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MAN-MADE TERRACES IN A GERMAN AGRICULTURAL LANDSCAPE

ABSTRACT: LÓCZY D., *Man-made terraces in a German agricultural landscape*. (IT ISSN 0391-9838, 1998).

Some of the man-made features have integrated into the landscape as its organic part and influence geomorphic and environmental processes. In the paper the function of terraces on arable land (*Ackerterrassen*) and in vineyards is investigated. The test area is a valley on the western margin of the Odenwald Mountains, the Meerbach valley, near the town Bensheim, Hesse, Germany. In the Rhine valley limited availability of land and the increasing concentration of population called for intensive farming on small plots at a very early date. Although some of the early settlements were later abandoned, some ancient patterns of cultivation manifested in a wealth of man-made features in the landscape, have survived to this day. The landscape ecological significance of terraces is manifested through the redistribution of moisture and nutrients available for agricultural crops. A survey of nutrient losses through runoff was made in various cross-sections and it was found that the partial basins with more terraces insignificantly contribute to the nutrient load of the trunk stream. That is interpreted as an evidence to the efficiency of man-made terraces in the conservation of soil fertility and in the prevention of eutrophication of water bodies.

KEY WORDS: Man-made Terraces, Erosion, Water pollution, Landscape ecology, Germany.

RIASSUNTO: LÓCZY D., *Terrazzi antropici in un paesaggio agricolo della Germania*. (IT ISSN 0391-9838, 1998).

Alcuni lineamenti antropici si sono inseriti organicamente nel paesaggio come una sua parte e influenzano i processi geomorfici e ambientali. In questo lavoro si tratta della funzione dei terrazzi nelle terre arative (*Ackerterrassen*) e nei vigneti. L'area di studio è una valle posta al margine occidentale dei rilievi dei Monti Odenwald, la valle Meerbach vicina a Bensheim Hesse (Germania). Nella valle del Reno la limitata disponibilità di terra e il progressivo incremento della popolazione ha provocato da tempo la necessità di una agricoltura intensiva in piccoli appezzamenti. Sebbene alcuni dei più vecchi insediamenti siano stati poi abbandonati, qualche antica traccia delle coltivazioni è rimasta in un paesaggio dai marcati lineamenti antropici. Il significato ecologico dei terrazzi si manifesta con la ridistribuzione dell'umidità e dei nutrienti per le colture. Un rilevamento della perdita di nutrienti con il ruscellamento è stato fatto in varie zone e si è trovato che i piccoli bacini con più terrazzi contribuiscono pochissimo al carico di nutrienti. Ciò è interpretato come una dimostrazione dell'efficienza dei terrazzi antropici nella conservazione della fertilità del suolo e nella prevenzione dell'eutrofizzazione delle acque.

TERMINI CHIAVE: Terrazzi antropici, Erosione, Inquinamento delle acque, Ecologia del paesaggio, Germania.

INTRODUCTION

Terraces break long and steep slopes and reduce their average angles and act as sediment traps. In areas where soil parent materials are mostly unconsolidated deposits, slope stability is generally increased by terraces. Promoting infiltration or diverting runoff parallel with contour lines, they are instrumental in erosion control. To some degree, other, at least partly man-made, features like hollow roads (surfaced or unsurfaced) fulfill similar functions in the landscape.

Since forest clearing in medieval times, the prevailing land use classes of basins remained to be pastures and meadows (with scattered fruit-trees, «*Streuobstwiesen*»), vineyards and aravle land arranged according to the relief conditions. Along the middle section of the Bergstrasse, however, built-up areas have recently expanded to reach 21 per cent of land (Bartelheimer, 1992). The survey of the extent of environmental pressure and possible responses also in this region has thus become an intriguing issue in research.

