

Urbanisation in Tonga: expansion and contraction of political centres in a tropical chieftdom

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Introduction

Throughout the Pacific the European colonization led to changes in settlement and land tenure patterns, drawing a dispersed population into villages along the shore. Such changes have been documented *inter alia* for Samoa (Watters 1958; Davidson 1974; Holmer 1980) and Fiji (Parry 1987). In these instances the ready availability of trade goods meant that closeness to these locations of import and distribution was advantageous. Many of the inland plantations were given up, as the land use changed from self-reliance to the production of cash crops such as copra. In addition, European colonial authorities favoured clustered settlements within reach of naval vessels for ease of administration and control. Likewise, Christian missionaries found villages more conducive to teaching and religious indoctrination. This view argues that the clustering of the population along the shore is almost solely due to the influences of European colonial forces. A similar process has been argued to be at work in Tonga (Wood 1938). But is this so, or are there other factors involved in the genesis of urbanisation which facilitated European control?

In its present configuration, as a constitutional monarchy under the rule King Tafa'ahau Tupou IV, the kingdom of Tonga is the last Polynesian chieftdom to survive into the twentieth century. Today, on all islands, the population lives in villages, yet all European visitors mention that the Tongan islands they visited were characterised by a pattern of dispersed settlement. No villages existed except for the capital at Mu'a and the rest of the population lived in households within well-fenced plantations.

In the early years of the nineteenth century, the Tongan settlement pattern began to change dramatically because of the outbreak of extended civil strife, which led to the congregation of people in fortifications. Since the fighting was not continuous, but occurred in spells, the population reverted to the traditional style of living in peaceful times. By the end of the Civil War in 1852, the population had once again congregated in fortified villages. For reasons discussed below, this settlement pattern was to persist and almost all modern-day villages can be traced back to fortifications erected during the Civil Wars.

The aim of this chapter is to illuminate the processes which led to this change in settlement pattern and to assess its archaeological manifestation. Firstly, I will look at the pattern of settlement before European contact. The presence, nature and location of the central places over

time will be discussed. Finally, I shall consider the proliferation of fortifications and locational choices involved. This study of urbanisation in a horticulturally-based and socially well stratified society will attempt to document changes in settlement in the context of cultural changes in general. The study has wider implications in the interpretation of urbanisation in the context of cultural change.

The settlement pattern of Tongatapu

Tongatapu is low-lying and undulating, with occasional knolls. The highest elevations are in the southeast and nowhere do these exceed 65 m. From the southeast the island slopes gently down to the northern mangrove-fringed coastline. For the most part the coast is cliffed (*liku* coast), the highest cliffs (up to 35 m) being found in the south. The central part of the island is occupied by a shallow lagoon (Fanga 'Uta), which except for a channel at its northeast margin is entirely enclosed by land. The island is surrounded by recent coral reef which varies in width from a few metres in the south, where it occupies a wave-cut notch, to over 7 km on the northern shore, where a shallow reef flat extends out to sea. Penetrating rainwater has washed out numerous caverns and caves in the reefal limestone, creating a karst landscape with dolines. These caves are most accessible in the eastern part of the island. The soil cover on the island is derived from volcanic ash deposits (tephra) and very fertile, with the most developed soils in the southeast. In the absence of an orographic pattern the rainfall varies greatly. Again the southeast of the island is favoured owing to its greater landmass.

Lapita colonisation

The settlement of Tongatapu had been effected in *c.* 1000 BC by colonists belonging to the Lapita culture, which was widely distributed through the southwest Pacific by that time (cf. Green 1979). The sites of the Early Lapita Period on Tongatapu (1500–800 BC) are confined to the shores of the more open bay which preceded the current enclosed lagoon. During the Middle Lapita Period (800–400 BC), sites were still largely concentrated around the bay, but some are found in places on the northern coast beyond the bay. Sites of the Late Lapita Period (400 BC to AD 500?) not only stretch along the entire northern shore of the island, but appear at places on the steeply cliffed southern coast where there is access to the beach. More important, however, is the presence of settlement in the interior of the island at this time. Overall, these changes suggest a development from a very decentralised structure of settlement at the beginning when marine foodstuffs were important in subsistence to a dense but dispersed pattern of settlement, essentially similar to that described by early European visitors, based on yams (*Dioscorea spp.*), breadfruit (*Artocarpus altilis*) and taro (*Colocasia esculenta*, *Alocasia macrorrhiza*), and the use of fermentation pits to store the excess.

The pattern at the time of European arrival

All European visitors arriving later than Tasman (1643; after Heeres 1898), who only saw parts of Tongatapu and Nomuka, mention that the Tongan islands they visited, usually Tongatapu, 'Eua, Nomuka or Lifuka, were laid out in a system of plantations. No villages existed except for the capital at Mu'a and the houses stood in the middle of well-fenced plantations (Cook 1777, Vol I, pp. 194, 213–14; Wilson 1799, Caption of map; Vason 1810, p. 130; Cook 1967, pp. 111, 141; La Perouse 1968, Vol. II, p. 172; Wales 1969, p. 812; Elliott 1984, p. 21). The Tongans refer to this as *fanongonogotokoto* (literally 'sending news while reclining'), which indicates a dense, but dispersed settlement pattern. It consisted of independent, roughly rectangular, fenced compounds ('*api*') adjoining each other, which contained both habitation sites and plantations. Access to the compounds was provided by a system of roads. Burial mounds, often surrounded by trees providing shade, were placed in an unenclosed area of 50–100 m² at the intersection of major roads (Cook 1969, p. 252; Wales 1969, p. 812).

