Contribution of Remote Sensing in the Less Favoured Areas of Europe - The Case of Brittany

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ABSTRACT

In contemporary context, there is renewed interest of environment. Not only studies in detail but rather analysis made in larger geographic units in a systemic point of view, in which remote sensing is one of the methods suggested by researchers for the analysis and quantification of changes that match regional mutations. In fact synthetic studies of environment are still rare, i.e. some research axes about landscapes in the seventies with LANDSAT MSS or more recently NOAA AVHRR data, or some methodological or more general articles about the GIS usefulness.

In Brittany, a region very polluted by agriculture, a PARE (The Armoricain -I.E. breton- Research and Environment Pole) has been created in 1991, regrouping different organisms. The chosen scale is that of the catchment area. COSTEL is one of the integrated teams in that project, and is in charge of the spatial aspect through the satellite data. The use of NOAA images on the one hand to define units of landscapes and their variations with climatic changes, and on the other hand for the catchment areas selection; The LANDSAT TM and SPOT data analysis for thematic studies on the land use and the water transfert problems in the catchment areas.

Most research on the less favoured areas has been carried out since 1985 from the CEC Joint Research Centre of ISPRA. About thirty remote sensing laboratories are participating in this international programme (S. FOLVING and J. MEGIER, 1990). The first results point to the interest for second generation satellites and geographical information systems to manage these regions generally characterized by a perceptible relief, irregular field sizes, an important rural depopulation, and an increasing development of fallows. At the present time considerable changes are occurring as part of the Common Agricultural Policy and thus research is not only focused on these marginal areas, but also on all peripheral regions concerned with environmental problems. In a similar way to this spatial extension, the use of remote sensing has changed with technological advances. Regional inven-


tories and analyses carried out using LANDSAT MSS data (J. COUDOUX, 1982) have been followed by more precise thematic studies applied on not always very well defined geographical areas. For example, the evolution of the spectral signature for a given crop is generally analysed by model data, with no reference to its spatial context. Some of these themes are studied in the marginal landscapes of Western Europe (i.e. the research of C.M. GIRARD et al in 1988 on grasslands), but more often the research is carried out at a very local level and not on a regional scale.

It is certainly not an easy operation to locate the fallows, to assess their impact, to follow their progression in areas with small land parcels, partly because of the relative weakness of the sensors’ spatial resolution. However, it is sometimes possible to assess the natural process of vegetation recolonisation with multidimensional studies when both satellite data and aerial photographs are used (B. VOGT 1991, L. LE DU 1989).

Presently global studies of the environment are more often carried out either at the catchment area scale - for example to consider sensitive diffuse pollution areas (J.Y. BOUCHARDY 1992, M. PAEGELOW 1991) - or at the regional level (G. MARRACCI and al 1986, J. MEGIER and al 1988, J. WILMET 1985). They are more developed since the introduction of GIS and since the use of NOAA data to assess biomass and examine climatic conditions. IGIS (Integrated Geographical Information Systems) mix in a synthetic and prospective manner remote sensing data and exogenous documents. It is now possible to consider economic development and planning at a regional level to control landscape degradation. However the multiplication of information sources is a delicate problem.

Rapid technological advances allow different structures of data to relay - for instance raster in vector transformation and vice versa - but the methodological reflection progresses slowly. First of all, it is necessary to study thoroughly the spatial and temporal scales relations of geographical phenomena perceived through cartographic
or remotely sensed data. Only a better knowledge of both environmental evolution processes and surface models will allow us to understand the spatial relationship between the data themselves and their extrapolation via a model. This problem concerns scientists from disciplines as diverse as biology, agronomy and hydrology.

Geographers have a preponderant role to play, since they are familiar with these questions of spatial organisation.

1. BRITTANY, A PERIPHERAL REGION WITH A FRAGILE ENVIRONMENT

The scientific community and the politicians are greatly preoccupied with the increasing urbanization of the littoral fringe, the extension of fallows and landscape reconversion. Conflicts proceed from these situations. Above all, the continuous development of agriculture over the last thirty years has made Brittany one of the foremost agricultural regions of France and indeed of Europe. Now the image of this region has changed from the “green lung” of Europe to that of being one of the most polluted agricultural regions, especially for its soils and waters.

This important and complex problem can only be considered in a multi-disciplinary research context. Hence the creation in 1991 of the Armorican Pole of Research on Environment (PARE Pôle Armoricain de Recherche sur l’Environnement), in charge of federating all research on the following subjects:

- Agriculture and environment
- Coast under agricultural influence
- The polar domain

2. STRUCTURE OF THE SCIENTIFIC COMMITTEE OF THE PARE

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The creation of an “environment centre” is one of the immediate objectives of the PARE to use in common its analytical material: Softwares for data and image processing and modelling on the one hand, analytical equipment for mineral and organic chemistry on the other hand. Therefore remote sensing has a privileged place in the PARE.

