

## **THE BOCAGE LANDSCAPE IN THE 'BOURBONNAIS' (ALLIER DEPARTMENT, FRANCE): BETWEEN HERITAGE AND MODERN DYNAMICS**

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**ABSTRACT** - The Allier department has an incredible range of landscapes among which the bocage is the most representative. The bocage is an enclosed field with scattered households. Some areas are also totally free of hedge. We did not want to compare the openfield and the bocage but we tried to prove that there was a different type of bocage. So we studied two opposed sectors situated in the East and in the West of this department. The use of aerial shootings and their processing in a G.I.S. (Geographical Information System) allowed us to map the differences between the two areas in the last 50 years. This objective description obtained from actual and past data helped us analyse the change factors in the whole bocage of the Allier department.

**Key words:** Bocage, Allier department, landscape mutation, G.I.S., photo interpretation.

Before describing or studying the area we have to define the terminology which is important and recurrent in our work.

First we will focus on the types of land use and the extension of the hedges. Still, we should not consider them as the main aspect of the landscape. BERQUE said in 1995 that: "landscapes are organised on different levels, comprising a strong cultural and aesthetical dimension which enable the identification of the objects owned on a visible area. So the landscape is a concrete reality independent from the observer, but we tend to stress more on the existence of a mental picture coming from a cultural production."

Secondly we will define the bocage. Pierre GEORGE described it in 1974: "the bocage is characterised by the development of the field enclosed by hedges which gives the impression of a wooden landscape [...] In some standard bocage some other aspects complete the hedges web: the parcels are irregularly shaped, the real villages are rare and the housing is scattered in hamlet and isolated farms." This definition seems maybe perfect but it does not meet the fieldtrip reality, not all the bocages fit this definition perfectly. The obstacles to apply this definition are numerous: the past implantations of the hedges, the parcel shapes and, of course, recent evolutions. If we only use the bocage definition as being parcels totally enclosed by functional hedges, there would remain almost no bocage in France today. Nowadays, almost all of the bocage landscapes have been modified by the agricultural revolution.

Finally we can define the G.I.S. (Geographical Information System) by a quote from F. DE BLOMAC in 1994: "a G.I.S. is an organised entity of devices, software, geographical data and staff able to compile, process, store, analyse, and offer them under different information geographically referenced."

### **1. THE BOCAGES OF THE ALLIER REGION:**

#### **1.1. The localisation and the general characteristics of the bocages:**

In the Allier region, except for the prolongation of the plain of the Limagne, the bocage replaces the open field. Traditionally, hedges, made of more or less thick vegetation, are surrounding parcels of meadows, generally of big dimensions but with irregular shapes. They hide scattered housing, composed of hamlets, isolated farms, and manors. Villages are small. The source of this type of landscape is a very strong agricultural ambivalence: on one side the big property, on the other side the small peasant property, the "locateries". If some of the "grand domaine" (big property) were managed directly by some local worthies, most of them were divided into several farms of about 40 to 50 hectares. This type of farms, or sharecropping, has strongly diminished and farming has developed since 1950. More and more parcels are leased and a large number of big properties have appeared, a lot of small family properties have been taken

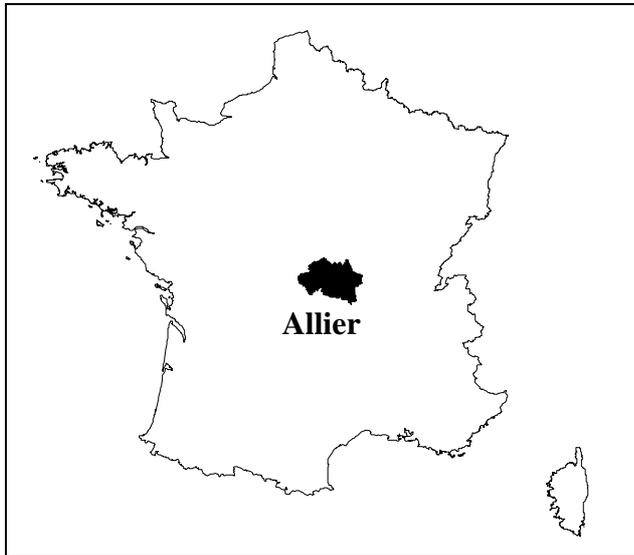
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THE BOCAGE LANDSCAPE IN THE 'BOURBONNAIS' (ALLIER DEPARTMENT, FRANCE):  
BETWEEN HERITAGE AND MODERN DYNAMICS

during the quick concentration of the farms. Yet, big properties tend to slowly disappear, due to successive