Tongatapu seems to have been thickly settled, except for the area near the southern and southeastern *liku* coast, which Anderson (1967, p. 1004-5) describes as only sparsely inhabited. The northern side of the island was densely populated, with plantations and houses extending directly to the shore (Ledyard 1963, p. 28). Anderson mentions that, coming from the northern shore, the island was densely settled 'for above a mile'. Behind this, for 'a mile or two', the plantations were bigger and more dispersed. Beyond this was uncultivated country covered with high grass, but also with occasional coconuts, which Anderson took as sign of some cultivation. The southern *liku* coast was uninhabited according to Mariner (Martin 1827, Vol. II, p. 228; Martin 1981, p. 384), as one could not land a canoe there. Based on the sparse evidence of Ledyard, Anderson and Mariner, it seems as if a tripartite settlement pattern existed on Tongatapu: a zone of densely set plantations near the northern shore, about 1–1.5 km wide, a zone of larger-sized plantations about 1.5–3 km wide and a zone of limited cultivation and habitation beyond.

Although the settlement was of a dispersed nature, it was laid out in an organised manner. The only early source for political organisation is Mariner who stayed long enough in Tonga to learn about this facet of Tongan society (Martin 1972, Vol. II, p. 216; Martin 1827, Vol. II, p. 174). According to him every island was divided into three districts, apparently administrative units, which were obliged to present foodstuffs during the '*inasi*' (first fruits/harvest) ceremonies: Hahake in the east or north, Hihifo in the west or south and Mu'a in the centre. The administrative centre was in the Mu'a. The best-known example of this is, of course, Tongatapu, where the capital place itself was called Mu'a, where the rulers had their houses. However, as Mariner indicates for Vava'u (Martin 1972, Vol. I, p. 158), an administrative centre ('metropolis') existed also in the Mu'a of Vava'u (see also Latukefu 1974, p. 224: 'Code of Vava'u 1839'). If each

island was divided into three administrative districts, we can also assume that each district was supplied with one administrative centre, which in all likelihood was by no means as elaborate as the one at each *mu'a*. Nonetheless, such an administrative centre would have contained at least one large meeting house (*fale hau*) for the kava ceremony and formal meetings. We can also expect some concentration of house-sites, which one might pick up archaeologically.

Compounds

The compounds (Tongan: *'api*) are the basic household unit of the observed settlement pattern, comprising basically one (extended) family and, depending on the family's status, retainers. Every *'api* was essentially self-contained and consisted of housing, cooking facilities, food-storage units, both above and below ground, and plantations, enclosed by a fence and bordered by roads at least on one side (Fig. 2). Wales (1969, p. 812) mentions that the compounds were roughly rectangular in lay-out. The dimensions of the compounds seem to have varied according to rank (Marra 1775, p. 62; Vason 1810, pp. 128-9; Dumont d'Urville 1835).

The available historical records are clear as to the general appearance of the *'api*: the compounds consisted of two parts, a living area, where the houses and food-storage and cooking areas were located, and a plantation area (Marra 1775, p. 62; Cook 1777, Vol. I, p. 214).

Based on European descriptions and Tongan traditions, we can attempt to reconstruct the lay-out. The main building was erected somewhere near the entrance. Since most of the European visitors refer to chiefly compounds, it is unclear whether the commoner's house was erected on mounds or not. It was surrounded by fruit- and other utility trees (for flowers, oils etc.), which provided shade and also acted as a windbreak. There will have been at least one outhouse, used for food-storage and for the accommodation of young boys. The brother-sister avoidance practised in Tonga required boys not to sleep under the same roof as girls, who slept in the parents', i.e. the main house. More probably, however, there were two outhouses, a boys' house and a separate storage house. We can also expect a separate cooking area, consisting of a cooking shed, most likely a *fale hunuki*, and an earth oven. Tongan traditions mention that cooking never took place in the main house. Storage pits are likely to have existed, though none of the European visitors talks about them. The chiefly compounds were larger versions of the commoners' *'api* and differed from these only in three aspects of their lay-out: they had an open well-kept lawn, acting as a reception area (*mala'e*), between the entrance to the compound and the main house and bordered by trees providing shade; the main house stood on a mound or platform; and they had a greater number of outhouses to accommodate the retainers. The main house was erected on a slightly raised floor of 0.3–0.5 m in thickness, which was larger than the actual house and provided a sort of verandah surrounding it. The floor was of beaten soil covered with a thick layer of grass, which in turn was overlain by thick mats. This provided for a relatively soft floor (*hulu*), which

could also be kept clean. The status differentiation of the chiefly house mounds (*tu'unga fale*, *paepae*) was maintained by the choice of material for retaining walls, whether coconut logs (*paepae falo*), coral boulders or beach rock slabs (*maka paepae falo*). The lowest-ranking sites had no retaining walls at all (McKern n.d.). The mound was surrounded by a shallow ditch from where the soil for the house floor(s) had been procured. We can expect the ditch to have at least two breaks, one near to, and possibly pointing towards, the entrance of the compound, and one leading towards the outhouses. The boys' houses, the buildings of the retainers and the cooking and food-storage areas were all located behind the main dwelling, which itself was surrounded by fruit and ornamental trees providing shade and acting as a windbreak (Cook 1777, Vol. I, pp. 193–4; Anderson 1967, p. 1004). In addition to the dwellings of the retainers, *kau nofo*, (Martin 1972, Vol. II, p. 297; Vason 1810, p. 94) and storage facilities, both storage houses and storage pits, we can expect a water cistern (*lepa*), which was used as a water supply and bathing place for the chief. Anderson indicates that the areas where the retainers lived were sectioned off by low fences.

