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EARTH SCIENCE CONSERVATION AND THE QUATERNARY RECORD IN NORTHERN AND MIDDLE BELGIUM

by

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ABSTRACT

A rationale is presented for the establishment of an efficient policy of earth science conservation of Quaternary deposits and environments in northern and middle Belgium. The special significance of the Quaternary record for earth science research in general is discussed, as well as specific problems related to the conservation of Quaternary type sites. These topics are illustrated by means of a number of actual examples of important sites.

KEYWORDS

Earth science conservation, Quaternary, Belgium.

1. INTRODUCTION

Deposits dating from the Quaternary period are widely distributed in northern and middle Belgium. Due to their special significance and characteristics as compared to most older geological deposits, the conservation of Quaternary type sites often presents specific opportunities but also problems which will be outlined in the following text. The examples of Quaternary sites and sequences given below only serve to demonstrate the diversity of these environments and are by no means intended as some kind of inventory, which remains a prerequisite for the integration of earth science conservation in landscape planning.

2. THE SIGNIFICANCE OF THE QUATERNARY RECORD

The Quaternary, the most recent geological period, is characterised by important global climatic changes. Consequently, it offers great opportunities for the detailed study of environmental changes and the evolution of ecosystems on time scales of 1 to 10^5 years. Furthermore, geological, geomorphological and pedological processes which were active in a more distant geological past may be better understood by the investigation of analogues in Quaternary environments. Late Quaternary sedimentary sequences and the present-day soilscape also provide substantial evidence on the way man has used and influenced his environment (e.g. Birks *et al.*, 1988 ; Langohr, 1986).

In northern and middle Belgium, the contemporary physical landscape largely results from the work of Quaternary geomorphological processes. Not only the geology testifies of the influence of these phenomena : the geomorphological and pedological features of the physical landscape itself contain a wealth of information on its genesis. As such, the Quaternary record constitutes the link between the landscape-forming processes and the present-day landforms.

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The Quaternary record in northern and middle Belgium allows the study of simultaneous environmental changes in different sedimentary milieus (e.g. coastal, alluvial and loess deposits) in a relatively small and climatically nearly homogeneous area. Moreover, the proximity of the Atlantic Ocean further adds to the interest of the Quaternary in this region (e.g. correlation of continental and marine records of global climatic and environmental changes). The investigation of more recent earth surface events in combination with the vast amount of historical and archaeological data from northern and middle Belgium permits to compare the anthropogenically "accelerated" processes with palaeo-events linked to "natural" environmental changes (e.g. Kiden, 1991 ; Langohr, 1990).

3. THE NECESSITY FOR EARTH SCIENCE CONSERVATION IN QUATERNARY GEOLOGY

General arguments for earth science conservation relate to social, ecological and scientific aspects (de Gans *et al.*, 1984 ; Gonggrijp and Boekschoten, 1981 ; Nature Conservancy Council, 1990).

From a scientific point of view, it is essential to preserve certain sedimentary sequences and palaeosoils as model or type sections, especially if they have been studied in the past and have been accepted by the international scientific community as sites of exceptional importance. In this way, they can be kept as permanent references for correlation purposes, and remain accessible for more detailed investigations when improved techniques become available.

Earth science conservation in the Quaternary should also extend to the preservation of modern analogues of certain geological, geomorphological, pedological and ecological processes and settings. These are found in many recent and subrecent natural or semi-natural environments This need is especially felt in densely populated and industrialised regions, where those environments are under severe pressure. As the physical landscape features form the basic framework of biological and geographical landscape structures, their preservation is also a prerequisite for landscape conservation in general. It is clear that in this case, the objectives of earth science conservation and nature and landscape conservation converge towards a common goal, which is even more so when not only scientific motives, but social and educational functions are considered as well. Mutual interests also exist with the preservation of the archaeological and historical heritage (e.g. Langohr *et al.*, 1982 ; van Mourik, 1988).

4. SPECIFIC PROBLEMS RELATED TO QUATERNARY EARTH SCIENCE CONSERVATION

Quaternary deposits are in general more vulnerable to human interference than older sediments, due to their unconsolidated nature, their position close to the surface, their limited thickness, their fragmentary character, and their greater complexity which makes an inventorisation often a difficult undertaking.