STUDY AREA

The narrow foothill zone along the western front of the Odenwald (fig. 1) inherited the name Bergstrasse («mountain road») from the Roman «*strada montana*», a paved link between the commercial centres of Northern Germany and the passes of the Alps. Along the ancient road loess

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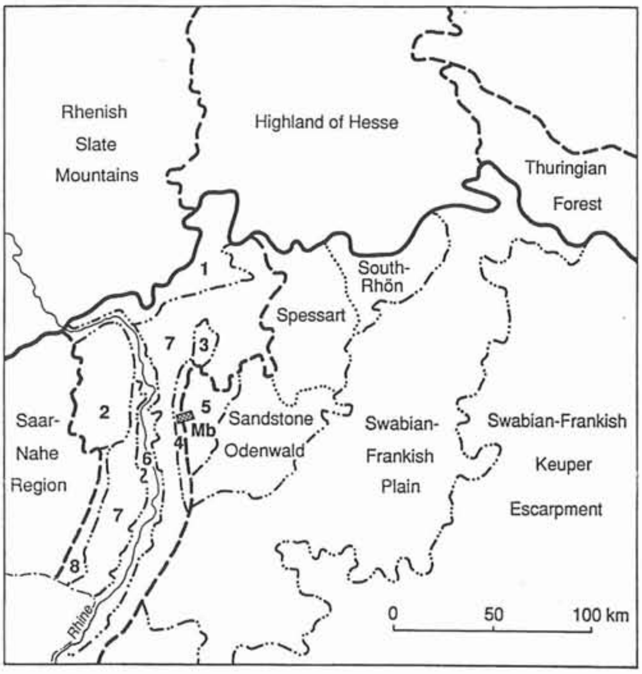


FIG. 1 - Physical geographical units in the environs of Odenwald Mountains (after Müller-Miny, 1960/61) with location of test area. A to d) landscape boundaries of various hierarchical level; e) national border. 1) Wetterau; 2) Rheinhessen; 3) Messel Hills; 4) Bergsrasse; 5) Crystalline Odenwald; 6) Rhine floodplain; 7) Upper Rhine-Lower Main Plain; 8) Weinstrasse; Mb) Meerbach valley study area near Bensheim.

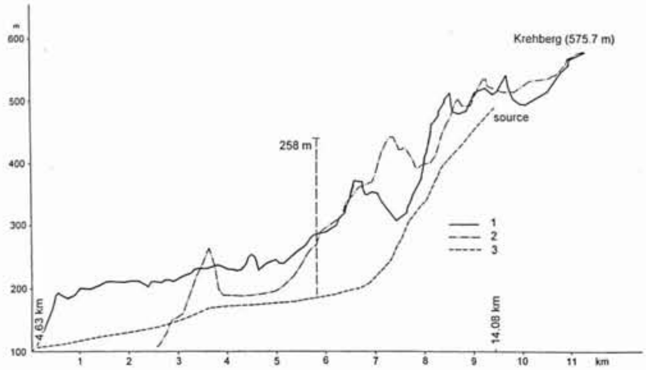


FIG. 2 - Longitudinal profile of the catchment. 1) northern divide; 2) southern divide; 3) Meerbach talweg.

soils and mild climate favoured farming. Virtually all loess-mantled areas were used for arable land.

A mostly agricultural area, the upper section of the Meerbach catchment (fig. 1), providing a cross-section of different environments was selected for the mapping and study of man-made terraces. The 13.67 km^2 mountain watershed of the Meerbach stream comprises five admonistrative units west of the town Bensheim. As the longitudinal profile of the stream and the divide (fig. 2) shows, this «two-storey» catchment stretches over the 500-530 m high late Tertiary pediplain as well as the Pleistocene pediment at 200-240 m, both dropping by steep (25-30 per cent) slopes developed along fault-scarps. In the asymmetrical valley land use strictly follows relief conditions (fig. 3). The distribution of soil parent materials (fig. 4) clearly marks the maximum extension of traditional farmland. The picture is mosaical. Sandy slopes loess and loess-loam of 4-6 m maximum thickness are the most common, but products of granite weathering, mostly silt to coarse sand (*grus*), also cover large areas. Remmants of the once extensive solifluctional debris loam mantles are only preserved in isolated spots.

