

AERIAL PHOTOGRAPHS AND SATELLITE IMAGES  
AS ARCHIVES (INFORMATION POWER IN HORIZONTAL AND  
VERTICAL SENSE)

Prof. Dr. L. DAELS

Laboratory for Regional Geography and Landscape Science  
University of Ghent.

Abstract

It is well known that aerial photographs and satellite images are rich sources of information about the present day situation of the earth surface phenomena. The title "aerial photographs and satellite images as archives" is indicating the historical value of these documents. The "horizontal" archives mean that the spatial distribution of the landscape elements produces important information about the historical developments of the concerned areas. The "vertical" archives point to the fact that the evidences of the past are present into soils as different layers. These buried evidences are creating different conditions at the surface which can be read upon aerial photographs and satellite images. The information thus obtained shows that most of the history books must be adapted urgently.

1. Remote Sensing and landscape research

The applications of Remote Sensing, including aerial photography, are numerous in the different fields of the Earth Sciences. The use however for the study of the landscapes and the associated settlements is not so frequent and this for two evident reasons.

The initial ground resolution of the satellite images was not sufficient for this research and the interest for landscape studies was not very high. These two reasons vanished completely the last ten years. The ground resolution of the satellite images improved greatly and the interest for landscape studies was growing tremendously over the ten past years. The following motives can be considered for explaining the revival of the landscape research.

1.1. Finally the planners and the decision makers understood that the solution for some large scale and urgent problems must be sought in the understanding of the environment. Highly specialised research is needed but even so the holistic approach of the landscape study. A landscape is indeed the result of the interactions between the physical and the human environment. The physical processes were modeling the landscape since millions of years. Man was interfering only since some thousands of years. The landscape is preserving the evidences of these processes and is testifying of the failures and successes of men. The landscape may be considered as the collective memory of humanity. This memory must be consulted carefully before decisions are taken which can have an impact upon the rural and urban landscapes.

The information, needed for the formulation of sound projects in relation with landscape - or agricultural reforms, is present in the landscape and must be made available by a good landscape examination. The failure of some projects is clearly the result of a lack of knowledge about the landscape and the negation of the personality, the individuality and the potentialities of the landscapes. Some of the directives of the European communities for the agriculture in the Mediterranean area resulted in a reversed outcome, as f.i. in Greece an accelerated soil erosion. The reason was that these directives were to general and not adapted to the possibilities of the different mediterranean landscapes.

1.2. Interesting psychological research was carried out about the influence of landscape and recognition upon the human and especially upon the mental evolution of the youth (R. KAPLAN, 1977; W. NOHL, 1980; KRUSE L. and R. ARIT, 1984; GIFFORD, 1987). Studies were also performed in relation with the visual management and the landscape aesthetics and the importance for the arts (PORTEOUS, D. 1982; USDA Forest service 1974; WOHLWILL, J.F., 1979; SANCAR, F.H., 1985). It is indeed most important that the individual feels part of the environment in which he lives. An identification between landscape and man must be established.

1.3. It is evident that the landscape plays an important role in the different activities of recreation and leisure and forms thus an active factor in the process of self development (BOERWINKEL, H.W.J., 1988; GIFFORD, R. 1987). It is superfluous to focus the attention on the influence of the landscape upon the different expressions of art: music, poetry, literature and painting (SVOBODA, H., 1985; SALTER, C.L. and W.J. LLOYD 1977; POCOCK, D.C., 1984).

2. Possibilities of Remote Sensing documents for landscape research.

The combined use of satellite images and aerial photographs proved to be a highly efficient tool for the exploration of the landscape archives. Some properties and technical possibilities, both digital and analogue, create new viewpoints and insights for the landscape research.

2.1. The multi-scale concept. With the Remote Sensing documents one can study the landscape upon a macro, meso and micro level.

