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II

CLIMATE, GEOLOGY, AND SOILS

II.1. Climate[1]

For a general description of the Irian climate the reader is referred to Braak (1954). Since 1954 a considerable amount of more detailed information has been made available in the Publicaties en Mededelingen van het Meteorologisch en Geophysisch Bureau (Bureau for Meteorology and Geophysics) at Hollandia, the first of which appeared in 1957. They were continued until a few years (exact data are impossible to give) after the departure of the Dutch (1962).

Much general information can be found in the Bureau's Publication no. 13 (Bureau for Meteorology 1962). The observations derive from 10 stations, namely: Hollandia (Haven), Hollandia (Sentani), Biak (Mokmer), Manokwari (Rendani), Mapia, Sorong (Jefman), Kaimana, Tanah-Merah, Merauke (Mopa) and Balim (Wamena), and give information on: monthly means of air pressure, air temperature, vapour pressure, relative humidity, wind speed, cloud amount, precipitation, duration of sunshine and number of days with thunder for 10 stations. Included are data for each year together with a five-yearly mean, and extreme values of the temperature and the number of days on which a specified amount of precipitation or a specified temperature was exceeded.

Other publications of the Bureau deal with precipitation and sunshine and global radiation respectively in more detail. These include on precipitation, Publications nos 2, 3, 5, 6, 7, 8-12, 17-19, Mededeling no. 1, and two maps (Bureau for Meteorology 1952-64, 1958, 1959b, 1959c, 1960a and 1960b), and on sunshine Publications nos 1 and 4 (Bureau for Meteorology 1957 and 1959a). After 1963 data concerning global radiation in Wamena (1959-61) and Sentani (1957-60) were published (Publications nos 15 and 16).

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II.2. Geology[2]

II.2.1. Introduction

The exploration of Irian geology started in the early years of this century and has since developed rapidly. The scientific views concerning the island's geological history have changed accordingly. For this reason it seemed advisable to precede the condensed bibliography presented below with a brief outline of some of the main points of Irian geology.

The island was formed by tectonical forces resulting from the shift of the Australian continent towards the Melanesian submerged block. The sediments lying in between were folded, and locally some volcanic activity took place. The greater part of the island is of Oligo-Miocene age; the uplift of the mountain areas began at that time and continued up till Plio-Miocene and recent times. Traversing the island from south to north, we come across the large and flat, low-lying Digul-Fly depression, bordering the very steeply rising Central Mountain Range. Locally in this range we meet with some elevated valleys, such as the Wissel Lakes, the Kamu Valley and the Balim Valley. Near the border with Papua New Guinea (141°E.L.) some local volcanic activity is present; it extends to the east, where it becomes more important.

Northward on the mainland the low-lying Lake Plain is found, bordered by the Northern Dividing Range. The northern coastal plain forms part of the Mamberamo Trough; it is flat except for some parts on the eastern side, where the border with the Melanesian platform is marked by mountains, such as the Cyclop Mountains.

In the Bird's Head the tectonic movements have been highly influenced by the pressure and the folding of the Banda-arc system in the west. In the northern parts of the Arfak Mountains locally some old volcanic units are found.

In the transitional area between the bended part of the Central Mountain Range system and the Tamrau Mountains some valleys occur, such as the Kebar plains and the Angi Lakes.

The oldest Paleozoic formations are represented by the Permian-Carboniferous sediments in the Central Range and the metamorphic rocks (Schists, Gneiss and basaltic intrusional material) on the northern flank of that range as well as in the middle of the Northern Dividing Range, and in the middle of the northern Bird's Head and on some of the islands (e.g. Japen and Waigeo). Crystalline intrusions and metamorphic rocks of the Cyclop Mountains represent much older formations. Mesozoic (Jurassic to Senonian) sediments are present on both sides of the Paleozoic rocks of the Central Range, but predominate in the highly elevated valleys. The New Guinea limestone of the Tertiary period (Paleocene-Miocene) forms extensive mountain areas in the Central Range and large parts in the centre of the Bird's Head, and also parts of the islands in Geelvink Bay. The Plio-Pleistocene formations (silt and sandstones, limestones, marls and shales) are found on the southern flanks of the Central Range: they cover large parts of the Northern Dividing

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Range and are also present in the Bird's Head and on the Bomberai peninsula, in Biak and on other smaller islands.

The low-lying southern plains as well as the Lake Plain and the northern coastal areas are covered by younger Quarternary deposits.

II.2.2. General Works

The first overall descriptions of Irian geology appeared in two works on the geology of Indonesia which devoted special sections to this part of the archipelago (Umbgrove 1949, Van Bemmelen 1949b). Summary surveys of Irian geology and mineral resources have been presented by Van Bemmelen (1949a), and Gheyselinck (1949). Later publications on general geological aspects are, among others, Verstappen (1960), Hermes (1974), and Helmcke et al. (1978).