3. AGRICULTURE AND ENVIRONMENT IN THE PARE

Characterization and operation of wet ecosystems under agricultural influence is one of the research proposals of the PARE put forward under the Environment programme of the CNRS. It is foreseen at regional level in continuation to actions that have been taking place for ten years, especially through the GSI (Group of Scientific Interest) for Environment. Three hundred thousand kilometers of hedges have been destroyed in Brittany since the Fifties, i.e. ten linear km. per km², and at the same time farmers have completely modified their farming methods. To understand these changes, it is necessary to acquire adapted fundamental knowledge, especially concerning water cycles. This will allow planning for a durable development of natural resources. Thus researchers have decided to study thoroughly the evolution of humid areas, unstable fragile areas which reveal the impact of agriculture on the environment. These areas where transfers are essentially lateral and with rapid dynamics are the interfaces (see next table).

| INTERFACES |
|-----------------|-----------------|------------------|
| Slope           | Lower part areas | River            |
| Slope           | Alluvial valley  | River            |
| Continental zone| Littoral marsh   | Coastal environment |

This ambitious programme is strongly impregnated with ecology, which planification of studies is represented by methodological, geographical and thematic choices:

- Analytic tools used in common, i.e. technical means and data banks.
- Two continental and two coastal sites have been selected:
  - The catchment area of “Naizin”, an intensive agricultural zone.
  - The lower course of the Vienne River.
  - The bay of Mont-Saint-Michel, a very diverse agricultural area.
  - The West marshes, in the southern part of Nantes.
- Development of four research trends relating to these sites:
  - Spatial and temporal dimensions of systems.
  - Agricultural flows and their impacts.
  - Diffusion process and biologic diversity in rural and coastal landscapes.
  - Integration of social and economic impact of environmental constraints.

4. REMOTE SENSING IN ENVIRONMENTAL STUDIES IN BRITTANY

Studies of the environment by remote sensing have been developed since the Eighties in Brittany at different levels: from the regional scale with NOAA or LANDSAT MSS data used as stratification tools to define landscape units, to the field size with LANDSAT TM or SPOT for more precise thematic studies such as fallow or moor detection, peri-urban areas development, or land use evolution...

Among the four sites chosen by the PARE, two of them are rather well known by COSTEL researchers (COSTEL: Climat et Occupation du Sol par Télédétection).

1) The bay of Mont-Saint-Michel: a consistent study area over several years.

It consists of a unique and very varied environment with a wide littoral fringe and a large spreading of the eastern part of its schorre. It can be defined as a mosaic of small littoral landscape units where high technology agricultural methods are practised alongside traditional methods:

- The Saint Malo-Range in the west, where vegetable crops are dominant.
- The double-oriented Dol Marsh: the White Marsh to the north with cereal economy in very tiny fields, and the Black Marsh to the south with meadows and maize in larger fields.
- The polders of the Bay of Mont-Saint-Michel: They are characterized by a more varied agriculture, turned towards breeding in the west, and more complex in the east with a mixture of carrots, onions, spinach, celery, maize, cereals, even meadows; all of them are included within large farms, often greater than 100 ha, which are scattered in a geometric, large mid-bocage landscape, divided into compartments by many sea walls.
- The Pontorson Marsh which is rather similar to the Black Marsh.
- The granitic range of Saint Broladre, 80-90 meters high, with an ovoid form, occupied by a traditional bocage with a mixture of both woods and various qualities of meadows.
- The eastern part of the Couesnon with in the south mostly cereals and vegetable crops in the north.

The main part of the Bay is sensitive to any sea level variation, and to pollution. Its evolution, in particular as related to transfers of agricultural origin, is studied by means of research programmes financed by the CEC. Two themes have been chosen: agriculture and farming methods on catchment areas, and coastal dynamics with the progression of the schorre and human interventions such as drainage, embankments, or shell-fish farming leading to sedimentation processes. Remote sensing studies are relevant to these two themes with aerial photographs dating from 1948 and satellite data. Geographers in the team have been mostly interested in mapping the landscapes and in the evolution of agriculture over the last forty years. A thesis study was made using LANDSAT TM and SPOT data on the Dol Marshes and the polders (L. HUBERT, 1989). A synthetic mapping document on the eastern part of Brittany and its borders with Normandy (8 748 km2) is now being compiled from LANDSAT TM images and various sources. The segmented and geometrically corrected colour composition is set out with one transect and twelve maps, explanatory sketches (i.e. topography, geology, climatology, water balances, land use, urban areas, industries, tourism...). This document both describes and explains the region, and it should become a reference document. Botanists and morphologists are particularly interested in defining more precisely the coastline for better protection and management. It is represented as a map of the pasture lands of the Mont-Saint-Michel obtained from remote sensing data. The results are very encouraging partly because of the important development of the vegetal cover, despite some omissions and lack of precision relevant to pioneer and mixed formations.

