent urbanization, suburb, etc...
DISCUSSION
OF SIGNIFICANT RESULTS

3. GEOLOGICAL STRUCTURE and
LANDFORM SURVEY

I. Geomorphic and Landform surveys
(Data 1241-10030
1242-10085
1243-10143)

These three images provide the expression of zones of equal geomorphological value, corresponding to characteristic landscape types having significant elementary land use combinations.

J. Lithologic surveys
(Data 1241-10030
1241-10033
1243-10143)

These same landscapes faithfully show up the distribution of various lithologic components of the lands: calcareous, molasse, siliceous, granitic.

K. Structural surveys
(Data 1228-10305
1241-10035
1352-10195
1443-10235)

ERTS documents have proven extremely useful in the interpretation of structures, especially in arid zones. One of the images (1241-10035) served as a basis for the study published in the Type II Progress Report n°2, Part II, Chapter 1: Study by B. DONVILLE, pp. 11-24).
DISCUSSION
OF SIGNIFICANT RESULTS

4. WATER RESOURCES

C. Estuary and wetlands
( Data 1228-10305
    1352-10192
    1353-10244 )

These three images of the French Atlantic
coast (Estuaries of the Loire and the Gironde)
illustrate the wealth of information available
(cf. FRALIT program).

D. Limnology
( Data 1241-10033
    1352-10192
    1353-10251 )

Vegetation zonings are always very apparent
in the littoral pools of the Atlantic and the Me-
diterranean.

G. Snow survey
( Data 1241-10030 1241-10035
    1295-10025 1242-10085 )

The good repetitive cover conditions made it
possible to form a very significant temporal
color composite by superimposing successive
MSS 7 imagery:

January, 1973 : 1187-10023 CYAN
March, 1973 : 1241-10030 MAGENTA
May, 1973 : 1295-10025 YELLOW

which leads to the decoding of 8 situations of
temporal variation in snow conditions and proof
that the ERTS imagery taken at different times
can be easily superimposed.
DISCUSSION
OF SIGNIFICANT RESULTS

5. MARINE RESOURCES

A. Locating biologically rich areas
(Data 1352-10192
1353-10244
1353-10251)
Very valuable complementary information on
the sedimentation conditions of the estuaries
(Loire and Gironde) and of the Arcachon Ba-
sin at high and low tide.

F. Estuary dynamics
(Data 1228-10305)
New state of coastal dynamics of the estuary
of the Loire (cf. F. VERGER's reports).

6. METEOROLOGY

B. Air surface
(Data 1295-10031)
A very noteworthy illustration of the cyclonic
conditions of the "MARINE WIND" and the
geographical limits of its influence.
(This document is exceptionally valuable).
LIST OF PAPERS


In ARNICA, Type II Progress Report no 2, pp. 11 - 24.

In ARNICA, Type II Progress Report no 2, pp. 25 - 39.

Display problems.
In ARNICA, Type II Progress Report no 2, pp. 40 - 54.

In ARNICA, Type II Progress Report no 2, pp. 55 - 70.

In ARNICA, Type II Progress Report no 2, pp. 71 - 82.

CONCLUSIONS

The following definitive perspectives, which will appear in the TYPE III FINAL REPORT, can now be formulated using the processing of the latest imagery concerning the ARNICA program.

1. Previously known land features can be recognized very accurately on the ERTS imagery (often even for objects smaller than 1 hectare, whenever contrast can replace resolution). Degrees of detection of the major signatures can be established.

2. The reverse procedure interpretation of imagery in order to determine elements not identified on the ground, requires a preliminary treatment of the information in zones equal in interpretation of densitometric value.

3. Such zoning involves an analogical use of the using chromatic methods (pseudo-color, color composite), especially the TEMPORAL COLOR COMPOSITE, which is particularly effective in assuring the best data compression formula because it gives the minimum number of repetitive combinations likely to guarantee the required determinations.

4. The computer processing of the imagery must be carried out using this analogical exploration by means of the treatment of digital equidensities most likely to assure the automatic charting of natural resource from the ERTS imagery furnished under conditions of minimal repetitiveness.
ERTS - IMAGE DESCRIPTOR

Cf. ATTACHMENT C

(18 sheets)
ERTS IMAGE DESCRIPTOR FORM

| USER NAME | KEY - Paul - Augustin |
| USER ID | FO 433 |
| AGENCY | CNRS Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE |

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**DATE** 12.20.73  
**USER ID** FO 433  
**AGENCY** CNRS Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE

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Code 563  
Building 23, Room E203  
NASA GSFC
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NASA GSFC
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**USER ID** FG 433  
**AGENCY** CNRS Service Carte Vegetation BP 4009 31 Toulouse France

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**MAIL TO** ERTS USER SERVICES  
Casa 563  
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**ERTS IMAGE DESCRIPTOR FORM**

**USER NAME**  REY Paul - Augustin  
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*For descriptors which will occur frequently, write the descriptor terms in these column heading spaces now and use a check (✓) mark in the appropriate ID lines. (For other descriptors, write the term under the DESCRIPTORS column).*

**MAIL TO**  ERTS USER SERVICES  
Cfa 563  
Bldg 23 Room E203  
NASA GSFC
**ERTS IMAGE DESCRIPTOR FORM**

**USER NAME**  REY Paul - Augustin  **DATE**  12.20.73

**USER ID**  FD 433

**AGENCY**  CNES Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE

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**DESCRIPTORS**

- Delta
- METER
- Sea
- Snow

**Frequently Used Descriptors**

- Alluvial Plain
- Basin and Range
- Coast Line
- Fault
- Fold
- Geology
- Harbor
- Agriculture
- Alluvial Plain
- Basin and Range
- City
- Coast Line
- Conifer
- Cropland
- Deciduous
- Fault
- Fold
- Forest
- Harbor
- Hardwood Forest
- Industrial Area
- Irrigation
- Vegetation

