Modelling the Nile Agricultural Floodplain in Eleventh and Tenth Century B.C. Middle Egypt

A study of the P. Wilbour and other Land Registers

Jean-Christophe Antoine

1. Introduction

Although they contain a wealth of geographical information, land registers have not been fully exploited with the aim of reconstructing the Nile Valley landscape. However, compared to other written or pictorial sources, they have several advantages. 1) The geographical information they contain is based on onsite observation and therefore directly reflects the reality of the time at least from the point of view of the land assessors who surveyed the fields.[1] 2) Being administrative documents, we may expect them to be free from artistic, religious, political or ideological interferences which often make the interpretation of other ancient sources difficult. 3) For the Pharaonic Period we have a relatively high number of documents dating from the eleventh to the tenth century B.C. (Twentieth Dynasty to Twenty-second Dynasty) which concern Middle Egypt.[2] Unfortunately, several of these documents are very lacunous, devoid of useful geographical information, or still incompletely published so that, in the final analysis, only three texts can be fully exploited, namely P. Wilbour, the Louvre AF 6345-Griffith fragments and P. Reinhardt.[3]

1 On this particular point see Antoine, 2011, p. 12.

2 For a comprehensive list of these documents see Vleeming, 1993, p. 78–80.

3 The Wilbour papyrus was published by Gardiner, 1941–1952, 4 volumes, especially volume II, Commentary and volume IV, Index by Faulkner, 1952; for the

One reason that probably explains why scholars seldom used these documents is that they are difficult to interpret due to the pending uncertainty concerning the exact meaning of several words which designate features of the geographical landscape, different types of soil or administrative categories of fields. In addition, the number of data they encompass, which in P. Wilbour probably represents several hundred thousand bits of information, needs the use of powerful statistical methods to obtain a meaningful insight of their content. Here, using such methods, we propose a model of the agricultural landscape of the Nile Valley in Middle Egypt around 1000 B.C.

2. A brief description of the three documents used for the analysis

Due to its good state of preservation and the impressive amount of 3400 recorded plots, P. Wilbour is the most important of the three documents. It contains two texts, text A and text B, both dated to the middle reigns of the Twentieth Dynasty.[4] From a geographical point of view, plots form small clusters unevenly distributed over a region which almost corresponds to the province of Beni Suef at the time of the expedition of Napoleon Bonaparte to Egypt (see figure 4). The geography of text A, which is the easiest to reconstruct,[5] shows that fields were located on the west bank of the Nile, which at that time probably ran somewhere to the west of its present bed.[6] These fields are distributed over four different zones from north to south where they do not occupy the same part

Louvre AF 6345-Griffith Fragments Papyrus see Gasse, 1988, p. 3–73, and for the Reinhardt papyrus, Vleeming, 1993.

4 Text A is dated to year 4 of Ramesses V and records a survey performed in the second half of July. Text B was based on a document anterior by a few years to text A, but it was written and modified after the redaction of text A, probably during the first years of the reign of Ramesses VI: Gardiner, 1948, p. 183–187; Haring, 1997, p. 316f; Antoine, 2010, p. 5–14.

5 Gardiner, 1948, p. 36–55; Gomaà et al., 1991, p. 105–166

6 Butzer, 1976, p. 33–35; Said, 1993, p. 61–63; Lutley/Bunbury, 2008, p. 3–5. Changes also concerned Lake Karun, which probably had a larger extension at that time: Hassan/Tassie, 2006, p. 37–40.

of the floodplain (see figure 4).[7] The geography of text B is more complex and remains a puzzling problem. As a whole, the surveyed region corresponds to that of text A, but it probably extends to the north up to the level of Atfith and – at least in part – encompasses the east bank.[8]

P. Wilbour displays a very complex administrative and fiscal categorisation of land (see table 1) which has been the object of several studies.[9] However, this can be simplified for this analysis. Text B is devoted to *khato* (*ḫ3-t3*) land, a category of royal land held on temple domains while text A records fields belonging to temples or secular institutions including plots of *khato*-land. Two fiscal categories of land can be distinguished.

The first covers fields classified as *ḳ3yt*, *tni* or *nḫb*, which appear in both text A[10] and B, correspond to plots of relatively large size, are taxed in cereals and are held by high-ranking administrators or their subaltern middlemen.

The *ḳ3yt* category is by far the most frequent of the three, while the two others occur only occasionally. From a fiscal point of view, the value of the land decreases from *nḫb* and *tni* to *ḳ3yt*. In text A *nḫb* plots are taxed at a rate of 10 khars/aroura versus 7.5 for *tni* and 5 for *ḳ3yt* plots. These figures should be compared with the estimated average yield of cereals at the time which was probably between 6 to 10 khars/aroura,[11] which strongly suggests that the *nḫb* and *tni* categories correspond to the most productive lands.

The second group of plots, which appears only in text A, is held by a great number of mostly private smallholders with a variety of professions. The majority of these plots are measured in aroura and taxed in cereals on a reduced portion of their surface at a constant rate of 1 ½ khars/aroura (type I and IA

7 Gardiner, 1948, p. 36–55; Antoine, 2011, p. 9–27. The limits of the four zones are not completely similar in these two reconstructions, while Gomaà et al., 1991, p. 138–141, propose a different organization of the zone.

8 Ibid., p. 173–178.

9 Ibid.; Helck, 1960; Menu, 1970; Janssen, 1975, p. 127–185; Id., 1986, p. 352–366 (review article of Stuchevsky, 1982); Katary, 1989; Haring, 1997, p. 284–301. For a recent review on land organisation see Katary, 2013, p. 719–783.

10 In text A, *tni*, *nḫb* and *ḳ3yt* are not explicitly named, yet their existence is deduced from the tax rates applied to plots in normal domains, which follows the same proportional ratio as that of *tni*, *nḫb* and *ḳ3yt* in text B: Gardiner, 1948, p. 28–29 and 180. Although for the sake of convenience we shall use the term "tax" to designate these rates, it should be kept in mind that it is not clear whether they actually correspond to rents perceived by the landholding institutions or taxes.

11 Ibid., 1948, p. 71.

plots). Strikingly, another part is measured in land-cubits and left untaxed (type II and IIA plots). Some of these untaxed plots were apparently not planted while others were probably cultivated, although we ignore which crops were grown there. Despite an impressive number of recorded plots, text A certainly does not cover the totality of the fields held by landholding institutions in this region, but probably a category of them selected based on still unclear fiscal or administrative criteria.[12]

	TEXT B	TEXT A		
Date	Early Ramesses VI (?)	Year 4 of Ramesses V		
Owning institutions	temples	temples and secular institutions		
Types of domain	*khato*-land	normal domains	*pš* domains	
Administration/holding	officials	officials	small "private" holders	
Fiscal plot category	*ḳȝyt-tni-nḫb*	*ḳȝyt-tni-nḫb*	Type I/IA	Type II/IIA
Number of plots	602	540	1781	471
Unit of measure	aroura	aroura	aroura	land-cubit
Mean surface in aroura	30.4	13.9	6.3	0.50
Plantation	cereal	cereal	cereal	?
Tax/rent in grain	yes	yes	yes	no

Table 1: The organisation of fields in Text A and Text B of the Wilbour papyrus

The Louvre-Griffith fragments and P. Reinhardt are dated to the Twenty-first or Twenty-second Dynasty and record fields belonging to Theban temples and located in the Tenth Nome of Upper Egypt as the town of Tjebu is named in both

12 See Katary, 1989, p. 23f and Antoine, 2011, p. 27. Based on the date of the record (end of July), Fairman once deduced that the assessment only concerned summer crops (Fairman, 1953, p. 118–123) which is very unlikely owing to the distribution of plots across the floodplain (Antoine, 2011, p. 27).

texts.[13] The Louvre-Griffith fragments share several features with P. Wilbour. The recto concerns fields of a relatively large size that are fiscally classified as *ḳ3yt* or *nḫb,* although the tax rate is clearly lower than in P. Wilbour.[14] The verso relates to small plots held by a variety of smallholders and taxed at a very low rate on a portion of their surface, while some are not taxed, all of this being reminiscent of the different category of plots of the *pš* domains of P. Wilbour.[15] Unfortunately, geographical information is preserved on the recto only.

P. Reinhardt as well is regrettably lacunar.[16] It records fields taxed in grain on a portion of their surface at the very high rate of 12 and sometimes 15 khars/aroura while the rest of the area is deducted from the assessment because the land was not suitable for cultivation or planted with other crops. Plots in this document fall into two administrative categories, namely cultivated fields (*iḥt*) and *corvée*-land (*bḥ* or *iḥt-bḥ*)[17] which are represented almost equally. Both are under the responsibility of officials or administrators. Among them are several water-chiefs (*ꜥ3-n-mw*),[18] a rare title which, with the classification of the land as *corvée,* may indicate that the parcels covered by this document require specific administrative control concerning both their irrigation and exploitation.[19] Although the fiscal organisation underlying P. Reinhardt clearly departs from that of the two other documents, all three documents share a feature of importance for the present analysis, namely that some plots or a part of their surfaces are not taxed in grain because the land was not suitable for cultivation or because it was planted with another crop.

13 Gasse, 1988, p. 50 dates the Louvre-Griffith fragments to the end of the Twentieth Dynasty while Vleeming, 1993, p. 79 dates them to between the Twenty-first and Twenty-second Dynasties on palaeographic considerations. On a discussion on this text see also Vleeming, 1991 and Haring, 1997, p. 326–342.

14 1 khars/aroura for *ḳ3yt* and 2 for *nḫb*.

15 On this opinion see Janssen, 1975, p. 149; Haring, 1997, p. 334; Katary, 2005, p. 151f.

16 Vleeming, 1993. On this document see also Haring, 1997, p. 326–342.

17 Vleeming, 1993, p. 51–55.

18 Ibid, p. 56–57.

19 Eyre, 1994, p. 77.

3. Geographical information in land registers

The geographical information used in this analysis is contained in the way the scribes indicated the position of each plot in the floodplain by reference to one and, especially in P. Wilbour, two landmarks (hereafter designated as the main and secondary landmarks respectively).[20] These landmarks consist of either settlements including cities, temples, villages (*wḥyt*), houses (*ꜥt*), fortified villas (*bḫn*), keeps (*sgr*)[21] and various farm buildings, or remarkable landscape features such as islands (*iw*), mounds (*i3t*), lakes (*š*), ponds (*brkt*) and groves together with different soil categories designated as *ḳ3yt* (high ground), *pꜥt*, *m3wt* (new land), *iw-n-m3wt* (island of new land) and *idb* (for details see Annex 1).[22] On the whole, the land surveyors who assessed the fields preferred settlements or landscape features designated by or associated with a proper name[23] to indicate field location, probably because they are less ambiguous than anonymous features and made the use of a secondary landmark unnecessary. When plots were located in some remote area of the floodplain at a distance from inhabited or well-known places, a landscape feature was selected as an identifier, with a settlement often functioning as a secondary landmark. Such a method is the rule in P. Wilbour, but was used less frequently in the Louvre-Griffith fragments and P. Reinhardt, probably because the valley was narrower in the tenth nome of Upper Egypt, so that plot were only rarely located far from any well-known place.