Conflicting interests may exist between the conservation of the Quaternary record and e.g. the exploitation of natural resources, groundwater extraction, agriculture, urbanisation, and even some forms of recreation or nature management. For example, even an apparently harmless lowering of the groundwater table by groundwater extraction or drainage would almost certainly cause compaction of fine-grained deposits and increase biological disturbance, resulting in the distortion of sedimentary structures. Furthermore, organic material, including the fossil content, would be oxidised and ultimately destroyed, and the deposits would be subject to physical and chemical alteration (e.g. clay migration, mineral weathering, acidification). Likewise, dredging of infilled water bodies to restore open water may destroy their sedimentary record completely.

Clearly, problems of this kind present a serious challenge to an efficient conservation policy, which should envisage an optimum preservation of the sedimentary record, including its sedimentological, mineralogical, pedological and (micro)palaeontological characteristics. Moreover, successful conservation of most sites is only possible when their spatial context is taken into account as well, as for example horizontal facies changes are important indicators for palaeoenvironmental conditions, and small geographical features can not be considered apart from their landscape- and environmental setting (e.g. de Gans *et al.* , 1984).

The need to preserve some natural or semi-natural environments or landforms as modern analogues presents problems comparable to those encountered in the conservation of ecologically valuable areas. As mentioned above, the objectives of nature conservation and earth science conservation may well converge, in which case a close cooperation would be mutually beneficial.

The current absence of an adequate inventory of the Quaternary in northern and middle Belgium makes the formulation of an earth science conservation policy for this geological period difficult. The weak interest in Quaternary research in Belgium compared to neighbouring countries, exemplified by the lack of funding in this area, will certainly not alleviate the problem.

5. A CONSERVIATIONIST'S VIEW OF THE QUATERNARY IN NORTHERN AND MIDDLE BELGIUM

Although a detailed inventory of suitable Quaternary type sections, sequences and environments is still lacking, a general overview will be presented here, subdivided by type of deposit or setting and with some comments as to their significance. Although the following list is certainly not exhaustive, it demonstrates the wealth of Quaternary features present in northern and middle Belgium.

5.1. Coastal and perimarine deposits

These occur in the coastal plain and in the lower part of the Schelde and IJzer rivers. They provide information on sea-level changes, possible tectonic and isostatic movements, coastal development, and related environmental changes during the Quaternary (Baeteman, 1989 ; Mostaert, 1985). The Holocene record is by far the most complete and goes back to about 8000 BP ; in areas with interdigitating peat and clastic deposits it is possible to reconstruct transgressive and regressive sea-level tendencies and attempt correlations with climatic fluctuations or coastal evolution patterns. Modern analogues of ancient depositional environments can be found in the Zwin Nature Reserve and along the Schelde estuary, but their preservation is at present seriously threatened.

5.2. Fluvial deposits

The infilling of major Quaternary valley systems, especially in northern Belgium (e.g. the Flemish Valley), consists mainly of fluvial deposits of considerable thickness (more than 20 m). They contain valuable indications on climatic changes and related palaeo-hydrological phenomena, mainly dating from the last two glacial-interglacial cycles (De Moor, 1963 ; De Moor and Heyse, 1978).

Abandoned river channels and floopain deposits in present-day and subrecent alluvial plains present evidence on climatically-induced changes in e.g. river discharge and sediment load (e.g. Huybrechts, 1989 ; Kiden, 1991 ; Munaut and Paulissen, 1973), and form a repository of palaeoecolgical information on former as well as on modern environmental changes, including those caused by human activities (e.g. vegetationalchanges, soil erosion, agriculture, settlement) (Beyens, 1983 ; Denys and Verbruggen, 1989 ; Minnaert and Verbruggen, 1986 ; Verbruggen, 1971).

The terrace sequence of the River Maas (Middle and Late Quaternary) is best developed downstream of Maastricht (Paulissen, 1973). The occurrence of some terrace levels is restricted to Belgian Limburg. The floodpain of the Maas has known an evolution different from other rivers in lower and middle Belgium and as such has a high geoscientific value. As it has already been severely affected by gravel extraction, there exists an urgent need to preserve some of the remaining area (Paulissen, 1983, 1986).