<u>Image format</u>	<u>Image scale</u>	<u>Area covered per frame</u>
-Low altitude aerial photogr. (230x230mm)	1/20.000	21 km <sup>2</sup>
-High altitude aerial photogr. (230x230mm)	1/120.000	760 km <sup>2</sup>
-Landsat scene (185x185mm)	1/1.000.000	34.000 km <sup>2</sup>

(after Lillesand and Kiefer, 1979).

These scale variations enable to study the settlements in detail, but also to see the villages in the larger environmental framework and, by the synoptic view of the satellite images, to understand the spatial relationships.

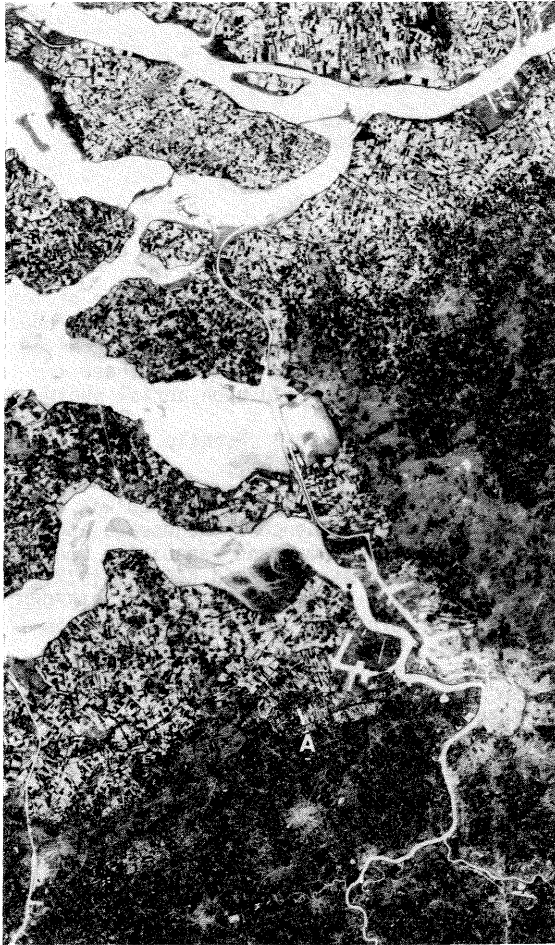


Fig. 1. Landsat 5 T.M. image (band 4) 04.11.1985.

The Landsat T.M. image (fig.1) is depicting the northern part of Flanders, the transition zone between the sandy area and the clayey flood plain of the Schelde river. The village of Verrebroek (A) is situated upon a sandy outcrop and is surrounded by the clayey polder area. The differences in spatial organisation, without seeing details, are clearly visible.

On the vertical aerial photograph (fig. 2) the differences of the field patterns on the sandy outcrop and on the surrounding clayey flood plain are obvious. The village of Verrebroek looks as an island amid the polder area.

2.2. Enhancement, photographic or digital, and filtering methods enable to make very clear some landscape elements and to eliminate the disturbing details. It became thus possible to extract, out of the enormous amount of information present in the image, the data which are important for the study purpose. On this filtered satellite image (fig. 3) only the linear features are visible. The general examination of the road- and hydrographic network and the shape and orientation of the field plots is thus possible. The sandy outcrop of Verrebroek appears again as an island amid the polder area.



Fig. 2. Vertical aerial photograph (scale 1/10.000) of Verrebroek (M.O.W.)