The archaeological record

The mounds plotted during the fieldwork form the totality of the evidence visible in the surveyed sample areas today. Assuming that the intensity of gardening, which can obliterate mounds, has been the same all over Tongatapu, the observed density distribution (Fig. 3) should be representative. The chronological perspective, however, has been collapsed. Therefore, the observed density distribution can be interpreted in two ways: either the density of settlements across Tongatapu is uneven, with land plots being either fewer or larger in the west than in the east, or the settlement density is not uneven, but the eastern area has been populated twice as long as the western area. The latter explanation would fit in well with the oral traditions, which say that the western areas were settled later than those in the east, and with the common assertion of historians that the creation of the Tu'i Kanokupolu title coincided with a settlement expansion in the western areas (cf. Gifford 1929, p. 87; Bott & Tavi 1982). However, the size distribution of mounds needs to be taken into account, as it varies greatly within Tongatapu. Excavations showed that house mounds grew over time as earth was added to prepare new living surfaces and became higher by on average 0.5 m when this happened (Spennemann 1989, Vol. I, App. 3). Using mound size, we can approximate the number of phases contained in each mound. Since the number of mounds of unknown function is comparatively high, no distinction can be made between burial and house mounds and all mounds of unknown function are treated as house mounds. This approach is justified if we assume that the ratio of house to burial mounds is the same throughout Tongatapu. The resulting figure of phases/km² (Table 1) provides a relative measure of settlement intensity, which takes the density and the size of mounds into account. These values replicate the pattern

observed above, with the western area having smaller values than those in the east. In comparison with the figures based purely on mound density, however, the phases/km² figures differentiate further within the western areas and emphasise the relative importance of the Kolovai area.

Given that the C14 chronologies of some sites (TO-Pi-7; TO-Pi-13; TO-At-85) indicate that a hiatus may exist between two phases of a house mound (Spennemann 1989, Vol. I, p. 364), I am inclined to interpret the observed difference in mound density between east and west (Fig. 3) as a function of settlement time, rather than settlement density. It is highly unlikely that the plantations in the eastern district were about half the size of those in the western district, which would be the case if the settlement density were twice as high, so that the chronological argument makes more sense. However, the picture is not as clear cut as one would like it to be.

The occurrence of Late Lapita sites in the western areas, C14-dated to at least the third century BC (calibrated), shows that some settlement had taken place in the area (Spennemann 1990). We may have to conclude, therefore, that the settlement push towards the inland areas occurred unevenly and began in the eastern districts. It is likely to be no coincidence that environmental parameters vital for successful horticulture, such as quality of soils and amount of precipitation, clearly favour the southeastern areas. A possible *terminus ante quem*, but a definite *terminus ad quem*, for the move inland is given by the late fourth-century BC date (calibrated) for the Lapita inland site (TO-At-96) in the Ha'ateiho area (Spennemann 1989, Vol. I, p. 174). This general pattern needs to be contrasted with the presence of a central place, the residence of the supreme chief, the Tu'i Tonga. As will be shown below, the location of the central place changes over time owing to changing political needs. Yet, throughout that change, the basic parameters of a single central place and an otherwise dispersed settlement pattern persists.

Description of the political centres

Various political centres have existed in Tongan history. Oral traditions (cf. Gifford 1924; Gifford 1929) record the succession of capital places: Toloa in the southeast, Heketa in the northeast, Mu'a at the eastern shore of the lagoon and, finally, Nuku'alofa, the present capital at the northern shore. In addition, some traditions refer to Niutao/Maka'unga as a former capital place. Let us examine the archaeological record of these places in turn.

Toloa

Toloa, the traditional site of the first capital and seat of the court of the Tu'i Tonga (the paramount chief of Tonga), is the area around Tupou College and the International Airport at Fua'amotu (Gifford 1929, p. 52) but the exact location is unknown and cannot be archaeologically established, at least on present evidence. While the Toloa area has not been examined in great detail in a coherent manner, three large blocks have been surveyed: Tupou College (Poulsen,

fieldnotes 1963), Airport (Spennemann 1986b) and Beulah College (Spennemann 1989). In all cases a high concentration of mounds was noted, highest at Beulah and Toloa, less in the vicinity of the airport (Table 1).

The size of the mounds does not in itself appear to be a reflection of rank. The testing of one of the large mounds at Beulah (TO-Be-16) showed that size here was owing to the large number (13) of superimposed construction horizons and house floors it contained. This testifies to some continuity of habitation on one spot and it could be that it is in this factor that we should seek the expression of higher rank. There is little evidence for the use of beach rock slabs in the area, such as is a known marker of status in later times (Spennemann 1989, Vol. I, p. 438). None of the mounds seen was slab-faced. It is possible, of course, that there are slab-built chambers in burial mounds in the area. We can thus conclude that if there is a first capital place somewhere in the Toloa area, it consisted of a conglomeration of earthen mounds, which may have had retaining walls of wood, like those reported for some mounds at the time of early European contact.

Heketa

According to the traditions, the capital and seat of the court of the Tu'i Tonga was then moved to Heketa at the northeastern shore of Tongatapu. This move is said to have taken place during the reign of the tenth Tu'i Tonga, Momo, or that of his predecessor, Tu'i Tonga 'Afulunga (Gifford 1929, p. 52). Heketa contrasts strikingly with Toloa in its rich architecture in stone. It comprises (Fig. 5) nine monuments faced with beach rock slabs and the Ha'amonga-'a-Maui, a large stone gateway (Fig. 4). Much of the area was covered in thick bush at the time of fieldwork and most monuments could not be investigated in detail: the slabs were often only visible for about 0.15–0.2 m in height. All sites, except for the three-tiered structure (*langi* Heketa), were paved with coral rubble, probably gathered at one of the very small pocket beaches at the nearby shore. A stretch of sunken road (site TO-Nt-52) leads to the Ha'amonga. The Ha'amonga itself is discussed in greater detail than the other monuments, as it is by far the most impressive of Tongan stone structures and its sheer size has implications for the logistic capabilities of the early Tongan rulers.