From a landscape ecological point of view, the catchment is subdivided into five units (fig. 5):

1) the upper catchment (pastures and arable on regolith and loam);
2) the mountain front (an ecological corridor of forests on granite block fields and measows on loamy colluvium and alluvium);
3) the northern part (called «summer side» by locals; vineyards and pastures on loess and loam);

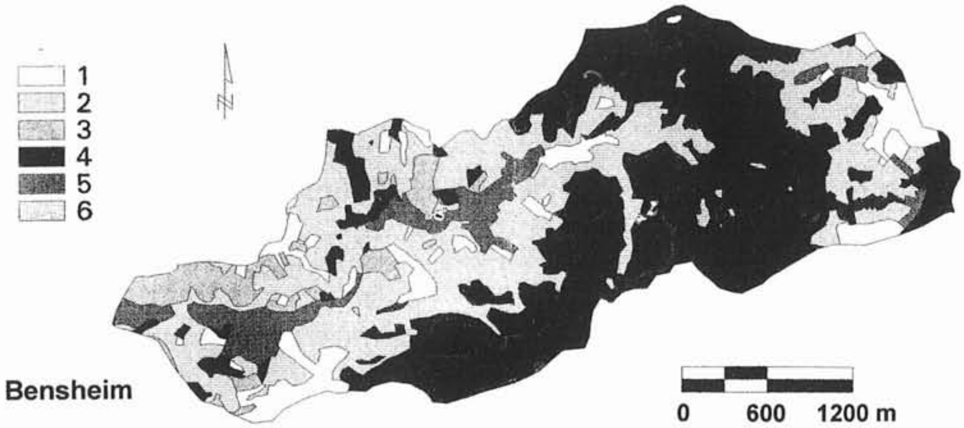
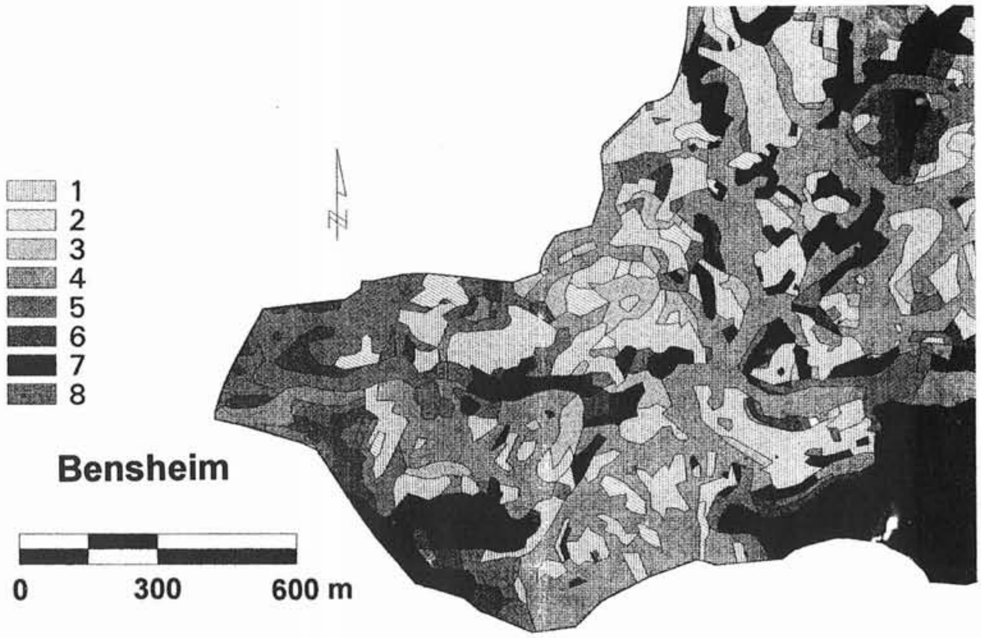


FIG. 3 - Land use map of Meerbach catchment, 1992. 1) arable; 2) pastures, meadows and other green areas; 3) vineyards and orchards; 4) forest; 5) built-up area; 6) pastures with scattered fruit trees («Streuobstwiesen»).

FIG. 4 - Soil parent materials in the Lower Meerbach catchment (Lóczy D. after Bodenschätzungskarten; Zakosek & *alii,* 1967 and own survey). 1) loess, slope loess with sporadic debris; 2) loess with discontinuous (debris) loam cover; 3) loess with continuous loam cover; 4) loam; 5) loam with outcropping intensely weathered regolith; 6) intensely weathered regolith with discontinuous loam mantle; 7) regolith with bedrock outcrops; 8) blown sand mingled with loess.



4) the valley floor (buil-up areas and gardens on alluvium);
5) the southern zone (the «winter side»; arable and pastures with fruit-trees on loess and loam; forests on regolith).

Man-made features are most abundant in units 3 and 4 (fig. 6).

