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Pressures and Perils in the Stony Bits of Lihir, Papua New Guinea

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Introduction

Small island communities are often under pressure or even in a perpetual state of peril. Narratives of climate change have focussed greater attention on the plight of Pacific Island communities (Barnett and Campbell 2010; Connell 2015), but it is worth recalling that some of these communities were already thought to be facing perilous futures in the colonial period, well before anyone was concerned about the effects of global warming. Despite the growing focus on rising sea levels and environmental change, many small island communities face a range of other problems. It is therefore important to understand how people have adapted to these challenges in the past, and how their options have been changing over time, in order to understand how they might adapt to the effects of climate change and other pressures in the future. In broad terms, the vulnerability of small island communities is shaped by a combination of factors, including crude population density, the physical characteristics of individual islands, the stocks of natural resources or ecosystem services owned by the inhabitants of these islands, and their access to goods and services beyond their territorial shores.

The Lihir group of islands in Papua New Guinea (PNG) has attained a certain notoriety because of the development of a large-scale gold mine on the main island of the group. In the 1980s, prior to the development of the mine, the smaller islands in the group were already experiencing the pressures of population growth. Mining activities commenced in the mid-1990s, and since then all sorts of social, economic and environmental changes have taken place as a result (Bainton 2010). The smaller islands have also experienced new forms of pressure that set them apart from all the other small island communities of PNG, where there is no huge gold mine in the immediate vicinity. Mining activities are currently expected to continue until at least 2040, which leaves plenty of time for these pressures to become even more pronounced in the absence of any affirmative action.

In this chapter, we examine the pressures and perils confronting the smaller islands in the Lihir group. Our chapter forms the second half of a broader analysis of land relations and pressures in Lihir, with the first half focussed on the direct and indirect forms of displacement created by the gold mining operation, both on the main island and the smaller islands (Bainton et al. 2022). Here our primary aim is to examine the relationship between the main island and the small islands, and the way that this relationship shapes local responses to pressure on the ecosystems that sustain the local population. Drawing on our combined experience of researching the social impacts of the gold mine, we present a long-term picture of these insular relations and pressures.[1]

The Moment of Exclusion or Inclusion

When the first social impact study was initiated in 1985, PNG's Department of Minerals and Energy and the Kennecott-Niugini Mining Joint Venture were both inclined to regard the shores of the main island as the outer limit of the area in which the social impacts of a future mine would be experienced (Filer and Jackson 1986: 148).[2] That is essentially because the exploration licence granted to this mining company only covered the main island, while another mining company was granted a licence to explore the

1 One of us (Filer) was lead author of the original social impact assessments for the mining project, while the other (Bainton) first came to Lihir as a PhD student in 2003, when the mine was already operational. Both of us have continued to reflect on the social impacts of the mine, from one vantage point or another, since we paid our initial visits.

2 The first social impact study was undertaken at the request of the New Ireland Provincial Government.

mineral resources that might be contained on one of the smaller islands. But it soon became apparent that the islanders themselves were not prepared to accept the right of the national government to make such artificial jurisdictional decisions. Indeed, most of them did not acknowledge the authority of the national government in any shape or form. Instead, a majority were members of a body called the Nimamar Association, which might best be described as a micro-nationalist movement (May 1982). The name of this body was an abbreviation of the names of the four islands in the Lihir group—Niolam, Malie, Masahet and Mahur. The members of this micro-nation regarded the state of PNG as an alien and unwelcome form of intrusion on their own sovereignty. Indeed, they already regarded the future advent of a large-scale mine as the fulfilment of a prophecy made by their own founder (Filer and Jackson 1986: 242–9).

There is no reason to believe that Lihirians had any conception of themselves as a singular micro-nation before the advent of European colonial rule. Yet they do possess a single vernacular language that is not shared with any other indigenous communities in New Ireland Province (Neuhaus 2015). During the 12 years that elapsed between the initial discovery of gold deposits in Luise Caldera in 1983 and the start of mine construction in 1995, local community leaders elaborated a variety of ways in which to assert their own collective identity and their claims to ownership of the mine located at the heart of this 'imagined community' (Bainton 2010).

Outsiders have sometimes applied the name Lihir to the main island on which the mine is now located. Lihirians themselves think of it as the name of their language group. The name of the main island that figures as Niolam in the name of the Nimamar Association is more accurately rendered as Aniolam—a name that translates as 'Big Island' or 'Mainland' in the Lihirian language. The other three names that figure in the name of the Nimamar Association are the names of three small islands located at various distances to the northeast of Aniolam (see Figure 6.1). In the 5 km of sea that separate Malie from Aniolam there is one very small island (Sanambiet) and one miniscule island (Mando) that are linked to Malie itself at low tide. Malie, Masahet and Mahur are known collectively as Ihot—a name that translates as 'Stony Places' or 'Rocky Places' in the Lihirian language.

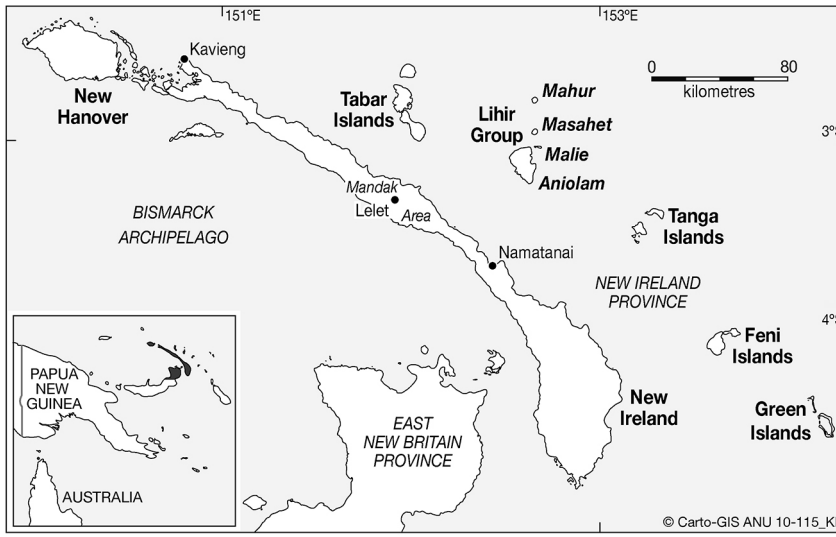

Figure 6.1: The Lihir group of islands

Source: CartoGIS Services, College of Asia and the Pacific, The Australian National University.

Small Islands Under Pressure

The island of Aniolam formed around five extinct volcanoes. It has a generally mountainous terrain, with dome-shaped peaks and razor-backed ridges separated by deep gullies, meaning that much of the available gardening land is located in coastal areas. By contrast, the islands of Malie, Masahet and Mahur are all raised coral shelves with flat tops, where crops are cultivated, and a narrow coastal strip, where most of the settlements are located (see Figure 6.2). A survey conducted in 1990 identified more than 400 separate hamlets across the whole island group, most of which were located within 200 m of the shoreline (Filer 1992a). Many of these hamlets are separated from each other and the surrounding vegetation by walls constructed out of slabs of coral limestone. This material is so abundant on the small islands that walls have also been built to separate clan territories and individual garden plots.

Figure 6.2: Masahet Island
Source: Photograph by Nicholas Bainton.

A calculation of the average number of rural villagers per square kilometre of land on each of the four islands in 1980 shows that densities were much higher on the small islands than on the main island (see Table 6.1).[3] A subsequent study found that malaria was 'meso-endemic' in settlements constructed on limestone soils, including all the small island settlements, but 'hyper-endemic' in settlements constructed on volcanic soils, including many of the settlements on the main island (Taufa et al. 1991). The obvious explanation for this difference is the lower rate of water retention on the limestone soils, but the variable incidence of malaria also helps to explain the higher population densities in this type of environment.

Table 6.1: Rural village population density in 1980

Island	Area (km²)	Population	Density
Aniolam	198.6	3,639	18.3
Malie	2.2	265	120.5
Masahet	8.1	841	103.8
Mahur	7.8	626	80.3
TOTAL	216.7	5,371	24.8

Source: Filer and Jackson 1989: 37.

