ENVIRONMENTAL CASE STUDIES

SOUTH PACIFIC REGIONAL ENVIRONMENT PROGRAMME (SPREP)

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South Pacific Study 4

PACIFIC PHOSPHATE ISLAND ENVIRONMENTS VERSUS THE MINING INDUSTRY: AN UNEQUAL STRUGGLE.

1 - GUANO , PHOSPHATES AND PACIFIC PHOSPHATE ISLANDS

A number of Pacific islands have been the scene of intensive tricalcium phosphate mining since the early 20th century. The best known and biggest deposits are on Makatea in French Polynesia, Nauru (Republic of Nauru) and Banaba, which is part of Kiribati.

Phosphate should not be confused with guano, which was also mined last century in various coral islands of the tropical Pacific. Guano is a build-up of bird droppings in places inhabited by large colonies of sea-birds. It can be directly applied as a fertiliser.

Because guanos can form calcium phosphates by the combination of their phosphoric elements with limestone under the effect of rain, there has been some confusion between the two substances.

World phosphate production has grown from a few thousand tons at the turn of the century to more than one hundred and thirty million tons today, over 80 % of which is extracted from sedimentary deposits formed by marine organisms combining with limestone, clays or other rocks. Phosphates are not only of recent origin, since each geological age has produced some. This mineral typically occurs in marine environments, although many deposits are today mined on the continents.

Phosphates which have at least partly developed from guanos have the advantage of being rich. Their P_2O_5 content is close to the 40 % maximum (Nauru : 38.9 %).

Tricalcium phosphate is not soluble enough in its natural state to be directly available to plants as a source of the phosphorus essential for their growth. It is therefore converted into a more soluble substance, known as superphosphate, by adding sulphuric acid.

The exposure to the open air of materials with a high phosphorus content overlying a limestone layer has produced similar types of calcium phosphates in various Pacific islands.

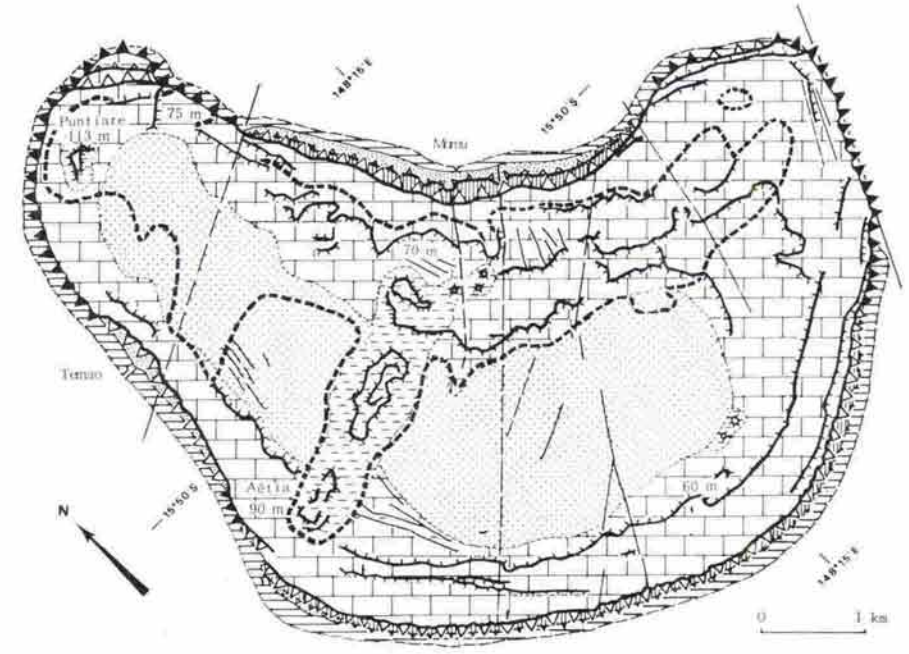
Nauru, Banaba, and Makatea are high coral islands, also described as raised atolls.

These islands are high in comparison to living or true atolls, whose emerged rim rises no more than a few metres above the lagoon. Nauru reaches to 70 metres, Makatea 111 metres and Banaba 90 metres.

Today, the Pacific phosphate islands all feature a climate in which evaporation is greater than mean precipitation (1700 - 2000 mm on average), which is relatively low for the tropical Pacific and highly irregular : 280 to 4500 mm in Nauru over 40 years, without the rainfall peaks due to cyclones, which spare this island located almost on the equator.