**Figure 1.** Localisation of the Allier department



splitting and to low interest in land. In parallel, during the second half of the 19<sup>th</sup> century, the big landlords were pushing the sharecropper to deal with cattle rearing for meat and to natural meadows, which meant extension. Nowadays the bocage seems to be a sensitive area, having undergone rural exodus for a long time, and decrease in the birth rate. Yet, they do not face the same stage of depopulation as in certain mountain ranges and they are still maintained by suckling cattle which are still strong or they are going towards diversification (i.e. increase in cereal farming).

Because of the duality between the “grand domaine” and the “locaterie”, the parcels are designed in original shapes. Indeed the “grand domaines” are usually composed of large and more or less regular parcels and they are organised around farm buildings. The parcels “of the locateries” are smaller, geometrically shaped, more or less long. In

addition, the main difference between these and the big farms is that the parcels are scattered in the surroundings of the hamlet.

Nowadays the Bourbonnais area is facing economic and social mutations. Even though the processes of parcel reallocation (“remembrement”) and the destruction of the bocage are still limited (because their implantation enabled the mechanisation) some communes have experienced a complete reorganisation of their surroundings.

Sometimes hedges can be subject to changes and modification in their upkeep, from individual destruction up to creation, and re-planting. On the one hand, the territory also benefits from the dynamism of the provincial towns. On the other hand, they may suffer from the drawback effects of the extensions of the main urbanised areas and from the development of roads and highways.

### **1.2. Regional nuances:**

Like BOUET and FEL in 1983, we tend to divide the Allier bocages under three big areas: the “Bocage Bourbonnais”, “Sologne Bourbonnaise” and the “Combrailles Bourbonnaises”. The last area, the Combraille Bourbonnaise, has had a past unlike the other two, and is closer to the neighbouring region of “Auvergne”. Because this area has had really little sharecropping, it has a different type of parcels shaping (smaller), we have not taken it into account in this paper.

The Bocage Bourbonnais, in the West of the department, gives the average idea of the area; it is its historical centre. The Bocage Bourbonnais has a better reputation than the Sologne. It is true that its soil is on granite or on metamorphic rocks. It is moderately undulating, within 200 and 400 meters and it is healthier and more fertile. The Sologne Bourbonnaise, in the East of the department, is the perfect example of the geohistorical standard of the whole Allier area. The soil is poorer because it is too flat, too acid, too impermeable, and with a layer of slag (mâchefer). As far as the landscape is concerned, two shapes of bocage coexist: in the West the bocage is according the average definition, whereas in the Sologne there is partial bocage with a large grid (See the “inventaire des paysages de l’Allier” and the article of GUIBAL and CUISENIER in 1982).

The administration has resumed the agricultural census for their own benefits, such as the regional divisions in the framework of the “Petites Régions Agricoles” (the grouping of homogenous communes). If we examine the agricultural production from 1970 to 1989, we notice an important difference. While the Bocage Bourbonnais tends to develop its meadow (+14 %), in Sologne (+5 %) the increase is less visible. As far as the cereal parcels in Sologne are concerned, they have decreased by 8 %, while in the Bocage Bourbonnais they have decreased by 28 %.

In opposition to the West of the department, the East is different from the point of view of the size of properties (even though there was some land division because of inheritance). The percentage of land ownership of more than 100 hectares is almost the same today as after World War II. This explains the big parcels in this area. In the Bocage Bourbonnais, since 1840, the influence of the big and very big domains has been less important. Already during the 19<sup>th</sup> century the decline of this influence started and increased between the two World Wars. So we chose a commune in each of those areas, “Le Vilhain” and “Pierrefitte-sur-Loire”, which really shows these different types of mutations.