From the geographical data, two sets of evidence can be derived. Firstly, by analysing the relative position of the main and secondary landmarks we can obtain information that helps to localise the different groups of landscape

20 Antoine, 2011, p. 9–27.

21 Following here the translation proposed by Gardiner, 1948, p. 35, but Cerny, 1958, p. 209f has proposed that *sgr* stands for *sg3* 'hill'.

22 On these words see mainly Gardiner, 1947, vol. I, p. 13; Id., 1948, p. 25–36; Vleeming, 1993, p. 45–48; Grieshaber, 2004. On *m3wt* see more specifically Yoyotte, 2013, p. 231–237 and Eyre, 1994, p. 75–77.

23 Schematically, two categories of landmarks can be distinguished: those I have called "defined" (Antoine, 2011) and those that are "undefined" since they need a secondary landmark belonging to the first category to be identified. Undefined landmarks mostly correspond to landscape features while the defined landmarks are mostly localities using the town determinative, suggesting they were settlements. Although some situation may be ambiguous, the designation of defined localities can be considered as a proper name in most of the cases.

features in the Nile Valley.[24] Secondly, this being validated, the position of plots according to their main landmark may be used to reconstruct the distribution of the different agricultural categories of fields in the floodplain.

4. Statistical methods used for the analysis

Because of the large amount of data, P. Wilbour was the document used to construct a model of the Nile Valley landscape. In a second step, this model was checked against the two other documents. Handling a land register such as P. Wilbour requires statistical methods appropriate for identifying complex interrelationship and free from any preconceived point of view to obtain an unbiased insight of the structure. These methods must also provide a synthetic, but not simplistic understanding of complexity. Here we used two such complementary methods. The first is a multiple correspondence analysis (MCA).[25] This global exploratory and descriptive method projects the relationship between data (appearing as a point cloud) on a two-dimensional graphic space in an easily and intuitively understandable manner, the proximity of two points positively correlating to their interrelatedness. The second method, namely multivariate logistic regression, identifies and measures the strength of factors that specifically distinguish two variables.[26] The strength of the association is measured by the odds ratio (OR). An OR above 1 indicates a positive association, while an OR below 1 indicates a negative one; the greater the OR is above 1 or the lower below 1, the stronger the association. Univariate analysis was performed with the ANNOVA test for quantitative and with the chi-2 test for categorical variables. A p value <0.05 was considered significant. Statistics were performed with IBM-SPSS 20™ software.

24 Details concerning this method can be found in Antoine, 2011.

25 Benzecri, 1973 and Le Roux/Rouanet, 2010.

26 Each component of a multivariable category is transformed into a new category coded 0 or 1 depending on whether or not the condition is fulfilled. On this method: Hosmer/Lemeshow, 1989.

5. Constructing the model from multiple correspondence analysis

The 3395 plots of texts A and B of P. Wilbour with all the information concerning their main landmark, land owning institution, administrative category of domain, administrator or holder's profession or occupation, fiscal category and unit of measure used, were entered into the analysis (see Annex 1 for details). The results are shown in figure 1.

Taking into account the respective effect of each variable and each plot on the entire population of plot, the analysis identifies two sub-clouds of points. Strikingly, landmarks are not evenly divided over these sub-clouds, thereby distinguishing two categories of landscape features. On one side are the soil categories *iw*, *iw-n-mꜣwt*, *mꜣwt*, *idb* and *pʿt* which occur with plots measured in land-cubit or the *nḫḥb* and *tni* fiscal categories of land. Plots on these soils are closely associated with priests, overseers of cattle who are probably attached to the local temple staff and their middlemen including cultivators and administrators. Accordingly, local temples are the landowning institution in this sector. High-ranking state officials, mayors of local towns and high army officers behave differently and are linked to the *ḳꜣyt* fiscal category of plots through the administration of *khato*-land. On the other side, we find settlements and landscape features closely attached to them, such as groves, mounds/kom, standing water areas (ponds and lakes) and high grounds (*ḳꜣyt*). Plots in this sector are measured in aroura and belong to smallholders who mostly exert a profession linked with the army. Of note, although *ḳꜣyt* is used to designate both a fiscal category of land and a landscape feature, the two meanings are quite distant, which indicates that they probably have little in common and warns us again the temptation of deducing the significance of fiscal terms from their geographical counterpart.

Thus, the MCA shows how the Nile Valley landscape in P. Wilbour was closely interconnected with the organisation of human settlements and marked by social, fiscal and economic considerations. However, this preliminary and global pattern requires further investigations and confirmation. I propose focusing on four aspects: 1) the organisation of the geographical features in the floodplain, 2) the specificity of *idb*, *pʿt*, *iw*, *iw-n-mꜣwt*, *mꜣwt* and *ḳꜣyt* categories of soil, 3) the irrigation system in the agricultural landscape and 4) the socio-geographical organisation of the land.

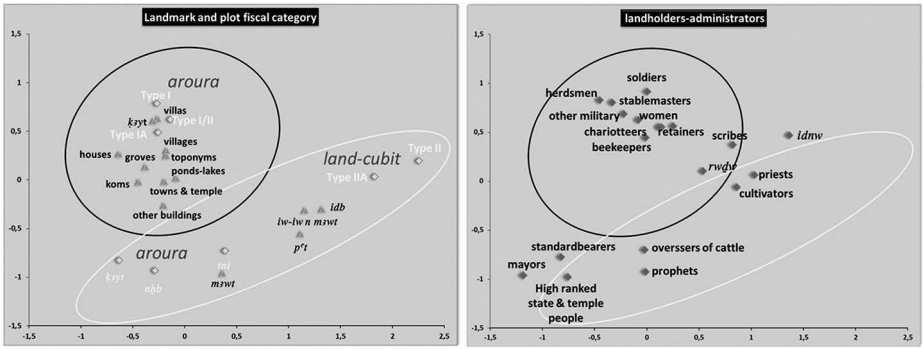

Figure 1. Results of the multiple correspondence analyses. For easier reading, a projection of the data is shown on two different screens. Ellipses encompass the two groups of data identified by the analysis. The scale of the two-dimensional space is arbitrary and was calculated by the software. The closer two points the more they are related and the greater their distance, the less they have in common.

6. Settling the organiation of the agricultural landscape

Comparing the relative position of the main and secondary landmarks in texts A and B affords the possibility of settling the landscape features in the Nile Valley in relation to one another. The analysis was performed by logistic regression and the results are summarised in figure 2, where arrows indicate the interrelations identified by the analysis. The ORs are not given here, as they have been published previously.[27] Making sense of this, at first glance, complex network requires the attempt to project the results on a typical profile of the valley at the level of Middle Egypt (see figure 5).[28]

Here, the Nile channel is gently meandering and probably ran at the west of its present bed in the eleventh century B.C. to the tenth century B.C., as previously mentioned. Typically, the floodplain near the river is delimited either by levees formed from deposits of fine sand and coarse silt during the inundation on the concaved deep side of the channel or by a sandy point-bar on the shallow convex side. Therefore, in a natural riverine system, levees form a discontinuous

27 Results of the analysis are detailed in Antoine, 2011, p. 9–27.

28 Butzer, 1976, p. 12–18; Said, 1993, p. 57–70; Hassan, 2010, p. 1–20.

line along the riversides as they alternate with low sandy bars on the same bank that are submerged during flood. Levees may span from several hundreds of meters to a few kilometres in width and are crisscrossed by undulations parallel to the main channel corresponding to oxbows or the ancient beds of the river. They rise to some meters above the valley flat but are usually covered by the flood. Only the highest grounds are likely to escape complete submersion. The floodplain corresponds to the low flat that lines the river channel beyond levees. In the region covered by P. Wilbour, the Nile River is not the only water course since the Bahr Yussef runs to the west on the desert fringe before entering the Hawara pass and debouching in the Fayyum depression. Compared to the Nile, this tributary probably meandered more than it is today, frequently abandoning old channels and oxbows.

If we now try to project the landscape features appearing in P. Wilbour on this Nile Valley profile, *ḳ3yt* (high grounds) are likely to be found on levees in keeping with the fact that they are associated with settlements.[29] Mounds (*i3t*) are also associated with settlements and high grounds. As modern koms, they probably result from the accumulation of debris generated during centuries of human occupation. Different varieties of groves are named in P. Wilbour. They are similarly associated with settlements suggesting that at least some of them may be artificial plantations. *Ỉw* can be securely identified with the islands of the Nile channel. Island formation is a continuous process resulting from the accumulation of sand followed by silt on point-bars. With time, the narrow channel separating the island from the bank can silt up, attaching the island to the riverside. *Ỉw-n-m3wt*, islands of new land, probably designate this phenomenon. The meandering course of the Bahr Yussef similarly allowed the formation of *iw* and *iw-n-m3wt*. *M3wt*, new land and *pʿt*, a rare word, probably designate different categories of new land formed over time by the meandering changes of the river or its tributary. They are likely to be found on the riverside since they connect with *iw* and *iw-n-m3wt*. *Ỉdb* is commonly rendered by "river banks".[30] Such a meaning is, however, unlikely since they are never associated with islands but appear to be located beyond *m3wt* to which they are associated. I have previously suggested that *idb* may designate the low flats of the floodplain[31], but it is more likely that they correspond to a subpart of them located in the meandering belt of

29 Interestingly, *ḳ3yt* were probably absent along the Bahr Yussef which was unable to develop prominent levees due to its low current (Antoine, 2011, p. 25) thereby confirming the identification of *k3yt* with levees.