Since no water catchment system has been provided in this very permeable terrain, the only available water resources lie underground.

The land environment is more diversified than



GEOMORPHOLOGICAL SKETCH OF MAKATEA

- Central depression (chalky limestone)
- Peripheral plateau (coral limestone)
- Hillocks
- Pleistocene fringing reef flat
- Coastal plain (sand and gravel)
- Present fringing reef flat
- Living cliff > 30 m
- Living cliff < 30 m
- Dead cliff > 30 m
- Dead cliff < 30 m
- Minor escarpment < 30 m
- Fault or fracture according to Obelliane 1963
- Boundary of phosphate workings

J. BONVALLOT-1988

2 Original tomano and pandanus forest on Nauru.

that of atolls as such ; in their natural state, the fauna and flora tend to be richer, although the patchy soils, irregular precipitation and, for islands such as Makatea, the risk of cyclones, restrict diversity. These islands are small. Makatea, the biggest, is only 30 square kilometres in area, Nauru barely 22 square kilometres and Banaba a little more than 6 square kilometres, whereas the large elevated atolls of the Loyalties, except for Tiga and Walpole, extend over several hundred square kilometres. These large islands do not however, contain the rich deposits whose exploitation has played havoc with the natural environment of the other three and sealed the fate of their populations.

Because of the way it was formed, the phosphate occurs on these islands in usually crumbly surface or subsurface deposits. These deposits fill nests (small isolated masses of phosphate) and pits from a few metres to a few dozen metres in depth, separated by walls and pinnacles of very hard dolomitic limestone. In contrast to underground mining, the plant cover has to be destroyed and the mining zone laid bare before this kind of mining can begin. The degree of destruction of the vital components of the environment, the soils, the vegetation and to some extent also the wildlife they sustain, is therefore directly related to the surface area of the deposits: these cover almost half of Makatea and 80 % of Nauru and Banaba.

2 - NATURE DAMAGED, PEOPLE SHIFTED

If the depth of the workings was very roughly evened out over the whole mined area and assuming that the phosphate layer was unbroken and homogeneous, Makatea would have been mined to a uniform depth of 0.5m, Banaba almost 2m and Nauru over 2m, since 1/2, 4/5 and 3/4 respectively of their total surface areas have been exploited. In fact, the layer was very patchy and estimates like this do not allow for the thickness of the topsoil layer stripped away before mining. The real harm done to the environment is consequently far more severe than the bare figures suggest. The result is a stony desert, a chaotic jumble of walls, towers and pinnacles of very hard limestone, interspersed with less jagged islands of rock, with which mining has replaced the original landscape of these islands. Manner, Thaman and Hassal (1985) refer to a "topographic jungle". (See photograph 1).

3 Cutting down the forest on Nauru to prepare for mining

This form of mining could not start until the vegetation had been completely removed. The plant cover partly comprised endemic species and sustained wildlife, including many birds. (See photograph 2).
Although relatively little use may have been made of the forest in the original economies of these islands, the plants gathered there, the resources obtained from some strategically planted species such as coconut and breadfruit and the materials it yielded all nevertheless made a valuable contribution.

This vegetation was vulnerable, as shown by the shallow soils and the many reports of the partial disappearance of certain species during the most severe droughts. When the soils were removed during the extraction process, the resource represented by the thin humus-rich layer overlying them was lost forever. (See photograph 3).

The island populations, no more than a few hundred strong when the Europeans took control, (250 on Makatea, less than 1500 on Nauru and under 500 on Banaba, after a swift decline), had overcome the lack of surface water by using the groundwater accessible in wells and caves through the fissures of the karst (rugged, porous Limestone terrain). In Nauru, a brackish lagoon (Buada Lagoon) was used for an original form of fish farming with the acclimatisation of milkfish *(Chanos chanos)* The mining industry swelled fresh water needs with the large labour force it had to supply and the systematic collection of rainwater was not always adequate to meet requirements. Nauru and Banaba have at times had to import water, especially during droughts.