### 1.3. Presentation of the two areas:

Each of the two communes belongs to really different regions of Allier, even before the agricultural changes of the last fifty years.

The commune of Le Vilhain is situated in the centre of the Bocage Bourbonnais; the morphology is really relevant as the altitude is between 280 and 412 meters. Small rivers shape the relief into small valleys dominated by plateaus. For the landscape look, we really have the feeling to be in a bocage, there are numerous parcels enclosed by hedges, usually low hedges with trees.

*The commune of Pierrefitte-sur-Loire is situated on the border of the Allier department, represented by the Valley of the Loire. Altitudes are less important and the relief is almost insignificant, 215 to 265 meters. Parcels seem to be bigger than those in the commune of Le Vilhain, they are often ploughed. When there are hedges, they are usually low and not often with trees. The two landscapes are really different, but they have experienced the same depopulation rhythm and the appearance of the type of agriculture that demands high productivity.*

In the Le Vilhain, the population decreased from 798 (in 1906) to 267 inhabitants during the last census in 1999. At Pierrefitte-sur-Loire the population decreased from 1094 (in 1886) to 534 inhabitants in 1999. We may notice that the demographic decrease was less important in the village of Sologne because of the proximity of the dynamic cities of Digoïn or Dompierre-sur-Besbre. But the isolated hamlets and farms were characterised by the same demographic crisis as that in the commune of Le Vilhain, due to the decrease of the population whose main activity was agriculture.

Indeed, concerning the consequences of the agricultural revolution, we have noticed the same phenomenon, i.e. the decrease of the farmers' number and the concentration of the farms. For instance, at Le Vilhain, between 1970 and 2000, the number of farms decreased from 72 down to 32 and at the same time their average size went from 32 up to 75 hectares. The same thing occurred in the commune of Pierrefitte-sur-Loire. Within 30 years, the number of farms decreased from 61 down to 28, and their size grew from 30 up to 76 hectares. On the other hand, agricultural practices evolved in Sologne. More and more farmers decided to equip their parcels with drains in order to improve their productivity. In 1979, no parcels were drained while in 1988 there were 650 hectares and, in 2000, 891 hectares. In the commune the phenomenon was limited and even declined. In 1979 there were 105 hectares and in 2000 there were 72 ha.

Finally the commune of Pierrefitte-sur-Loire has experienced very recent reorganization of two different kinds. In 2000 in order to allow the building of a highway, a reorganisation took place in the southern part of the commune, as well as the neighbouring areas. The next year the commune decided to extend their land reforms to the whole surrounding area, only the village area did not change. Yet, in Le Vilhain, it was not decided to make this kind of modifications. In addition, the neighbouring communes did not decide to reorganise the land either.

The main difference seems to be that Pierrefitte-sur-Loire adopted modern agricultural practices in order to adapt its web of parcels. We may notice the same phenomenon for the Sologne Bourbonnaise which seemed to choose high productivity agricultural practices, oriented towards industrial cropping, without including cattle husbandry. The perfectly opposite trend occurred in the Bocage Bourbonnais. The consequences on the bocage landscape were much less important in this area of Sologne. It is with the help of the aerial photographs that we tried to quantify this phenomenon observed on the field.

## **2. THE USE OF THE G.I.S. FOR THE CARTOGRAPHICAL REPRESENTATION OF THE BOCAGE:**

### **2.1. For a standardisation of the data sources:**

In our case, there are several types of bocage landscapes in the Allier department. Of course, differences are mainly visual and they can be observed even by a simple impression. There are some objectives means to differentiate them. Statically we may compare the bocage at different times and dynamically we may quantify the landscape evolutions. The G.I.S. offers numerous possibilities and is used more and more in the assessment of landscapes and their mutations.