30 On *idb* see Gardiner, 1948, p. 26–27 and Meeks, 1972, p. 149.

31 Antoine, 2011, p. 25.

the river. The last features to be considered in this landscape model are standing waters. They are designated by several words. *Brkt*, the ancestors of Arab *birket* or pond, is associated with settlements. *ḥn*, lakes or swampy lakes, probably correspond to back-swamps which developed in the lowest part of the Valley sustained both by the flood and ground water resurgences. The last category, *ḫnm*/*mḫnm,* is the most difficult to identify because of the scarcity of occurrence of this word which has been suggested to designate basins from which fields may be irrigated, as compared to other areas of standing water.[32]

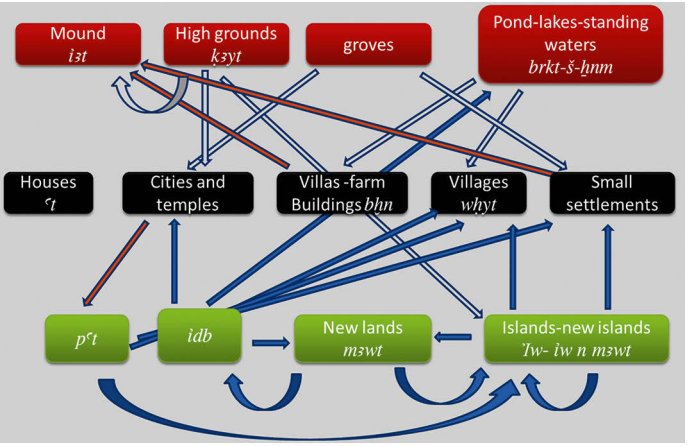

Figure 2. Schematic result of the logistic regression analysis of the relation between main and secondary landmarks. Arrows indicate the associations identified by the analysis between the different landscape features.

7. The specificity of *iw*, *iw-n-mȝwt*, *mȝwt*, *idb*, *pʿt* and plots measured in land-cubits

As seen above, these words designate categories of soil we may suspect to lie within the river's meandering belt and for which the MCA indicates a specific pattern. To identify what characterises this pattern, multivariate logistic regression was performed comparing the plots in texts A and B located on these soils with those elsewhere in the floodplain in terms of fiscal categories of land

32 Eyre, 1994, p. 80, note 161.

and surface.[33] The proportion of plots on these soils is the same in the two texts and amounts to 16 %. The logistic regression identifies a strong association with *tni* and *nḫb* land (OR: 11.6; 6.6-20.5 95 % CI[34]) and untaxed plots measured in land-cubits (OR: 4.2, 2.3-7.8 95 % CI) while taxed plots measured in aroura and pertaining to private smallholders (Type I and IA plots) are conspicuously rare (OR: 0.16; 0.09-030 95 % CI).

Another important feature is that the area of plots on these soils is less than elsewhere in the valley, as shown in figure 3, regardless of the domain categories and of text A or text B. This is not only due to the very small size of plots measured in land-cubit, but also to the fact that *tni* and *nḫb* plots are significantly smaller than those fiscally classified as *ḳꜣyt*. A sub-analysis with each of these soil categories provides the same results, except for *mꜣwt* which, although associated with *tni* and *nḫb,* does not specifically occur with plots measured in land-cubits. In contrast, plots situated on levees (*ḳꜣyt*) follow a completely different pattern since the logistic regression retains that they are rarely of the *ḳꜣyt* fiscal category of land (OR: 0.18; 0.09-0.35 95 % CI), thereby confirming the antinomy suggested by the MCA.

Thus, P. Wilbour tells us that lands planted with grain and promising the highest yield coexisted with plots measured in land-cubits on the meandering belt of the river and, as shall be seen below, probably along the Bahr Yussef.[35] But what are the agricultural characteristics of these plots measured in land-cubit? First, if 55 % of them lie on the soil categories considered above,[36] a significant proportion is found elsewhere, in particular near villas and small localities.[37] However, to interpret this point one should keep in mind that if

33 The analysis was adjusted for texts A and B to avoid bias due to a specific effect of one of the two texts.

34 CI indicates the 95 % confidence interval of the OR value. All the ORs specified in this study have a p value <0.05.

35 The co-occurrence of plots measured in land-cubit and those classified as *tni* and *nḫb* raises the question whether they were located in the same areas. This question can only be approached by a study of the individual landmarks in text A. Plots were considered to be in the same location when the orientation and the main and secondary landmarks were identical (Antoine, 2011). Compared to aroura measured plots, those in land-cubit do not specifically lie in the same localities as plots of normal domains.

36 241/440 land-cubit measured plots with 123 of 233 plots on *idb*, 53 of 87 plots on *iw* and *iw-n-mꜣwt*, 40 of 84 plots on *pʿt* and 25 of 52 plots on *mꜣwt*.

37 143 plots are near settlements (32.5 %).

settlements were preferentially used as landmarks because they provide precise information on plot localisation,[38] they do not provide information on the nature of the soils in their immediate surroundings, which may or may not be identical to the soil categories discussed here. P. Wilbour provides further important details on these small plots. Half of them are artificially presented as if part of their surfaces was liable to a tax not associated with grain, as a corn rate was not applied.[39] The other half was not cultivated for reasons that are clearly specified,[40] the most frequent being that the land was *wsf* (inactive or resting), which probably indicates a kind of fallow[41], and less frequently due to *wšr* (dryness). If Gardiner's reading and interpretation of this word is correct, this would mean that the field had not received water.[42] All of this suggests a method of irrigation which departs from that of lands naturally covered by the flood. P. Wilbour remains especially discrete on the nature of the crops raised here. Two plots are said to be cultivated with vegetables and five with flax, but we are probably close to reality when interpreting the scarcity of these indications as designating exceptional situations rather than a general rule. To obtain more information we need to turn to the Louvre-Griffith fragments and P. Reinhardt.

38 Compared to the previous plots, which are clearly said to be on (*m*) the soil categories studied here, the other plots are in the vicinity of settlements but at a distance which remains unknown. The usual absence of a secondary landmark with settlements prevents any conclusion on the nature of the soil in their vicinity. The only specification is their orientation toward the settlement used as landmark according to the cardinal points.

39 238/440 plots measured in land-cubit are expressed by figures a and b with a<b (type II plots). The total a+b follows the same distribution as the surface of untaxed plots (type IIA) which indicates that the actual surface of the plot is a+b. This pattern of expression by two figures is reminiscent of the way the taxed plots pertaining to small holders and measured in aroura (type I plots) are presented, but the relation between the two figures is different in type I plots, since b is clearly a part of a. On these plots see Gardiner, 1948, p. 93–94 and Katary, 1989, p. 13.

40 These plots correspond to variety IIA of Gardiner's classification but, as showed by Katary, 1989, p 82, a part of them is in fact measured in aroura but not assessed by the surveyors. This category is classified by Katary as variety I/II and must therefore be excluded from the analysis of Gardiner's type IIA category.

41 Katary, 2005, p. 140f.

42 169/202 are *wsf* and 32 *wšr*. The reading of these annotations is difficult because of their very cursive script. On this see Gardiner, 1948, p. 93f.

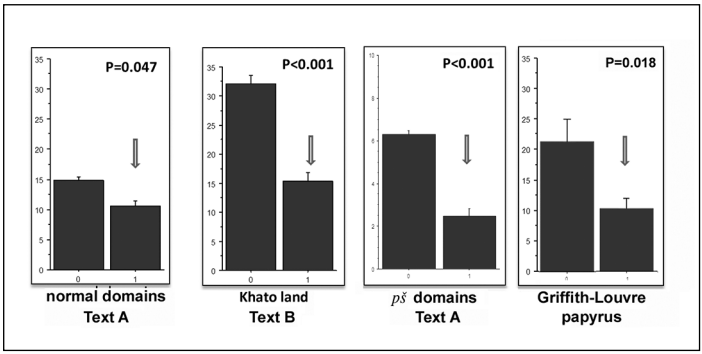

Figure 3. Comparison of the mean surface of plots on iw, iw-n-mȝwt, mȝwt, idb and pʿt (arrow) with plots located elsewhere in the floodplain in the different documents. Bars indicate the standard error.

8. Validating and refining the model on the Louvre-Griffith fragments and P. Reinhardt

The Louvre-Griffith fragments provide information on 180 plots, all of the *ḳȝyt* and *nḫb* fiscal categories of land, *tni* being missing in what is preserved of the document. Unfortunately, because of numerous lacunae, only 84 plots are fully exploitable. As in P. Wilbour, the *ḳȝyt* fiscal category largely dominates, representing 92 % of the plots. Concerning landmarks, fields are mostly on high grounds (*ḳȝyt*) (80 % of cases), the others lying on *pʿt*, *idb*, *iw* and in one case on *nḫb,* which therefore, as *ḳȝyt*, can be used to designate a soil category. According to what was encountered in P. Wilbour, these landscape features are mostly in the vicinity of settlements or hills.[43] Interestingly, plots located on *pʿt*, *idb*, *iw* and *nḫb* are smaller than those on *ḳȝyt* with a mean surface of 11 arouras versus 22.8 ($p<0.05$) (see figure 3), which corroborates what appears in P. Wilbour, although this result should be interpreted with caution due to the high number of missing data. Departing from the situation prevailing in P. Wilbour is the strong association of the *ḳȝyt* category of land with their homonymous landscape

43 28 plots are near a locality designated by a proper name, 13 near a keep/hill (*sgr*/*sgȝ*), ten near a temple and five near a landscape feature situated in the countryside.

feature, which suggests that these plots were located on high flats probably covered by the flood along the river bed or near the desert fringe.[44]

P. Reinhardt provides further interesting information since all the analysable plots lie in the meandering river belt. Indeed, of the 13 preserved landmarks used to indicate plot localisation, seven are *iw*, four *iw-n-mꜣwt*, one *mꜣwt* and one *idb*, while *pʿt* is absent.

Due to the lacunous state of the document most of the plots are missing a significant part of their information. However some interesting numerical data can be obtained. The median value, which cut the population of plot surfaces in two equal parts, is 2.4 aroura, varying from 0.125 to 22 arouras,[45] which is small if we compare these figures with the surface of fields located on *ḳꜣyt* in P. Wilbour and the Louvre-Griffith fragments. Once more this confirms the small plot size in this part of the floodplain. Another very important argument for the model validation is the very high tax rate of 12 khars/aroura, probably the highest ever attested in pharaonic Egypt. This perfectly corroborates the model which predicts that the land in this part of the floodplain provides the best yield.

One characteristic of the fiscal organisation of fields in P. Reinhardt is that the plot surface is regularly reduced by iterative subtractions of an untaxed area.[46] The subtracted parts are tiny, with a median value of 0.63 arouras, which is very reminiscent of the surface of plots measured in land-cubits in P. Wilbour.[47] A very interesting feature for our purpose is that P. Reinhardt provides the reason as to why the reduced surface was excempted from the corn tax. The preserved examples are listed in table 2 with their translation as proposed by Vleeming.[48] Fifty seven % of the exceptions were due to the land being exposed to excessive moisture, as is indicated by the use of words such as *ḫr*, low land or fen, *mḥyt*, marsh, or *ḫꜣt*, lagoon. In 19 % of the cases, the parcels were planted in cucurbits,

44 In this part of the valley, the profile is convex with the lowest part lying near the western desert fringe: Butzer, 1976, p. 15.