5.3. Lake and mire deposits

Although not very widespread in northern and middle Belgium, these environments provide for near-ideal preservation of clastic or organic sediments in a more or less closed system. Lateglacial lake deposits testify of the large short-term climatic fluctuations and palaeo-ecological changes at the transition from full-glacial to warmer Holocene conditions (e.g. Denys *et al.*, in press ; Verbruggen, 1979b), while present-day lakes, pools and marshes, such as the "vennen" in the Kempen area register a.o. recent eutrophication, heavy metal pollution, and acidification (Beyens, 1984).

The protection of these wetlands should include the surrounding higher landscape positions as well. This will permit to preserve and study the dynamic processes (erosion, sedimentation, lateral water flow with associated eluviation and illuviation of chemical compounds) that were and still are active in the landscape. Only such a "system" approach (landscape system, hydrological system, ecosystem, soil system...) will permit a holistic understanding of nature's complexity.

5.4. Aeolian deposits

A large part of middle Belgium is covered by aeolian loess deposits of mainly Weichselian age. Soil characteristics and sedimentary structures allow estimates of palaeoclimatological parameters. Some marker horizons defined in the Belgian loess stratigraphy (e.g. Kesselt, Rocourt, Warneton, Harmignies) have found more widespread acceptance in western-european nomenclature and are correlated with important climatic changes (Paepe & Vanhoorne, 1967 ; Langohr & Sanders, 1984).

Present-day or Holocene coastal and inland dunes, as well as Weichselian loess, coversand and dune formations form potential analogues for the interpretation of

PLATE 1

Foto 1. The Nature Reserve of the Westhoek is the last vast area in Belgium where geomorphological processes typical for an active coastal dune area can be studied. The picture is taken from the top of a parabolic dune ; downwards one can observe successively 1) the bare blowout area, 2) the "panne" depression, or dune valley, at an altitude where the sands remain permanently moist and where a first colonisation of groundwater tolerating plants colonise the sand, 3) the somewhat higher and older parts of the dune valley with gradually a better developed shrub vegetation.

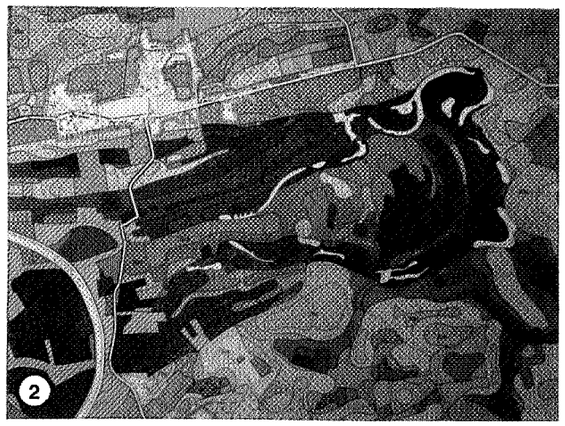
Foto 2. The Belgian Soil Map, based on field observations at regular distances of about 75 m, is an excellent tool for detecting valuable areas for conservation projects. The picture shows an old meander of the ScheldT River, with a large variety of conditions. Considering the huge amount of information such areas can provide about past environmental conditions, they should be protected with priority.

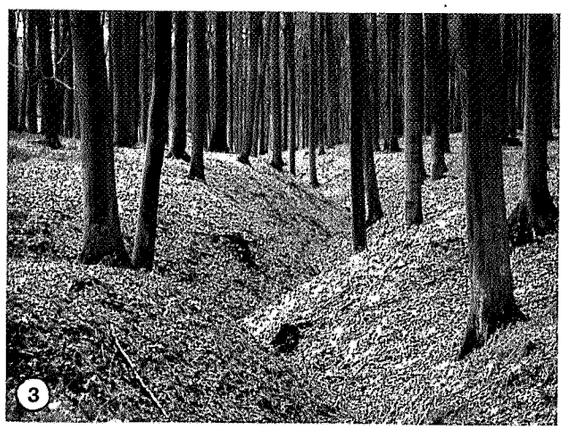
Foto 3. In the Zoniën Forest, situated in the middle of the Belgian loess belt, soils have never been under cultivation nor pasture. This makes this area unique for various topics in earth science such as : mode of deposition of the loess, geomorphology, soil genesis. The picture shows a zigzagging V-shaped gully incision. Because of the active anthropogenic erosion and sedimentation such an original valley bottom type is not observable any more in the cultivated part of the loess belt.