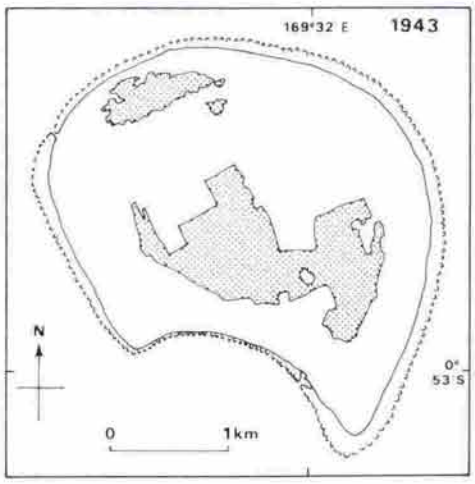
A theory has developed that mining has had an indirect impact on the quantities of water retained, especially on Nauru. Four of the seven known traditional wells on Banaba are said to have disappeared as a result of mining.

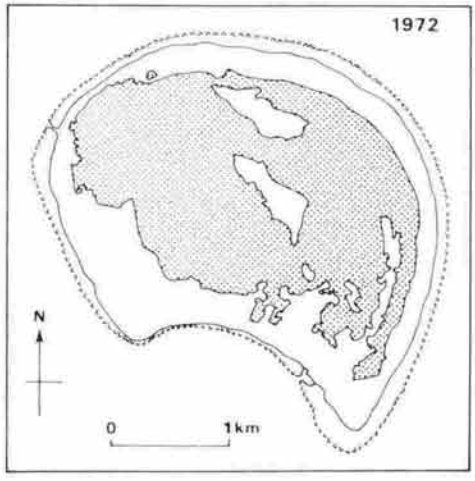
The damage to the natural environment has been accompanied by harm to the human environment. The landowners and political entities to which the islands belong have gradually seen their right to tangible compensation recognised but, either because of its own needs , or as a result of the Second World War, the mining industry has uprooted island populations in very painful circumstances. Banaba was almost completely abandoned after mining stopped in 1979.

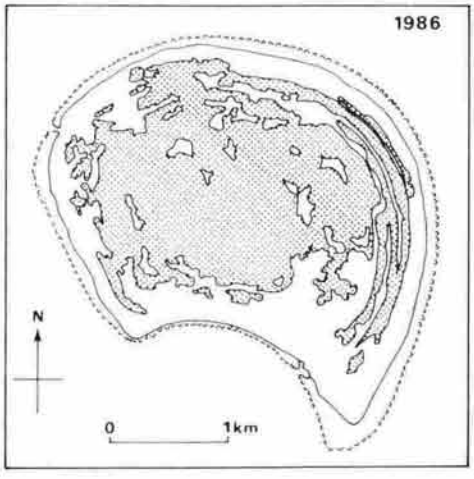
The cessation of all mining activity on Makatea twenty years ago turned the island into a desert with less than thirty people remaining.

Now partly uninhabitable, these islands no longer justify regular and frequent communications with the outside world for their tiny populations. They appear to have been deliberately left to fend for themselves.

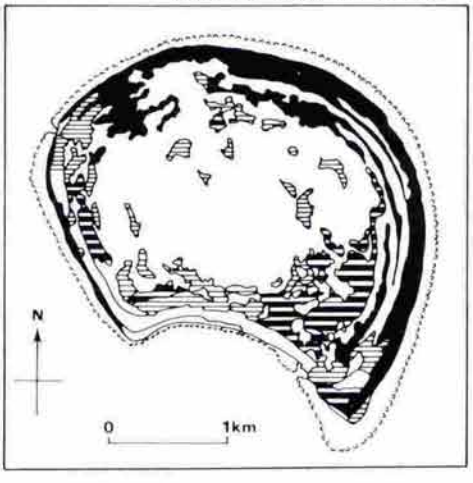
The vigourous population revival recorded in Nauru makes that island's circumstances







BANABA Vegetation in 1986



different. Nauru's population (5000), status (independant republic since 1968) and resultant control over its mineral wealth are factors which have put the Nauruans in a position to plan their island's rehabilitation and manage the profits from its sole resource for the future.

3 - THE ENVIRONMENTAL IMPACT : A HEALTHY RESPONSE BUT AN IMPOVERISHMENT

Bearing in mind that nothing has been done to favour it, the vegetation has shown an astonishing capacity for natural regeneration after being totally destroyed. Another fact worth noting is that the avifauna (bird life) which has in similar circumstances been seriously disturbed by the destruction of its nesting areas (*Sula abboti* on Christmas Island in the Indian Ocean), did not suffer too drastically from the changes brought about by mining.