45 Calculated on 118 data.

46 Such an administrative method is also illustrated on the verso of the Louvre-Griffith fragments.

47 Calculated on 60 data. Range: 0.125-7.35 arouras. The median taxed surface calculated on 33 data is 2 arouras, ranging from 0.25 to 9. However there is no indication in the P. Wilbour that surfaces measured in land-cubit should be subtracted to an aroura-measured surface. Obviously the two documents use different methods of accountability. However, in both of them a series of small plots is not cultivated in cereals while grain assessment or taxation is the main goal of these texts.

48 Vleeming, 1993, p.65–69.

vegetables or grass for horse breeding. Thus, Reinhardt papyrus sheds an interesting light on the plots measured in land-cubit of P. Wilbour, confirming that a part of them was cultivated, and informing us about the nature of the cultivated plants. We have seen that the rare indications furnished by P. Wilbour in this domain probably reflect unconventional situations. It is thus tempting to consider that other, yet similar plants were cultivated in the land-cubit measured plots of P. Wilbour. The main difference lies in the reduced use of fallow (*wsf*) and the absence of dry fields (*wšr*) in P. Reinhardt. Therefore, P. Wilbour and P. Reinhardt probably reflect three limitations of cultivation on *iw*, *iw-n-mꜣwt*, *mꜣwt* and *pꜥt*, namely excess of water, dryness and land fatigue, which requires a fallow period to regenerate. All of this is probably connected with the irrigation system.

Land categories	Translation (VLEEMING)	Number of occurrences	Remarks
ḫr	Low land/fen	42	occurs with *tni*
mḥyt	Marshland	20	occurs with *bꜣnt*
ḫꜣt	Lagoon	4	occurs with *bꜣnt*
šꜥ	Sand	2	
tni	Elevated land	13	occurs with *ḫr*
nḥb	Fresh land	1	
wsf	Fallow land	2	
wꜣḏ	Vegetable land	2	
bꜣnt	Gourd land	10	occurs with *mḥyt* or *ḥꜣt*
šꜥti	Mowing land	10	for the pharaoh's horses
TOTAL		115	

Table 2: Distribution of the different categories of land not liable to grain tax in the Reinhardt papyrus

9. The irrigation system in the land registers

For a long time it has been commonly admitted that the basin system of irrigation, which was for the first time fully analysed in the *Description de l'Egypte* at the end of the eighteenth century A.D.,[49] existed at least to some extend in pharaonic times.[50] This system depends on an adjustment of the natural flood basins by a series a dykes lining the Nile bed where levees are lacking, completed by transversal embankments extending from the river to the desert edges. Long feeder canals branching from the Nile are necessary to bring water to the desert's edge, while short canals feed levees near the riverbanks. This is completed by sluices controlling water movements between basins or within canals. A system such as this allows a single winter crop cultivated after the flood, followed by a summer fallow before the next inundation. However, artificial irrigation can be conducted during the dry period on restricted areas by means of water elevation devices near wells where the water table adjoins the surface or near canals, and during the flood on levees lining waterways.[51] However, this system was never fully developed and remained in an embryonic stage for centuries before the mid-nineteenth century A.D.[52]; in ancient times the available evidence indicates a limited use of artificial irrigation which was probably restricted to orchard plantations.[53]

This immediately raises the question regarding any evidence of the existence of an irrigation system in these documents. We have to admit that they are scant since words designating wells (*šdt*) and canals (*mr*) are absent, while dykes (*dnit*) are occasionally mentioned and in P. Wilbour only. However, localities incorporating *mr* in the formation of their name or using the canal sign  in their determinative are relatively frequent in P. Wilbour.[54] Figure 4 shows

49 Girard, 1824, p. 1–22. For a description of the classical basin system see Willcock/Craig, 1911; Barrois, 1904; Besançon, 1957, p. 199–200.

50 See for example Butzer, 1976, p. 41–46, Lloyd, 1983, p. 327 but also with a modulated opinion Kemp, 1989, p. 10.

51 Besançon, 1957, p. 89–90.

52 Alleaume,1992, p. 301–322; Michel, 2005, p. 253–276

53 Butzer, 1976, p. 41–51; Eyre, 1994, p. 57–80.

54 Gardiner, 1948, p. 29–30. In texts A and B, twelve localities incorporate *mr* in their name and 22 use the canal sign in their determinative. In text A they amount to nine and fifteen respectively, representing 20.7 % of all the toponyms in this text. The detail is as follows according to the four zones where the first figure gives the number of toponyms including *mr* in their composition and the second

their distribution among the four zones of text A.[55] A striking feature is their predominance in Zone 1 where 57 % of them occur versus 10 to 22 % in the other zones.[56] An analysis of the orientation of plots according to the cardinal points has suggested that fields in Zone 1 principally follow the Bahr Yussef, while another part lies on the left bank of the Nile.[57] In Zone 2 fields mostly adjoin the riverbank and in Zone 3 they are generally at a distance from watercourses, probably being located in the central part of the floodplain. Finally, in Zone 4, the situation is a mixture of these patterns since some plots are positioned along the river bed, while others are at some distance (see figure 4). Thus, the high frequency of toponyms referring to a canal in Zone 1 strongly suggests that the canal in question was the Bahr Yussef or its embranchments and probably not artificial constructions. One illustrative example of this may be the well-known town of Miwer (*Mr-wr*, "The Great Canal") that recent investigations have shown to have been located close to the Bahr Yussef in antiquity.[58] Whether these conclusions may be extended to the other zones remains speculative, but here also the natural branch of the Nile was possibly alluded to in toponyms referring to a canal.[59]

The absence of canals among landmarks in land registers is thus problematic. It is possible that the land surveyors considered that they did not provide reliable topographic information, but it is also noteworthy that *mr* is absent from the hydrological vocabulary in the Amenemope Onomasticon,[60] which could indicate that another word was used to designate canals while the usage of *mr*

---

the number of those using a canal as determinative (the first group being excluded): Zone 1: 4/8; Zone 2: 2/1; Zone 3: 2/5; Zone 4: 1/4.

55 On this map and the discussion of the localisation of fields in the four zones of text A, see Antoine, 2011, p. 17–21. For another interpretation of the data see Gomaà et al., 1991, p. 138–141.

56 Zone 2: 13 %; Zone 3: 10.2 %; Zone 4: 21.7 %.

57 Ibid., p. 18.

58 Bunbury, 2012, p. 52–54.

59 A close analysis of these toponyms and of the plots adjoining them may therefore help to precise the limits of the different zones.

60 *m r* still occurs in official or literary compositions using an academic style such as P Harris I, I 50 (Grandet, 1994, Vol. 3, p 74). In P. Turin Cat 1923 Rt1-8 (Kitchen, 1983, p. 368), an administrative document, *m r* probably designates the canal joining the Ramesseum to the Nile, which may indicate a restricted meaning of this word. To the best of my knowledge, among land registers of the period a canal (*m r*) only appears in P. Berlin 23253 II, 53 and III, 21 (Gasse, 1988, p. 102–103).

was limited to the name of toponyms whose origin probably went back to a remote past. It has been proposed that *ḫnm*/*mḫnm* may designate feeder canals[61] but this word does not appear in the other land registers. In the Amenemope Onomasticon,[62] it follows swampy lake (*ḥnw*), lake (*š*), well (*ḫnmt*) and precedes a word which in the Miscellanies designates a water area associated with a villa (*bḫn*) and in which fish and hippopotamuses abound.[63] All of this suggests that *ḫnm* designates some kind of natural standing water area; all the more so since it never occurs in association with the soil categories located in the meandering belt of the river, the very region where we may expect feeder canals to originate.[64] Figure 4 provides further interesting findings since it shows that the distribution of plots located on *iw*, *iw-n-mꜣwt*, *mꜣwt*, *idb* and *pʿt* and that of toponyms referring to a canal in the four zones of text A are well correlated. Where reference to a canal is frequent, the proportion of fields located in the meandering belt of a water course is high, which suggests that a significant proportion of fields located on *iw*, *iw-n-mꜣwt*, *mꜣwt* and *pʿt* were probably along the Bahr Yussef.

Two dykes are mentioned in the P. Wilbour, namely the dyke of Spermeru in Zone 3 and that of Pi-Ihay ("The Byre") in Zone 4. Schenkel has proposed to identify them with two of the transversal dykes that crossed the valley in the nineteenth century and appear on the map of Linant de Bellefonds, but this remains hypothetical.[65] The exact localisation of Spermeru and Pi-Ihay is unknown. The former probably needs to be searched in the northern half of Zone 3[66] on the western fringe of the valley, while the latter is associated with fields belonging to the sanctuaries of Sako at the eastern limit of Zone 3 and 4. An *idb* is said to adjoin this dyke, which possibly indicates a location adjacent to the Nile near Zone 3. What is relevant for this study is that dykes occur in a region

61 Eyre, 1994, p. 80, n. 161.

62 Gardiner, 1947, Vol.I, p. 7f.

63 *ḫninі*: P. Lansing 12, 10; P. Anastasi IV 1b5 (Gardiner, 1937, p. 35 and 111); *ḫnm* appears in the Stela of Shoshenk (line 12) where a field is said to be fed (with water) from a *ḫnm* (Blackman, 1941, p.83–95).

64 A further argument against the hypothesis that *ḫnm* could have succeeded to an obsolescent *mr* comes from the analysis of the distribution of this word in the four zones of Text A. Indeed among the 11 *ḫnm* named in this text, 5 are in Zone 4 and 2 in each of the other zones which clearly departs from the distribution of toponyms referring to a *mr*, which largely predominate in Zone 1.

65 Schenkel, 1994, p. 29f. On ancient dykes see also Gomaà et al., 1991, p. 33–72.

66 Spermeru has been identified with Safaniya by Gomaà et al., 1991, p. 78.

where the assessed fields probably lay in the central part of the floodplain, which suggests that they are associated with the more common categories of land, namely those located in natural inundation basins.