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**MAIL TO**

ERTS User Services

Code 563

Bldg. 23 Room E203

NASA GSFC
ERTS IMAGE DESCRIPTOR FORM

**USER NAME**  Rey Paul - Augustin

**USER ID**  FO 433

**AGENCY**  CNRS Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE

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MAIL TO  ERTS USER SERVICE
Codex 563
Block 23 Room E203
NASA GSFC
# ERTS IMAGE DESCRIPTOR FORM

**USER NAME**  REY Paul - Augustin  
**DATE**  12.20.73  
**USER ID**  FO-433  
**AGENCY**  CNRS Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE

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*For other descriptors, write the term under DESCRIPTORS column.*

MAIL TO  ERTS User Service  
Cod. 563  
Bldg. 23 Room E203  
NASA GSFC
**ERTS IMAGE DESCRIPTOR FORM**

**USER NAME** Paul - Austin  
**USER ID** F0 433  
**DATE** 12.20.73  
**AGENCY** CNRS Service Carte Vegetation BP 4008 31 TOULOUSE FRANCE

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MAIL TO

ERTS User Services  
Code 563  
Building 23 Room E203  
NASA GSFC
**ERTS IMAGE DESCRIPTOR FORM**

**USER ID** 433

**USER NAME** Ben Paul-Austin

**DATE** 12-20-73

**AGENCY** CNES Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE

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MAIL TO

**ERTS USER SERVICE**

Coll. 563

Block 23 Room E203

NASA GSFC
## ERTS IMAGE DESCRIPTOR FORM

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MAIL TO  
ERTS User Service  
Can. 563  
Bldg. 23 Room E203  
NASA GSFC
**ERTS IMAGE DESCRIPTOR FORM**

**USER NAME**  REY  Paul - Augustin  
**DATE**  12.20.73

**USER ID**  FO.433

**AGENCY**  CNRS Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE

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|            |               |             |      |          | CONIFER |
|            |               |             |      |          | DUNE |
|            |               |             |      |          | HARDWOOD FOREST |
|            |               |             |      |          | SEA |
|            |               |             |      |          | SUBURBAN AREA |
| 1352 10192 5 | ✔             | ✔           | ✔    | ✔        | AGRICULTURE |
|            |               |             |      |          | BAY |
|            |               |             |      |          | COASTAL DUNE |
|            |               |             |      |          | CONIFER |
|            |               |             |      |          | CONSEQUENT LAKE |
|            |               |             |      |          | CROPLAND |
|            |               |             |      |          | DUNE |
|            |               |             |      |          | FOREST |
|            |               |             |      |          | GRASS LAND |
|            |               |             |      |          | HARDWOOD FOREST |
|            |               |             |      |          | ISLAND |
|            |               |             |      |          | MARSH |
|            |               |             |      |          | METEOROLOGY |
|            |               |             |      |          | SEA |
|            |               |             |      |          | STREAM |
|            |               |             |      |          | SUBURBAN AREA |
|            |               |             |      |          | VINEYARD |
| 1352 10192 6.7 | ✔             | ✔           | ✔    | ✔        | AGRICULTURE |
|            |               |             |      |          | BAY |
|            |               |             |      |          | CONSEQUENT LAKE |
|            |               |             |      |          | DUNE |
|            |               |             |      |          | ESTUARY |
|            |               |             |      |          | FOREST |
|            |               |             |      |          | HYDROLOGY |

*For descriptors which will occur frequently, write the descriptor term in these columns heading spaces new and use a check (✔) mark in the appropriate ID lines. (For other descriptors, write the term under the descriptors column).*

MAIL TO  ERTS USER SERVICES  
10500 GLENN  
BUILDING 23  ROOM E203  
NASA GSFC
ERTS IMAGE DESCRIPTOR FORM

USER NAME  REY Paul - Augustin          DATE  12.20.73
USER ID  FO 433
AGENCY  ONRS Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE

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MAIL TO  ERTS User Service
          Code 563
          Bldg. 23 Room E203
          NASA GSFC
**ERTS Image Descriptor Form**

**User Name**: REY Paul - Augustin  
**User ID**: FO 433  
**Agency**: CNRS Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE

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Cod 563  
Bldg 23 Room E203  
NASA GSFC
**ERTS IMAGE DESCRIPTOR FORM**

**USER NAME**  REY  Paul - Augustin  
**USER ID**  FD 433  
**AGENCY**  CNRS Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE

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MAIL TO
ERTS USER SERVICE
CBox 563
Bldg 23 Room E203
NASA GSFC
ERTS IMAGE DESCRIPTOR FORM

USER NAME  REY  Paul - Augustin
USER ID  F0 433
AGENCY  CNRS Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE

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<td>BASIN AND RANGE  COAST LINE  CUESTA  FAULT  FOG  FOREST  GEOGRAPHY  GEOLOGY  HARDWOOD FOREST  MEANDER  VEGETATION</td>
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* For descriptions which will occur frequently, write the description term in these column heading spaces now and use a check (✓) mark in the appropriate ID lines. (For other descriptions, write the term underneath the DESCRIPTORS column.)

MAIL TO  ERTS USER SERVICES
Code 563
Bldg. 23 Room E203
NASA GSFC
ERTS IMAGE DESCRIPTOR FORM

USER NAME       REY, Paul - Austin                     DATE       12.20.73
USER ID          F0.433
AGENCY         CNRS Service Carte Vegetation BP 4009 31 TOULOUSE FRANCE

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MAIL TO       ERTS USER SERVICE
               CORL 563
               BLDG. 23 ROOM E203
               NASA GSFC