In its natural state on Makatea, the plateau forest is dominated by tree species such as *Pisonia grandis, Pandanus tectorius* and *Guettarda speciosa.*

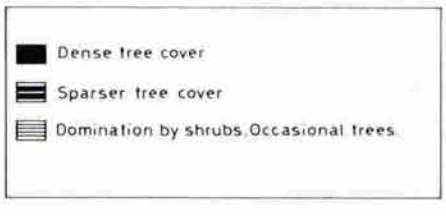
Recovery has been such in the area where mining began three quarters of a century ago that the vegetation cover is now complete.

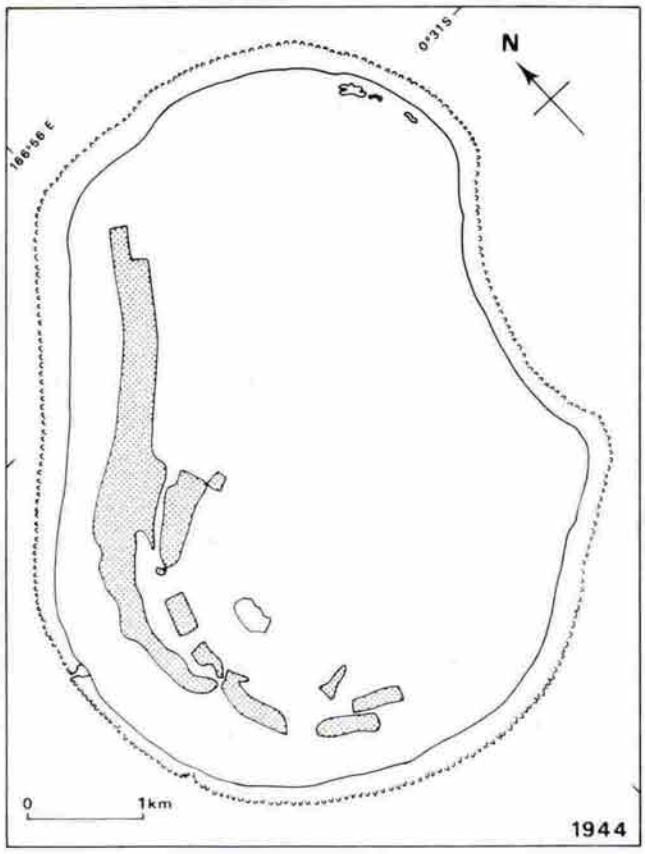
In the most recently exploited areas (25-30 years ago), in the bottoms of hollows, heliophilous (sun-loving) grasses and shrubs of the indigenous flora are already dominant. Species such as ferns flourish in the damp and dimly-lit environment of the deepest pits and recesses. (See photograph 4).

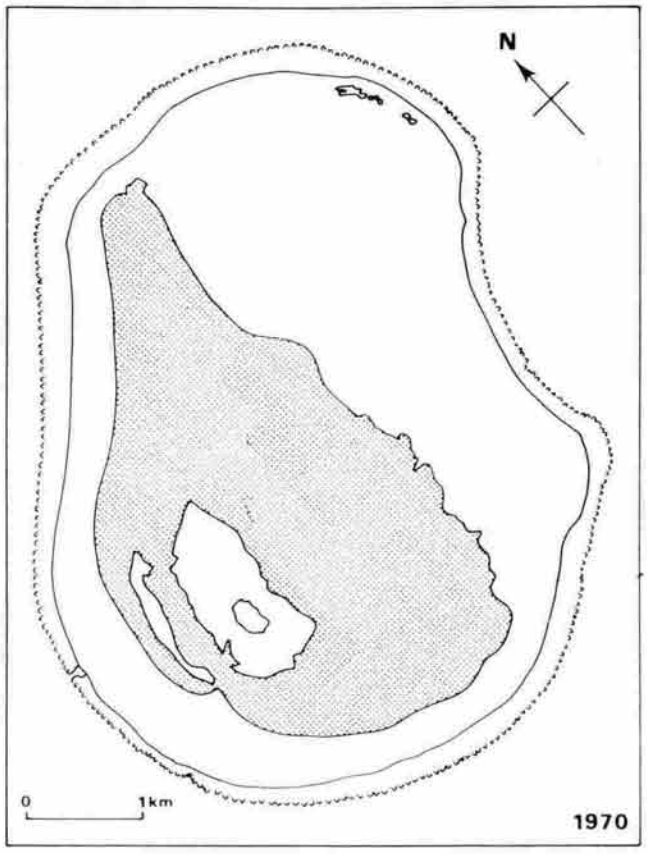
In the areas where mining first took place, as organic matter has added richness to the soils and erosion of pinnacles has continued, this low and incomplete plant cover has developed to a stage where ligneous (woody) species predominate. Lastly, in the final stage of total cover (more than 50 years on) closed vegetation cover similar to the original forest is re-established (Florence 1982-1988).