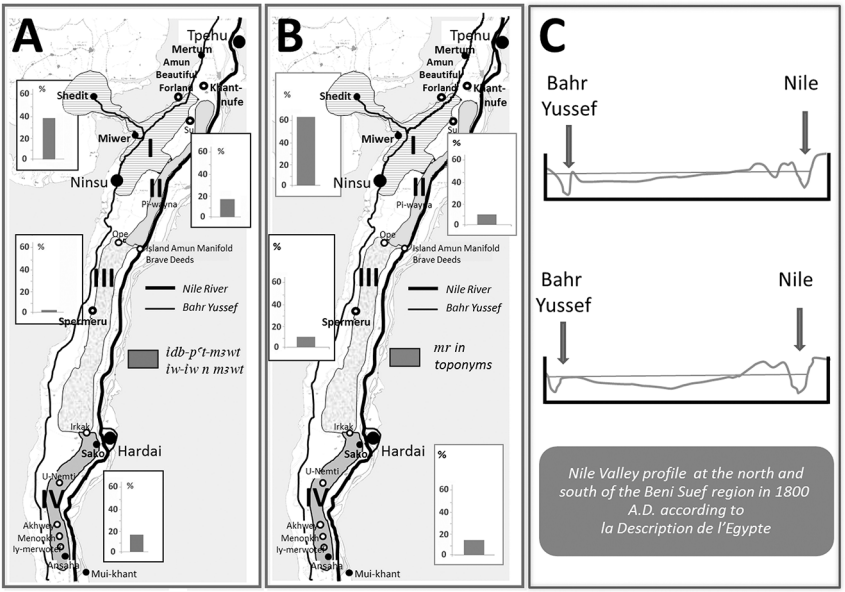

Figure 4. Proportion of fields on idb, pˁt, iw, iw-n-mɜwt and mɜwt (A) and of toponyms incorporating the word mr (canal) or using the canal sign as determinative (B) in the four zones of Text A of P. Wilbour. Roman numerals indicate the zone number. The possible distribution of plots in the floodplain in the four zones is from Antoine, 2011. *The Nile River and Bahr Yussef courses are hypothetical. In C is the schematic Nile valley profile according to the* Description de l'Egypte *at the level of Zone 1-2 (upper row) and Zone 3 (lower row).*

10. The socio-geographical pattern of the agricultural landscape

Multiple correspondence analyses have shown the importance of social factors in the organisation of land in P. Wilbour. A detailed analysis of plots in the *pš* domains of text A was therefore conducted to specifically assess this point using multivariate logistic regression with the primary landmarks categories as dependent variables and professions or occupations as explanatory variables.

The results are summarised in table 3. They confirm what was suggested by the MCA. Two groups of association clearly occur. On the one hand, plots on soil categories lying in the meandering belt of waterways, namely on *iw*, *iw-n-mȝwt*, *mȝwt*, *idb* and *pꜥt*, which are associated with local temple staff including priests (*wȝb*) and prophets, overseers of cattle, scribes and high ranking officials but also administrators and cultivators who for the most part were the middlemen of these people in the administration of normal domains.[67] On the other hand, plots near settlements and their neighbourhood, such as groves, mounds and high grounds (*ḳȝyt*), are associated with professions mostly linked with the army. Some of these associations provide interesting clues to the economic activity conducted in these categories of settlements.

This is particularly the case for the strong relationship of herdsmen with *ꜥt* (OR: 13.15; CI 3.05-56.8) which highly suggests that these settlements where closely linked with cattle farming. The word *ꜥt* is usually translated as "house" which is here inadequate since it clearly has a professional connotation and something like farmstead is probably more accurate.[68] This kind of settlement is especially abundant in Zone 3 where military professions and particularly simple soldiers predominate and where Spermeru is the only centre of some importance. Another interesting association is that of stable masters (*ḥry-iḥw*), a category of support personnel for the army[69] (OR: 2.0; CI 1.45-2.77), and charioteers (*kṯ*) (OR: 3.62; CI: 1.86-7.06) with *bḫn*.[70] In literary sources[71] *bḫn* is depicted as a large and idyllic farm villa, possibly fortified,[72] reflecting the wealth

67 On *iḥwtyw* see Menu, 1970, p. 135–145; Moreno Garcia, 2009–2010; Janssen 1986, p. 356f, reporting the translation of "agent of the fisc" proposed by Stuchevsky. On *rwḏw*: Kruchten, 1979. On the organization of temple land holding see mainly Janssen, 1986; Haring, 1997; Id., 2009; Katary, 2013.

68 Similarly at Deir el-Medina, *ꜥt* designates a kind of workshop while house (the dwelling place) is designated by *pr*. Demarée, 2006, p. 57–66 proposes "workplace" as the best translation in the theban context. On *ꜥt* designating a farm building isolated in the fields see Meeks, 1972, p. 59 with further references. See also Willems, 2007, p. 47.

69 Schulman, 1964, p. 81–86; Chevereau, 1994, p. 45; Gnirs, 1996, p. 78–79.

70 Of 52 individuals holding plots near a castle (castle of Piot, of Iot and of Meryset), 26 are stablemasters and four charioteers.

71 P. Lansing 12, 1 and P. Anastasi III 3, 7.

72 Gardiner, 1948, p. 34 translates *bḫn* by "castle" but O'Connor, 1972, p. 693 rightly proposes "villas" which is more appropriate.

of its high-ranked owner.[73] The specific presence of plots around *bḫn* associated with professions linked with the use of horses for military purposes suggests that at least some of these settlements were specialised in horse breeding.[74]

	lady	soldier	sherden	charioteer	stablemaster	herdsman	priest	prophet	scribe	officials & overseer of cattle	rwdw	cultivator
Villages (*wḫyt*)	+	+	+	+	+			+	+		+	+
Houses (*ʿt*)						+						
Villas (*bḫn*)				+	+							
Small settlements		+	+			+						
Cities												
Mounds (*i3t*)	+											
Ḳ3yt	+											
Groves		+	+									
Idb								+	+	+		+
Pʿt							+				+	+
m3wt								+			+	+
jw/iw-n-m3wt									+	+	+	+

Table 3: Logistic regression of the 2253 plots of pš domains of Text A of P. Wilbour. The main landmarks are used as dependent variables and professions and occupations as explanatory variables. + indicates a statistically significant positive association. Empty boxes indicate absence of association. For the sake of simplicity ORs are not given.

73 In P. Wilbour the adjunction of the town determinative suggests that *bḫn* was then perceived as a toponym.

74 Of note, in the aforementioned passage of P. Lansing, the *bḫn* harbours a stable and chariots are built there from wood.

Finally, the only settlement category which escapes this dichotomous socio-geographical organisation is *wḥyt*, since plots around them pertain to a wide variety of professions including the military and their associated professions and members of temple staff. In several sources *wḥyt* contrasts with *dmi* ("town") and it is frequently translated as "village".[75] However, the word probably had a more specific meaning. Names such as "The Village of the army/troop" suggest that military colonies settled here at an undetermined point in time. However, in many instances there is no specific clue as to the origin of these localities. On the whole, ladies, soldiers and Sherden are over-represented near *wḥyt*.[76] The presence of Sherden may be a remnant of foreign troops who once were installed in specific regions of Egypt.[77] The association of some of the *wḥyt* mentioned in P. Wilbour with soldiers is in keeping with the frequent military connotation of the word during the New Kingdom and its association with people of foreign origin may refer to the notion of tribes also conveyed by the word.[78] The presence of scribes and priesthood members may be explained by the fact that several of these villages harboured a small temple[79] and needed administrative staff, but it may also indicate an organisational and economic dependence on the distant sanctuaries of the regional metropolis, since the personnel of metropolis temples probably were the main holders of plots on the meandering belt of waterways.

11. Discussion

The model developed here was obtained from statistical methods appropriate for the purpose and commonly used in the social or biological sciences. The main interest of these methods is that the resulting model is independent from

75 On *wḥyt* see Spalinger, 2008, p. 154–162; Willems, 2007, p. 47–48.

76 Among 132 individuals holding plots near villages, 24 are women, 21 soldiers and 8 Sherden. Most of these women were probably the spouses or widows of members of the army: Katary, 2001, p 61–82; Antoine, 2010, p. 5–14.

77 See P. Harris I, 77, 4-6, rhetorical stelae from Deir el-Medina (Kitchen, 1983, Vol. 5, p. 91), and P. Amiens-Baldwin, Rt. A V, 4. (Janssen, 2004).

78 Familial lineage, even expanded, may be an important factor of the structure of *wḥyt*, which also applies to settlement founded by an individual as is clear from Mose's inscription: Spalinger, 2008, p. 154–162 and Willems, 2007, p. 47–48.

79 See for example the chapel (*ḫnw*) of Montu in the Village of Inroyshes (A 29, 18). Villas may also have some place of worship as the Tabernacle (*sšmw*) of Pre in the Villa (*bḫn*) of Meryre (A 34, 21).

any preconceived point of view and affords a synthetic and holistic vision of the organisation of the ancient Egyptian landscape around 1000 B.C. both in terms of geography and sociology. As seen above and as will be discussed here, this model is coherent, in a large number of cases, it is able to predict the expected profile of a plot or an individual exercising a given occupation; although none of them evidently follows this profile in 100 % of the cases.[80] The fact that this model was obtained from the most informative document, P. Wilbour, unavoidably raises the question of the general value of this document, as it covers only a limited part of the Nile Valley.[81] Interestingly, two other land registers, dated one or two centuries later and covering another part of the valley, not only confirm what the model predicts, but which, despite their lacunous state, also shed further light on what remains unclear in P. Wilbour. Other land registers, especially P. Prachov, would also help to improve and test the model but, unfortunately, they still await full publication.[82] Archaeological and botanical methods may also contribute to the model but, for evident reasons, they focus on settlements and their immediate surroundings while the countryside proper still escapes exploration.

Text A and text B of P. Wilbour in their present state cover 20,100 and 16,255 arouras respectively.[83] After elimination of plots counted twice in text A[84] and estimation of missing data,[85] the total amount of land is 22,700 arouras in text

80 Using ROC curves and scoring of the variables retained by logistic regression as characterising a specific category it is possible to demonstrate that, on the whole, 65 % of landmarks follow the model. The proportion is 71-91 % for *idb*, *pꜥt*, *mɜwt*, *iw*, *iw-n-mɜwt*, groves, and villages and 55-64 % for the other settlements and associated landscape features. Concerning the localisation of plots according to profession, 50 % of plots, on the whole, follow the model. The proportion is 65-68 % for the military and 35-45 % for priests and their middlemen because their plots were not restricted to the meandering belt of the river. However, 76 % of plots on *idb*, *pꜥt*, *mɜwt*, *iw* and *jw-n-mɜwt* follow the social categories predicted by the model.

81 Fairman, 1953, p. 118–123.

82 The P. Prachovs (Turayev, 1927) may be particularly promising since it probably records several hundreds and possibly more than one thousand plots. At present it has only be partially published by Gasse, 1988, p. 123–138.

83 Some plots of *khato*-land appear in both texts but the total amount is negligible.

84 In *pš* A and B entries. For this see Gardiner, 1948, p. 72f.

85 This, of course, includes plots for which the surface is lost but also in text A plots pertaining to Theban and Heliopolitan temples of Zone 1, that once were recorded on another papyrus roll, and the erased section of *khato*-land in Zone 4.