The hedge is the main "object" of the bocage. Because of its cartography it is an indispensable tool to describe the bocage. According to J. BAUDRY and A. JOUIN (2003): "The termination of the hedge is a delicate job". All writers, or almost all, agree on the fact that a hedge is a line of trees and/or bush. But it is difficult to know which quantity of trees or bushes is needed to make a hedge [...]. Finally, the hedge is also a social object, a technical artefact. Yet some spontaneous hedges exist without being planted. We can say that they have the hedge status if they are subject to some upkeeping process". After this general definition, J. Baudry and A. Jouin add that "each assessment, cartography or research process must start with a hedge definition". This is the most precise possible way to include it into the development of a G.I.S. database. In our case, we have decided to select seven hedge types. We can divide them into two main groups: the functional hedges and the residual hedges. The residuals are low or spontaneous hedges with empty spaces as well as tree lines without any low stratum. Whereas the functional hedges, which do not necessarily benefit from regular upkeeping, there are low hedges with or without trees. They can also be made up only of tall trees.

As far as cartography is concerned, we consider that the techniques to draw the entirety of the mutual limit of the two parcels are very important, even though if there could be some openings, the widening of a passage for livestock or to allow the traffic of agricultural equipment which is becoming bigger and bigger. The extremities of those linear objects correspond to a change in the orientation or the occupation of the land.

In order to make this map of land occupation, we used aerial photography from several years, some from missions in the fifties (1950 for Le Vilhain and 1954 for Pierrefitte-sur-Loire) and another from 1999. The choice of the data is easy to explain, the most recent available photos are the 1999 ones, and the oldest ones are from 1954. To go back 50 years ago allowed us to describe the bocage immediately after World War II, before the big changes. The best would be to make maps every ten years. This is technically possible because there have numerous air missions since the fifties, but the amount of work and the costs of the photographs would make this type of studies hardly possible.

Not all the aerial photographs we could use have the same mount and should not be treated in the same way, nevertheless they all have common points.

The photography shooting was from a very stable plane, usually in the summer in order to have really good climatic conditions. They are influenced by the emulsion type, the scale, the focal of the camera and the recovery rate between the photographs. In our case, the 1950 and the 1954 photographs are panchromatic (black and white) and the scales are at 1:25,000. The 1999 photographs are different: they are digitalised and sold under the BD ORTHO trademark (registered trademark of the IGN), a type of orthophotography. As far as photo recovery is concerned, it is the proportion of the common area between the photography and its neighbouring area in the total area of the picture. As pictures have been taken by strips, we observe two recovery rates: the "intrabande" (intra-strip) recovery (between two successive pictures within the same strip) and the "interbande" (inter-strip) recovery (between two pictures and between two strips). It is interesting that the high percentage of overlapping of "intrabande" recovery will allow us stereoscopic vision and thus will help us understand the picture. We could only do it for the years 1950 and 1954. For the year 2002 we did not really need it, the quality of the photos allows us good understanding.

As far as orthophotography is concerned, sources are the same, there are aerial photographs with a 1:25,000 scale, except that the shootings are scanned and then they are processed in such a way as to correct these three distortions: the gradient of the shooting axis, the lens distortion and land relief. The first distortion is due to the lack of verticality of the shooting axis, the plane is never perfectly horizontal when photos are taken. In order to correct this drawback, we have to determine the exact position and orientation

of the plane during the shooting. In order to do this we use the aero triangulation. As far as lens distortion is concerned, the new equipment limits these distortions. To correct the problems due to land relief, we use a DEM (Digital Elevation Model) of the studied area.

After correcting these distortions, it is possible to replace the photographs in a geometrical projective; this is orthorectification. Afterwards these pictures are assembled together like a puzzle in order to create orthophotographs. The BD Ortho is the result of this technology. It is a setting of coloured orthophotographs, corrected with a “Lambert 2 étendu” projection with a 50 cm resolution and covering a whole department. The error scale can be between 1.25 m and 10 m depending on the pixel positions in the picture and their real position on the land, and also on the precision of the reference mark and the DEM. These photographs can be directly seen in the G.I.S. software. The orthophotography is not exactly the representation of reality, but the error range is almost nonexistent. For instance, some areas are invisible because they can be hidden by a building or a forest edge.