In Nauru, where approximately 10 % of the flora is indigenous, Manner, Thaman and Hassal (1985) identified two vegetation forms in the original tableland forest, which only accounted for about 15 % of the plateau area when the observations were made (1983) and certainly represent no more than 10 % (less than 200 ha) today.

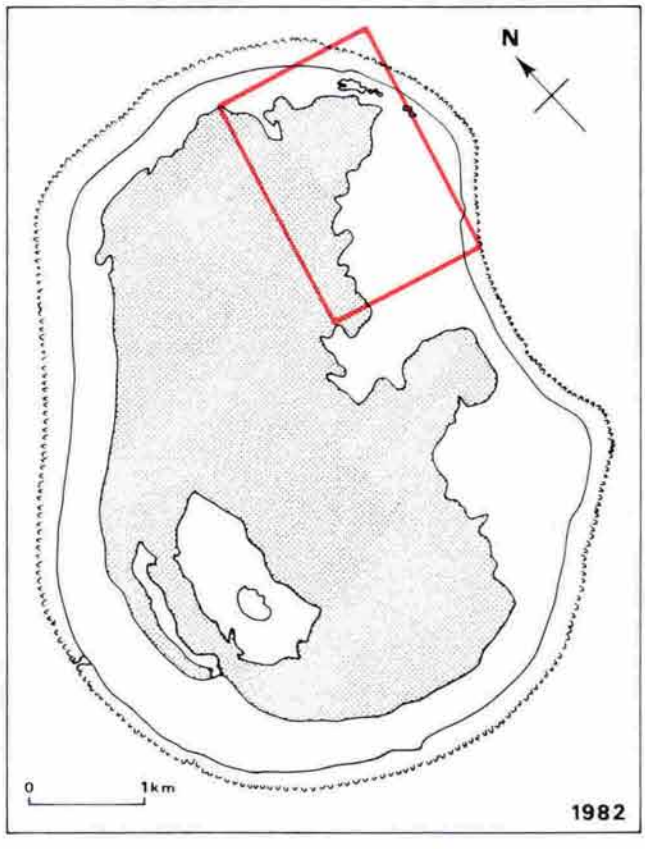
The first, which typically occurs on the surrounding rocky slopes and residual limestone outcrops scattered over the plateau surface, is dominated by *Ficus prolixa.*