CLASSIFICATION OF MICROFORMS BY THEIR ORIGIN

According to their origin and further evolution, the small-scale features (ca 0.5-5 m in both horizontal and vertical dimension), some of them rather ancient, can be grouped into the following categories:

1) scarps
   entirely artificial: ploughland steps, vineyard terraces/stone walls;
   induced by man but subsequently shaped by natural processes: «Nutzwechselstufen» («taluds»);
2) road network
   artificial: foot-paths and cart-tracks;
   only induced by man: hollow roads in loess;
3) water-courses
   artificial: water-mill canals, drainage ditches in vineyards;
   natural features with human intervention: canalised stream sections.

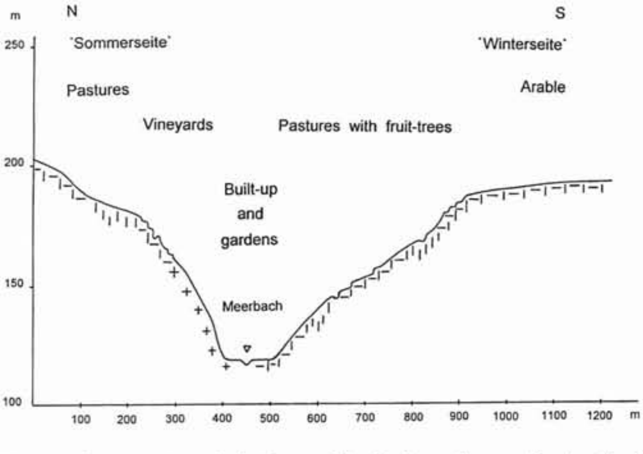


FIG. 5 - Cross-section of the Lower Meerbach catchment showing land use on the «summer» and «winter» sides and on the valley floor.

The so-called «ploughland terraces» («*Ackerterrassen*») in the test area are not like the lynchets of the chalklands of England (Goudie, 1985), but up to 200 m long features separating strips of 100 m wide land (fig. 6). they have most probably developed along permanent field boundaries through ploughing (Scharlau, 1956/57; Schaeffer, 1957). Another group of «*Nutzwechselstufen*» or «*Kulturwechselstufen*» is known: along arable/grassland («*Wiesenrandstufen*») or arable/forest («*Waldrandstufen*») margins as a result of dirrerent rates of soil erosion. They are similar to the «taluds», first described in the United States (Soil Survey Staff, 1951). Taluds are farmland steps resulting from soil accumulation beyond hedges or stone walls running transverse to slopes. they are typical in some «bocage» landscape of Western europe (as reviewed by Reed, 1986), where fields were not merged to obliterate the old patterns.

FIG. 6 - Distribution of major man-made steps in the study area. 1) steps (above 1 m rise); 2) long slopes; 3) flat valley floors; 4) point sources of agricultural pollution (stalls, dung heaps etc.).

A major function of scarps in the landscape is soil conservation. In the test area slopes are found where more than 15 per cent of total relief falls onto scarps and thus overall slope is considerably reduced. Large amounts of colluvium (B horizons of forest soils) have accumulated behind them. Estimating tha 1 m length of scarp 0.6 m^3 washed-down soil (a reasonable figure from field observations), as much as minimum 20,000 m^3 is stored upslope in the lower portion of the catchment alone. This compares with another 20,000 m^3 retained along some floodplain section and ca 85,000 m^3 accumulation in the alluvial fan a the outlet. The colluvium also influences throughflow, has implications to soil moisture conditions and indirectly to denitrification.

Another reason why scarps and hedges should be maintained is bioecological: these narrow strips provide links in the landscape between habitats of wildlife otherwise isolated. Even the largest game of the study area, the roe-deer, can find shelter in them (Haber & Salzwedel, 1992).

A microclimatological aspect comes into view first of all in the case of vineyard terraces and stone walls. Frost being a major threat for vinestocks, the terraces and walls carefully designed not to dam downslope cold air flows. In clear weather dry walls store heat and radiate it back to promote the ripening of grapes.

The water-mill canals, built from the early 15^{th} century, have locks to redistribute water during flood discharges, when the Meerbach carries 5-8 m^3 water as opposed to 0.03 m^3 baseflow. The surviving canals are important sources of water for riparian vegetation and flower gardens; they allow sedimentation off the main channel and accelerate the decay of organic matter through absorbing oxygen along cascading sections.