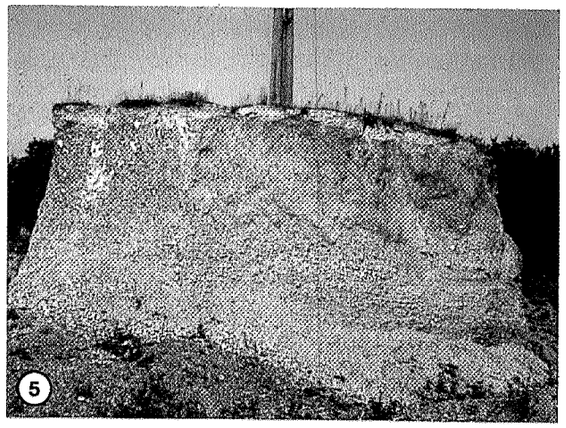
Foto 4. Outcrop of Brussels sands on a plateau position of the Zoniën Forest. The well preserved soil shows evidences of an old cracking pattern below a sharp boundary at about 70 cm depth. This morphology is considered to be a relict from permafrost conditions that occurred probably in one or several of the Dryas periods.

Foto 5. The morphology of the Campine Plateau is quite monotonous. This area shows however under a thin sheet of aeolian coversands several facies of Middle Pleistocene fluvial deposits of the Rivers Meuse and Rhine. All these facies have once been visible in gravel or sand quarries, but most of them have disappeared. This image has been taken in As and shows the top of a 10 m thick redbrown gravel facies deposited by the River Meuse. On top of these gravels and very near to the surface, an important pedo-complex composed of several paleosoils has developed.

Foto 6. In the valley bottom of the River Meuse, several fluvial terraces have been developed, each of them with a characteristic stratigraphical sequence. Some of these terraces occur only in the belgian part of the Meuse valley North of Maastricht. The terrace Eisden-Lanklaar we show here is thought to be aggraded during the late Saalian time. In some areas, as here in Eisden, an important periglacial soil has deformed the surface of the gravel terrace. This soil has been named the drop soil of the Eisden type (Gullentops & Paulissen, 1978). The authors suggest that the base of this soil indicates the position of the former permafrost table.







older geological deposits and also contain unique evidence on e.g palaeo-wind directions (De Ceunynck, 1984 ; Heyse, 1979).

The Westhoek Nature Reserve for example, at the southwestern limit of the Belgian coast, is a 340 ha large area where very active geomorphic and pedogenetic processes can be observed and monitored in a coastal dune area. From this point of view it is as valuable for earth scientists, ecologists and even archaeologists (De Ceunynck & Thoen, 1981). Moreover, thanks to the existence of numerous sets of air photographs, the landscape evolution during the last century can be followed very precisely.

In the low-lying coversand area with a relatively high groundwater table, conservation of type sections will often present technical problems. There are however exceptions. Examples are a.o the Lateglacial dune of Opgrimbie with two soil catenas, resp. of Bolling and Allerod age (Paulissen & Munaut, 1969), and dune profiles at Lommel-Kattebos (Munaut, 1967).

5.5. Tectonic landscapes

The northeastern border of the Kempen Plateau is well known as an example of the geomorphological expression of Quaternary faulting, characterised by typical and unique tectonic landscape features (Paulissen *et al.*, 1985). At some places, this relatively young tectonism is subdivided along two fault lines displaying several phases of activity.

5.6. Soils and natural palaeosurfaces

As the upper meters, and often even the upper decameters of the subsoil in northern and middle Belgium consist of Quaternary unconsolidated marine, coastal, fluviatile or aeolian sediments, buried soils are frequently observed. Such palaeosoils, and their variability in function of lateral changes (e.g. hydrosequences, lithosequences, toposequences), present an excellent record to the palaeoenvironment (Langohr & Sanders, 1984).