The Ha'amonga-'a-Maui

The Ha'amonga (site TO-Nt-4) consists of two upright pillars of coral limestone and a connecting lintel of beach rock morticed into the tops of the upright stones (Fig. 4). The Ha'amonga opens north and south and the lintel is oriented exactly east–west. All three stones are carefully dressed and the corners between the sides carefully cut, as far as the porous material permits. The entire structure has a marked tilt to the north. The vertical square-cut mortice at the top of the uprights has sufficient width to allow the lintel to slip in edgewise with several centimetres of play on either side, and sufficient depth that the lintel is level with the tops of the uprights. Much has been speculated about the overall weight of the stones of the Ha'amonga, since this gives some insight

into the technical capabilities of Tongan culture at the time (McKern 1929, p. 64). Applying a volume/weight ratio for coral limestone of $1.9 \pm 0.2 \text{ t/m}^3$ (Fisher 1987), the visible portion of the western (eastern) upright weighs over 58.8 ± 6.2 (51.1 ± 5.4) metric tonnes. The lintel of beach rock weighs a mere 8.5 ± 0.9 tonnes. The calculation of the number of people needed for the erection of the individual uprights of the Ha'amonga rests both on ethnographic observations and modern experiments (Stone 1926; Atkinson 1956; Heyerdahl 1958; Skjolsvold 1961; Heizer 1966; Coles 1973). Applying the figure of 16 (22) men per tonne of weight needed for dragging a stone on a wooden sledge over a distance of 1 km per day, about 950 ± 100 (1300 ± 150) men were required for the western upright. This figure does not take into account the fact that these people needed to be fed for the time of the exercise. Dating of the Ha'amonga rests entirely on the dating of the reign of the eleventh Tu'i Tonga, Tu'itatui, who according to the traditions was the builder of the monument. Opinions on this matter are widely divergent: in the early part of the eleventh century AD (McKern 1929, p. 65), the twelfth century (Wood 1938, p. 6), the late twelfth or early thirteenth century (Gifford 1929, p. 51) and the fourteenth century (Thomson 1902, p. 83). All these estimates rely on a genealogical list of all Tu'i Tonga and on the length of the generation allowed for each of them.

The 'esi Makafakinanga and *langi* Heketa

The 'esi Makafakinanga (TO-Nt-9) is a low rectangular mound with a convex top, faced with slabs of beach rock. On top of the mound is a large upright piece of coral limestone, 1.9 m wide and 2.5 m high, weighing over 4 metric tonnes (McKern 1929, pp. 17-18; Spennemann 1987b). According to one oral tradition, this stone slab was used by the Tu'i Tonga Tu'itatui to lean against while holding court and to protect his back against assassination from behind (hence its name Makafakinanga, 'stone to lean against', Rutherford 1977, p. 33). The *langi* Heketa (TO-Nt-10) is a three-tiered structure of slightly trapezoidal shape, 1.5 m high. Measuring 24 m by 16.5 m, it is faced with beach rock slabs. There is no surface evidence for any burial vault. A one-tiered *paepae* (house platform, site TO-Nt-11) abuts the northwestern corner of the *langi*, 0.5 m high and measures 32.5 by 19.5 m in horizontal dimensions. Traditions say that on top of this platform there was a house in which a *matapule* (ceremonial attendant to and talking chief for a Tu'i Tonga) lived, who acted as caretaker or guardian of the grave. A stone house with four posts is said to have been erected on top of the *langi*, facing the south (McKern 1929, pp. 38-9): a fragment of worked beach rock, the present whereabouts of which are unknown, had been found on the *langi*, thought to be an end piece of a stone beam used for the construction of stone houses (McKern 1929).

Lay-out of the capital

Figure 5 gives a tentative reconstruction of the lay-out of the capital. As can be seen, a large gap exists between the Ha'amonga and the 'esi Makafakinanga. If we interpret the Ha'amonga as a gateway, an explanation strongly supported by the road (TO-Nt-52) which leads up to it, then we can expect that every visitor to the royal compound passing through the Ha'amonga would have entered a grassy open space, a *mala'e*, and faced the Makafakinanga. This lay-out is in keeping with the descriptions of 'normal' chiefly places by early European visitors. We can expect that the *mala'e* would have been bordered by trees providing shade, possibly toa trees (*Casuarina equisetifolia*). The large platform behind the Makafakinanga would have been the site of a large house, either the *fale* of the Tu'i Tonga or the *kava* house. The houses of the wife (wives) of the Tu'i Tonga and of other high-ranking people of the court would have stood on the other platforms. The dwellings of the retainers need to be imagined to the sides of the main area. We can expect that the compound was fenced in and that the fence reached from the Ha'amonga to the sea. If we consider the lay-out as reconstructed, two points are worth stressing. Firstly, Heketa is a 'normal' chiefly compound, but executed on a grandiose scale and with monumental materials. Secondly, both residential and sepulchral monuments are present.

The shift of the capital to Mu'a

Traditions say that the capital was removed from Heketa to Mu'a by the son of Tu'itatui, the Tu'i Tonga Talatama (Rutherford 1977, p. 33; Bott & Tavi 1982, p. 94). The reason given in one tradition, that his sister, the Tu'i Tonga Fefine Fatafehi, could not endure the sound of the waves constantly beating on the reef, is descriptive of the actual situation: the beach at Heketa is called 'Utulongoa'a, noisy rocks (Gifford 1923, p. 242). In another tradition, recorded in numerous versions (Gifford 1924, pp. 30, 46-7), it is said that Tu'itatui's sons Talatama and Tala-'i-Ha'apepe moved the capital to Fangalonganoa ('quiet shore') near Mu'a, because they feared their canoes might get wrecked by the rough and heavy seas at Heketa. The reason for moving the court from Heketa to Mu'a is quite likely contained in these traditions, being the need to have a capital at a location which permitted the safe anchorage of canoes.

Between Heketa and Mu'a

In addition to this established tradition on the shift of the capital, there is one which claims that an interim capital existed at Niutoa, halfway between Heketa and Mu'a (Wordsworth & Alexander 1957). The tradition claims that Tu'itatui shifted his residence from Heketa to Niutao Point, the westernmost point of the eastern part of Tongatapu, just inside the entrance of the Fanga 'Uta Lagoon and thus in a more sheltered environment than Heketa. Besides one *langi* (*langi* Lolotelie), three unfaced (?) mounds named Kolotolu (literally 'three villages'), all located between Navutoka and Niutao Point, are said to be associated with the reign of Tu'itatui. The most important site in this context, however, is *langi* Tamatou, which is situated near Maka'unga some distance north of Mu'a (McKern 1929, p. 55). In this *langi*, the thirteenth Tu'i Tonga, Niu-

koe-Tamatou, a wooden dummy, is said to have been buried, the use of a wooden dummy legitimising the succession of power from the childless twelfth Tu'i Tonga Talatama to his brother Tala-'i-Hapepe. Tradition claims that no human remains were buried there. Interestingly enough, excavations at the *langi* by McKern (1929, p. 113) failed to find any evidence for a burial vault and the big pocket of white coral sand encountered in the centre of the *langi* was empty. Generally, conditions for the preservation of bone in coral sand are very good, so that bones, but not wood, would have survived if they had been present.