The study of the environment emphasises especially the notion of landscape perceived as a social product and as a heritage of human intervention on a more or less dynamic natural environment. The coastal landscape is thus analysed through the littoral gradient idea. Varied units can be distinguished in this coastal fringe where special planning policy is needed. Aerial photographs and satellite images are used to locate these homogeneous units. These areas are defined in relation to digital elevation models: A degree of visibility depending on a given path is defined to contribute to the choice of priority sectors to be preserved (cf. photography 1, L. LE DU, P. GOUGER, 1992). Moreover these studies on landscapes are one of the main research subjects of the COSTEL team. The first
studies from 1984 proposed a new regional division of Brittany (R. BARIOU and al., 1984). A new typology of the rural landscapes of the western part of France has been recently carried out using NOAA AVHRR data (V. DUBREUIL, 1992).

2) Study of sensitive areas in Central Brittany.

This subject is articulated around the CORMORAN project (Characterisation, Observation, Modelisation of transfers in agricultural intensive environments) and is part of a broader study about the impact of agrosystems on the environment. It is a good example of the mobilization of researchers from different horizons: pedologists, geologists, agronomists, chemists, and geographers are all studying wet areas located in low grounds where intensive breeding is practised.

The study area corresponds to the NAIZIN catchment area located in Central Brittany. It is a small region, 7 kilometers long for a 12 km² area with uniform bedrock of brioverian schists, at 65-136 m altitude. This catchment area is itself included in the larger Blavet catchment area. The latter is 136 km long for a 2 250 km² area, is less than 300 m high, and its bedrock is made up of schists and granites. The NAIZIN catchment area is the only European site located in an intensive breeding region (dairy cows, pigs, battery-reared hens) that has been subject to precise studies for twenty years: for instance, hydrological data have been regularly registered since 1971 by the CEMAGREF(), and both nitrates and phosphates have been registered also since 1975.

A simulation of the transfers and their effects will be undertaken with a GIS whose input parameters typology is as follows:

- Topographic data
- Pedologic data
- Land use maps

![Location of the study area](image-url)
- Maps of active areas for water transfers
- Rainfall and temperature data
- Hydraulic conductivity and retention data

The temporal variation of the system varies from episodic rainfall to study runoff to the water balance for a year, and remote sensing is incorporated at two levels:

- For an accurate mapping of surfaces covered with maize and winter bare fields, and to assess fallows and landscape changes.

- For a localization of wetlands in order to map active areas for water transfers. Satellite data are really well adapted to the mapping of wetlands even for small catchment areas. It is possible for instance to delineate both a river’s mean water bed and different submersion classes up to wet areas, with two LANDSAT TM images registered during the lowest water level period for the first and during a flood event for the second (cf. photography n2). A spatial extrapolation of this model to a neighbouring catchment area is considered as follows:

- A diachronic study and an integration with the CEMA-GREF’s data to describe different possible scenarii (simulating different potential evolutions of land use, either over the whole catchment area, or more locally, by changing production types. This to define what could be the hydropedological consequences on the catchment area, and the origin of pollution whether from cultural habits changes or from new speculation choices.

- Research of landscape units using both SPOT and NOAA: the latter is useful as a stratification tool for locating rather similar catchment areas.

- An extrapolation of the results from NAIZIN to other areas.

These few examples show the sudden awareness of environment problems in peripheral regions of Europe and the interest of the remote sensing approach to these problems. In Brittany, as elsewhere, politicians and public institutions are making an increasing financial effort. The decision to install in our region an image processing centre at the disposal of researchers clearly demonstrates the present impact of remote sensing on planners and decision-makers.

However, care must be taken not to expect too much from remote sensing, which is obviously not the answer to all environmental problems. Nevertheless, an environmental analysis method can be very useful to thematician.

Fig. 1 - Map of the possible points of vue from a given path located on the sea. Ile Grande, Trégor (Brittany). COSTEL, University of Rennes 2, 1992.
REFERENCES