Since the 1999 BD Ortho we have been able to digitalise directly land occupation. Before that we could use pictures on paper, which needed a particular treatment. The results of aerial pictures process must be as close as possible to the BD Ortho in such a way as to superimpose the shooting of the two different years. This process will lead to the creation of some orthophotographs with the help of the old pictures. Several steps are needed to get to this result. Firstly, we have to scan the aerial shootings, and then we have to transmit them to the adapted software to create orthoreferences. This means that the picture depends on ordinates which come from the “Lambert 2 étendu” projection system; we must use specialised software to improve the adjustment (i.e. with ER mapper). We use the DEM: the DS Alti (registered trademark) which enables us to modify the photographs depending on the relief. In order to adjust the shooting we use the BD Ortho which eases the selection of reference marks (building, crossing...). For each marks on the BD Ortho we replace their ordinates at the same position as in the older photography. We have to scatter a lot of reference marks on the picture in order to avoid mistakes. Once the data are entered and processed by the software, we can directly see the results in the G.I.S. We get the same data for a diachronic study.



**Figure 2.** *Aerial views of the commune of Le Vilhain between the locality of Nabourdin and Les Thibaudats.*

In 1950

In 2002

Source: IGN

Depending on chronology, photo-interpretation is more or less easier. The 1999 study is really precise: we can even see the horizontal signalisation of the road which allows a really good differentiation between the ploughed area and the meadow, and also a good visualisation of the different types of hedges. The pictures taken in the fifties are less precise due to poor production quality. Their lack of colour

THE BOCAGE LANDSCAPE IN THE 'BOURBONNAIS' (ALLIER DEPARTMENT, FRANCE):  
BETWEEN HERITAGE AND MODERN DYNAMICS

diminishes the details. The most difficult differentiation is the between the ploughed area and the meadow. In some cases we had all the pictures of the aerial mission and we could work with a wide span of pictures and therefore perceive the volumes. The stereoscope considerably helped the understanding of the photographs because of its binocular vision. The hyperstereoscopy (the lenses of the stereoscope by enlarging the shooting and stress on the elevation) enabled a good interpretation of the hedge shape as well as their composition (the existence of the trees and the size of the bushes). This hedge understanding was more complicated for the 1999 missions.

## 2.2. The digitalisation:

The next step was to digitalise the parcels and the hedges in order to create a database which has been included into G.I.S.

The digitalisation of photographs will give us a new tool to work with. It is a digitalised picture which can be made of points, lines, and polygons. For each object, data are associated. The data regroup different information: the three-level precision for land occupation. As far as hedges are concerned we will determine the kind of bordering parcels as well as the type of hedges. To define a parcel we used the aerial photographs and each time we saw a discontinuity (a modification in land occupation, rivers, hedges, roads ...) we used it as a line.

We started with the digitalisation of the parcels of the two communes delimiting the type of land occupation (fields, wood, buildings ...). One of the tools of Arcview 3.2 enables the extraction of the parcels borders creating linear objects, but still remembering which parcels it delimited. We also include into the database the type of hedge; in case there was no hedge, we entered a type zero hedge. (See fig. 3).



Figure 3. Piece of hedge map of the Le Vilhain in 1950

1. Low hedge, 2, Low hedge with some trees. 3. Bush hedge, 4. Tree hedge with some trees, 5. Tree hedge with no lower stratum, 6. Destroyed hedge, 7. Other types of linear object (small wall)

## 3. INTERPRETATION OF THE FIRST RESULTS:

### 3.1. First observations:

After we made the first map, we could do a lot of statistics. This enables to differentiate the mutations between the two and to check the hypothesis we made during the first part of the article. Firstly, as far as the agricultural tendencies of the two communes, the land occupation maps and their statistics show

that Pierrefitte-sur-Loire maintains farming whereas in Le Vilhain it almost disappeared. Indeed, between 1950 and 2002, farming decreased from 916 to 361 hectares. But on the commune of Pierrefitte, they remained at the same level and they even increased a little from 1051 to 1166 hectares between 1954 and 2002. On the other side, on one of them, the meadow areas increased and on the other one they decreased. At Le Vilhain, the meadow areas increased from 1,337 to 1,788 hectares. At Pierrefitte, they diminished from 1,112 to 858 hectares. We can also add the increase of the wooden areas from 247 to 339 hectares at Le Vilhain and from 136 to 173 hectares in the Sologne commune.