A and 20,000 arouras in text B, totalling approximately 43,000 arouras. This represents only a limited proportion of the cultivated surface of this part of the Nile Valley during the Ramesside Period. However, these figures may help to obtain a rough estimation of the actual arable surface. *Khato*-land in text A represents 5.45 % of the total estimated surface and text B in all certainty contains a complete record of *khato* land in approximately the same region and at the same time. Assuming that the distribution of fields among the main landholding institutions in text A[86] is representative of the general situation in Middle Egypt at that time, we may estimate that the total cultivated area was approximately 367,000 arouras,[87] meaning that P. Wilbour may represent 12 % of the cultivated surface, which is an acceptable and representative sample. For comparison, the surface cultivated in 1800 A.D. can be estimated by planimetry from the map of the *Description de l'Egypte*[88] using ImageJ software. This gives an estimate of 2061 km^2 making some 841,000 arouras, more than twice the surface obtained for the Ramesside Period.[89] Another illustrative comparison can be made with the 292,500 aroura of arable land ascribed to the Oxyrhynchite Nome in the fourth century A.D.[90] Taking into account that the nome covered about 70-80 % of the region surveyed in the P. Wilbour at that time, the order of magnitude is very similar to that of the Ramesside Period. Thus, the assumption used here to estimate the cultivated surface of P. Wilbour at the time appears to be quite plausible. Even if we add landed property of institutions not named in the document, comparison with the arable surface at the time maps of the

86 Namely Theban, Heliopolitan, Memphite, and local temples and secular institutions provided there were no other categories of landholding, particularly completely private holdings, which escaped administrative recordings.

87 Calculated as follows: (43,000 arouras/5.45) x100.

88 Using maps 15–19 of the *Description de l'Egypte* Volume V, Paris 1818. Although of fairly good quality, these maps show a slight distortion of reality when attempting to overlap the position of BeniSuef, Medinet al Fayyum and Samalut with satellite images; this leads to an overestimation of surface of about 10.4 %. This was taken into account in the figure given here.

89 The same methodology can be applied with modern surfaces by using satellite image. This results in 8900 km^2, about 3.26 million arouras, i.e. more than ten times the area estimated for the P. Wilbour.

90 Rowlandson, 1996, p. 17. This estimation relies on a fourth century text which indicates the total amount of land cultivated in cereals to which is added the estimated surface of vineyards, gardens, inhabited places, dykes and canals, totalling about 800 km^2.

Description de l'Egypte were produced raises the suspicion that cultivated zones probably predominating around settlements, alternated with regions where the floodplain was left to its natural regime.

An important aspect revealed by the model is the almost dichotomous organisation of the landscape opposing *iw*, *iw-n-mȝwt*, *mȝwt*, *idb* and *pʿt*, which probably lay in the meandering belt of the River Nile and the Bahr Yussef to landscape features lying near settlements or in the floodplain. The former represent 11 % of the total surface of texts A and B,[91] which compares with the modern proportion of land situated in the same area of the valley in the region of Beni Suef (15.3 %) and Beni Mazar (4.1 %) as estimated from satellite imaging – that is to say in the north and south part respectively of the area covered by P. Wilbour.[92] It is particularly interesting that the modern repartition of land follows what is observed in text A with a higher proportion of land in the meandering belt near Beni Suef, next to Zone 1 and 2 and a lower one near Beni Mazar, which corresponds to Zone 3, thereby confirming that P. Wilbour may be fairly representative of the general situation at the time.

The *Description de l'Egypte*[93] provides further interesting information of the Nile Valley profile in this part of Middle Egypt (see Figure 4). In the north, at the level of Beni Suef, it mentions a 2 km wide levee lining the river followed in the east by a sloping floodplain gradually descending to the Bahr Yussef and the desert's edge. A different situation prevails in the south where the floodplain is marked by a longitudinal central depression called the Bahr Bathen, "the inner river",[94] where the state of flood persists longer than elsewhere. The *Description de l'Egypte* adds that these profiles were associated with different irrigation systems. Due to the westward slope, a natural irrigation was possible all over the floodplain in the north; artificial irrigation was necessary on the large meandering belt that lines the river while natural irrigation was centred on the middle of the floodplain in the south and artificial irrigation was restricted to

91 Calculated on the preserved data. To this, the surface of plots on high grounds (*ḳȝyt*) which also lie in the meandering belt of the Nile should be added, which brings the proportion to 12.2 % of the total surface.

92 As measured by GIS analysis from satellite data: Afify, 2010, p. 6 and Wahab/El Semary, 2012, p. 5685.

93 Martin, 1825, p. 6–15. For an analysis of the geographical information provided by the *Description de l'Egypte* see more particularly Gomaà et al., 1991. On the presence of a central channel probably temporarily flooded in this region of Middle Egypt see Subias et al., 2013, p. 27–44.

94 Or the "the river belly".

the very banks of the Nile and the BahrYussef.[95] These data shed light on what occurs in Zone 3 and 4 of P. Wilbour where fields were probably mainly located in the central part of the valley, suggesting that their irrigation depended on inundation basins in keeping with the presence of dykes in this region.[96]

As already discussed, the fact that land registers seldom, if ever, mention canals is a puzzling problem.[97] In the P. Wilbour, toponyms referring to a canal perhaps allude to the Bahr Yussef. However, the existence of irrigation canals is attested in inscriptions or representations since the origin of Pharaonic Egypt[98] but usually in a religious setting or in a context of propaganda to the benefit of a ruler or a nomarch. This raises the question of the real development of this irrigation system and of the surface that was actually irrigated by means of dykes and canals. Land registers show that – at least in the region of Middle Egypt studied here and in the eleventh to tenth century B.C. – there was probably only limited modification of the riverine system. Local short dykes leaning on natural heights in the valley may have sufficed to increase the duration of water stagnation in inundation basins, while adjustments of the short temporary channels branching on the riverbanks[99] may improve irrigation in the meandering belt by facilitating water access and drainage.[100] Butzer has estimated that "an average flood would allow a single crop season over perhaps two-thirds of the alluvial surface"[101] with an unmodified water regime, which largely covers the cultivated area estimated from P. Wilbour. In this system, levees are formed during the inundation season when the floodwater tops the bank, rapidly depositing its load of fine sand and coarse silt. As floodwater flows away from the channel, water velocity diminishes and sediments accumulate with greater thickness closer to the channel and finer silt accumulates in depressions, provided water remains for a sufficient time.[102] If we project these

95 GIS analysis shows that the valley is occupied by a series of inundation or discharge basins arranged in a north south manner in the region of Beni Mazar: Wahab et al., 2012, p. 5685.

96 Subias et al., 2013, p. 33–35.

97 Among the eleventh to tenth century B.C. land registers, a canal is only named in P. Berlin 23253 II, 53 and III, 21. On canals in general in the Nile Valley landscape see Michel, 2005, p. 257f.

98 Schenkel, 1978.

99 These channels are well illustrated on the maps of the *Description de l'Egypte*.

100 Willems, 2013, p. 347–349.

101 Butzer, 1976, p. 20.

102 Hassan, 2010, p. 5–6.

data on the typical Nile valley profile of figure 5, it appears that the maximum of silt deposit, and thus of lands able to provide the best yield, lies in the low flats lining the Nile or the Bahr Yussef and in the central depression of the valley. These regions may be exposed to moisture in cases of excessive flood or, if waters stay longer or if drainage becomes deficient while, with a too brief stage of the flood or an insufficient inundation, they may be exposed to dryness.

These elements help to understand the agricultural specificity of plots localised on *iw*, *iw-n-mȝwt*, *mȝwt*, *idb* and *pʿt*, which provide the best yield when planted with grain and can also be cultivated with vegetables, fodder and cucurbits on small parcels. Land with a high grain yield or under an alternative culture was probably not restricted to this part of the floodplain;[103] however, they both occur on the same category of soils, although not necessarily in the same fields at any given time.[104] Furthermore, cultivation on these lands needs adaptation and is not a straightforward process as it is exposed to particular risks such as dryness or excessive moisture, and may need periods of fallow if the interpretation of *wsf* is correct. Constant high grain yield over the years is not secure as is shown by fluctuations of the classification of a given plot as *ḳȝyt*, *tni* or *nḫb* in text B. All of this probably accounts for the designation of half of the fields as *corvée*-land in P. Reinhardt, that is to say as a category of land which needs compulsory and administratively controlled exploitation. The high proportion of fields held by a water-chief in this document is certainly an indication that water control plays an important role in their management and needs specific skill.[105] The limitation of the available surface in this part of the floodplain is another important factor and probably explains why plots were smaller here than elsewhere. Alternatively, the reduced size of the plots and the need for compulsory labour may be due to the necessity of developing more work and energy to obtain the expected yield, which could only be achieved on smaller surfaces.

A system of fallow (*wsf*) restricted to very small plots measured in land-cubits regularly occurs in P. Wilbour where it represents 38 % of the fields measured in this unit, in contrast with other documents, including the verso of the Louvre-Griffith fragments, P. Reinhardt and P. Berlin 23253, where

103 44 % of plots measured in land-cubits in the P. Wilbour are located elsewhere.

104 The situation is apparently different in the P. Wilbour and the P. Reinhard. In the former, the coexistence in the same place of both types of culture is uncommon while it is the rule in the latter.

105 Vleeming, 1993, p. 56–67; Endesfelder, 1979, p. 37–51 compared this title with *ḥry-mw*, *ʿȝ-bʿḥ*, *mr-bʿḥ* and *hry-bʿḥ*. On *bʿḥ* designating a garden land possibly artificially irrigated see Eyre, 1994, p. 70–71.

they are mentioned only occasionally. This may indicate regional differences in agricultural practice, the consequence of local variations of soil quality, or climatic changes between the eleventh and tenth centuries B.C.[106] Katary recently proposed that *wsf* plots may be subject to a rotation of culture alternating grain, vegetables and fallow in a way prefiguring what is illustrated in the Fayyum in the Ptolemaic period,[107] i.e. in a region which entirely depends on artificial irrigation as it is not reached by the flood.[108] This remains speculative, however, it is clear that the soil was not suitable for cultivation for a period of time and had to rest.[109] This may be explained by the fact that plants cultivated on these fields needed more nutrients than those supplied by the flood. This raises the question of whether some of these plots may have been artificially irrigated or whether they produced a second crop during the dry season, which would expose the land to exhaustion and would explain the necessity of a fallow period if this was repeated over several consecutive years. As we have seen, land-cubit measured plots may have predominated along the Bahr Yussef, which has only low levees, so that a mechanical or manual water-lifting may be easier here than on the Nile banks.[110] Artificial irrigation and additional work demand may also explain why these plots were so small. In P. Reinhardt, vegetables, cucurbits and grass were cultivated in regions exposed to an excess of water, probably in low flats. In P. Wilbour vegetables were probably not cultivated on plots measured in land-cubits, but other crops such as cucurbits, lentils or leguminous may have been planted there. A second crop of cereals may also explain why tax was higher on *nḫb* and *tni* lands if it is assumed that tax collection took into account two harvests a year.[111] P. Berlin 8523, which dates to this period,[112] illustrates several of these points and shows another way of irrigating this type of fields, which is not illustrated in the land registers. Here, a small parcel (one aroura)

106 There are indications that the Second Intermediate Period and especially the tenth century B.C. were particularly wet: Said, 1993, p. 152.