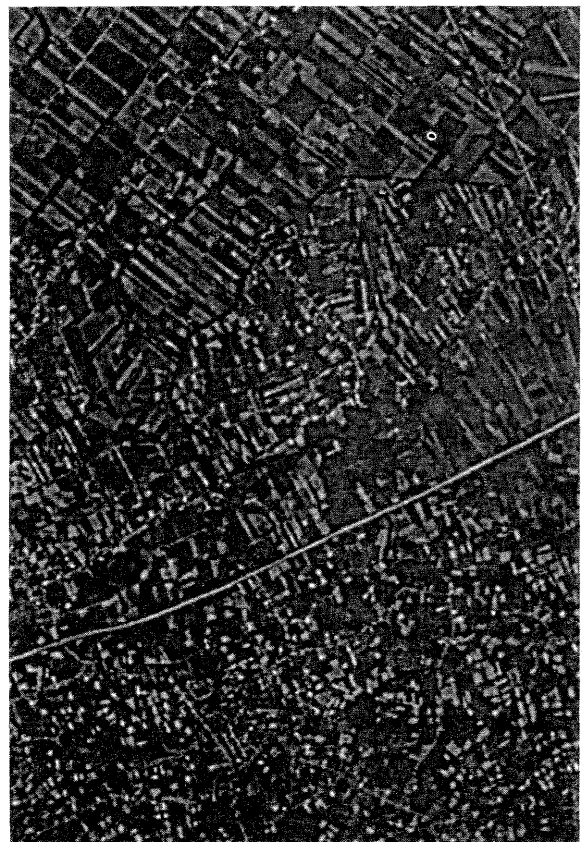


Fig. 3. Filtered satellite image.

2.3. Some landscape elements which are not visible for the normal human viewing can become visible upon aerial photographs or upon satellite images. This "visibility" problem is double. Some surface phenomena as f.i. shadow marks (micro-relief), soil marks (drainage) or vegetation marks are difficultly observable in the field but became obvious by a bird view. These marks are very often ephemeral and are only visible when very specific conditions of soil moisture and plant growth are present (fig. 4).

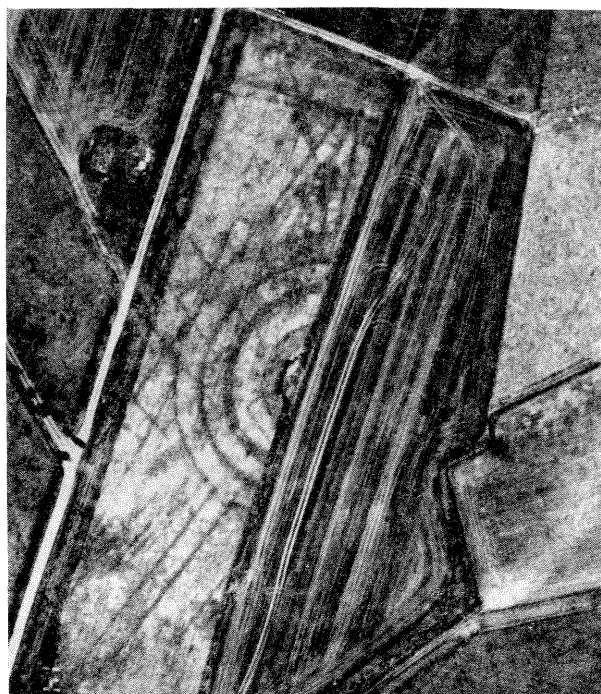


Fig. 4. Oblique aerial photograph of the Waardamme area (J.SEMEY)

This oblique aerial photograph is taken near to the village of Waardamme in sandy Flanders. A strange design of concentric circles appears. It remains an enigma. In analogy with other similar sites it looks like a cult place of the Bronze Age.

Other landscape informations, as vegetation stress of vegetation sickness are characterized by changes in reflection, especially in the near-infrared part of the spectrum, not visible for our eyes. These informations become obvious on the colour infra-red emulsion, or on the near Infra-red bands of the satellite images.

Thermal characteristics, also an important component of the environment, can become visible by a thermal scanning, as f.i. on band 6 of the Landsat T.M. images.

2.4. Aerial photographs and especially the satellite images allow a temporal analysis. The comparison between images taken during different seasons or at different years can show different aspects of a landscape or make clear the evolutions which are going on in a landscape. This possibility is especially interesting in areas where quick changes are occurring as f.i. in the fringes of the deserts or in the periphery of the big cities.