As far as hedges are concerned, we can show that there are two types of evolution depending on their extension and on their physiognomy changes. (See tab.1.a and 1.b.)

The first difference is the change in the web bocage density since the fifties. At Le Vilhain the average density changed from 170 m/ha in 1950 to 128 m/ha in 2002. The figures for Pierrefitte are less important: from 130 m/ha in 1954 to 67 m/ha in 2002. The second difference is the irregular reduction of hedges in the commune. For Le Vilhain, it declined from 459 km to 325 km, which is a 29 % reduction. At Pierrefitte, the decline was more important, we observe an almost 50 % reduction, i.e. from 349 km to 177 km.

On the whole, all types of hedges from the two communes declined, nevertheless, we can still observe some interesting differences. The first refers to the hedge line without low stratum (type5). At Pierrefitte there is a consequent decrease (from 7,844 meters to, 4877 meters), while at Le Vilhain there is more hedge (from 3,050 m to 3,958 m). We can assume that at Pierrefitte the hedges were removed, while at Le Vilhain, they seem to come from the damaged hedges, whose only remains would be some trees. We can conclude that at Pierrefitte already during the fifties, the bocage experienced some aggressions. We can also observe the second indication of the main damages made to the bocage in Sologne. At Pierrefitte, the hedges made of some trees (type 2) experienced the bigger losses, 70 %, from 164,599 m to 47,344 m. Indeed, this type of hedge requires more upkeeping: bush cut, pruning, tree replacing... the decrease is also visible but less brutal (- 39.4 %), its dimension dwindles from 207,053 to 125,442 meters.

**Table 1.a.** Evolution of the hedge in the commune of Le Vilhain

	1950			2002			Evolution (in %)
	Number of hedges	in meters	in %	Number of hedges	in meters	in %	
total	4,955	<b>459,580</b>	100	2,751	<b>325,420</b>	100	<b>-29.2</b>
type 1	2,267	193,759	42.2	1,147	124,059	38.1	-36.0
type 2	2,022	<b>207,053</b>	45.1	838	<b>125,442</b>	38.5	<b>-39.4</b>
type 3	410	36,034	7.8	459	44,849	13.8	24.5
type 4	176	15,033	3.3	236	23,860	7.3	58.7
type 5	29	<b>3,050</b>	0.7	39	<b>3,958</b>	1.2	29.8
type 6	4	255	0.1	4	255	0.1	0.0
type 7	47	4,426	1.0	28	2,997	0.9	-32.3

Source: photo-interpretation

**Table 1.b.** Evolution of the hedge in the commune of Pierrefitte-sur-Loire

	1954			2002			Evolution (in %)
	Number of hedges	in meters	in %	Number of hedges	in meters	in %	
total	3,730	<b>349,446</b>	100	1,296	<b>177,578</b>	100	<b>-49.2</b>
type 1	1,480	116,845	33.4	519	70,910	39.9	-39.3
type 2	1,587	<b>164,599</b>	47.1	282	<b>47,344</b>	26.7	<b>-71.2</b>
type 3	149	13,741	3.9	131	13,257	7.5	-3.5
type 4	335	34,380	9.8	296	38,130	21.5	10.9
type 5	61	<b>7,844</b>	2.2	36	<b>4,877</b>	2.7	-37.8
type 6	0	0	0.0	8	451	0.3	0.0
type 7	118	12,037	3.4	24	2,609	1.5	-78.3