3 The areas specified in this table have been slightly adjusted in light of more recent calculations based on satellite imagery. The landmass of Aniolam has also expanded slightly as a result of the dumping of mine waste rock into Luise Harbour during the course of mining operations.

Ninety per cent of the land on the small islands was already being used for the cultivation of food crops or cash crops before the construction of the mine. The rest was either occupied by human settlements or was otherwise unsuitable for cultivation. Part of the mountainous interior of the main island showed no sign of having been cultivated at any time in the past, so the average number of villagers per square kilometre of land 'in use' was more like 25 than 18.

A survey of village agricultural systems conducted in the mid-1990s, before the start of mine construction, drew a broad distinction between the system found on the small islands and the one found on the main island. The key difference between the two systems was the length of the fallow period in the swidden farming cycle. On the main island, a patch of land would be cultivated for 1 or 2 years and then left fallow for at least 5 years, and often for as long as 15 years, before being cultivated again. On the small islands, the fallow period was only 3–5 years in length, so the fallow vegetation did not have time to approximate anything that could be described as secondary forest. This difference in the intensity of cultivation, which clearly reflects the relative scarcity of cultivable land on the small islands, was accompanied by some differences in the relative significance of the food crops that were being cultivated. On the main island, the most important crops were the short yam (*Dioscorea esculenta*) and sweet potato, followed by the long yam (*Dioscorea alata*), cassava, banana and taro. On the small islands, sweet potato, cassava and both types of yam were of equal importance. In both systems, there was a difference between those gardens in which a planting of yams might be followed by a planting of other root crops, and those in which two plantings of sweet potato and/or cassava were made before the land was left fallow (Hide et al. 1996).

Further evidence of the relative significance of different food crops in these two agricultural systems is available from a national nutrition survey conducted in the early 1980s, since the Lihir group of islands was included in the survey sample (see Table 6.2). The greater preponderance of sweet potato and cassava in the diet of the small islanders, and the complete absence of taro, is further evidence of the growing scarcity of arable land, since both crops produce greater yields from soils of lower quality. These figures also indicate the relative importance of coconuts in the small island system, not only as a source of food but also because the very limited availability of fresh water meant that villagers were drinking a lot of coconut milk and were especially reliant on it during periods of drought or dry weather.

Table 6.2: Percentage of households consuming different food crops on previous day in 1982

System	Coconut	Sw. potato	Yam	Cassava	Banana	Taro
Main island	62	58	46	28	17	9
Small islands	81	94	58	39	6	0

Source: Hide et al. 1996: 66, 77.

The authors of the first social impact study for the future development of the mining project conducted their own survey of the main island's agricultural system at the end of 1985. They calculated that 19 food gardens on Aniolam ranged in size from 900 to 2,800 m^2, and that the main constraint on garden size was the need to build a bamboo fence around the perimeter in order to keep the pigs out. Since the fences began to deteriorate after nine months, the food crops had to be harvested within that period, leaving tree crops like breadfruit, banana and papaya to keep growing as the garden began to revert to fallow (Filer and Jackson 1986: 39). They also reckoned that the area of land in fallow at any one time was roughly 7 or 8 times the area under active cultivation, which led them to estimate that each person required a minimum of roughly 5,000 m^2 (or half a hectare) of cultivable land in order for the system to provide an adequate food supply for households that could not afford to purchase food from elsewhere (ibid.: 40).

When the social impact study was being revised and updated in 1988, the authors conducted an additional survey of eight food gardens on the island of Masahet, and found that these were smaller, on average, than those on Aniolam, ranging in size from 440 to 700 m^2. The higher density of the human population was found to be associated with a lower ratio of pigs to people and a more concerted effort to separate the pig habitat from the areas of settlement and active cultivation. On Masahet, a combination of stone walls and bamboo fences was built in order to divide the whole island into three concentric zones, and thus confine the pigs to the area of secondary forest between the coastal zone of human settlement and the interior plateau where short-fallow swidden cultivation predominated. Where stone walls had been built to protect gardening areas, tubers and vegetables could be cultivated for a longer period without the risk of pigs breaking through rotting fences (see Figure 6.3). Furthermore, since the fallow period was much shorter than on the main island, various measures had been adopted to compensate for the desiccation and degradation of the soil (Filer and Jackson 1989: 39–40).

Figure 6.3: Garden stone wall, Masahet Island
Source: Photograph by Simon Foale.

In 1992, the mining company commissioned another survey of village agriculture, with a sample comprising 16 households in three villages on Aniolam and 6 households in one village on Masahet (Bonnell 1992). This survey found that 86 people on Aniolam accounted for 38 gardens under cultivation, with a combined area of 5.436 hectares (632 m^2 per person), while 50 people on Masahet accounted for 50 gardens with a combined area of 2.405 hectares (481 m^2 per person). These figures suggest that the total area of land cleared for new swidden gardens in the decade preceding development of the mine would have been 250–300 hectares per annum (around 1.5 per cent of the total surface area) on the main island, and 85–100 hectares per annum (or 5–6 per cent of the total surface area) on the small islands.

Despite the differences in average garden size and the duration of the swidden cycle discovered by subsequent surveys, the authors of the first social impact study suggested that both agricultural systems required the same amount of cultivable land per head of population—about half a hectare—in order to be sustainable (Filer and Jackson 1986: 40). On this basis, they calculated that more than 60 per cent of the 'usable land area' would already have been required to feed the resident population of two of the small islands—

Malie and Masahet—in 1980, and if the population was growing at an average rate of 2 per cent per annum, the supply of cultivable land would have run out before 2020 (ibid.: 41).

This does not mean that the islanders would run out of food; it simply means that they would have to import more food from elsewhere, and so would have to find the means to pay for it. In this respect, the villagers on the main island, who still had plenty of cultivable land, also had an option that was ceasing to be available to those on the small islands. They could sell cash crops, or surplus food crops from their gardens, or some of the domestic pigs that made a nuisance of themselves, or else the products of their hunting and fishing practices, and use the proceeds to buy some of the other things they needed. The 1980 national census gave some evidence of the extent to which they were able to exercise this option (see Table 6.3).[4] In 1985, the average cash income from the sale of export crops (copra, cocoa and chillies) across the whole of Lihir was thought to be approximately 40 kina (then equivalent to 40 US dollars) per capita per annum, but the average would have been considerably lower on the small islands (Filer and Jackson 1986: 55).

Table 6.3: Sources of household income from own agricultural production in 1980

Island	Households	Copra (%)	Cocoa (%)	Chilli (%)	Veg. (%)	Fish (%)
Aniolam	906	41.9	43.3	0.8	18.9	14.7
Malie	71	5.6	0.0	21.1	4.2	2.8
Masahet	199	9.5	1.5	38.7	5.5	4.0
Mahur	139	53.2	3.6	28.1	2.9	1.4
TOTAL	1,315	36.3	30.4	10.5	14.4	11.0

Source: Filer and Jackson 1986: 51–2.

In 1968, it was reported that the Malie islanders were exporting 50 bags of copra each month from their coconut plantation on the tiny (50-hectare) islet of Sanambiet (Gormley 1968). Twenty years later, they were barely selling any copra at all. Some of the palms on Sanambiet had been cut down to make way for food gardens during a drought in 1982, despite the very poor quality of the soil, and coconuts were only being used for domestic consumption and pig fodder (Filer and Jackson 1989: 40). Even on Mahur

4 The figures for cocoa and chillies are for the number of households claiming to grow them, whether or not they sold them, while the other figures are for claims of sales.