Relict soil surfaces and soil profiles undisturbed by man are very rare in Western Europe. Many originally forested areas have undergone some degree of human impact such as periods of cultivation (including levelling of the original microtopography, addition of fertilisers, burning of the litter and humus layer, homogenisation of the soil up to several decimeters) or intensive grazing by cattle. However, exceptionally there are a few areas where the original soil surface and the soil profile have remained nearly untouched by anthropogenic influence.

One of these areas is the 34 km² of the Zoniën Forest, situated in the middle of the Belgian loess belt. This site is unique for earth science conservation, including geomorphology, sedimentology and notably pedology (Langohr & Cuyckens, 1986a, 1986b). In Europe, it is by far the largest area of soils developed on thick loess deposits which have never been cultivated nor fertilised by man or by grazing cattle. According to the soil prospection data (Langohr & Sanders, 1985) no significant erosion or sedimentation processes have occurred here since the beginning of the Holocene and the physical landscape of today corresponds almost exactly to the relief of the area at the end of the loess deposition, towards the end of the Pleniglacial and before the Lateglacial. As the area covers several small watersheds, one can observe various undisturbed landscape positions from valley bottoms over valley slopes up to the interfluve plateau positions (Langohr & Sanders, 1985). Concomitantly the relief and the soils here are closest to the conditions that the earliest Neolithic farmers faced when they started to colonise the Belgian loess belt some 7000 years ago (Langohr, 1990).

5.7. Anthropogenically determined sequences and palaeosurfaces

The importance of direct and indirect man-made changes of the original topography is largely underestimated. The detailed soil survey of Belgium in the period 1950-1970 provided the first information on the character and the distribution of man-induced phenomena in the upper soil layer. Combined pedological, historical-geographical and archaeological investigations give further evidence on the extent of the human impact on the physical landscape. Buried soil horizons and truncated soil profiles reveal how the original landforms have been levelled or accentuated.

In this way, the presence of so-called "plaggen"-soils in poor sandy areas of Flanders and especially of the Kempen could clearly be shown (Verbruggen, 1979a). These are relatively fertile, thick, humus-rich man-made soils on small parcels of permanent crop production. They result from centuries of application of manured sods as fertiliser, in regions where good crop production was extremely difficult before the introduction of chemical fertilisers. As the plaggen-soils were situated in the immediate neighbourhood of farms and villages, most of them have disappeared today as a result of farm and town expansion. It is important to conserve not only some of the old farm buildings, but also the land parcels and soilscape associated with man's past agricultural activities.

In other regions comparable signs of early man-made soil improvement and modification were found. The most striking of these may well be the domed fields ("bolle akkers") in the Waasland-region. In this case, the anthropogenic relief was built in one phase during a single, well-defined period : a considerable amount of nutrient-rich, better-structured material seems to have been excavated from deep ditches around the field and spread over the exhausted soil surface (Van Hove, 1988).

An important phenomenon in the coastal region and in wide alluvial plains concerns historical peat excavation (De Ceunynck *et al.*, 1986). The fact that nearly all the excavated zones have been buried under later sediments complicates the correct evaluation of this phenomenon, however.

The most recent and still largely uninvestigated source of information on human impact in the Flemish landscape consists of a large set of aerial photographs collected specifically for this purpose on the authority of the Seminarie voor Archeologie of the University of Gent. The complexity of the documented phenomena clearly requires a multidisciplinary research effort, while their widespread distribution presents a serious problem of protection and conservation.

6. CONCLUSIONS

The significance of the Quaternary record for earth science research in general, as well as for related studies in environmental sciences, fully justifies the establishment of an efficient conservation policy for a number of type sites and physical landscape features in northern and middle Belgium.

In view of the vulnerability of Quaternary deposits and landforms to human interference and the possibly conflicting interests with other types of land use and subsurface exploitation, there exists a strong need for a detailed inventory of Quaternary geological features with respect to their scientific interest and their social value.

REFERENCES

BAETEMAN, C., 1989 (Ed.) - Quaternary sea-level investigations from Belgium. *Belg. Geol. Dienst, Professional Paper,* **1989/6,** 104 p.