Mu'a

Mu'a was the capital place at the time of the early European visitors, and many of them were received there by the Tu'i Tonga, the Tu'i Ha'atakalaua (head of chiefly lineage created by fission from and thus lower-ranking than the Tu'i Tonga lineage) or, less commonly, the Tu'i Kanokupolu. (head of chiefly lineage created by fission from the Tu'i Ha'atakalaua lineage). The monuments at Mu'a were noted and cursorily described by Cook and his officers (cf. Cook 1777, Vol. I, p. 224; Anderson 1967, p. 1004; Cook 1969, pp. 250–2; Wales 1969, pp. 812–13). Subsequent visitors variously described, depicted and measured them (Wilson 1799, pp. 283–5; Dumont d'Urville 1835; Forbes 1853; Thomson 1894; Baessler 1895, p. 312; Bastian 1895; Thomson 1902; Maudslay 1930 (1st edn. in 1878), p. 237). The first mapping of Mu'a was provided by Dumont d'Urville (1835). It identifies a few of the mounds and gives some information as to who was buried in them. Further mapping was done by McKern (1929, p. 89), who stayed in Tonga in 1920/21.

During the 1985 field season the monument complex was re-surveyed and a new map was produced (Fig. 6), which forms the basis for the present assessments.

Lay-out of the capital

While the capital at Heketa was in the form a chiefly compound but on monumental scale, that at Mu'a differed considerably. At the time of European contact the visitor did not enter a compound, but a cluster of compounds apparently structured around a central *mala'e*. Cook gives a description of Mu'a in 1777, which is reproduced in full.

It was a village most delightfully situated on the bank of the inlet, where all or most of the great men in the island resided, each having his house in the midst of a small plantation, with lesser houses and offices for servants & ca. These plantations were all neatly fenced round, with the most part only one entrance ... Publick roads and lanes lay between every plantation so that no one trespasseth upon another. Great part of some of these plantations were laid out in grass plats, and planted with such things as seemed more for ornament than use; but hardly any were without kava plant ... There were some large houses near the publick roads uninclused with large smooth grass

placed before them; these I was told belong to the King, they seemed to be common to every one and were probably the places where they have their public assemblies.

(Cook 1967, p. 127)

The eighteenth-century situation was the product of a long history. Mu'a consisted of two parts: one, Lapaha, within an old fortification and occupied by the Tu'i Tonga and the Tu'i Ha'atakalaua; the other, Tatakamotonga, built as an annexe to the south and belonging to the Tu'i Kanokupolu. Mu'a, the term for the central district of any island and its administrative centre, covers Lapaha, Tatakamotonga, and (today ?) the village of Talasi'u, north of Lapaha. Each of the three lineages mentioned above had its own compound: the Tu'i Tonga, with the house Olotele as the focal point; the Tu'i Ha'atakalaua with the house Fonuamotu; the Tu'i Kanokupolu with the house Langakali. These three compounds consisted of a series of smaller compounds, all arranged around a central grass-covered space at the top of which a large meeting/kavahouse (*fale hau*) stood. The houses of the high-ranking chiefs residing here were surrounded by servants' and retainers' quarters. As becomes obvious from Cook's description, the plantations within these compounds were not laid out for the growing of staple crops, but for the production of flowers, scented oils, kava and the like. Given the social structure, the inhabitants of these compounds would be provided by the commoner population with all foodstuff needed.

A major difference between Mu'a and Heketa is that the monumental architecture is entirely sepulchral at the former. Though early visitors mention that the houses stood on mounds, none of them say that these were slab-faced or even stone-faced platforms (*paepae*). McKern (1929) who conducted a thorough survey of the archaeological monuments at Mu'a, recorded several earth mounds now destroyed, but does not mention any slab-faced *paepae*.

The archaeological monuments at Mu'a

The archaeological landscape of Mu'a is dominated by the slab-faced royal tombs (called *langi* for the Tu'i Tonga lineage and *mala'e* for the Tu'i Ha'atakalaua and Tu'i Kanokupolu lineages) which make up the Mu'a Monument Complex. In addition to the stone-faced monuments, we have to discuss the fortification and what is said to be a large-scale land reclamation which occurred during prehistoric times. The monument complex at Mu'a can be divided into six groups (Fig. 6): (1) the monuments inside the fortification ('Inner Group'); and (2) the row of large monuments on the outside ('Main Group') form a north-south alignment, interrupted only by the defensive ditch; (3) north of the fortification and parallel to the alignment referred to above is a row of small monuments in front of the Main Group ('Small Group'); (4) west of these three groups are the 'Telea Group'; and (5) a group of two small monuments across the road from the Main Group ('Northern Group'); (6) towards the southwest is the 'Loamanu Group'. On the whole, the *langi* and *mala'e* at Mu'a are arranged in two north-south alignments, that to the west showing some

interruption (Fig. 6). The distribution of the size of stone slabs within the individual slab-faced monuments at Mu'a shows a that the stones in the northern and southern faces are significantly smaller than those in the eastern and western ones (Student's t , $P=0.016$, $df=2250.68$). For this dichotomy two avenues of explanation are open:

- 1) the areas east and west of the sites may have had a higher status, as important activities may have taken place there;
- 2) the northern and southern sides were neglected since there were other monuments nearby which hid them.