Island, where more than half the households reported some copra sales in 1980, the market had dried up as the price of copra fell relative to the cost of hiring a motor boat to transport it to the nearest point of sale on the main island.[5]

The chillies being grown on the small islands were inter-planted with other garden crops, so did not have the effect of reducing the amount of land available for food production and did have the advantage of a fairly high value-to-weight ratio. The combined value of chilli exports from all three of the small islands was still around 30,000 kina in 1985, which would have yielded an average per capita income of around 15 kina, but the trade had entirely ceased by 1988 (Filer and Jackson 1989: 85). By that time, the most significant of the crops being traded out of Masahet Island were the pineapples that were also planted in regular food gardens (ibid.: 39). The harvest of marine resources such as crayfish and lobsters from the reefs around the small islands provided a regular supplement to the diet of the islanders, but there was no surplus left over for export, nor any local enthusiasm for using the small number of sea-going vessels as fishing vessels, given that they were mainly being used to transport people and cargo between the islands (Filer and Jackson 1986: 33). In 1985, one man described the production and export of shell money as the main 'business' activity on the small islands (ibid.: 93). In 1988, the annual value of this particular export was estimated to be 50,000 kina (Filer and Jackson 1989: 86). At that juncture, it seems safe to say that the islanders were making almost no money at all from any agricultural activity. Most of their cash incomes were more likely derived from the export of human beings.

The authors of the original social impact study could not find reliable figures on the rate of growth of the resident village population in the decades preceding the 1980 national census (Filer and Jackson 1986: 32–4). Subsequent discovery of a complete set of village books from 1958 has enabled us to compensate for this deficiency in the demographic record, and hence to compare the rates of change on the main island and the three small islands (see Table 6.4).

5 In any case, the only fibreglass motor boat based on Mahur Island had broken down and drifted all the way to the Solomon Islands in 1987 (Filer and Jackson 1989: 110).

Table 6.4: Rural village populations in 1958 and 1980

	1958			1980			% change		
Island	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**
Aniolam	1,269	1,122	2,391	1,915	1,724	3,639	50.9	53.7	52.2
Malie	107	101	208	130	135	265	21.5	33.7	27.4
Masahet	314	270	584	439	402	841	39.8	48.9	44.0
Mahur	230	192	422	315	311	626	37.0	62.0	48.3
TOTAL	1,920	1,685	3,605	2,799	2,572	5,371	45.8	52.6	49.0

Source: 1958 village books and 1980 national census.

The first point to notice about these numbers is the excess of males over females on all four islands in 1958, especially on the small islands of Masahet and Mahur. The excess seems to have diminished in 1980, and even to have been reversed on the small island of Malie. However, these calculations do not take account of the number of individuals who were absent from the islands when the populations were counted. The 1958 village books only recorded three absentees, who are included in the figures shown here, although the true figure may have been higher, since the village books were meant to determine the amount of head tax to be collected from the residents of each village. The 'rural community registers' produced in advance of the 1980 national census were meant to include a more accurate count of the number of absentees. The New Ireland register showed that there were 510 individuals then absent from all the villages of Lihir—278 from Aniolam and 232 from Ihot. Since most of the absentees would have been males, the preponderance of males in the total village population was likely to have been just as great in 1980 as it was in 1958, which is indicative of high maternal mortality rates and low female life expectancies across all four islands.

Once absentee rates are taken into account, it would seem that the overall rate of population growth between 1958 and 1980 would have been much the same on the small islands as on the main island, although it still seems to have been lower on Malie, where the proportion of absentees was almost exactly the same as on Masahet—about 12.5 per cent of the total village population. The proportion of absentees was lower on Mahur—about 10.5 per cent of the village population—but still higher than on the main island of Aniolam, where it was only 7 per cent. This suggests that migration was already functioning as a kind of safety valve to relieve the pressure of

a growing population on the limited natural resources of the small islands. We do not know enough about the absentees to know exactly how they came to leave the islands, but the authors of the social impact studies thought it was likely that many of the small islanders, in particular, had taken advantage of the educational opportunities offered by the Catholic Church in order to join the formal sector workforce in other parts of the country (Filer and Jackson 1989: 120–2).

The History of Island Symbiosis

There is clear evidence that the people of Ihot, especially those of Malie and Masahet islands, had been responding to the local scarcity of cultivable land and other subsistence resources for several decades—if not centuries—before the discovery of the gold deposit (Filer and Jackson 1989: 38–41). The intensification of their agricultural system was one of these responses. However, to understand the full range of responses, it is necessary to recognise the specific forms of symbiosis or mutual dependence that have characterised relationships between the small island communities and the larger population of the main island.

Father Karl Neuhaus established a Catholic mission station at Komat, on the southwestern coast of Aniolam, in 1931.[6] Shortly afterwards, he recounted the 'tragic' circumstances in which a man called Targolam from Masahet became the first Lihirian to be baptised (as Johannes) in 1907. Targolam was arrested by German government officials in 1906 because he was one of two men held responsible for leading an attack on a group of labour recruiters in 1905. A subsequent government report noted that the attack was most likely provoked by their 'recruitment' of a local woman against the wishes of her husband, which was said to be one example of a pattern of behaviour that was upsetting the local men because there was a 'pronounced lack of women on the islands'. Neuhaus concluded from his reading of the report that the attack was probably justified, but that Targolam was not the ringleader, and his arrest was mainly due to the fact that he and his fellow villagers were accused of attacking another village on Masahet in which 'they killed and ate various people'. It was the people of this village, one of whom had apparently been a member of the colonial police force, who encouraged the German officials to take revenge on their enemies. Targolam

6 He had first visited the islands in 1913 and continued to make regular visits after 1918.

was imprisoned at Namatanai, on the east coast of New Ireland, and died shortly after he was baptised. Neuhaus described him as the 'patriarch of Christianity' in Lihir (Neuhaus 1932).

This account is noteworthy for several reasons. The government report attributed the shortage of women on the small islands to a high rate of female mortality in a previous epidemic of dysentery, but since the shortage was still evident in 1958, it seems to have been a more enduring phenomenon, and would thus have limited the rate of population growth over a longer period. It is also somewhat surprising that different villages on an island as small as Masahet could function as autonomous political communities and engage in periodic acts of warfare, yet still survive to fight another day. Their mutual hostility might have been an effect of tensions induced by the advent of German colonial rule, but it is more likely that pre-colonial political communities in Lihir generally numbered no more than 200 people, and that Malie was the only one of the three small islands that was too small to contain more than one such community. Neuhaus did not say whether he believed that the people of Masahet were in the habit of eating each other, or how often they might have done so. However, Father Andrew Pong, who was the first Lihirian (and second Papua New Guinean) to be ordained as a Catholic priest, was quite fond of recollecting that his forbears from Malie would sail their canoes across to the main island, and then kill and eat various people when they got there. By the time the mining company arrived, Pong had established himself as the 'patriarch of Christianity' among the Catholic population of Lihir (Filer and Mandie-Filer 1998: 9).[7] And his emergence as a leader was not unrelated to the observation made by the early Catholic missionaries, that the people of the small islands were 'much more open and lively than the bush people from the big island' (Skalnik 1988, quoted in Filer and Jackson 1989: 172). Father Neuhaus might even have established his mission station on one of the small islands, if only there had been a harbour for his boat. In the 1980s, no visitor could fail to notice that the small islands boasted by far the most elaborate and finely decorated churches in the whole of Lihir, aside from the one at the central mission station (Filer and Jackson 1986: 108). And in 1985, the small islands accounted for 18 of the 31 Lihirians employed by the Catholic parish, including the teachers at the vocational school and the nurses at the health centre attached to the mission station (ibid.: 149).

7 Methodist missionaries had gained the adherence of a minority of the population on the main island in the 1930s (Hemer 2011).

Figure 6.4: Shells used to make shell money
Source: Bainton 2010: 96.

One might therefore be led to suppose that the relationship between the small islands and the main island was traditionally a relationship of domination or subordination, and that this relationship has simply acquired a novel Christian form. Yet there were some ways in which the people of Ihot have always relied on resources that could only be obtained from the main island and could not simply be obtained by force. For example, they do seem to have specialised in sailing long distances to neighbouring island groups as participants in a regional maritime trading network, but the timber required to make the canoes on which they sailed was most likely sourced from the main island. Before the Second World War, it was reported that some of them were sailing to the Tabar island group to exchange live pigs, tobacco and dances for shell money and food crops (Groves 1935: 360). These exchanges were part of a network through which shell money produced on the island of Lavongai (New Hanover) moved in a southeasterly direction, towards Bougainville, while the pigs generally moved in the opposite direction as the shell money was used to purchase them (George and Lewis 1985: 33; Bainton 2010: 94–9). But where did the pigs come from? In the Lihir case, the small island traders most likely used some of the shell money obtained from Tabar to buy pigs from people

on the main island. In the 1980s, they were still using shell money (as well as cash) to buy pigs from this source, but after the Second World War they were also buying the shells as raw material from other parts of New Ireland and making the shell money themselves (see Figure 6.4).[8] And that is why they described the production of shell money as a kind of 'business', even if this business had also come to be seen as part of a wider enthusiasm for the maintenance of customary social institutions (Clay 1986: 193).