BEIJENS, L., 1983 - Palynologische aanwijzingen voor de verarming van de flora in het stroomgebied van de Mark (Antwerpse Noorderkempen). *Dumortiera,* **26**: 1-6.

BEIJENS, L., 1984 - Paleoecologische en paleoklimatologische aspecten van de Holocene ontwikkeling van de Antwerpse Noorderkempen. *Meded. Kon. Acad. Wet. Lett. Sch. Kunsten België, Kl. Wetensch.,* **46/2**: 17-56.

BIRKS, H.H., BIRKS, H.J.B., KALAND, P.E. & MOE, D., 1988 (Eds) - The Cultural Landscape. Past, Present and Future. *Cambridge University Press.*

DE CEUNYNCK, R., 1984 - A contribution to the study of the dune deposits of the Belgian coastal plain. *Bull. Soc. belge Géol.,* **93**: 251-254.

DE CEUNYNCK, R., TERMOTE, J. & VAN STRYDONCK, M., 1986 - Laat-Middeleeuwse veenwinning rond de Moeren. *Westvlaamse Archeologie,* **2**: 61-71.

DE CEUNYNCK, R. & THOEN, H., 1981 - The Iron Age settlement at De Panne-Westhoek. Ecological and geological context. *Helinium,* **21**: 21-42.

DE GANS, W., CLEVERINGA, P. & GONGGRIJP, G.P., 1984 - Een ontsluiting in de wal van een pingoruïne nabij Papenvoort (Dr). *RIN-Rapport, Rijksinst. Natuurbeheer,* Leersum, 53 p.

DE MOOR, G., 1963 - Bijdrage tot de kennis van de fysische landschapsvorming in Binnen-Vlaanderen. *Tijdschr. Belg. Ver. Aardrijksk. Stud.,* **32**: 329-443.

DE MOOR, G. & HEYSE, I., 1978 - De morfologische evolutie van de Vlaamse Vallei. *De Aardrijkskunde,* **4**: 343-375.

DENYS, L. & VERBRUGGEN, C., 1989 - A case of drowning - the end of subatlantic peat growth and related palaeoenvironmental changes in the lower Scheldt basin (Belgium) based on diatom and pollen analysis. *Rev. Palaeobot. Palynol.,* **59**: 7-36.

DENYS, L., VERBRUGGEN, C. & KIDEN, P., in press - Palaeolimnological aspects of a Late-Glacial shallow lake in Sandy Flanders. *Hydrobiologia.*

GONGGRIJP, G.P. & BOEKSCHOTEN, G.J., 1981 - Earth-science conservation : no science without conservation. *Geol. & Mijnbouw,* **60:** 433-455.

GULLENTOPS, F. & PAULISSEN, E., 1978 - The drop soil of the Eisden Type. *Biuletyn Periglacjalny.* **27**: 105-116.

HEYSE, I., 1979 - Bijdrage tot de geomorfologische kennis van het noordwesten van Oost-Vlaanderen (België). *Verh. Kon. Acad. Wet. Lett. Sch. Kunsten België, Kl. Wetensch.,* **41/155**, 257 p.

HUYBRECHTS, W., 1989 - Palaeohydrologic condi-

tions in the Mark river basin during the last 15.000 years. *Geol. & Mijnbouw,* **63/** 175-189.

KIDEN, P. 1991 - The Lateglacial and Holocene evolution of the Middle and Lower River Scheldt, Belgium. *In :*Starkel, L., Gregory, K.J. & Thornes, J.B. (Eds). *Temperate Palaeohydrology,* , John Wiley & Sons, 283-299.

LANGOHR, R., 1986 - la pédologie et l'évolution des terres dans la région limoneuse de Belgique. *Hommes et terres du Nord,* **2-3**: 94-97.

LANGOHR, R., 1990 - The dominant soil types of the Belgian loess belt in the early Neolithic. *In :* Cahen, D. & Otte, M. (Eds). *Rubané et Cardial,* E.R.A.U.L., 117-124.

LANGOHR, R., BEERNAERT, F. & FOURKIOTIS, G., 1982 - Detailed survey of man's impact on soils and land morphology in a forest area. Example of the Zonien Forest (Belgium). *Proc. Int. Congr. Neth. Soc. Landscape Ecology,* 140-141, Pudoc, Wageningen.