Source: photo-interpretation

THE BOCAGE LANDSCAPE IN THE 'BOURBONNAIS' (ALLIER DEPARTMENT, FRANCE):  
BETWEEN HERITAGE AND MODERN DYNAMICS

Beyond the evolution of the surroundings, we can also observe important divergences between the two communes. Firstly, the very good maintainance of the hedges along the roads and the paths at Le Vilhain. In 1950, about 95 % and 98 % of the road edges were still hedges. In 2002, there was a slight decrease; the figures are between 91 % and 99 %. While in the commune of Pierrefitte, there is a big decrease in the hedges number, in 1954 there were between 85 % and 97 %, in 2002 the figures were under 62 % (the lowest was 53 %). We can try to explain those changes by the impact of the reorganization process when roads were improved and paths were modernized. This happened at the same time as the land property reform.

The second main event is the important loss of hedges between meadows and the ploughed area. In Le Vilhain, they decreases from 95.7 % to 82.5 % (which is a really good percentage). At Pierrefitte, there was a serious fall: 89.8 % to 54.1 %. We suppose that the farmers are willing to increase their productivity by removing the hedges as well as the vermin living in hedges. Also we can observe some similar points, like the better maintainance of the hedges when they are between meadows: at Le Vilhain the figures are between 95.4 % to 86.8 %, at Pierrefitte they are between 98.8 % to 72.7 %. We can imagine that husbandry does not need as much agricultural machinery as farming. Cattle can also find protection close to the hedges. The figures are much lower when the hedges are between ploughed areas: at Le Vilhain between 72.5 % to 68.3 % and at Pierrefitte between 43.2 % to 44.6 %. Already during the fifties, in the Pierrefitte commune, the parcels were not often surrounded by hedges.

**Table 2.** *The Rate of the parcels bordered by hedges*

	Le Vilhain		Pierrefitte	
	1950	2002	1954	2002
Total	80.0	68.3	65.7	40.8
Meadow / meadow	95.4	86.8	89.8	72.7
Meadow / ploughed	95.7	82.5	82.9	54.1
ploughed / ploughed	72.5	68.3	43.2	44.6
ploughed / road	98.1	93.4	97.1	53.7
ploughed / path	97.1	99.7	85.6	58.0
Meadow / road	96.7	91.7	93.6	56.5
Meadow / path	95.5	96.1	91.4	61.4
Others	18.5	15.2	24.3	12.7