Nor were pigs and timber the only useful things that the small islanders got from the main island. In the 1980s, people from Malie and Masahet were obtaining bamboo poles and sago fronds from the northeastern part of the main island in order to construct the walls and roofs of their houses (Filer and Jackson 1986: 30, 42).[9] It is not clear how much they paid for these commodities, or whether they were able to obtain some of their supplies at no cost from close relatives. But when the mining company required bamboo for construction of their exploration camp, local villagers claimed that this was one of their 'cash crops' and proceeded to haggle over the price (Filer and Jackson 1989: 216).

At this juncture, some people from Malie and Masahet were certainly using relations of kinship and marriage to access additional gardening land in the northeastern part of the main island (Filer and Jackson 1986: 43). This was already a fairly well-established way of dealing with the shortage of land on the small islands. In the 1960s, a government official noted the social tension that arose when some people from Masahet went one step further and planted coconuts on the land they were gardening (Gormley 1968). The planting of tree crops is widely regarded as a way to claim use rights that extend for a lengthy period, but when those tree crops are also cash crops, the original owners of the land would be especially upset by the prospect of their loss. The general decline of copra production across the islands would have alleviated this particular source of tension by the 1980s.

The arrival of the mining company created a new opportunity for people on the small islands to enlarge the scope of what had long been their main way of alleviating pressure on their narrow resource base, which was for some of them to find paid work in other places and remit a portion of their incomes

8 The shells were purchased in bottles, then polished, drilled and strung together in spans or fathoms about 1.5 metres long. This was a group activity undertaken for several days at a time (Filer and Jackson 1986: 39).

9 The limited supply of bamboo on Malie was mainly used to stake yam vines, while the Masahet islanders were using a type of hibiscus, as well as imported bamboo poles, for this purpose. The people of Mahur still had sufficient local supplies of bamboo and sago for building purposes.

to relatives who stayed on the islands. As we have seen, some such work had been found on the main island, mostly through the good offices of the Catholic Church. The arrival of the mining company seems to have resulted in some diminution in this traditional source of employment. In 1985, the small islands accounted for 72 per cent of the wages that the parish paid to Lihirian workers, but by 1987 the figure had fallen to 53 per cent (Filer and Jackson 1989: 244). The fall may have been partly due to the fact that the exploration camp was a good deal closer to the small islands than the Catholic mission station.

The authors of the original social impact study estimated that 29 per cent of the people employed by the mining company for some period of time in 1985 came from the small islands, which was roughly the same as the proportion who came from Putput, the village adjacent to the exploration camp (Filer and Jackson 1986: 144). More significant, perhaps, was the fact that the small islands accounted for five out of the nine local 'staff' employed by the company at the end of 1985, since these were skilled workers who commanded higher wages and, unlike the unskilled casual workers, were entitled to accommodation in the exploration camp. This is significant because people from the small islands were initially excluded from the category of 'local' people who were meant to be given preference in the work of exploration (ibid.: 148).

Since unskilled casual workers were employed for relatively short periods of time and were not provided with accommodation by the mining company, they either had to accommodate themselves on nearby land to which they had some customary right, or else be hosted by local landowners living in the vicinity of the exploration camp. This was not an ideal situation for casual workers from the small islands. Twenty-one men from Masahet were briefly jailed in 1985 after two of them threatened to assault one of the expatriate geologists because the company was only providing them with one free meal at lunchtime each day, and they were not inclined to spend all their wages on the payment of rent to local landowners or the purchase of food from local trade stores (Filer and Jackson 1986: 126).

In 1987, the small islands still accounted for 20 per cent of the value of wages paid by the mining company to Lihirian workers, but the share going to the village adjacent to the exploration camp had risen to 46 per cent (Filer and Jackson 1989: 238). Most of the casual workers from the small islands were still 'squatting' on land that belonged to the local villagers (ibid.: 241), but their average wage was 38 per cent higher than that of workers from the

main island (ibid.: 243). That was not because they were receiving a special accommodation allowance, but rather because they had higher levels of skill. In 1987, the estimated per capita income from employment on the project (by both the mining company and its contractors) was 40–100 kina on Masahet, 20–40 kina on Malie, and 10–20 kina on Mahur (ibid.: 240). It is hard to know how much of this money actually found its way back to the islands. However, when these sums are combined with the value of wages paid to islanders working in other jobs on the main island, or in other parts of PNG, it is likely that remittances from such sources were a far more significant source of cash income for households located on the small islands than were sales of shell money and pineapples.

Recommendations for Mitigation

The authors of the social impact study that was first drafted in 1986, and then revised in 1989, said that something had to be done to address what they described as 'an approaching ecological and demographic crisis' on the small islands (Filer and Jackson 1986: 26). This would be a key part of a wider program of action to mitigate the future social and economic impacts of the gold mine. Since the study was commissioned by a 'liaison committee' including representatives of the national government, the provincial government and the mining company, it was not clear who should take responsibility for which parts of this action program, but the general assumption was that the mining company would assume most of the responsibility once the development agreements were put in place.

The authors doubted whether the islanders could do much more to raise the productivity of the local agricultural system, with or without external assistance. They were likewise sceptical of the chances of persuading the islanders to adopt modern contraceptive practices, at least in the short term. That was not just because they were devout Catholics, but also because the church itself was the main provider of health services to its local flock. So they focussed their attention on the question of how the islanders might benefit from the prospect of further employment during the construction and operation of the mine. And that was because all parties were generally agreed, at least by the time that the impact study was revised in 1989, that indigenous Lihirians, including those born on the small islands, should have first preference in the allocation of jobs by the mining company and its contractors.

Given that the mine would be located on the main island, and that the customary owners of the mine lease areas were likely to get first priority in the allocation of all the 'benefit streams' that it generated, there was no question of recommending a form of affirmative action that would give any sort of priority to employment of Lihirians from the small islands, even if it could be argued that they were in greater need of it. So what was recommended was a set of measures to ensure that jobs would be fairly equally distributed between the different parts of Lihir, including the small islands and those parts of the main island that were furthest from the mine lease areas. The justification for doing so was that the customary owners of the area earmarked for mining operations would receive a share of the mineral royalties, as well as compensation payments for environmental damage, while people already living in fairly close proximity to the mine site would be in a better position to benefit from the company's obligation to procure goods and services from the locally based contractors who would be the targets of its business development program.

The basic issue here was the likelihood that the mining company would persist in its policy of only providing accommodation to local employees who were at a senior level in the corporate hierarchy. If workers at lower levels were expected to reside in their villages and commute to work on a daily basis, then those living in villages at some distance from the mine site would only be able to do so if the local transport network was substantially upgraded. Otherwise, they would either be marginalised in the local labour market or would make a nuisance of themselves by 'squatting' on other people's land, just as they had done during the early years of exploration (Filer and Jackson 1989: 347). And if the number of such people were to grow with the overall expansion of the mine-related workforce, so would the risk of conflict with the local landowners.