LANGOHR, R. & CUYCKENS, G., 1986a - Het Zoniënbos, een unicum voor de aardwetenschappen. *In :* Dry Borren Raad (Ed.), *Zoniënwoud, kwijnen of overleven ?* 160-173.

LANGOHR, R. & CUYCKENS, G., 1986b - Une forêt aux pieds de "limon", sol et relief en Forêt de Soignes : des témoins uniques ! *Rés. Nat.,* **3**: 51-58.

LANGOHR, R. & SANDERS, J., 1984 - Apport de la pédologie à la reconstitution du paléoenvironnement en Belgique au Quaternaire. *In :* Cahen, D. & Haesaerts, P. (Ed.). *Peuples chasseurs de la Belgique préhistorique dans leur cadre naturel. Inst. roy. Sc. Nat. Belgique,* 41-52.

LANGOHR, R. & SANDERS, J., 1985 - The Belgian loess belt in the last 20,000 years : evolution of soils and relief in the Zonien Forest. *In :* Boardman (Ed.), *Soils and Quaternary Landscape evolution,* John Wiley & Sons, 359-371.

MINNAERT, G. & VERBRUGGEN, C., 1986 - Palynologisch onderzoek van een veenprofiel uit het Doeldok te Doel. *Bijdr. Arch. Dienst Waasland,* **1**: 201-208.

MOSTAERT, F., 1985 - Bijdrage tot de kennis van de kwartairgeologie van de oostelijke kustvlakte op basis van sedimentologisch en lithostratigrafisch onderzoek. Unpub. Ph. D. thesis, R.U.Gent, 587 p.

MUNAUT, A.V., 1967 - Recherches paléo-écologiques en Basse et Moyenne Belgique. *Acta Geogr. Lov.,* **6**, 191 p.

MUNAUT, A.V. & PAULISSEN, E., 1973 - Evolution et paléo-écologie de la vallée de la Petite Nèthe au cours du post-Würm (Belgique). *Ann. Soc. Géol. Belg.,* **96**: 301-348.

NATURE CONSERVANCY COUNCIL, 1990 - Earth Science Conservation : a strategy. *Nature Conservancy Council, Peterborough.* 84 p.

PAEPE, R. & VANHOORNE, R., 1967 - The stratigraphy and palaeobotany of the Late Pleistocene in Belgium. *Mém. expl. carte Géol. & Min. Belgique,* **8**, 95 p.

PAULISSEN, E., 1973 - De morfologie en de kwartair stratigrafie van de Maasvallei in Belgisch Limburg. *Verh. Kon. Acad. Wet. Lett. Sch. Kunsten België, Kl. Wetensch.,* **127**, 267 p.

PAULISSEN, E., 1983 - De geomorfologische kaart en het Gewestplan. *De Aardrijkskunde,* **5**: 95-99.

PAULISSEN, E., 1986 - De Maas : kenmerken en betekenis. *In :* De Maas. Dode riool of levende waterloop ? *Verslagboek Maassymposium 1-2/3/1986,* 1-22. Maaseik.

PAULISSEN, E. & MUNAUT, A.V., 1969 - Un horizon blanchâtre d'âge Bölling à Opgrimbie. *Acta Geographica Lov.,* **7**: 65-91.

PAULISSEN, E., VANDENBERGHE, J. & GULLENTOPS, F., 1985 - The Feldbiss-Fault in the Maas Valley bottom (Limburg, Belgium). *Geol. & Mijnbouw,* **64**: 79-87.

VAN HOVE, R., 1988 - Bolle akkers. *In :*Van Hove, R. (Ed.) : Verklarende Woordenlijst. *Bijdr. Archeol. Dienst Waasland 1,* Bijvoegsel, 13-14.

VAN MOURIK, J.M., 1988 (Ed.) - Landschap in Beweging : ontwikkeling en bewoning van eenstuifzandgebied in de Kempen. *Ned. Geogr. St.,* **74**, 191 p.

VERBRUGGEN, C., 1971 - Postglaciale landschapsgeschiedenis van Zandig Vlaanderen. Unpub. Ph. D. thesis, R.U.Gent, 440 p.

