# 5 Morphology of Climatic Zones or Morphology of Landscape Belts?

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ON 22nd and 23rd September 1926 the *Gesellschaft deutscher Naturforscher und Ärzte* met in Dusseldorf. At this conference a series of lectures was given on the morphology of climatic zones. The earth was divided into morphoclimatic zones, and the surface landforms of each area were discussed. While climatic zones are usually delineated on the basis of average values of precipitation, temperatures and humidity, it is to be expected that any attempt to delineate 'morphological climatic zones' will produce divergent interpretations. The obvious question to ask at this stage would seem to be: 'Is climate or are certain climatic zones responsible for distinctive geomorphological features?'

## SOME BASIC MISCONCEPTIONS

In my view, two basic errors have been made in the past with respect to the whole problem.

In the first place, the present-day surface landforms are for the most part not the result of present climates, but the product of Pleistocene processes. Consequently the active present-day forces and their morphological expression depend on the climatic zones in which they occur.

With few exceptions climate everywhere has considerably altered since the Ice Age which itself showed wide climatic variations. Now it is an irrefutable fact that natural forces act together and tend toward a balanced relationship. Gradually a condition approaching equilibrium is achieved, so that the effect of any single factor may become significantly modified. But as soon as a change of climatic conditions occurs there is a consequent change in the balance between the various controlling factors. A period of intense erosion, deposition or both may then follow. At present a period of relative calm is being experienced, whilst the protective plant cover, the residual boulder pavement or the gentle slope, for example, severely limit or negate the erosive forces. Thus paleo-features are found, that is the larger landforms, which cannot be explained by forces active today.

Only minor work on river banks or on slopes which have not yet been reduced continues at a modest pace under the present climate. That former glaciation and the period of tundra conditions with its soil flows and solifluction are responsible for many of the present surface features in Germany no one today can seriously deny. The same is true of the 'pluvial' period in the majority of dry areas, but even on the Equator block-debris slopes under the rain-forest, oversized valleys and erosion surfaces covered by swamp prove that the majority of present-day surface landforms are paleo-features. Consequently it would seem appropriate to view the theme thus: 'Surface landforms and their expression in this or that climatic zone'.

In the second place is it, in fact, true to say that present-day morphogenesis is principally dependent on climate?

Theoretically, the answer to this is 'yes', but in practice it is 'no'. Just as in our latitudes the summer is warm and the winter cold, with pressures and winds determining the temperature conditions during these two seasons, so too do the geomorphic forces depend on climate; except that it is the nature of the plant cover, the rock type and even the regolith which in practice determine the effect of the formative processes and the geomorphic development.

*An argument against morphoclimatic classification*

One example may help to demonstrate why the 'morphological-climatic zones' approach followed at the conference is untenable. The tropics have been divided into three morphological climatic belts: the equatorial with a hot-wet (doldrum) climate; the savanna with a predominant wet season; and the savanna with a predominant dry season. This brief categorisation contains no indication as to how a delineation of the landscapes is to be achieved. The wet-humid doldrum climates are contrasted with the periodically dry climates: the former must, therefore, experience rainfall all the year round. But this 'all-the-year-round' rainfall régime is found only in a few areas of this 'wandering' doldrum belt: almost everywhere a one-to-two month dry season is experienced with at most very little rainfall. Further, in which category do the climates experiencing two wet and two dry seasons belong? Even if we include all climates with a relatively short dry season in our equatorial climate, then we have shown that the suggested climatic classification is unsuitable as a basis for morphological research.