One of the earliest and strongest demands of community leaders across the main island was that construction of the mine should be made conditional on the construction of a 'ring road' around the whole island. If properly maintained, this would enable buses or trucks to convey workers from their villages to the mine site or the associated town site on a daily basis and take them home again after their shifts were finished. But what about the small islands? It was not hard to imagine the operation of a ferry service, although ferries would still have to travel a distance of 30–40 km to reach the most far-flung island of Mahur. The trouble was that none of the small islands had a jetty or wharf capable of accommodating such vessels, and even fibreglass banana boats had trouble navigating their way through the fringing reef,

especially at low tide or in bad weather. It was in fact the government, not the mining company, which sought to deal with this problem by blasting passageways through the reefs in the 1980s. The authors of the social impact study wondered if the mining company could be asked to lend a hand in this enterprise in its capacity as a good corporate citizen (Filer and Jackson 1989: 340). But it was not clear what steps might later be taken to establish the infrastructure required for the operation of a proper ferry service or how that operation would be funded and managed.

Wholesale Economic Transformation

In 1985, the authors of the social impact study were presented with a letter from the leaders of the Nimamar Association, which they insisted was not a manifesto, even though it described their desire for a radical reordering of society that combined a form of millenarianism with specific economic and political objectives (Bainton 2010: 63–8). Nimamar members not only claimed that they had predicted the arrival of the mining company but also predicted that 'Lihir will become a city'.

And so it came to pass, in one way or another. Following a lengthy negotiation process, the mining agreements were eventually signed in 1995 (Filer 1995), and mine construction was completed by 1997. The development of the mine brought vast amounts of physical infrastructure and services to the island group. In addition to the special mining lease (SML) in Luise Caldera, three other leases were granted by the state in the northeastern corner of Aniolam to enable the development of the mining camps and townsite, and the airport that services the company and the residents of Lihir. An unsealed ring road was constructed to link the mining project and the town with all the coastal villages around Aniolam, fulfilling one of the demands from community leaders.[10] The development of the mine also required the relocation of households in the two coastal villages of Putput and Kapit to make way for the plant site and the stockpile within the SML. These were two of the five villages on the main island that were classified as 'affected area' communities due to their proximity to the project and their loss of customary land rights. Although the relocation of Kapit village has been an abject failure (Hemer 2016; Bainton et al. 2022), these newly defined affected area villages generally received the greatest share

10 It takes approximately three hours to drive all the way round the ring road.

of benefits, including improved housing, sealed roads, reticulated water supplies and electrical connections, and numerous mine-related payments. While these freshly developed villages may not have constituted a 'city', they certainly took the form of a model Melanesian suburb (Filer and Mandie-Filer 1998).

The development and expansion of the mining economy has brought wholesale economic change to Lihir. Through the payment of compensation, royalties, salaries and wages, and the awarding of local and national contracts, the mine has pumped several billion kina into the islands and the local region since operations first began. For example, between 1997 and 2018, the mining company paid out over 719 million kina in royalties, of which 20 per cent was paid directly to Lihirian landowners (Anon 2019). In 2019, the company paid out some 228 million kina in salaries and wages to more than 3,000 Papua New Guineans, many of whom were Lihirians. In 2016, the mining company reported that a total of 232.6 million kina had been paid to Lihirians between 2006 and 2015 under the terms of the primary benefit-sharing instrument known as the Integrated Benefits Package Agreement (Bainton and Macintyre 2021).

While these economic flows amount to a massive increase in per capita income, and a huge improvement in services and infrastructure, they have also irreversibly transformed Lihirian social relations as mine-derived wealth and mine-related impacts are unevenly distributed throughout the group of islands. Plain observation reveals that wealth is increasingly concentrated in the hands of a small group of male lease area landowners, most of whom reside in the 'mine-affected area'.[11] These inequalities have been the source of enduring and acrimonious conflict between, and within, the so-called 'affected' and 'non-affected' villages. It might therefore be argued that chronic economic inequality created by the mine represents a more perverse realisation of the dream to transform Lihir into a city. Some households, especially those in Putput village, are now wholly integrated into the cash economy, but most Lihirians residing on the outer islands, along with many households on the main island, still rely upon swidden agriculture to supplement incomes derived from the mining economy.

11 When the main compensation agreement was signed in 1995, there were 90 so-called 'block executives' recognised as the principal customary owners of these lease areas, and 75 per cent of them were living in the mine-affected villages on Aniolam (Filer and Mandie-Filer 1998: 4).

Small Islands Under Even More Pressure

Between 1996 and 2003, the social and economic impacts of mine construction and operation were monitored in a sequence of seven reports commissioned by the mining company (then Lihir Gold Ltd). The first four reports were compiled by Martha Macintyre; the last three by Martha Macintyre and Simon Foale. The consequences of population growth on the small islands of Ihot constituted one of the topics addressed in these reports.

The fourth report in the series included a graph showing the 'land needs' of the inhabitants of each of the small islands as compared with those of the main island (Macintyre 2000: 25). This graph was based on the earlier calculation that each individual would need at least half a hectare of cultivable land in order for the local agricultural system to provide an adequate food supply for households that could not afford to purchase food from elsewhere (Filer and Jackson 1986: 40). The graph showed that land needs on the island of Malie had already reached 130 per cent of the available land by 1999, while those on the island of Masahet were roughly 90 per cent. The graph was revised in each of the subsequent reports (Macintyre and Foale 2001: 14; 2002: 27; 2004a: 22). The last one showed that land needs on Malie were nearly 140 per cent of the available land by 2003, while those on Masahet were almost exactly 100 per cent, those on Mahur were more than 60 per cent, and those on Aniolam were almost 40 per cent. The most pessimistic predictions of the first social impact study were therefore confirmed (Filer and Jackson 1986: 41).

The graphs containing the calculations of 'land needs' may even have underestimated the extent of the problem by assuming that the area of cultivable land on each of the small islands was actually constant. Aside from the expansion of village settlements, there was evidence that garden fallows were subject to encroachment by rhizomatic weed species, especially 'kunai' grass (*Imperata cylindrica*) and the 'malo' fern (*Dicranopteris linearis*) (Macintyre and Foale 2002: 42). The spread of the fern was especially noticeable on Masahet, but also in some parts of what had now been designated as the 'mine-affected area' on the main island (ibid.: 149). The labour required to clear these forms of invasive vegetation was a deterrent to further cultivation of the land (see Figure 6.5).

Figure 6.5: Malo ferns on Masahet Island, 2002
Source: Photograph by Simon Foale.

In these early years of the mining operation, people from Malie and Masahet were still trying to deal with the scarcity of cultivable land on their own islands by making gardens in the northeastern part of the main island (Macintyre 2000: 24). By 2003, people from Malie had gardens that covered a single block of land, about 47 hectares in extent, within an undeveloped part of the area leased to the mining company for its town site and migrant workers' accommodation blocks (Macintyre and Foale 2004a: 35). The total amount of land in the mine-affected area that was still available for gardening was evidently shrinking more rapidly than it was on the small islands, even while the resident population in this area was growing at an even faster rate. So, if it were true that 50 per cent of Malie households, and 25 per cent of Masahet households, were now reliant on food obtained from gardens on Aniolam, it was hard to see how this source of supply could be maintained, let alone expanded (ibid.: 21).

In the early years of the mining operation, some of the households on the small islands were still able compensate for the scarcity of gardening land with the wages obtained from their participation in the mining workforce. In 1999, they accounted for 73 (or 31 per cent) of the 234 Lihirians directly employed by the mining company (Macintyre 2000: 59). By 2003, the number had gone up to 91, but this was now only a quarter of the number of Lihirians working directly for the company (Macintyre and Foale 2004a: 72). There would have been other people from the small islands who were employed by the company's local contractors, or who had other jobs in the formal sector workforce, but the authors of the social monitoring reports were unable to discover their number. The 2000 national census counted 472 households in Ihot, so it is reasonable to assume that three-quarters of these households had no direct access to a wage income from employment in the formal sector workforce.

At that juncture, the uneven distribution of cash incomes between the households of Ihot was reflected in the state of their housing. In 1999 there were 88 permanent and 143 semi-permanent houses out of a total of 545 houses on the small islands (Macintyre 2000: 29). 'Semi-permanent' houses were those with corrugated iron roofing and some milled timber woodwork. The remaining 314 houses were made of the 'bush materials', like bamboo and sago, that were partly imported from Aniolam. Some of the housing improvements were ultimately funded by the mining company though an institution known as the Village Development Scheme, but others were

based on the incomes of the occupants.[12] The proportion of bush-material houses was notably higher on Mahur than it was on Masahet and Malie, which reflected the lower average cash incomes on the most remote of the three islands. In Putput village, adjacent to the mine site, there were no bush-material houses at all.