107 Katary, 2005, p. 145–147.

108 Manning, 2003, p. 30.

109 As *wsf* plots represent about 1/3 of plots measured in land-cubit, we may speculate that fallow occurs for one year every two years.

110 Levees are about one meter above the flood plain along the Bahr Yussef agains 2 to 3 meters along the Nile (Subias et al., 2013, p. 38). See also Willems, 2007.

111 On the hypothesis that *t n i* land which Vleeming translates as "elevated land" were possibly artificially irrigated and may give two crops a year, see Vleeming, 1993, p. 68.

112 Allam, 1973, p. 275–276 and Id., 1994, p. 1–7.

of a landholding is planted with vegetables and depends on a well (*šdt*) for its irrigation. Interestingly, the landholding is composed of *nḫb* and *ꜥmꜥmt* land, the latter term designating a mud flat.[113] This text corroborates the hypothesis that *nḫb*-land may have been artificially irrigated to achieve a non-cereal crop or lay near over-watered soils, probably in low parts of the floodplain just above the water-table, where a well may be easily dug and water may stay a long time, thus transforming the soil into mud.

Whatever the uncertainties still pending regarding the nature of these lands, and despite the difficulties involved in their exploitation, lands located on the meandering levee belt of the river clearly had significant economic value, as is shown in P. Wilbour by the contrasting sociological pattern of their holders, who are mostly local temple staff and high-ranking officials. The weight of social factors in the organisation of the Nile valley landscape is another important result of this analysis and deserves more specific comment. It is important to underscore here how social factors may help to clarify economic activity in or around some categories of settlements.

12. Conclusion

The study of landmarks used in land registers to describe plot localisation allows the reconstruction of the ancient Nile Valley landscape with the help of statistical methods to analyse the complex structure underlying such texts as P. Wilbour. The model deduced from this text is coherent and is validated by documents of the tenth century B.C. in another part of Middle Egypt, and by confrontation of the results with information on the modern and pre-modern situation, despite obvious differences. This model improves our understanding of the terminolopgy used to describe landscape features, whether inhabited or not. It suggests minimal adjustment of the natural riverine system and a specific agricultural exploitation of the meandering belt of both the Nile and the Bahr Yussef. Besides regional geomorphological factors, social and economic aspects significantly contributed to the organisation of this landscape.

113 On this word see Gardiner, 1947, p. 10–12, where it is interestingly associated with *ḳꜣyt*, *tni* and *nḫb*. The word occurs as a landmark in the Louvre-Griffith fragments and in text B of the P. Wilbour (18, 8) where it enters in a compound name: *š-ꜥmꜥmt*, Lake of Mud, associating here also a mudflat with a standing water area.

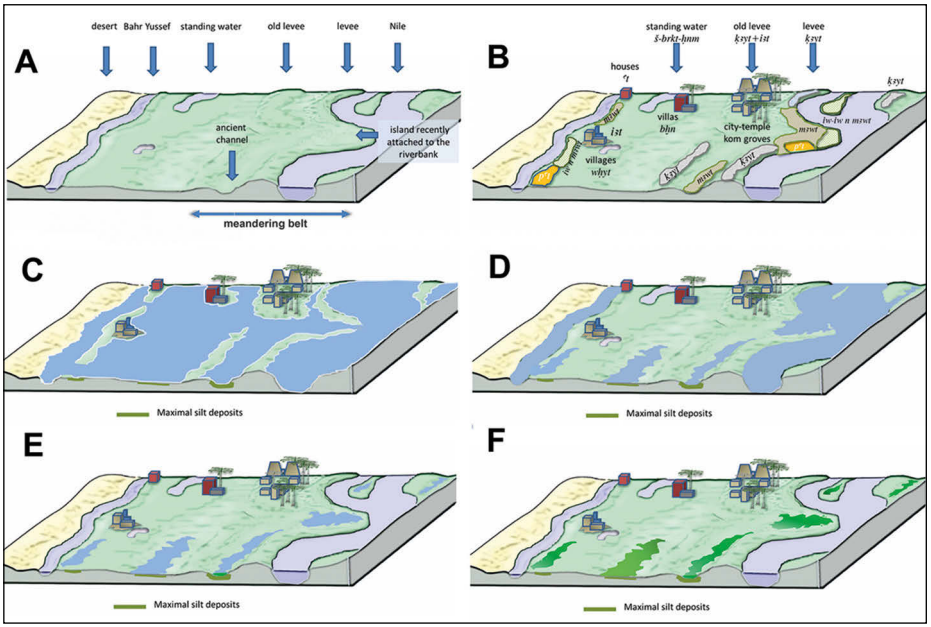

Figure 5. Typical profile of the Nile Valley in the region covered by the P. Wilbour. A: Natural profile with landscape features. B: Projection of landscape features named in the papyrus according to the results of logistic regression analysis of the relationship between main and secondary landmarks. C-F. Hypothesised flood regime with no or minimal artificial adjustment of the floodplain, showing the expected distribution of maximum silt deposits and land of the best quality (green).

Annex 1

Variables and their categorisation entered in the analysis. One entry corresponds to one plot to which the variables listed below were attached as appropriate.

- Text A or text B.
- Main landmark: landmark categories describing plot localisation pertain to three groups.[114] The first refers to elements of the agricultural landscape. These include *ỉdb*, *pʿt*, *ḳ3yt*, island and new island (*ỉw* and *ỉw-n-m3wt*) and new land

114 Gardiner, 1948, p. 25–36; Antoine, 2011, p. 9–27.

(*mꜣwt*) which were considered as many categories; the second group refers to human settlements and includes the following categories: well-known cities[115] and their temples with their pylons (*pr*, *ḥwt*, *bḫn*), villages (*wḫyt*), houses (*ʿt*), villas (*bḫn*) and agricultural buildings including byres (*ihꜣy*), granaries (*šnwt*), and stables (*iḥw*), other buildings (*isbt*, shelter; *sgr*/*sgꜣ*, keep/hill; *wḏꜣ*, storehouse; *ḫr*, tomb), and finally the numerous otherwise unknown small localities (other localities) which the town determinative suggests to have been inhabited places. The last group comprises the following categories: mound (*iꜣt*), grove (*nhꜣt*, sycamore, *štꜣ*, copse; *ḥḏ*, clearing (?), and other plantations), and resting waters (*ḫnm*, *m-ḫn*: basins, *š*: lakes, and *brkt*: ponds) which appear to be associated with settlements.

- Land holding institution: secular,[116] local, regional,[117] Theban, Memphite, Heliopolitan temples.
- Domain category: *rmnyt*, *rmnyt pš*, *šmw pš*, field for the white goats (*mkiḃ ḥḏ*), herbage (*smw*), field of Pharaoh (*ꜣhwt Pr-ʿꜣ*), *khato*-land (*ḥꜣ-tꜣ*)/*mine*-land (*mỉnt*), other, not specified/lost.[118]
- Land holders: P. Wilbour lists more than one hundred different occupations which were assigned to 29 socio-professional categories.[119] Women (*ʿnḫt-nw-nỉwt*), cultivators (*iḥwty*), herdsmen (*mnỉw*), beekeepers (*bỉty*), representatives (*rwḏw*), deputies (*idnw*), and godfathers (*it-nṯr*) were easily classified since they bear only one title. All individuals bearing the title soldier (*wʿw*), charioteer (*kṯ*), stable master (*ḫry-iḥw*), priest (*wʿb*), prophet (*ḫm-nṯr*), scribe (*sš*), whether with or without extension, were entered into as many categories. We considered the Sherden mercenaries (*šʿrdn*) proper as a category, while their retainers (*šmsw*) and standard-bearers (*ṯꜣysryt*) were grouped with individuals of the same rank. High ranking persons included a King's son, the Vizier, the High Priests of Thebes and Heliopolis, the Steward of the House of Amun, and overseers of cattle and local temples and mayors of regional towns. Other military included shield bearers, retainers, quartermasters and others. The remaining titles were summed up under the category "other" while the "lost" or "unspecified" categories encompassed persons for whom the title

115 Gardiner, 1947, Vol. II and Id., 1948, p. 196, table III.

116 Harems, landing places of Pharaoh, and *mine* and *khato*-lands

117 Regional sanctuaries designate temples not located in the surveyed region or in Thebes, Heliopolis, or Memphis.

118 Gardiner, 1948, p. 23–25 and 169f. For fields of Pharaoh see also Haring, 1997, p. 321f.

119 Gardiner, 1948, p. 79–84.

was lost or not given. For normal domains of text A, the profession of the main responsible administrator (the one introduced by *r-ḥt*) was kept when a subordinate administrator introduced *bym-ḏrt* was also named.[120]

- Fiscal categories of plot: *ḳȝyt*, *tnỉ*, *nḫb*, type I, type IA, type I/II, type II, type IIA, lost.
- Surface unit: aroura, land-cubit.
- Plot surface in aroura: small plot: <10 arouras in text B and in normal domains of text A and <5 arouras in *pš* domains of text A; large plot: >10 arouras in text B and in normal domains of text A and >5 arouras in *pš* domains of text A; lost.

Bibliography

Afify, Afify/Arafat, Sayed/Aboel Ghar, Mohamed/Khader, Magdi, Physiographic soil map delineation for the Nile alluvium and desert outskirts in the middle north of Egypt using remote sensing data of Egyptsat-1, in: US-Egypt Workshop on Space Technology and Geo-information for Sustainable Development, Cairo 2010. http://www.aag.org/cs/projects_and_programs/geoinformation_for_sustainable_urban_ management/2010cairoworkshop, 14.6.2010.

Allam, Schafik, Hieratische Ostraka und Papyri aus der Ramessidenzeit (Urkunden zum Rechtsleben im alten Ägypten 1), Vol. I, Tübingen 1973, p. 274-275.

Id., Implications in the hieratic P Berlin 8523 (registration of land-holding), in: Essays in Egyptology in honor of Hans Goedicke, ed. by Betsy Morrel Bryan/David Lorton, San Antonio1994, p. 1-7.

Alleaume, Ghislaine, Les systèmes hydrauliques de l'Egypte pré-moderne. Essai d'histoire du paysage, in: Itinéraires d'Egypte, Mélanges offerts au père Maurice Martin, ed. by Christian Décobert, BdE 107 (1992), p. 301-322.