2.5. The multispectral nature of the satellite images makes possible to perform digital classi-

fications, using the appropriate algorithms. These classifications are touching the very fundamental behavior of the surface phenomena, they are indeed based upon the exchange of energy, incident and reflected, showing the specific spectral reflectance characteristics of the objects (fig. 5).



Fig. 5. Supervised image classification of S.W. Messinia (Greece).

Here an example of supervised image (SPOT) classification in order to identify the soil forming sediments in a part of S.W. Messinia (Greece).

Black = water  
 Dark grey = soils developed on alluvium  
 Grey = soils developed on colluvium  
 Light grey = soils developed on flysch material  
 White = soils developed on limestone material.

Different classification methods were developed, each adapted to specific interpretation needs (LILLESAND and KIEFER, 1989).

The meaning of this enumeration of some possibilities of the Remote Sensing documents is to show that these documents form a powerful tool for the study of landscapes, the associated settlements and the spatial relationships between them. The Remote Sensing enables as well the analytical as the holistic approach.

### 3. The landscape as archives.

This statement means simply that the landscape contains a lot of information, but, exactly the same as for archives, it needs serious work and skill to extract this information.

The landscape archives show two dimensions: a horizontal and a vertical.

3.1. Horizontal landscape archives are pointing to the fact that spatial distribution of the surface phenomena learns about physical and human processes. The following schematic representation shows the arrangement of the landscape elements typical for the different reclamation periods in sandy Flanders.

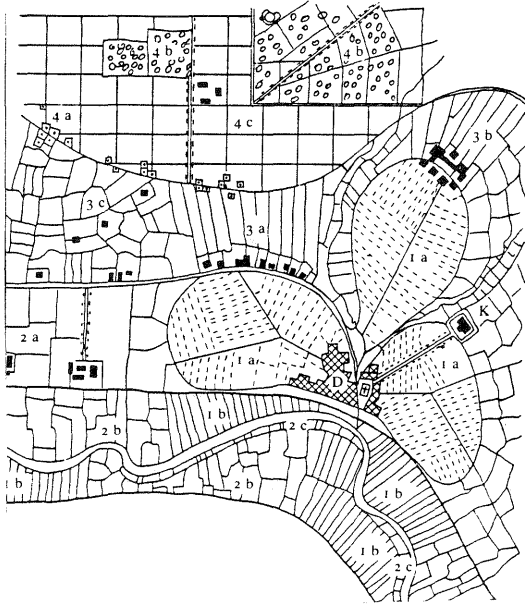


Fig. 6. Model of landscape genesis (after A.VERHOEVE and F.SNACKEN).

- D. Central place village with church.
- K. Castel with alley.
- 1. Oldest reclamation upon good soils.
  - a) open field; b) meadows.
- 2. Later reclamation upon less good soils.
  - a) big isolated farmsteads.
  - b) meadows (closed landscape).

On the following aerial photographs one can recognize easily the characteristics which are schematically represented upon the foregoing diagram.

3.1.1. The village of Mullem (fig. 7) situated in the southern part of East Flanders, in a slightly rolling sandy loam area. The aerial photograph shows clearly that Mullem is situated in an open field landscape, no living enclosures are surrounding the fields plots. The houses are concentrated in a nucleated village and the road network is radial. This landscape is typical for an old reclaimed area, anyhow before the year 1000 AD, but mostly much older.

3.1.2. Kaprijke (fig.8) is situated in the northern part of East Flanders and shows a landscape image which is strongly different from the landscape characteristics of Mullem. This is a flat and sandy area, with at certain spots, a deficient drainage. The reclamation of this area occurred much later, during the 13th and 14th century, and was carried out in a systematical way resulting in a checkerboard division of the field plots. After the demographical explosion in Western