Figure 6.6: Ceremonial men's house on Malie Island, 2007
Source: Photograph by Nicholas Bainton.

In 2001, the disparities between the three islands of Ihot were given a further boost when the people of Malie mounted a successful campaign for their island to be included in the 'mine-affected area' because of the damage that it was supposedly suffering from the operation of the mine (Macintyre and Foale 2002: 142–7).[13] This meant that they would be entitled to new forms of compensation, including further improvements to their housing stock, which would not be made available to residents of the other two islands. Within a few years, every house on Malie, including the ceremonial men's houses, was constructed from permanent materials (see Figure 6.6). This has

12 In 1998, the Malie islanders opted to take the cost of building six of these houses as a cash payment so that they could build 12 houses themselves at half the unit cost. The Masahet islanders expressed a similar preference, but were still waiting for the money to arrive (Filer and Mandie-Filer 1998: 15).

13 The Lihir Mining Area Landowners Association, which is the body representing the lease area landowners, already recognised Malie Island as part of the mine-affected area at the start of mining operations. That was not because of the environmental impact of the mining operation on the island itself, but because the islanders traditionally harvested subsistence resources in the area surrounding the new town site (Filer and Mandie-Filer 1998: 3).

increased the demand for residential land, as each new household expects to build a permanent house that requires an area of at least 90 m^2—an area roughly equivalent to half a tennis court. As a result, the residential zone on Malie is very tightly packed, and some people have started to build their houses in areas formerly reserved for gardens and tree crops. The incidence of land scarcity across the three islands was now quite clearly correlated with the extent of people's dependence on the continued operation of the mine to provide the incomes or benefits required to compensate for the pressure that rapid population growth was placing on the local agricultural system.

Left to Their Own Devices

The mining company terminated the social monitoring program in 2004. This meant that the collection of evidence about the social and economic changes taking place in different parts of the Lihir island group became the responsibility of company staff who were already fully engaged in the management of 'community affairs'. In any case, the company had not previously shown much inclination to act on the recommendations of its consultants, including those directed towards the peculiar problems of the small island population. The people of Ihot have thus been left to devise their own solutions to these problems.

When Macintyre produced the first graph showing the 'land needs' of the inhabitants of each of the small islands as compared with those of the main island, she observed that

> [t]he problem of overpopulation on Malie and Masahet is rapidly approaching the point where the environmental issues relating to long-term economic sustainability will constitute a crisis. This is not recognised by most Lihirians and those who do acknowledge it do not see reduction in the birthrate as a solution.
>
> (Macintyre 2000: 19)

As predicted in the earlier social impact studies, the local influence of the Catholic Church, combined with the subordinate status of women in Lihirian society, discouraged the implementation of birth control initiatives, and this in turn had contributed to ongoing population growth on the smaller islands. At the same time, community members have not consistently raised such issues with the company or the government because their attention has

mostly been absorbed by the political process of negotiating the unequal distribution of economic benefits and environmental impacts associated with the mining operation (Macintyre and Foale 2004b).

One thing that did survive the end of the social monitoring program was a demographic monitoring program, the results of which were stored on a database, known as the Village Population System (VPS), which John Burton had installed in the company's computers before the start of mine construction (Burton 1994, 2007). This was intended to reassure local community leaders that company managers would be able to tell the difference between genuine Lihirians and migrants from other parts of PNG when allocating jobs in the mining workforce (Bainton 2017: 322–3). By the end of 2014, the VPS database showed the extent of the change that had taken place in the Lihirian rural village population on each of the four islands in the Lihir group since 1980 (see Table 6.5).[14] An updated version of the 'land needs' graph would show that the Masahet islanders had gone well past the threshold of sustainability by 2014, and even the Mahur islanders would now be approaching it (Bainton et al. 2022: Figure 2). However, it is evident that the overall rate of population growth on each of the three small islands since 1980 has been rather oddly correlated with the extent to which they are short of cultivable land, as well as being correlated with their proximity (or ease of travel) to the main island. On the other hand, the rate of population growth on the main island has been considerably higher than on any of the three small islands. And since previous calculations suggest that there is more cultivable land per head of population on the main island than on any of the three small islands, there appears to be no simple relationship between population growth rates and the degree of population pressure on local agricultural systems.

Table 6.5: Lihirian rural village populations on the four islands in 1980 and 2014

	1980			2014			% change		
Island	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**
Aniolam	1,915	1,724	3,639	6,690	6,267	12,957	249.3	263.5	256.1
Malie	130	135	265	396	359	755	204.6	165.9	184.9
Masahet	439	402	841	904	850	1,754	105.9	111.4	108.6
Mahur	315	311	626	600	536	1,136	90.5	72.3	81.5
TOTAL	2,799	2,572	5,371	8,590	8,012	16,602	206.9	211.5	209.1

Source: 1980 national census and 2014 Village Population System.

14 These figures do not include the number of Lihirians resident in the three 'rural non-villages' on the main island.

A comparison of the numbers in Tables 6.4 and 6.5 indicates that the excess of males over females, already evident in 1958, was still present in 2014. It also reveals that the population growth rate has been higher on the main island than on any of the small islands throughout this longer period. On the other hand, differences in the rate of growth between the three small islands appear to have changed over the course of this period. While Malie had the lowest growth rate (27.4 per cent) in the period from 1958 to 1980, it had the highest growth rate (184.9 per cent) in the period from 1980 to 2014. The reverse was the case in Mahur: a relatively high growth rate (48.3 per cent) in the earlier period was followed by a relatively lower growth rate (81.5 per cent) in the later period.

These discrepancies cannot simply be due to differences in fertility and mortality rates on different islands. In the earlier period, as we have seen, the lower growth rate in Ihot, as compared to Aniolam, was partly due to a higher rate of emigration from the small islands. The question then is whether migration also helps to explain the discrepancies observed in the more recent period.

As predicted in the original social impact studies, most of the Lihirians exiled in other parts of PNG had returned to the islands by the time that mining operations began in 1997. This was reflected in the 2000 national census, which counted a rural village population of 10,924—more than twice the number counted in the 1980 census. But development of the mining project then began to have an independent effect on the distribution of the local population. This is immediately evident if we compare the rate of population growth in the northeastern part of Aniolam that was designated as the 'mine-affected area' in the original development agreements with the rate of population growth in the rest of the main island (see Table 6.6).

Table 6.6: Lihirian rural village populations in two parts of Aniolam in 1980 and 2014

	1980			2014			% change		
Area	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**
'Affected'	545	466	1,011	2,371	2,179	4,550	335.0	367.6	350.0
'Unaffected'	1,370	1,258	2,628	4,319	4,088	8,407	215.3	225.0	219.9
TOTAL	1,915	1,724	3,639	6,690	6,267	12,957	249.3	263.5	256.1

Source: 1980 national census and 2014 Village Population System.

Here we can see that the population of the 'affected' villages grew by 350 per cent between 1980 and 2014, while the population of the 'unaffected' villages grew by 220 per cent. The growth rate in the unaffected villages was much the same as the growth rate for the whole island group, but was much higher than the growth rate for the small islands of Ihot (see Table 6.5). It therefore seems reasonable to infer that a substantial number of people from Ihot have taken up residence in the affected area on Aniolam since the start of mining operations, while very few people from the unaffected parts of Aniolam have done so. In which case, it would appear that the advent of the mining project has created a new form of symbiosis between the main island and the small islands that reaches beyond the practices already documented in the original social impact studies.