II.2.3. Geological Exploration

The literature on the geological exploration of Irian is immense and is spread over a great variety of journals and other publications. The earlier publications belong to the period of exploration dealt with in section VI.2.2 (Expeditions). Alongside the few geologically relevant publications there listed, mention must be made of Heldring (1911), Brouwer (1917, 1923), Loth (1924), Rutten (1923, 1924), and Zwierzycki (1921, 1927, 1930).

A new period of geological research started with the arrival of two private companies in the Irian area, The most successful of these was the Netherlands New Guinea Petroleum Co. (NNGPM). It began its activities in 1935 and continued in operation until 1960. In 1962 the NNGPM left the area, but shortly afterwards its successor, Pertamina, took the initiative for further research. On the geological investigations under the aegis of the NNGPM, see: Visser and Hemmes (1962). This publication contains a wide variety of articles and many (coloured) geological maps of the territory.

Later research concentrated on the tectonic history, geology, operations on reefs and oil fields in the Salawati basin, and later also on the Bombarai and Bintuni basins. On the former a series of articles appeared in the Abstracts of the meetings of the American Association of Petroleum Geologists and SEPMI (Abstracts 1974, Froidevaux 1978).

On the prospects of exploration generally, see Soeparjadi (1974). The N.V. Mijnbouw Maatschappij Nederlandsch Nieuw-Guinea, which went in search of gold and other minerals in 1937, was less fortunate. At the outbreak of the war it stopped its activities, and did not resume these after the war. Instead, the Government encouraged and sponsored mineral research undertaken by the Mining Department of the Delft University of Technology, supervised by professors C.L. van Nes and G.J.H. Molengraaff. In 1959 the mineral research organization was institutionalized in the Foundation Geological Investigation New Guinea. More details on these government sponsored activities can be derived from the bibliography added to the monograph by d'Audretsch et al. (1966). A concise résumé of the mining potentials of Irian is to be found in Vink (1960). For later reports on mineral resources and their exploitation see Reynolds et al. (1973) and Wilson (1981).

A fascinating feature of Irian are its glaciers. For early reports on these glaciers see section VI.2.2 (Colijn and Dozy), but also Hope et al. (1976), and Hope and Peterson (1975).

II.3. Soils[3]

The pedological (soil science) investigation of Irian soils began in 1932, when F.A. Wentholt undertook his first expedition, which carried him to five locations on Irian's north coast. Other investigations followed, both by him and by others, but even today our knowledge is fragmentary. As the accessibility of many parts of the island is poor, systematic soil surveys of larger areas are rare. The areas examined for their agricultural potential are relatively small and most of the investigations tend to confirm the view, expressed in an early publication on Irian soils by Mohr, that in general the soil fertility is low. In the main, agricultural potential is confined to young alluvial valleys and coastal plains.

The first study on Irian soils in general, the one alluded to in the preceding paragraph, is found in the chapter on New Guinea in Mohr (1934). At the time the available information was very scanty indeed. The progress made since is reflected in Van Baren (1954). As a preliminary introduction to the subject the article has its merits. But it has the disadvantage that it uses an outdated terminology, which modern pedologists have since exchanged for a new one, that is utterly unfamiliar to students of other disciplines. To find his way among its terminological distinctions, the interested outsider should consult the detailed inventory of Papua New Guinea soils drawn up by Bleeker (1983). The work provides a model for the type of description one would wish to see available to Irian development workers in connection with their manifold problems with soil fertility. Soils in Irian are of a diversity equal to that of Papua New Guinea, a diversity which can be summarized as follows: In the young and flat coastal areas and river estuaries various types of hydromorphic soils are found, such as alluvial soils, Hydraquents and Tropaquents, bog and peat soils, Histosols, Fibrists and Hemists, and acid sulphate soils, Sulfaquents. Locally a range from saline soils, Halaquepts, to soils having an illuvial clay layer, Natraqualfs, may be encountered in subrecent marine clayey deposits.

In the southern parts of these same plains, on the lower elevated shields, older and poorer greyish to yellowish soils with clay illuviation, Udults, often with hydromorphic features and with whitish horizons or white and purple coloured mottles, Aquults, and sometimes rich in hardened material or concretions, Paleaquults to Plintaquults, are dominant. Northwards, on the slopes of the uplands, we find complexes of eroded and young soils, Tropepts, and more developed soils, Tropudults, both often in the Lithic subgroup. In the belt of mountains of intermediate elevation of the Central Mountain Range variants of complexes of eroded Udepts, stony or Lithic phases and often hydromorphic soils, Aquepts, up to poorer more developed soils with clay movement or with podzolic features, Aquults, are encountered. At the same elevations in the centre of the island peat soils, Fibrists, are present in the mossforest zone. The soils in the higher elevated intermountain valleys consist of Histosols, often flooting, and hydromorphic mineral soils like Aquepts and transitions of these main groups. Above the tree limit the soils comprise complexes of shallow and stony soils: Entisols,

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sometimes hydromorphic soils, Aquepts, and in the higher parts with a cryic temperature regime, often containing peaty, Histic, phases. The highest peaks are covered with eternal snow or have bare stony or rocky slopes.