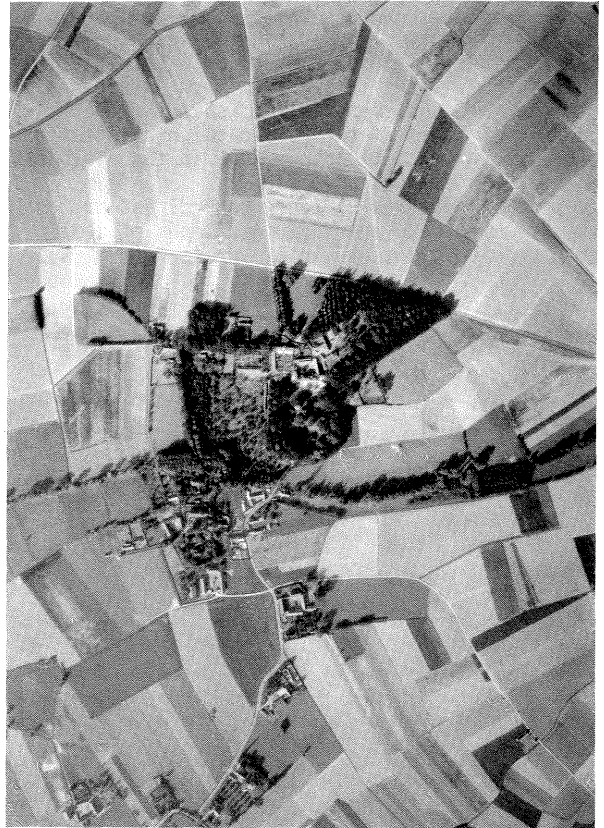


Fig. 7. Vertical aerial photograph (scale 1/10.000) of the village of Mullem in the sandy loam region of Flanders (M.O.W.).

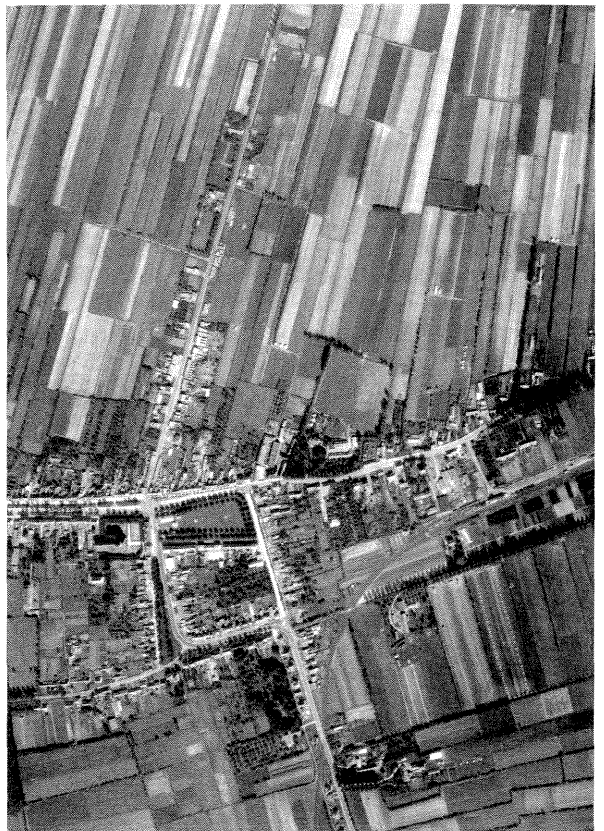


Fig. 8. Vertical aerial photograph of the village of Kaprijke (M.W.O.).

Europe during the 13th century there was an urgent need for new agricultural land. The counts of Flanders was stimulating these new land reclamations and founded several reclamation centers. This systematic spatial organisation is clearly visible around the village of Kaprijke. The original reclamation blocks, fenced with drainage channels, were later divided in long strips, giving the typical aspect to this region.

3.1.3. The following example (fig. 9) is situated in the Eastern part of the Flemish coastal area.



Fig. 9. Vertical aerial photograph of the Eastern polder area (scale 1/10.000) (M.O.W.).