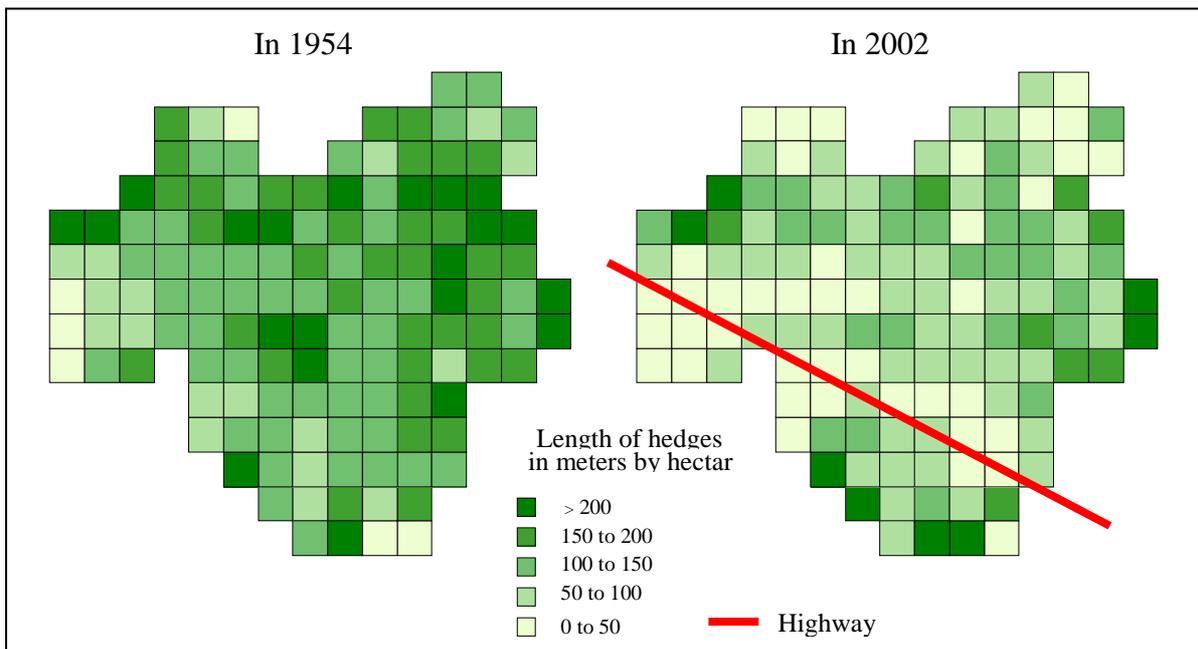
Source: photo-interpretation

### 3.2. The trend: Going towards a better understanding with the G.I.S.:

In order to the G.I.S. more, we created grid maps meant to simplify the aspect of the mutations in the bocage landscape. The use of grid maps enables us to differentiate better between the two areas and within each commune.

We also drew those maps with an Arcview 9.0 tool, which we divided into squares on the whole chosen area. With the help of MapInfo we linked each square (or map subdivision) with data. Then we calculated the areas of the different types of land occupation and the height of the various kinds of hedges, belonging to each square. We were able to obtain numerous types of maps: the map in figure 4 shows the density of hedges for each subdivision in the commune of Pierrefitte-sur-Loire. For instance, we may highlight the low hedge rate per total in order to see which type of hedge is more visible in one of the communes.

In this article we will focus on the presentation of the intra-communal evolution of the bocage web density during the last 50 years.



**Figure 4.** Hedge density according to a grid system in the Pierrefitte-sur-Loire commune

This figure offers a better visualisation of the hedge evolution in the commune of Pierrefitte-sur-Loire. We may notice that the hedges totally disappeared along the highway. The parcels along the river Loire (the northern part of the commune) were cleaned off their fences. Still, in other areas, the hedge density remained constant, for instance the eastern area of the commune.

We chose not to include the same type of maps for the Le Vilhain in this article, because it showed the same situation although the commune did not experience any reorganization process. Some areas were subject to significant hedge removal, but only in limited strips, only some parcels. In the other areas of the commune we may notice the good status of the hedges as shown by the photo-interpretation statistics.

## CONCLUSIONS

To conclude we can try to start explanations about the bocage evolutions, even though we are limited by the photo-interpretation when we have to isolate and describe one of the components of landscape mutations.

For 30 years, various conferences, like the conference in Rennes (France) in 1976, as well as some studies have described the dwindling of the bocage in France, and also the consequences of the “reorganization” (the reshaping of the landscape). As observed in the commune of Pierrefitte-sur-Loire, the hedges have diminished more than in the Vilhain commune. There are also spontaneous evolutions which have no links with land property policies. The reduction of the hedge web in the commune of Le Vilhain shows these spontaneous mutations.

The reduction of the hedges, and thus, independently, of the commune, is variable, as shown in the grid map (figure 4). At Pierrefitte-sur-Loire, some parcels are enclosed even though they have faced a “reorganization”, but at the Le Vilhain, there are areas where all the hedges have been removed. This type of localised evolutions comes from the farmers’ or the landlords’ personal choices to modernise their property or not.

We may also notice the neglected parcels because of their low productivity, which leads to an increase in the wooden areas of both communes. This phenomenon is not so important in Le Vilhain, probably because of the stronger relief.

Still using the G.I.S., we may work with the physical factors, for instance, the slope role in the modification of web hedges. The human factors may also be included into the database, such as the

THE BOCAGE LANDSCAPE IN THE 'BOURBONNAIS' (ALLIER DEPARTMENT, FRANCE):  
BETWEEN HERITAGE AND MODERN DYNAMICS

ownership type (landlord or leasing), the farmers' age and the accessibility of the parcels... All these may be done by using both the land surveys and the maps drawn according to aerial photos.

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