MICROFEATURES AND POLLUTION FROM AGRICULTURAL SOURCES

The intensification of agriculture reached its peak in Land Hesse in the mid-1970s, when on the average 160 kg N/ha, 100 kg P_2O_5/ha and 170 kg k_2O/ha fertilisers were applied on agricultural land. In spite of a 25 per cent rise in fertiliser prices at the end of the 1970s, a significant drop in the amounts applied in only observed for phosphorus, while N levels only show minor fluctuations.

The contamination levels on the Meerbach and its tributaries, as surveyed by author at baseflow, are still tolerable (fig. 7-8). The middle section of the Meerbach belongs to Class II (moderately contaminated) on the map of water-quality for the water-courses of Hesse (1984). The still acceptable levels of nitrate pollution are partly due to man-made terraces since colluvial accumulations store more moisture than eroded loess surfaces. Thus, denitrification is more rapid along the field margins (Burt & Haycock, 1992; Köster & *alii*, 1988).

Fig. 8 clearly shows that nitrate levels are highest in the uppermost section where grazing land is not separated by scarps from the stream channel. They are reduced at the confluences of sub-catchments nos 7 and 8 where the density of terraces (fig. 6) is highest, although phosphate contents slightly increase. This is mostly particulate P and its occurrence is due to the lateral erosion of slope deposits. A significant portion of nutrients washed down onto the valley floor is decomposed in the oxygen-rich water of mill canals or trapped in their buffer zones (Kraus, 1984; Karl & Porzelt, 1992).

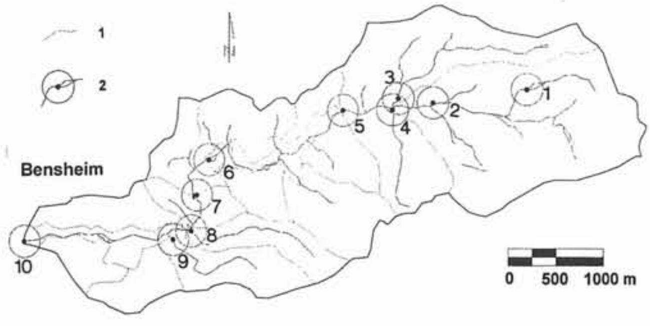


FIG. 7 - Sites of nutrient load measurements on the Meerbach catchment. 1) water-courses; 2) measurement site.

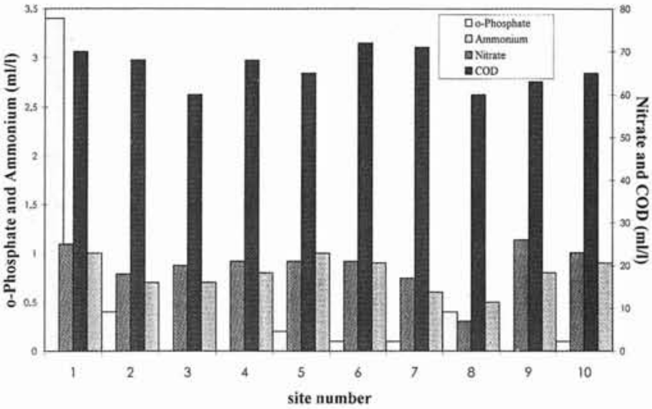


FIG. 8 - Amounts of nutrients measured at the sites on fig. 7 (Lóczy D., 1992).

LANDSCAPE PLANNING

The Meerbach catchment is part of the Bergstrasse-Odenwald Naturpark, which is meant to satisfy the recreation demands of the inhabitants of the overpopulated and denaturalised industrial regions along the Rhine (Lesr, 1984). Agricultural use (largely a part-time occupation by now) is being adjusted to the expanding touristic function: vineyards, pastures with scattered apple and plum trees and extensive grazelands gain in importance. Blackthorn and blackberry hedges should be restored on ploughland terraces to create shelter and habitats for widlife as well as attractive sights for visitors. In frame of the «renaturalisation» project of water-courses in Hesse, the Meerbach should also receive a more natural channel form. Mill canals also deserve maintenance.

The study of man-made landforms is also timely in Hungary today. The re-privatisation of agricultural land brings about changes in cultivation patterns. Although large-scale farming remains predominant, smallholders began to cultivate a considerable portion of arable land they may appreciate the soil conservation function of minor surface features in the future.

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