It is a flat polder landscape developed upon the clayey sediments deposited during the floodings occurring between the 11th and the 12th century. The image shows that the general structure of the landscape is completely different from the foregoing landscapes. The spatial distribution of the landscape elements is now strongly determined by the presence of the creeks formed during the floodings and by the dikes, constructed afterwards for the protection of the region. Most of these creeks are now silted up, but still recognizable in the field pattern.

The meaning of the discussion of these examples is only to emphasize that a careful examination of the spatial distribution of the landscape elements learns a lot about the physical and cultural-historical development of an area.

### 3.2. Discussion of some examples of the vertical archives.

The exploration of the vertical archives is more difficult. In this case one has to examine the evidences of past processes preserved in successive layers in the soil. A multidisciplinary research, pedology, archaeology, palynology, history and geography is needed to understand this information source.

The buried phenomena however cause differences at the surface which can influence the vegetation growth in a positive or negative sense. A systematic air survey is carried out at the Ghent University (Seminary for Archeology, Prof. Dr. J. BOURGEOIS - Mr. J. SEMEY) and the results are astonishing. It became obvious that, based on the detection of these traces, some conceptions about the history of Flanders, will have to be revised.

3.2. A first oblique aerial photograph (fig. 10) shows a part of the French-Belgian Moeren, in the North-West of the country. Formerly it was a mud-flat.

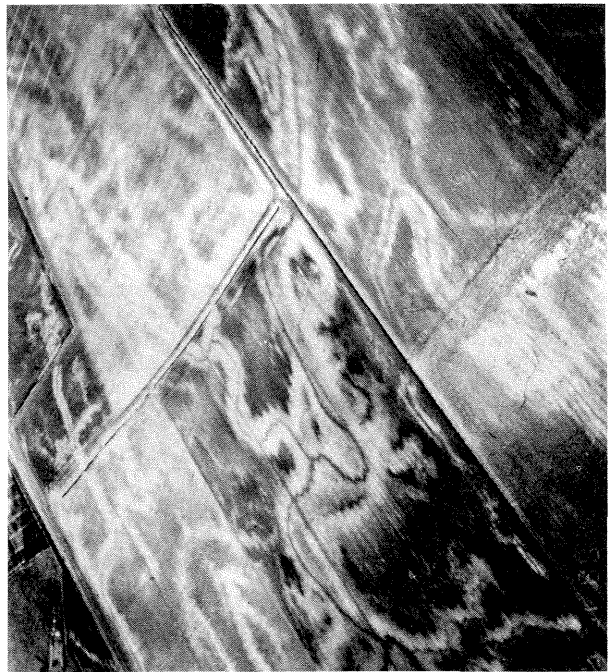


Fig. 10. Oblique aerial photograph of a part of the Belgian-French Moeren (J. SEMEY).

During the 17th century this area, flooded every tide, was reclaimed and became an agricultural area. The channels of this former mud-flat, since long silted up, are still visible under ideal circumstances of soil moisture and vegetation conditions.

3.2. These traces are often ephemeral. The evolution in the visibility is illustrated by the two following oblique aerial photography.

In the surroundings of Aartrijke (fig. 11) an indication of an urnfield, (A) a burial place of the Iron time, (1100 Bc) is visible.