It seems likely that both propositions are true. The chronological consequences deriving from the second explanation allows us to arrive at a monument sequence for Mu'a. What I would like to stress in this context is that the monuments clearly have display sides, consisting of larger slabs, and that these display sides were the eastern and especially the western faces. This suggests that the emphasis was placed on social activities taking place towards the west, where we may therefore expect a large *mala'e* or central plaza. For the Loamanu cemetery the eastern side is the display side (larger stones), in keeping with the location of the socially important activities taking place in the central plaza.

As is evident in examples from Pangaimotu (site TO-Pi-13), Kanokupolu and Feletoa (Vava'u, northern Tongan islands), the display sides, which in the case of Pangaimotu is the only slab-faced side, are oriented towards the direction from where visitors would come. If we apply this concept to Mu'a, where many display sides face towards the lagoon, then the monuments were primarily erected to impress visitors arriving by canoe, possibly from outer islands, rather than people coming from the landward side. This is consistent with the overseas contacts suggested in the traditions, a point taken up in the discussion of the harbour and wharves below.

In this context it is of importance to note that *langi* TO-Mu-8, which I believe to be the first *langi* to be erected at Mu'a, already shows this phenomenon. This indication that the orientation of monuments towards the lagoon began with the very beginnings of Mu'a is the more important in the light of the monument group at Heketa. Here the southern side of *langi* Heketa has the largest stones, suggesting that visitors would have come from the southern, landward side. This interpretation, of course, is consistent with the fact that the gateway at the Ha'amonga is south of the *langi*.

The fortification of Mu'a

An important landmark at Mu'a is the large fortification (TO-Mu-4). There is a ditch, measuring at the present time 10-12 m in width and 1.2-1.8 m in depth, which encloses a rectangular area. The original depth has not been ascertained. At the northern part of the eastern side a stretch of inner bank survives. The fortification is open towards the lagoon, where the ditch ends at an old

shoreline, about 75 m (southern) to 250 m (northern) from the present shoreline. Since the land between the old and the present shoreline has allegedly been reclaimed (see below), the fortification predates the reclamation. No traditions seem to exist to explain why the fortification was established; according to one of McKern's informants (1929, p. 93), the twenty-third Tu'i Tonga Takalaua either built or refurbished it. It is known from traditional sources that several assassinations of Tu'i Tonga took place, one of them giving rise to a split in power and the creation of the Tu'i Ha'atakalaua title (see below). The name of the capital place itself, Lapaha, is interesting in this context, as it means 'the appearance of assassination' and is similar to the Fijian Labasa (Gifford 1923, p. 127). However, there is some indication that it was not assassination which caused the erection of the fortification, but a full-scale war, apparently civil war: the name of the *langi* Tauatonga (either site TO-Mu-9 or TO-Mu-27; McKern 1929, pp. 40–1, 56) translates as 'tomb of the war of Tongatapu' (Gifford 1923, p. 126). It is possibly no coincidence that TO-Mu-9 was the first tomb to be built after the fortification (according to a site chronology based on stone slab sizes, Spennemann 1989, Vol. I, p. 472).

The great land reclamation

The Holocene shoreline at Mu'a is a clearly visible geomorphological surface feature. There is a claim that the land between the present and the former shoreline was reclaimed, a logistical feat which McKern doubts (McKern 1929, p. 100). A perusal of the map of Mu'a (Fig. 6), however, shows that the area in question is rectangular in plan and its lagoon margin has a number of rectangular protrusions. Rectangular shores do not exist in nature. The new land was made in such a way as to accommodate the residence of the Tu'i Ha'atakalaua and an entire harbour and wharf area.

The reason for this large-scale land reclamation is unclear. As McKern (1929, p. 100) correctly remarks, there is no apparent need for it, as a harbour could have been built at the existing shore. It has been argued by some authors (e.g. Kirch 1984, p. 227) that new land was required to accommodate a new administrative office. The assassination of the 23rd Tu'i Tonga Takalaua caused his son Kau'ulufonua Fekai to separate the secular leadership (*hau*) from the spiritual/sacral leadership. While Kau'ulufonua as Tu'i Tonga retained the latter, he transferred the secular and administrative duties to his brother Mo'ungamotu'a, who became the first Tu'i Ha'atakalaua.

The wharf and harbour

Since the draught of even the large double-hulled canoes (*kalia/tongiaki*) was not very great, they could easily enter the Fanga 'Uta lagoon, so that Mu'a was accessible to every type of traditional craft. Normally, if the canoes were not to be used for some time, they were dragged ashore and placed in large canoe houses (Gerstle & Raitt 1974, p. 4; Snow & Waine 1979, p. 273). When not

in use for a shorter period of time, they were anchored a short distance offshore. At Mu'a, however, canoes were apparently berthed on long piers running into the lagoon. The pier for the Tu'i Tonga's canoe was erected in stone and thus is still visible. The whole complex, the Mounu, consists of a buttress-like wharf area faced with boulders of coral limestone and slabs of beachrock, from which protrudes the pier itself (Fig. 6). The remains of the pier run out about 25 to 30 m into the lagoon and consist of a pile of small coral limestone blocks, which today is partly exposed at high tide and well exposed at low tide. This pier was obviously not the only one in existence, but since stone construction of any kind was a high-ranking privilege, all other piers would have been made of wood and so have not survived. The only other place in the entire region where a similar wharf construction can be seen is Bau in Fiji (Hornell 1926).

There the entire island was provided with piers, giving it a cog-wheel appearance. In Bau the procurement of stone was no problem and the entire harbour area was slab- or boulder-faced.

Kanokupolu/Kolovai

Discussing the land reclamation at Mu'a, I mentioned the creation of the Tu'i Ha'atakalaua title. A similar split in power occurred seven generations of Tu'i Ha'atakalaua later, when by collateral fission the Tu'i Kanokupolu title was created for the governance of the western area of Tongatapu, which at that time had apparently seen an increase in population (Rutherford 1977). Over time, the Tu'i Kanokupolu increased his powers and eventually surpassed the Tu'i Ha'atakalaua. The Tu'i Kanokupolu took residence both in Mu'a, where a compound was established south of the fortification at Tatakamotonga, and at Kolovai/Kanokupolu, where the installation ceremonies took place. As before with Heketa and Mu'a, the new administrative centre at Kanokupolu is a planned 'capital'. However, most of it is executed on a smaller scale, and stone architecture is limited to the tombs.