From Conakry to the Ivory Coast the coastal area receives three

to five metres of rain and experiences an extreme dry season of four to five months. Without doubt one must regard this area as a 'periodically dry climate with predominant rain'. The plant cover of this area is a particularly luxuriant and dense rain-forest. The soil is weathered to a great depth, and in fact is a soft, moist laterite of cellular structure. Exactly the same erosion processes are present here as in the tropical rain-forests which do not experience a long dry season, that is a vigorous linear downcutting by mountain streams together with landslips, which in conjunction with the formation of bowl-shaped valleys, sharpen the ridges. The features that are formed in this periodically dry savanna with a predominant rainy season are exactly the same as those in the hot-wet equatorial climate. In Upper Guinea, on the other hand, instead of tropical rain-forest, moist savanna with high grass, dry forest and park landscape have developed. Why? *Because here the soil has dried out and slips do not occur in the absence of dense rain-forest.* This hardening of the soil occurs above all in those places where the soil has dried out forming a tough, iron-rich crust in the laterite. Thus, it is the vegetation cover and not the climate that is the determining factor. It is the *landscape* belts and not the *climatic* belts which are important.

## LANDSCAPE BELTS

In the montane 'mist forest' (*Nebelwald*) of the tropics, which does not experience a hot-wet climate at all, landslips are even more strongly developed than in the equatorial zone for the very reason that forest-cover and soil-moisture conditions are conducive. All difficulties are easily solved if instead of climatic zones as criteria, one considers the *consequences* of climate, namely vegetation cover, weathered rock and moisture, that is the *landscape belts.* Such morphological landscape belts are readily discernible and comprehensible in contrast to the climatic zones which are seasonally variable and by no means so tangible. While the former are certainly dependent on climate, the morphological differences, as produced by the protecting vegetation cover and the soil type and composition, take priority. Local soils which hinder erosion are, for example, the iron-rich crusts of laterite, lime crusts and moor soils. This example, which proves the inadequacy of the climatically based classification of surface landforms could be repeated many times. One is reminded

of some of the basic differences in erosion which exist—those in the tundra with ground ice and soil-creep; in the subpolar zone without ground ice but with powerful earth flow and dissection; and the subpolar forest areas with a long snowy winter, spring meltwater, summer and winter rain with and without ground ice. One only has to consider the effects of ground ice in the formation of extrusive ice surfaces (*aufeisböden*) on floodplains and the effects of ground ice melting on the riverside slopes including collapse of long sections of steep river banks. Further, one might cite the basic differences within the subtropics according to whether one considers sclerophyll forest regions or savannas. Even within this latter zone the presence or non-presence of a limestone crust causes marked morphological differences.

Nebelwald *conditions*

The following example may show the advantages of the landscape morphology approach. According to detailed maps of central and southern Peru, the surface landforms exhibit features due to landslipping. Let us assume that these maps are correct and that they indeed show specific features. Today everything is covered with *borsten* grass and dwarf-bush steppe. The land is partly cold high-steppe with cattle rearing and partly moderate high-steppe with agriculture. There is no ground ice and soil-creep could hardly have developed. The dryness of the climate hardly allows slip to occur, so that it would seem that here we are dealing with large landforms which must have arisen during the Pleistocene period. Now in north and east Peru on the 2500–3500 m-high mountain chains, *Nebelwald* occurs in which, according to Pöppig's work, enormous landslips with steep-sided walls and narrow ridges have developed. Thus these mountains, which are now under steppe, exhibit the features of the *Nebelwald* belt. It appears, therefore, that we are dealing with a paleo-landscape whose essential forms have developed under *Nebelwald* conditions. In Peru there is the moist desert climate of the coast; in the east the hot-wet doldrum climate. Where should one put the high *Nebelwald* climate or the high-steppe? Are we left with anything else apart from *Nebelwald* climate or high-steppe climate? Would not this be merely a superfluous description? Surely it is easier to speak of 'the surface features or surface configuration of the *Nebelwald* or the high-steppe', that is to use landscape terminology. Moreover expressions such as 'surface features

of the interior and high deserts' imply landscape concepts. Why do we go only half way?

Landscape morphology will inevitably take the place of the morphology of climatic zones, because it succeeds in describing and explaining the phenomena far more simply and clearly. Obviously not all difficulties arising from transition zones, local soils and local vegetation will be overcome as soon as landscape morphology is introduced, but in any case the result will be far more satisfactory than if one bases morphological research on climatic zones.