VERBRUGGEN, C., 1979a - Paleo-ecologische en palynologische benadering van enkele bekende historisch-geografische problemen in Vlaanderen. *Bronnen hist. geog. België,* (Handel. Coll. Brussel 25-27 april 1979) : 487-497.

VERBRUGGEN, C., 1979b - Vegetational and palaeoecological history of the Lateglacial period in Sandy Flanders (Belgium). *Acta Univ. Oulensis,* **A 82 Geol. 3**: 133-142.

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GEOCONSERVATION - BESLUITEN - CONCLUSIONS

door - par

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1. RESULTATEN

Een synthese maken van de verschillende bijdragen op dit symposium zal misschien op het eerste zicht een onmogelijke opdracht lijken. We hebben vandaag immers 16 bijdragen gehoord over de meest diverse aspecten van Earth science conservation. Dat vergt een inspanning, niet in het minst omdat we 3 talen hebben gehanteerd. Toch zijn wij de mening toegedaan dat deze oefening de moeite loonde, omdat zij ons toeliet ons op zeer korte termijn vertrouwd te maken met het onderwerp in al zijn aspecten en met al zijn problemen. Een eerste zeer concreet - en dus zeer belangrijk resultaat is dat de BLUG er op deze manier in geslaagd is om de probleemstelling en de mogelijke oplossingen in al haar aspecten op de meest gecondenseerde manier over te brengen bij de grootst mogelijke groep van geïnteresseerden. Het bewijs hiervan ligt in uw talrijke aanwezigheid en in uw niet aflatende aandacht en interesse.

Un deuxième résultat consiste dans le fait que l'UBLG a réussi à réunir autour de la table toutes les parties concernées. Et elles sont nombreuses : les géologues professionnels, les géologues amateurs, les représentants des associations de protection de la nature, les représentants des administrations concernées, les enseignants du secondaire, les exploitants. Il est peu dire que les intérêts de tous ces groupes ne sont pas les mêmes. A première vue, il existe même des intérêts opposés. Mais ce ne sont sans doute que des apparences, à conditions que personne ne reste sur des positions extrêmes ou ne refuse le dialogue. L'UBLG insiste sur le fait qu'il n'entre pas du tout dans ses intentions de chercher des confrontations ou de cultiver les divergences de vue qui pourraient exister, et qui existent. Mais je crois que ce symposium a très bien démontré la volonté de coopérer car chacun ici-présent est convaincu de l'intérêt commun que nous avons tous dans la conservation du patrimoine géologique.

Verheugend is ook dat met dit symposium de balans terug in evenwicht wordt gebracht. Naar het voorbeeld van het buitenland - en hier denk ik aan de bijdragen uit Groot-Brittannië, Frankrijk en Nederland - wordt het geologisch patrimonium minstens op voet van gelijkheid gesteld met fauna en flora. Als er al historische, estetische en/of wetenschappelijke criteria bestaan voor de terechte bescherming van fauna, is nu geen enkel argument meer voorhanden om dit niet te doen voor het geologisch en fysisch-geografisch erfgoed. Meer nog, de Belgische, Vlaamse en Waalse wetgever voorziet hiertoe de mogelijkheid uitdrukkelijk via de wetgeving op monumenten en landschappen, natuurbehoud, natuurlijke rijkdommen, reservaten. Het geologisch patrimonium moet dus zijn plaats innemen in de rij van de met zorg te omringen "monumenten". Dit is ons derde resultaat. Hoe we dit in de toekomst concreet gaan invullen, zal afhangen van de strategie die we wensen te volgen. Maar dat hiertoe verschillende mogelijkheden open liggen hebben de buitenlandse bijdragen genoegzaam aangetoond.

2. INTERETS

Vous avez sans doute remarqué que les termes utilisés dans les annonces pour notre symposium sont : "conservation, préservation, .." et pas "protection, classement, ...". Il y a des raisons pour cela. Dans nos contacts préalables au symposium, avec les représentants de l'industrie d'extraction, nous nous sommes rendus compte que pour eux, un éventuel classement de site (ou d'une partie), représente bien souvent une moins-value économique en hypothéquant partiellement ou totalement

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