Antoine, Jean-Christophe, Dead people in P Wilbour. What can we learn from them?, in: Göttinger Miszellen 225 (2010), p. 5-14.

Id., The Wilbour papyrus revisited. The land and its localisation. An analysis of the places of measurement, in: Studien zur altägyptischen Kultur 40 (2011), p. 9-27.

120 Ibid, p. 65–70 and Menu, 1970, p. 44–53.

Id., Social position and the organisation of landholding in Ramesside Egypt. An analysis of the Wilbour Papyrus, in: Studien zur altägyptischen Kultur 43 (2014), p. 16-46.

Barrois, Julien, Les Irrigations en Egypte, Paris 1904.

Benzcéri, Jean-Paul, L'analyse des Données, Vol. 2. L'analyse des correspondences, Paris 1973.

Besançon, Julien, L'Homme et le Nil, Paris 1957.

Blackman, Aylward, The stela of Shoshenk, Great Chief of the Meshweh, in: Journal of Egyptian Archaelogy 27 (1941), p. 83-95.

Bunbury, Judith, Geoarcheology in: SHAW, IAN, The Gurob Harem Palace Project, Spring 2012, in: Journal of Egyptian Archaeology 98 (2012), p. 52-54.

Butzer, Karl, Early hydraulic civilization in Egypt. A study in cultural ecology, Chicago 1976.

Cerny, Jaroslav, Some Coptic Etymologies III, in: Bulletin de l'institut français d'archéologie orientale 57 (1958), p. 203-213.

Chevereau, Pierre-Marie, Prosopographie des cadres militaires égyptiens du Nouvel Empire, Antony 1994.

Demarée, Robert, A house is not a Home. What exactly is a hut?, in: Living and Writing in Deir el-Medine, ed. by Andreas Dorn/Tobias Hofmann, Basel 2006, p. 57-66.

Endesfelder, Erika, Zur Frage der Bewässerung im pharaonischen Ägypten, in: Zeitschrift für ägyptische Sprache und Altertumskunde 106 (1979), p. 37-51.

Eyre, Christopher, The water regime for orchards and plantations in Pharaonic Egypt, in: Journal of Egyptian Archaeology 80 (1994), p. 57-80.

Fairman, Herbert, Review work: the Wilbour Papyrus by Alan H. Gardiner, in: Journal of Egyptian Archaeology 39 (1953), p. 118-123.

Faulkner, Raymond, The Wilbour Papyrus, Vol. 4, Index, Oxford 1952.

Gardiner, Alan, Late-Egyptian Miscellanies, Brussels 1937.

Id., Ancien Egyptian Onomastica, Oxford 1947.

Id., TheWilbour Papyrus, Vol. 2, Commentary, Oxford 1948.

Gasse, Annie, Données nouvelles administratives et sacerdotales sur l'organisation du domaine d'Amon. XX^{e}-XXI^{e} dynasties, Bibliothèque d'études 104 (1988).

Girard, Pierre-Simon, L'agriculture et l'industrie, in: Description de l'Egypte, Vol 17, Etat moderne, Paris 1824.

Gnirs, Andrea M., Miltär und Gesselschaft. Ein Beitrag zur Sozialgeschichte des Neuen Reiches, Studien zur Archäologie und Geschichte Altägyptens 17, Heidelberg 1996.

Gomaá, Farouk/Müller-Wollermann, Renate/Schenkel, Wolfgang, Mittelägypten zwischen Samalut und dem Gabal Abu Sir, Beihefte zu Tübinger Atlas des Vorderen Orients B/69, Wiesbaden 1991.

Grandet, Pierre, Le papyrus Harris I (BM 9999), Bibliothèque d'études 109 (1994).

Grieshaber, Frank, Lexikographie einer Landschaft. Beiträge zur historischen Topographie Oberägyptens zwischen Theben und Gabal as-Silsila anhand demotischer und griechischer Quellen, Göttinger Orientforschungen IV/45, Wiesbaden 2004.

Hassan, Fekri, Climate change, Nile floods and riparia, in: Riparia Dans l'Empire Romain, ed. by Ella Ermon, Oxford 2010.

Hassan, Fekri/Tassie, Geoffrey, Modeling environmental and settlement change in the Fayum, in: Egyptian Antiquities 29 (2006), p. 37-40.

Haring, Ben, Divine households. Administrative and economic aspects of the New Kingdom royal memorial temples in Western Thebes, (Egyptologische Uitgaven 12), Leiden 1997.

Id., Economy, in: UCLA Encyclopedia of Egyptology, ed. by Elizabeth Frood/Willeke Wendrich, Los Angeles 2009, http://repositories.cdlib.org/nelc/uee/1028.

Hosmer, David/Lemeshow, Stanley, Applied logistic regression, New York 1989.

Helck, Wolfgang, Materialien zurWirtschaftsgeschichte des Neuen Reiches, Vol. 2, Mainz 1960.

Janssen, Jacobus, Prolegomena to the study of Egypt's economic history during the New Kingdom, in: Studien zur altägyptischen Kunst 3 (1975), p. 127-185.

Id., Agrarian administration in Egypt during the Twentieth Dynasty, in: Bibliotheca Orientalis 43 (1986), p. 352-366.

Id., Grain Transport in the Ramesside Period: Papyrus Baldwin (BM EA 10061) and Papyrus Amiens, (Hieratic Papyri in the British Museum 8), London 2004.

Katary, Sally, Land tenure in the Ramesside Period, London 1989.

Id., Land tenure in the New Kingdom. The role of women smallholders and the military, in: Agriculture in Egypt. From pharaonic to modern times, ed. by Alan Bowman/Eugene Rogan, Oxford 2001.

Id., The administration of institutional agriculture in the New Kingdom, in: Ancient Egyptian administration, ed. by Juan Carlos Moreno Garcia, Leiden 2013, p. 719-783.

Id., The *wsf* plots in the Wilbour Papyrus and related documents. A speculative interpretation, in: Cahiers de recherches de l'Institut de papyrologie et égyptologie de Lille 25 (2005), p. 137-155.

Kitchen, Kenneth, Ramesside inscriptions, Vol 5 and 6, Oxford 1983.

Kemp, Barry, Ancient Egypt. Anatomy of a civilization, London 2006.

Kruchten, Jean-Marie, L'évolution de la gestion domaniale sous le Nouvel Empire Égyptien, in: State and temple economy in the Ancient Near East, Vol 2, (Orientalia lovaniensia analecta 6), ed. by Edward Lipinski, Leuven 1979, p. 517-525.

Lloyd, Alan, The Late Period, 664-323 B.C., in: Ancient Egypt, a social history, ed. by Bruce G. Trigger et al., Cambridge 1983, p. 279-348.

Lutley, Katy/Bunbury, Judith, the Nile on the move, in: Egyptian Antiquities 32 (2008), p. 3-5.

Le Roux, Brigitte/Rouanet, Henri, Multiple correspondence analysis, London 2010.

Meeks, Dimitri, Le grand texte des donations au temple d'Edfou, Bibliothèque d'études 59 (1972).

Martin, Pierre Dominique, Des Provinces de Beny-Soueyf et du Fayoum, in: Description de l'Egypte, Vol XVI, Etat moderne, Paris 1825, p. 6-15.

Manning, Joseph, Land and power in Ptolemaic Egypt, Cambridge 2003.

Menu, Bernadette, Le régime juridique des terres et du personnel attaché à la terre dans le Papyrus Wilbour, Lille 1970.

Michel, Nicolas, Travaux aux digues dans la vallée du Nil aux époques papyrologique et ottomane. Une comparaison, in: L'agriculture institutionnelle en Égypte ancienne. État de la question et approches interdisciplinaires, ed. by Juan Carlos Moreno Garcia, Cahiers de recherches de l'Institut de papyrologie et égyptologie de Lille 25 (2005), p. 253-276.

Moreno Garcia, Juan Carlos, Les *iḫwtjw* et leur rôle socio-économique du III^{e}au I^{er} millénaire avant J.-C., Cahiers de recherches de l'Institut de papyrologie et égyptologie de Lille 20 (2009-2010), p. 321-351.

O'Connor, David, The geography of settlement in Ancient Egypt, in: Man settlement and urbanism, ed. by Peter Ucko et al., London 1972, p. 681-698.

Rowlandson, Jane, Landowners and tenants in Roman Egypt. The social relations of agriculture in the Oxyrhynchite Nome, Oxford 1996.

Said, Rushdi, The River Nile, geology, hydrology and utilization, Amsterdam 1993.

Schulman, Alan, Military rank, title, and organization in the Egyptian New Kingdom, (Münchner Ägyptologische Studien 6), Berlin 1964.

Schenkel, Wolfgang, Die Bewässerungsrevolution im Alten Ägypten, Mainz 1978.

Id., Les systèmes d'irrigation dans l'Egypte Ancienne et leur génèse, in: Archéo-Nil 4 (1994), p. 27-35.

Spalinger, Antony, A garland of determinatives, in: Journal of Egyptian Archaeology 94 (2008), p. 154-162.

Stuchevsky, Iosif, Zmledel'tsy gosudarstvennogo chozyaïstva drevnego Egipta epoki Ramessidov, Moscow 1982.

Subias, Eva/Fiz, Ignacio/Cuesta Rosa. The Middle Nile Valley. Elements in an approach to the structuring of the landscape from the Greco-Roman era to the nineteenth century, in: Quaternary International 312 (2013), p. 27-44.

Turayev, Boris, Papyrus Prachov (Sobranya B.A. Turayeva), Leningrad 1927.

Vleeming, Sven, Papyrus Reinhardt. An Egyptian land list from the tenth century B.C, Leiden 1993.

Id., A review of Gasse, 1998, in: Enchoria 18 (1991), p. 217-227.

Wahab, Mohamed Ahmed/El Semary mahmoud, The correlation between physiography and soils west of the Nile Valley. A case study from Egypt, Biba-Bani Mazar area, in: Journal of Applied Sciences Research 8 (2012), p. 5682-5689.

Willems, Harco, Dayr al-Barshā. Volume 1: the rock tombs of Djehutinakht (No. 17K74/1), Khnumnakht (No. 17K74/2) and Iha (No. 17K74/3); with an essay on the history and nature of nomarchal rule in the early Middle Kingdom, Orientalia Lovaniensia Analecta 155, Leuven 2007.

Id., Nomarchs and Local Potentates. The Provincial Administration in the Middle Kingdom, in Ancient Egyptian Administration, ed. by Juan Carlos Moreno Garcia, Leiden/Boston 2013, p. 341-392.

Willcocks, William/Craig, James, Egyptian Irrigation, 3rd ed., London 1911.

Yoyotte, Jean, Histoire, géographie et religion de l'Egypte Ancienne, Opera selecta, Leuven 2013.