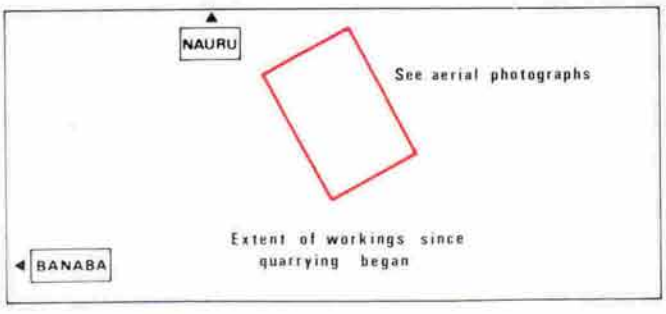






NAURU Vegetation in 1982

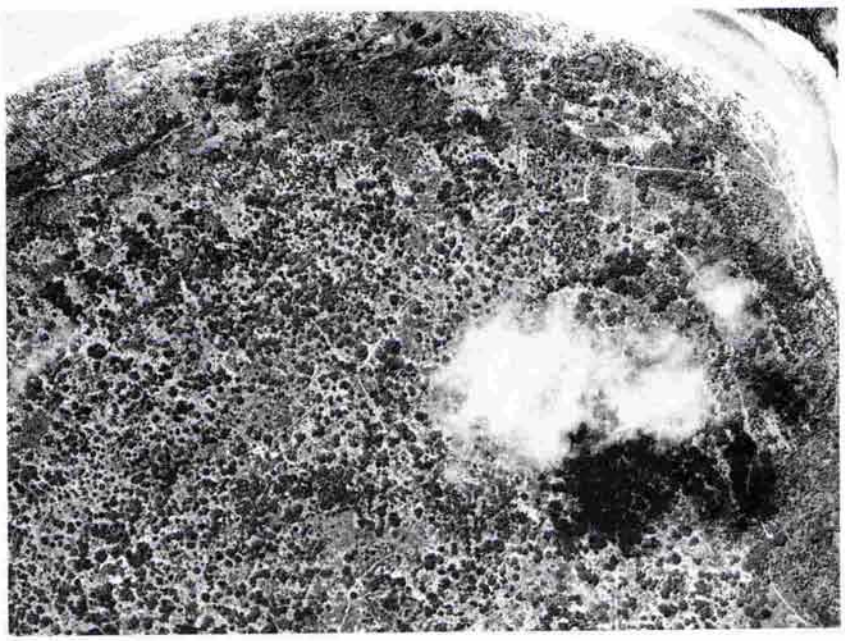




The second, which would appear originally to have covered more than 9/10 of the plateau, is almost entirely composed of *Callophyllum inophyllum* (tomano), an attractive tree whose wood, sap and fruit oil had many uses in traditionnal culture.

Mining sites are recolonised in the first twenty years by exotic grasses, rushes and ferns, which spread readily. Over the following two decades these are replaced by pioneering

1982



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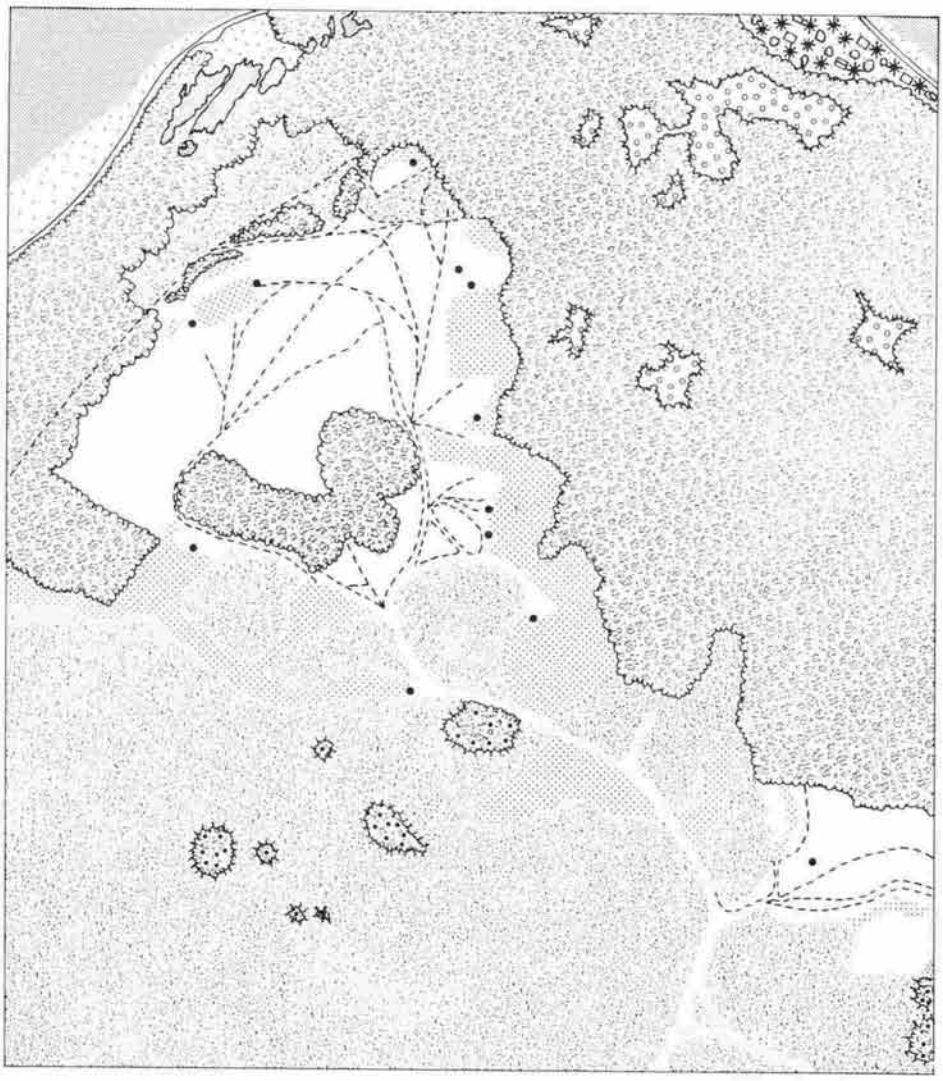
woody shrubs, which encourages the growth of shade-tolerant plants. (See photograph 5).