In the Northern Dividing Range complexes of brown to yellowish younger and older soils with clay illuviation, and in the range of shallow and stony to deeper and sometimes hydromorphic profiles, Inceptisols and Ultisols, are dominant.

In some limestone areas, also on several islands, older red soils, Rhodustalfs, and shallower soils rich in carbonate, Rendolls, form the transition between smaller and greater karstic areas.

At the foot of the slopes of many mountains colluvial fans and transitions into alluvial fans bear younger soils, Entisols and Inceptisols, besides other deposits, like stone streams with coarse boulders.

At the foot of the Cyclop Mountains, very strongly weathered, old and purplish red soils rich in ironoxydes, Oxisols, are found.

Narrow beaches and ridges are composed of sandy soils or Psamments. In soil investigation and mapping two periods may be distinguished, viz. the pre-World War II period of scarce, local reconnaissance mapping, and the post-war, more intensive type of mapping with the aid of aerial photographs, carried out mainly to investigate agricultural potential in plains, valleys and other areas, see Reynders (1961a).

In the past the influence of man on the soil was very limited (local erosion or landslides). Recently in some coastal regions (e.g. to the south of Geelvink Bay) numerous wild occupations are taking place without environmental factors being taken into account, which may cause soil deterioration in the future.

A collection of results of numerous soil surveys carried out in Irian up to 1962 is presented in Haantjes et al. (1967). In this work attention is paid to soil forming factors of the major soil groups, which are illustrated on a coloured soil map, 1:2.500,000. References are given here to all published and unpublished soil reports and surveys and investigations in both the eastern and the western part of the island. These unpublished or mimeographed reports are present in the library of the Agricultural Research Institute at Manokwari.

General information on Irian soils may also be drawn from various chapters of the well-known handbook by Mohr et al. (1972). On nutritive elements, deficiencies and tropical crops, see Schroo (1959, 1961, 1964a, 1964b). For publications on soils, soil suitability and shifting cultivation, see Reynders (1961a, 1961b, 1962a, 1962b, 1962c, 1964). Some articles covering the field between geology and pedology are Ashizawa (1971) and Reynolds et al. (1972). On sheet IX, South-east Asia, of the Soil Map of the World, scale 1:5,000,000, the soil distribution of Western New Guinea is given. The explanatory text is presented in vol. IX of the FAO/UNESCO publication, 1976.

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III

ZOOLOGY AND BOTANY

III.1. Zoology

Social scientists conducting field research in Irian should have a reasonable knowledge of the animals and plants of the area, and more so of the plants than of the animals. It is on plants that the people rely for their food and medicine. They are horticulturalists and most of them have a keen interest in, as well as a good practical knowledge of, the plants of their environment. For this reason we can afford to be brief on the fauna of the area. For an introduction to the fauna of the area the following publications are recommended: Westermann (1947, 1948-49), Boschma (1954), Brongersma (1954, 1956a, 1956b, 1958), and Konrad and Sukarja Somadikarta (1975).

III.2. Botany[1]

Summary introductions to the flora and vegetation of Irian are provided by Beversluis (1954) and Van Steenis (1954). More elaborate are Paymans (1976), Van Balgooy (1976), and Fundter and Wisse (1977). A phytogeographical analysis which provided the basis for Van Balgooy, is Lam (1934). Useful introductions to food crops and ethnobotany are given by Massal and Barrau (1956), Barrau (1958, 1963), and Powell (1976). For the determination of plants use may be made of Backer and Bakhuizen van den Brink (1963-68), a complete, non-pictorial, flora, useful for the identification of a wide range of "ordinary" plants in Irian such as weeds and roadside and garden plants, and of the Handbooks of the flora of Papua New Guinea (Handbooks 1978-81). Of the latter, two parts have been published so far.

Further, mention should be made of a relatively brief work which may be of great use to the social scientist who sees himself confronted with problems of plant determination and feels the need to make enquiries with a botanical institute, namely Womersley 1969. Womersley (1981) is an elaborate manual for social scientists containing instructions for collecting and conserving herbarium materials. Among other works that may be recommended are the so-called Boswezen Rapporten, a series of aerial surveys and forest explorations published by the Forestry Service in Netherlands New Guinea, mostly between 1950 and 1961. Most of these reports are mimeographed, others only typewritten. Usually pho-

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