This new form of symbiosis must also be partly shaped by the fact that the population living in this mine-affected area is actually much higher than might be inferred from the figures shown in Table 6.6. That is because a very substantial number of undocumented migrants from other parts of PNG have settled in this area under the sponsorship of those same community leaders and local landowners who insisted on their exclusion from the VPS database (Filer and Mandie-Filer 1998). Given that these people occupy a sort of liminal social space in which their presence is both recognised and denied, it has been very difficult to count them, let alone to determine what they do for a living. However, most of the adult members of this migrant community seem to be employed, more or less formally, by Lihirian patrons who derive most of their own income from their relationship to the mining company—whether as recipients of wages, royalties, business contracts or other benefits distributed under the terms of the development agreements (Bainton and Macintyre 2013; Bainton 2017). If we add the workers formally and directly employed by the mining company, who are either permanent residents of the township or temporary (commuting) residents of the nearby accommodation blocks, there could have been as many as 10,000 people resident in this mine-affected area in 2014.

If people still living on Malie and Masahet islands are still attempting to cultivate food crops in what is now the mine-affected area on Aniolam, which is the only part of the main island where they used to make extra gardens in the past, their task is now a great deal more formidable. That is because there is a lot more competition for access to a rapidly diminishing area of cultivable land in this part of the main island, just as there is on the two small islands, and some of that competition would be coming from relatives who have recently relocated themselves and their families from the small islands to the main

one. However, the development of the mining economy has also reduced the relative importance of food and cash crop cultivation as a livelihood strategy for a substantial proportion of the Lihirian population, especially those living in the mine-affected area, which now includes Malie Island. It is therefore necessary to consider some of the other ways in which this new mining economy has influenced the pattern of inter-island relationships.

Time–Space Distanciation and the Intensification of Custom

Since Macintyre and Foale last reported on the number of mine workers who come from the small islands, the absolute number of employees from Ihot has continued to grow, even though the proportion of Ihot residents in the total Lihirian mining workforce has diminished. This generally has more do with the company's commitment to 'local Lihirian' employment as a condition of the benefit-sharing agreement than any explicit strategy to offset the pressures facing small island communities. For example, in 2011 the mining company directly employed some 2,212 people. Lihirians made up 33 per cent of the workforce. About 18 per cent of these Lihirians came from Ihot, which represented a significant drop from 1999 when Ihot residents made up 31 per cent of the workforce. In 2011 Ihot workers received approximately 4.3 million kina in salaries and wages for that year alone (Bainton 2013). Given the increase in contracting opportunities for local landowner businesses (Bainton and Jackson 2020), it is likely that a comparable number of Ihot residents have been employed by these local companies. Although a much smaller number of people from Ihot have established businesses that can contract with the mining operation, these businesses still pull a considerable flow of income to the small islands.

Overall, salaries and wages represent the most significant source of income and are spread more evenly across the four islands compared with other mine-derived income streams. Mineral royalties constitute a discernibly smaller portion of these flows.[15] The distribution of royalty payments across Lihirian society reflects the ownership patterns of lease land areas in terms of geographical

15 The royalty rate is set at 2 per cent of gross revenue from gold sales. The royalties are split as follows: New Ireland Province (50 per cent); Nimamar (Lihir) Local Level Government (30 per cent); Special Mining Lease Landowners (20 per cent). A lack of public reporting has made it difficult to discern how the Local Level Government and the Provincial Government have allocated and spent their portions of the royalty payments.

proximity and inheritance within matrilineal descent groups. The villages that are closest to the mine contain more lease area landowners, and these villages have consequently received the largest share of royalty payments. In 2011 the company paid out 46.2 million kina in royalties. Although 8 million kina was paid directly to lease area landowners, only 72,000 kina was received on the smaller islands, which reflects the smaller number of people on Ihot who can claim rights over parcels of lease land on Aniolam.

The flow of mine-derived income from Aniolam to Ihot points to numerous spatio-temporal changes occurring in Lihir. For the residents of Ihot, time and space have simultaneously shrunk and stretched. Anthony Giddens refers to this as 'time–space distanciation', by which he means the processes whereby societies are stretched over longer or shorter spans of time and space (1995: 90). On one hand we find economic and technological changes have created a 'compression' effect, dramatically reducing the time needed to access the islands or to communicate with people living on Aniolam and beyond. On the other hand, these changes have 'stretched' social relations and accelerated time as mine-derived incomes are ploughed into customary activities in ways that expand the network of people embedded in these relations of reciprocity and increase the frequency and intensity of these events. These twin processes shape the pressures facing the residents of Ihot and how they have responded to them. Let us explain.

Following the earlier recommendation for a ferry service to link the smaller islands to the main island, the mining company has operated a fleet of fibreglass banana boats to ferry Ihot workers to the mine site (see Figure 6.7). The majority of Ihot workers make the long (and wet) commute daily, while a smaller fraction resides in the mining camp if they have a 'special case' for accommodation; others make arrangements with relatives in affected-area villages, which is one of the ways that a growing number of Ihot people have taken up residence in the affected area on Aniolam. Access to more cash has also resulted in a greater number of privately owned banana boats across all four islands. This has increased social connectivity between the residents of Aniolam and Ihot. It has also made it possible for Ihot residents to access services, and for some residents to regularly make subsistence gardens, in northeastern Aniolam. Access to mobile telecommunications has also dramatically improved the situation on the smaller islands and provided enhanced connection to friends and relatives on Aniolam and in the outside world, as it has elsewhere throughout the Pacific Islands (Foster and Horst 2018). Mobile technology has been especially important for enhanced safety at sea and helping to locate travellers that find themselves adrift.

Figure 6.7: Fibreglass banana boats at Mahur, 2016
Source: Photograph by Nicholas Bainton.

Despite the improvements to life on the smaller islands, these changes have not entirely offset pressures on land and natural resources. In fact, the expansion of the mining economy has paradoxically contributed to other factors (besides population growth) that have intensified these pressures. As more Lihirians are drawn into the cash economy and substitute store goods for garden goods, this has resulted in the gradual loss of gardening skills and knowledge. This shift has most likely decreased horticultural efficiency and increased the amount of land required per head of population. Very few Lihirians have adopted agricultural intensification techniques, on Aniolam or Ihot, and efforts by the mining company, the local-level government and the landowner association to support agricultural extension services throughout Lihir have been inconsistent at best.

A significant portion of the wealth derived from the mining economy has been absorbed into the local ceremonial economy, which revolves around an extended cycle of mortuary feasts (Bainton and Macintyre 2016). As customary activities have flourished—as a kind of cultural response to the effects of resource extraction—this has simultaneously increased the pressure on local resources and increased the number of disputes concerning the inheritance of land on the smaller islands and Aniolam. The demand for extra pigs and yams as key items of exchange within that ceremonial economy can be considered as a key driver of land pressure (and ecosystem change)

in its own right, because pigs and yams both make their own demands on the local food-cropping systems. Ceremonial yam gardens in particular are likely to have a significant impact, because there is much prestige associated with the size of yams presented at feasts, and the most effective means of achieving large yam sizes is to clear new areas of primary forest, since soil fertility tends to be higher here than on land that has been under fallow. Since this agricultural strategy is no longer possible on Malie and Masahet, people on these islands are further reliant upon their relatives on Aniolam for access to large yams. Ceremonial yam gardens tend to be much larger in area than gardens established for domestic subsistence. To meet the expanding needs of this ceremonial cycle, Lihirians have also made a habit of purchasing pigs and garden produce from fellow Lihirians and from other island groups, which has become a mechanism by which Lihirians redistribute a portion of the surplus income obtained from the mining economy. This practice has less to do with conserving scarce resources and is more related to the speeding up (or the compression) of the local feasting cycle, which has generated a requirement to mobilise larger feasts at shorter notice. Ready access to sea transport makes it easier for large groups of people to travel to the smaller islands for customary feasts for shorter periods of time, and for hosts and donors to roam around the local region in search of pigs that can be bought with a combination of cash and shell money for exchange at these events.

Figure 6.8: Customary feast on Mahur Island, unveiling of *mormor* (memorial depicting deceased clan members), 2015

Source: Photograph by Nicholas Bainton.