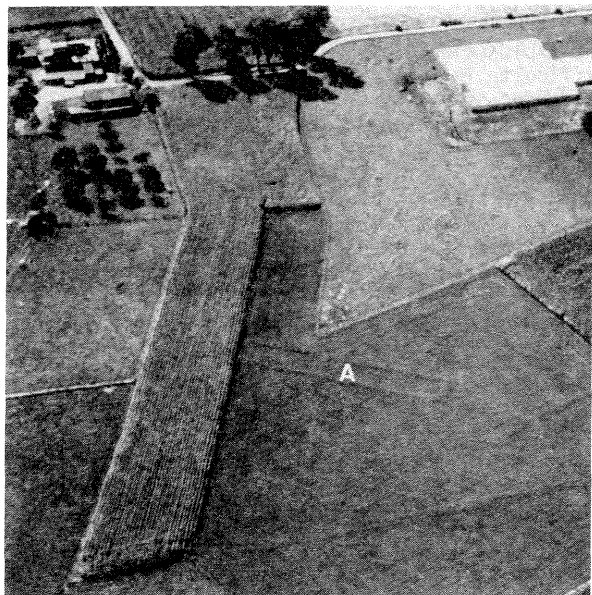


Fig.11. Oblique aerial photograph of the area of Aartrijke (J.SEMEY).

One year later, the same area was observed from the air (fig.12), but from an other viewpoint.

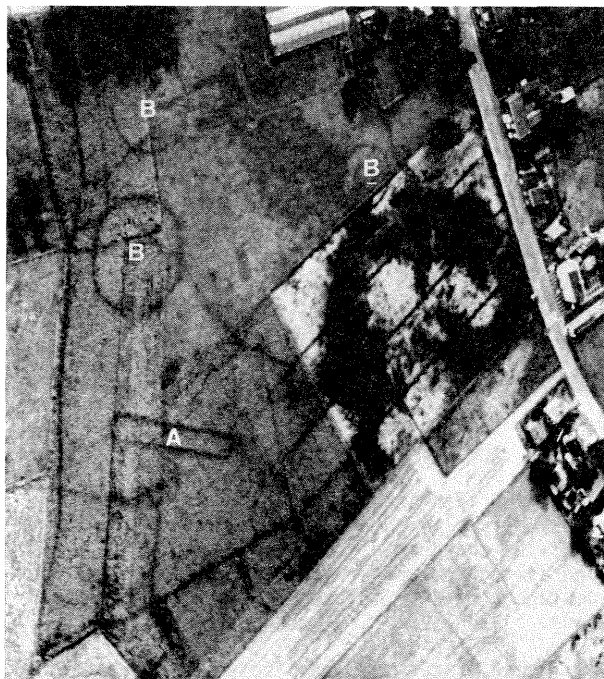


Fig. 12. Oblique aerial photograph of the area of Aartrijke (one year later) (J.SEMEY).

Not only the urnfield is appearing (A) but also a number of rounded burial-places of the Bronze Age (A) (1500-1100 BC.).

The observation of these two images learns that these traces appears only under specific conditions of soil and vegetation. These images show also a remarkable continuity of the occupation but also that the population density in this area was much higher than be thought before.

3.2.3. A following example (fig. 13) shows a very complex situation.



Fig. 13. Oblique aerial photograph of Assenede (J.SEMEY).

The curved lines (A) are testifying of the channels or creeks passing through the area during the floodings.

The concordant design of the fields is recent but the discordant field parcels are referring to an older system.

A corner of a site surrounded by a large ditch can be seen. It is an indication of a mediaeval farmstead (B). On top of the site a trace of a former well or watering place (c) is clearly visible. In the under left part of the image traces can be observed of a double ditch system forming the enclosure of an old settlement (D), perhaps dating from the Iron Age.

At the upper right part of the image black spots occur referring also to a settlement from the Iron Age.

A last example (fig. 14) is given by an oblique aerial photograph of Sint-Laureins situated in the Northern part of Flanders.

One can see clearly the design of the creeks formed during a catastrophic flooding happening in the year 1390.



Fig. 14. Oblique aerial photograph of the area around Sint-Laureins (J.SEMEY).

These creeks are since long silted up, but, under specific conditions of soil moisture they become again visible.

#### 4. Conclusion.

These examples show that as well the spatial as the time dimensions of the earth surface phenomena must be studied for understanding fully the landscape of to-day. The landscape, our environment, is indeed the result of the interaction happening between the phenomena occurring in a spatial relationship and the phenomena succeeding in time. Here and now is one point of the reality.

It is obvious that the Remote Sensing techniques became indispensable for performing these studies.

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