From forty to eighty years, more and more indigenous species reclaim sites on the pinnacles and loose slopes. (See photograph 6).

Generally speaking, the exotic plants which open the way for recolonisation of mining areas are fairly quickly replaced by the hardiest ubiquitous species among the indigenous ligneous shrubs.

On the other hand, certain indigenous species which were widespread in the past now appear to be threatened. Nine of the seventeen species of edible pandanus which used to be present on the plateau have disappeared. Others, such as *Casuarina litorea,* could be planted there and help restore the plant



Interpretation of photograph

- Ocean lagoons of karst origin
- Coastal zone with human habitation and cultivation
- Tomano forest on the plateau
- Deteriorated scrub vegetation
- Shrub and tree cover on rocky outcrops
- Old workings with dark limestone pinnacles (more than 2 but less than 20 years ago)
- Recent (less than 2 years) and present workings with light pinnacles
- Area where the forest has been cleared to prepare for mining. Topsoil present
- Areas ready for quarrying: soil cover stripped
- Feeder roads and quarry tracks
- Mining with crane-mounted grab-buckets

0 — 500 m

cover. Its results on Banaba, where it has been planted along the roadsides, have been spectacular.

The recolonisation which has taken place on Nauru and Makatea is therefore comparable in many respects.

Many of the arborescent species succeeding the first sun-loving species are however absent from the new vegetation in both islands, including the areas where mining was first abandoned. Despite the relative vigour of the new plant growth, therefore, the re-established forest cover is different in composition from the primary forest.

According to the survey by Manner, Thaman and Hassal (1985), at the beginning of the present decade, Nauru's flora consisted of 467 species, 320 of late introduction (after WWII) and 50 indigenous, or introduced by the original inhabitants. Of these 50 plants, 13 were considered to be endangered and some had already died out.

Such detailed observations and information are not available for Banaba. In an environment very comparable to Nauru's and under a very similar climate, free of cyclones, the evidence would nevertheless suggest that a parallel series of events took place, with many of the same species since the two islands are only 300 km apart. Droughts are also frequent on Banaba and precipitation is just as irregular there.

It is in any event quite clear that part of the tree cover dies in either island in the driest years.

Ferns play an active part in the recolonisation of the post-mining wasteland. A number of the woody species which occur in the new plant cover are common to Nauru and Makatea. On the other hand, two trees would appear to play a more important part than on Nauru, *Terminalia catappa* and *Casuarina equisetifolia*.

Although the land fauna would appear to have suffered comparatively little from the modification of habitats caused by mining, three of the five indigenous land bird species on Makatea are no longer found; their disappearance cannot however be interpreted as a consequence of mining.

The Noddy tern, an indigenous bird inhabiting the original plateau forests and the rocky areas spared by mining on Nauru, is thought to have been significantly reduced in numbers because of the shrinkage in its natural habitats. Allowance also needs to be made for the fact that terns are hunted by the Nauruans.

4 - MANAGED REHABILITATION : DREAMS AND REALITY

Protection of the environment's remaining resources and the rehabilitation of old workings were clearly not major considerations for the interests which exploited phosphates in the Pacific islands for decades. The sheer scale and spectacular nature of the damage done to the environment have, however, inevitably been a source of concern for the inhabitants, despite the compensation obtained, and have prompted other observers to ponder the future of these environments.

The loudest claims came from Nauru, whose inhabitants stayed on the island. As early as 1939, the Council of Chiefs raised the question of the island's rehabilitation with the administering authorities.

A survey was carried out in 1953 by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) of Australia. The authors noted that agriculture was in a depressed and neglected state, but also stressed that the plateau's agricultural potential was limited by poor soils and irregular rainfall. The complete rehabilitation of the mining zones to turn the plateau lands

4 Vegetation recovery on Makatea, 30 years after phosphate mining was stopped. Note the pit formation.

5 Vegetation recovery on Nauru, 40 years on.

6 Vegetation recovery on Nauru after 80 years. In the background, the wooded Buada lagoon area.

over to agriculture was, in their opinion, quite out of the question.

This prospect was however again explored in 1966 by an independant committee of experts as a result of approaches made by the Nauru Government just before Independence to the governments of the countries involved in phosphate mining.