The choice of the locality is predetermined by two factors. The need for an administration in the western part of Tongatapu, which ruled out the establishment of the administrative centre in the central area, such as Pea/Ha'ateiho, and the need to have permanent accessibility by canoe, as the power of the Tongan chiefs appears to have been supported by the capability to command a large fleet of canoes. These two factors limit the choice of place considerably. The entire southwestern shore is ruled out, as this is the weather shore which does not offer protected landing places for canoes. The northern shore of the island is dominated by extensive sand- and mudflats which do not permit the navigation of canoes through the tidal range. Judging from aerial photographs, the only place on the entire northern shore west of Nuku'alofa, which has some deeper water channels which appear not to fall dry at low tide is Kanokupolu. Given the shape and the extent of the deeper area, this is a natural configuration, although artificial deepening once the administrative centre was established cannot be ruled out. In the archaeological record, the

Tatakamotonga compound at Mu'a, with a ditch and bank, was identified by McKern (1929, p. 94) in the 1920s, though he did not find any slab-faced or stone-faced monuments associated with it. However, two slab-faced monuments exist at Kanokupolu and Kolovai. The former (TO-Ka-8) is the large *mala'e* of the Tu'i Kanokupolu, an almost square earth mound, measuring about 31 by 30 m. The mound surface had been cleared of vegetation at the time of my inspection, exposing a rounded top with a stone enclosure of square form formed by rectangular slabs of beachrock and paved with coral rubble and black pebbles of volcanic rock (*kilikili*). The existence of this geographically isolated example of a slab-built monument reflects the rise of political leadership not wholly centred at the traditional capital. To what extent this trend was reflected at lower levels than that of the Tu'i Kanokupolu is impossible to say.

The rise of the west and the proliferation of central places

Oral traditions assign the foundation of Kanokupolu as a new administrative centre in the west to some unruliness of the people of Hihifo (cf. Wood 1938, p. 11; Rutherford 1977, p. 36; Bott & Tavi 1982, p. 114). While the Tu'i Kanokupolu had a compound at Mu'a and while he also lived there from time to time (cf. Wilson 1799, p. 265), both his *mala'e* and the place of his installation to the title were at his main residence at Kanokupolu. This decentralisation of power at a lower administrative level course provided the possibility for rivalry and competition. This is in fact what happened. Both Kanokupolu and Mu'a were political centres in use during the initial contacts with the Europeans. While at this time the traditional centre of Mu'a was still the societal capital, Kanokupolu was beginning to gain pre-eminence, at least on the political level. When Tasman visited Tongatapu in 1643, he anchored off the Kanokupolu/Kolovai peninsula. One sketch in his logbook shows the compound of the chief at Kanokupolu (Heeres 1898, p. 28). Cook (1969, pp. 250–1) also anchored off the peninsula and in fact traversed the area. A contingent of the first missionaries took up residence there, as the 'Dugonagaboola' (Wilson 1799) was very powerful.

By the second half of the eighteenth century, the Tongan political system was becoming unstable with the rivalry between various lineages developing into open conflict. The arrival of the Europeans, and the supply of goods and weapons, only accelerated an existing process. Warfare erupted in 1799 and lasted until 1852, when the country was unified under Taufa'ahau Tupou I. It was not a continuous war, but a period of civil strife with sporadic outbursts of fighting. The insecurity of the times made it necessary for the population to move closer together and to settle in fortified villages. While so far no nucleated settlements had existed save for the capital places themselves, the Civil Wars forced the population to congregate in fortifications, which over time created an established new pattern of settlement, which lives on in the form of the present-day villages.

The fortifications as well as the evidence of the traditional road system can be used to investigate the political and demographic landscape on Tongatapu at the end of its traditional history.

Population distribution at the time of European contact

The demography of the Tongan islands in pre-contact times is a bone of contention. Detailed work has been carried out *inter alia* by McArthur (1968), Walsh (1970), and more recently Bakker (1979), using demographic techniques. The available eyewitness estimates and educated guesses on the population size of Tongatapu between 1800 and 1850 cluster between 8000 and 20,000. Assessing the size of the Tongan population as a whole, and the population of Tongatapu in particular, is fraught with problems, deriving from the inaccuracy of the eyewitness estimates, 'natural' population fluctuation within the Tongan islands, increased fluctuation as a result of the Civil Wars and the possible occurrence of epidemics which went unrecorded. It is obvious from various sources (cf. Vason 1810) that the population declined during the Civil Wars, due both to fighting and, more importantly, to starvation because the fields could not be tilled. Food shortages and famines are recorded on Tongatapu for 1836 and 1840 (Moulton 1914, p. 422). Census figures are available from 1891 onwards, although the accuracy of the earliest returns has been questioned (McArthur 1968, pp. 77–8).

The earliest eyewitness estimate, advanced by Cook, reported about 12,000 people along the coast of Tongatapu in 1777. His estimate has frequently been doubted, on the grounds that numbers would have been swelled by visitors from the outer islands (McArthur 1968; Bakker 1979). However, the number of such visitors could well have been equalled by the number of residents who stayed at home to look after small children and tend the gardens. However, I am inclined to assume that the population of Tongatapu at the time of Cook's visit was in excess of 12,000 people. Beveridge (1824), who has provided the most detailed pre-census eyewitness breakdown for the principal villages of Tongatapu (Table 2), gives a total figure of 34,800 people, which is much higher than that of any other source (Fig. 7). Urbanowicz (1972, p. 92, note 1) argues that Beveridge wilfully overstated the figures in order to 'convince the Wesleyan missionaries of the tremendous market for material goods and Christianity'. However, Reverend W. Lawry, who was acquainted with Beveridge (he came out on Beveridge's ship) and stayed as a missionary in Tonga in 1822–1823, would have been able to correct these figures if they had been blatantly wrong, particularly since he had much more on-shore experience in Tonga than Beveridge. Lawry, however, in co-operation with the other resident missionaries, assumed a total population of 50,000 for all Tonga in 1847 (Lawry 1850, p. 111) and planned a Tongan bible edition of 50,000 copies. Matoto (1971, quoted after Thaman 1976, p. 88) also assumes a pre-