When rich landowners (some of whom trace their descent to the outer islands) co-host or contribute to extravagant mortuary feasts on Ihot, they direct the flow of mining wealth from Aniolam to the smaller islands. As an indirect effect of mining, this flow of wealth provides collective prestige for communities and clans while simultaneously squeezing individual households: pressures are transmitted across the seas, from one island to the next, through kinship lines as clan members exhaust their resources in order to participate in these moments of ritual excess (see Figure 6.8). Just as it was once recognised that Ihot communities had constructed the most elaborate church buildings, Ihot residents are now recognised for building the most elaborate ceremonial men's houses and hosting the most elaborate feasts. Many Lihirians regard the smaller islands, particularly Masahet and Mahur, as the seat of customary practices and knowledge because they are less proximate to the mine and its impacts and because there has been a stronger commitment to 'strengthen custom' within these communities (Bainton et al. 2011). As a result, local big men on Ihot are seen as the guardians of Lihirian custom, even if their customary feasts and exchanges have become increasingly competitive and reliant upon the mining economy and threaten to spiral out of control. In this respect, there is also something of a paradox in the cash-fuelled expansion of the ceremonial economy and the simultaneous erosion of traditional technical and environmental knowledge.

Conclusion: Crisis, Class and Constraint

In a report written for the PNG Department of Environment and Conservation in 1992, Filer suggested that the negative impacts of the future mining operation could be grouped under two main headings, which he called the 'stratification effect' and the 'demoralisation effect'. The first of these was said to follow from 'the probability that different members of the local community will experience the different aspects of the development process in different forms and degrees, and the process as a whole will therefore give rise to new forms of inequality, division and conflict within the community' (Filer 1992b: 5). The second was said to follow from:

> the probability that the community as a whole will be 'overpowered' by the presence of the project, existing mechanisms of social control will be disrupted and devalued, and local people's respect for 'custom' will progressively be transformed into a frustrating sense of dependency on the project as the source of all their problems and the only source of their solution.
>
> (ibid.: 5)

In the same report, he suggested that 'custom' was 'the largest single umbrella beneath which the people of Lihir still choose to take shelter in a fairly wide range of circumstances', even if it might prove to be 'an inadequate defence against the stratification effect, and may be further weakened as a consequence' (ibid.: 6).

In a subsequent report to local community leaders in 1994 (which was mostly written in Tok Pisin), Filer listed seven 'social problems' that were likely to arise as a result of the mining operation. These were: (1) 'resource scarcity or over-population'; (2) the 'influx of outsiders'; (3) the 'breakdown of law and order'; (4) the 'unequal distribution of income'; (5) the 'subordination of women'; (6) 'power struggles within the community'; and (7) the 'project dependency syndrome' (Filer 1994: 2). The first six of these problems could be understood as manifestations of the stratification effect, while the last made reference to the demoralisation effect. These predictions have turned out to be fairly accurate, and it is hardly surprising that all these problems have been most acute in what came to be designated as the mine-affected area. But how have they manifested themselves in the relationship between Ihot and Aniolam?

The crisis confronting the outer islands can be understood as a type of cumulative impact, where pressures that were evident before mining started have intensified and transformed over the duration of the mining operation. Although mining wealth has evidently flowed to the residents of Ihot, and helped to improve material living standards, these 'benefits' of extraction are also a source of inequality that amplify social tensions throughout the islands. Class differences have now more or less settled into place. The majority of Lihirians who command control over mine-derived forms of wealth live in the northeastern corner of Aniolam, the mine-affected area. Customary obligations may cut across these differences and provide conduits for the circulation of wealth, but these distributive moments and movements cannot unsettle the structural differences between those people who enjoy privileged and continuing access to mining capital and services, and those people who must content themselves with lesser prospects. For the population on the smaller islands, these differences appear at night as distant shimmering lights of 'development' that are easily seen when they look across the seas to Aniolam. In this regard, both the stratification effect and the demoralisation effect are manifest in Ihot through the feeling of resentment and relative deprivation.

In the long term it remains to be seen whether the wealth produced by the mine will be converted into a form of sustainable development that can support the small island population into the post-mining future. While the process of mine closure will play out over an extended period and may present new opportunities for future planning, current prospects do not look promising. This is despite great efforts by the Lihirian political elite to devise and implement their 'Lihir Sustainable Development Plan' (Bainton 2010; Bainton and Macintyre 2021). In the meantime, a growing number of households will have to contend with the effects of a 'simple reproduction squeeze' (Bernstein 1979) that has gripped the smaller islands. As we have demonstrated, population growth combined with other novel factors makes it harder for some households to access land and resources for subsistence and increases their dependency upon the (finite) mining economy. This squeezing effect takes a variety of historically specific forms, most notably through the proliferation of customary activities and obligations. These ceremonial commitments also act as another anchor that prevents some Ihot households from moving elsewhere to escape the clutches of this reproduction squeeze.

While some Ihot residents have managed to move to Aniolam, the real puzzle is how many of them are doing what to make a living there. The company's monitoring programs have not tracked this trend, and in the absence of such data it is difficult to predict the long-term prospects for these people. On the other hand, very few residents from Ihot or Aniolam have left the islands altogether. For most small island communities, out-migration is the only viable coping strategy. In Torres Strait, for example, patterns of circular migration have emerged, whereby younger residents migrate down to mainland Australia in search of jobs and services that are absent in the islands. Many of these 'emigrants' later return to their island homes to retire. Similar patterns have long been evident throughout PNG. These circular rural–urban–rural movements are shaped by economic drivers and strong attachments to 'place' (McGavin 2016). But as previously observed, mining has given rise to new patterns of rural–rural, or rural–resource migration (Bainton and Banks 2018). Local residents, who may be displaced by the mine or crowded out by in-migrants, rarely want to move to other places out of fear that they will lose their just entitlement to mining benefits. And in the case of Lihir, the Ihot population seems to be fixed to an even greater extent as a result of an extractive–ceremonial complex. In other cases and places, there are not the same attractors.

We envision several possible future scenarios for the communities of Ihot. The long-term post-mining outlook may revolve around increasing pressure on customary arrangements to access land on Aniolam. It is unlikely that many people will purchase land on mainland New Ireland or elsewhere in PNG. While some Lihirians have already purchased properties abroad, in most cases these are 'investments' that generate an income that allows them to remain in Lihir. This trend may increase among wealthier Lihirians. As income-generating opportunities decline in the post-mining era, becoming landlords in other places may be one of the most viable economic opportunities available to Lihirians. The option to invest in other places is probably more realistic for lease area landowners with access to money, and not likely to be an option that many people from Ihot can afford. At present, very few Lihirians permanently reside away from the islands, and it is difficult to predict whether this will change in the future. For most Lihirians, the balance of attractions is presently greater than the balance of impacts—or there are other structural or cultural reasons that prevent them from moving elsewhere. This balance may shift with mine closure, and we may witness a more mobile Lihirian population. This attraction, and the balance itself, is a major driver of pressures. Despite the emergent challenges of mine-induced land scarcity, the balance of attractors means that the vast majority of Lihirians have elected to remain in their group of islands. This in turn highlights the land and services paradox: as services become increasingly viable as the population grows (as the cost per capita decreases), land—itself a core provider of services—has a finite capacity.

Although the pressures that are currently faced by the Ihot population are not climate-induced, sea level rise and coastal inundation and erosion are being experienced in some locations, especially on Malie. However, future climate changes will exacerbate other pressures and existing vulnerability. If there are longer and more frequent droughts this will make life more intolerable on Ihot and increase dependency on the mining economy for subsistence. Climate effects are likely to be uneven, exposing the inequalities between the people living on the main island with more resources at hand, and those living on the smaller islands with more limited options to choose from.

In the end, the solutions to land pressure on small islands are limited, and the income streams that supplement subsistence-based livelihoods are contingent upon the operation of the mine. For this reason, it is worth recalling the conclusions reached by the authors of the original social impact assessments for the mine: if no steps are taken to address the crisis confronting the outer islands, then the Ihot population will have to live with

the fact that there is no way of supporting their projected population with the present system of subsistence. The population of the outer islands will not simply be unsupportable in the manner to which mining will have accustomed them but will be unsupportable in *any* reasonable manner. A steadily growing population of Ihot may have no option but to migrate in search of an alternative livelihood. The question is, where will they go?

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