The committee came to the conclusion that the general rehabilitation of the areas devastated by mining was technically possible but impossible in practice.

If Nauruans are to be able to continue living on their island after the closure of the mine, the vital factors are a reliable water supply and regular communications with the outside world. A modern aerodrome acting as a water catchment system would be the best way of utilising a large part of the bare surface of the plateau. The rapid growth of Nauru's population should be an incentive for investigating the possibilities of extending the croplands, but it would be futile to hope that the whole plateau could be made agriculturally usable.

It is impossible to consider importing into Nauru as much material as has been extracted. In some areas, however, the pinnacles could be knocked down and crushed, then levelled and covered with both imported and/or locally available soil. For denuded areas not spontaneously recolonised, the experts proposed to speed up new plant growth by sowing legumes and fast-spreading creepers to increase the production of organic matter, and by planting tomano *(Calophyllum i.)* and *Terminalia* whose seeds cannot be dispersed by the wind or by birds.

In 1988, a Government Commission of Enquiry continued to develop arguments and investigate legal avenues whereby Nauru could obtain compensation from the countries which had mined phosphates up to Independence and furthered enquiries into the technical requirements for rehabilitation.

Meanwhile, in the Anibare and Ijuw districts in north-eastern Nauru, the tall tomano trees in the few remaining hectares of original forest on the " topside" (plateau) were being ripped out by bulldozers. (See photograph 7).

Obstinacy is almost the only way to describe current plans for resuming mining in old quarries. It was recently estimated (1987) that, in Nauru, there was 1 to 2 % of residual phosphate in the areas worked by hand and with light equipment when mining started, and 7 % to 10 % in workings where grab-buckets on cranes were used.

The commission considers that such a resumption of mining would be beneficial for technical reasons prior to restoring the vegetation. In 1988, the Nauru Phosphate Corporation was conducting levelling and vegetation regrowth trials over limited areas.

7 Experimental levelled area on Nauru (1988).

Kiribati lacks a structure comparable to the Nauru Government's Commission of Enquiry and equally detailed information about projects relating to the future of Banaba is therefore not available. Rehabilitation of the mining zones is not even mentioned in the sixth national development plan (1987-1991).

On Makatea, the mining equipment and buildings which were simply abandoned when mining ceased are mostly in a dilapidated state. Almost a quarter of a century after the closure of the mine, plans for a resumption of activity, which would have used at least part of the available equipment and know-how, have long-since been forgotten.

Every now and then fresh interest is nevertheless shown in this island ; twenty-five years ago, it stood out as a major centre of activity in the various archipelagoes comprising French Polynesia and one-quarter of all private sector salaries were being paid there. Promises to turn industrial wasteland back over to agriculture, given the current economic circumstances of the Territory, are no more realistic than suggesting that tourism would be a viable investment.

5 - PROPER MANAGEMENT FOR NEW DEPOSITS? MATAHIVA IN THE TUAMOTUS

It is unlikely that any new phosphate deposits will be discovered on the islands, or parts of islands, in the tropical Pacific which are structurally comparable to Nauru, Banaba or Makatea, but some true atolls may contain such deposits. Consideration can therefore be given to the way these resources should be managed to protect the environment, the economy and the society, for those atolls that sustain a permanent population.

The atoll of Matahiva in the western Tuamotus, 330 km north of Tahiti, has a phosphate deposit with an average P_2O_5 of 37.5 %. The original feature of this deposit is that it occupies a section of the lagoon area (approximately 1/5), which is in the process of drying out into pools, lying under three metres of water and a layer of seven metres on average of mud, sand and other materials. The lagoon is roughly 25 square kilometres in area. Almost 700 of the 1600 or so hectares of emerged land are occupied by a thriving coconut grove.

In 1983, the population consisted of 215 inhabitants forming 40 households, most of whom lived in a single large village near the main passage in the western part of the atoll, close to the landing strip. The fish traps which accounted for most of the island's fishing activity were also to be found there. The deposit is situated in the same western part of the lagoon near the main passage ; this area would be the site of major environmental upheavals if mining were to go ahead.

To avoid Matahiva being turned into a desert and then deserted, impact studies have outlined the action to be taken before beginning to mine the deposit and after it runs out in order to protect the environment and prepare the atoll for new economic activities.

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This study was carried out with the assistance of the governments of Nauru, Kiribati and French Polynesia and with the cooperation of the Commission of Enquiry into the rehabilitation of the worked-out phosphate lands of NAURU.

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