contact population of about 50,000 for Tonga overall, which, using the proportions of the 1891 census, gives a population of almost 22,000 people on Tongatapu. According to Dumont d'Urville (1835), the missionaries mentioned to him in 1826 that Tongatapu could field 5000 warriors and that the district of Hihifo had about 4000 inhabitants, a figure tallying well with Beveridge's estimate two years earlier. Unless one accuses the missionaries of deliberate misrepresentation, we can accept the magnitude of Beveridge's population estimates.

Fortifications

European descriptions of fortifications

The fortified villages (*kolo*) of the Civil Wars period were defended by a ditch and inner bank of earth, on top of which a palisade was erected. In some cases the defence system consisted of two ditches and banks (Fig. 8). The gateways were often protected by an earth wall erected some 10 to 20 m in front of them, preventing direct assault. To achieve the same effect, pit traps with sharpened bamboo spikes were dug. Mariner, describing an attack on the *kolo* of Nukunuku (in 1808?), mentions the use of drawbridges to give access across the deep ditches (Martin 1972, Vol. I, p. 351). Wilkes (1845, Vol. II, p. 122) talks of a fortification at Mu'a consisting of a soil wall reinforced with logs, on top of which a palisade was set up. Some of the fortifications were left open towards the sea to allow access by canoes, which were beached inside the defences (Erskine 1853, p. 148).

Fortifications were not maintained over the whole period of civil strife. They were kept up as long as needed and then fell into disrepair. When fighting broke out again, they were quickly renewed. Historical sources mention that a fortification consisting of ditch and bank could be built within two or three days. During the periods between fighting, the people would live away from the fortifications (Bennett 1832; Orlebar 1976, p. 49). Missionaries living at Hihifo (now Kolovai) had their premises erected on the outside of the fort (Thomas n.d., p. 32). In case of war the people 'would be called in from the out villages and towns and concentrated at the respective fortresses' (Turner 1861, quoted in Cummins 1977, p. 91). This implies that the urbanisation represented by the fortifications was only temporary and that the dispersed pattern was maintained. Fortifications on Tongatapu came in different forms. Almost as many round or oval as rectangular fortifications are known and there is no definite spatial patterning of these ground plans, although there is a tendency for rectangular fortifications to be more common in the west (Table 3). When a village directly abutted the shore, the seaward side was undefended, to allow canoes to be beached within the defences, as already mentioned. Such fortifications are in the shape of a semi-circle or a rectangle open to one side. Examples are the forts of Pea (TO-Pe-7), Vaini (TO-Fo-3 & -4), Kolovai (TO-Ko-4) and Mu'a itself (TO-Mu-4). Some fortifications built

at or very close to the coast had a protection seaward, such as Nuku'alofa (TO-Nu-6) and Ma'ofanga (TO-Nu-7). In some places, such as Nuku'alofa, the canoe houses were undefended outside the defences, while at others, such as Ma'ofanga, the solution was to fortify the seafront, but leave gaps through which the canoes could be dragged ashore (see figure by de Rienzi 1837, Vol. II, p. I Plate 211, re-cut from an original by de Sainson).

Distribution of fortifications

As can be seen from Figure 9, the density of fortifications increases towards the west, where they reach *c.* 16.25 x 10.2 per km², while in the southeast they are only 9.61 x 10.2. The entire area north of Mu'a is devoid of fortifications. It is true that the eastern half of Tongatapu has not been surveyed systematically. However, the road network was traversed, so that, given that many fortifications on Tongatapu are the sites of modern villages, the lower density of fortifications in the east seems to be real. This conclusion is strengthened by another observation. It is very likely that the distribution of fortifications reflects fairly accurately the distribution of the population, as it does not make sense to construct fortifications away from population concentrations. The total fortified area in the western part of the island, including the fortifications at Ha'ateiho, TO-Pe-11 and TO-At-30, amounts to almost a million m² (986,620 m²). In the east, including the fortification of Vaini but excluding the royal compounds of Lapaha and Tatakamotonga (much older than the other forts and thus need to be discounted in this exercise) the total is 320,000 m². If the defended area of a fortification were proportional to the number of people defended, then the population distribution between west and east would be 3.12:1. Some population estimates for 1824 are given in Table 2. On the basis of the population estimates for 1824 (Table 2), the population distribution between west and east is 2.97:1, a figure which matches well the estimate based on the fortifications.

Topographical determinants of fortification

Since Tongatapu is an extremely flat island, topographical variation in the location of forts is relatively restricted. Save for site TO-Fu-49, which sits on top of a gentle knoll, and sites TO-Nu-6 and TO-Fo-5, where old patch reefs have been encircled by a ditch, all fortifications are built on flat land. Even in the three cases mentioned, the pattern is that of a flat-ground fortification. Whereas the walls commonly consisted of soil, walls of stone rubble were erected if the material was available (TV-Vn-7: McKern 1929, pp. 76–7; Spennemann 1987a, Vol. II, pp. 180–2). It is also interesting that none of the Tongatapu fortifications backs onto the *liku* coast. An example of such a fortification is known from 'Ata Island, south of Tongatapu (Anderson 1978, p. 6), where people from 'Atata, an islet off the north-western coast of Tongatapu, fled during the Civil Wars (Gifford 1929, pp. 278–83; Maude 1986, pp. 83–7). Some of the Tongan fortifications on Vava'u made use of necks of land, which could be cut off (McKern 1929, pp. 76–7; Davidson 1971, p. 35;

TV-Vt-12: Spennemann 1987a, Vol. II, pp. 160–4; TV-Vn-7: Spennemann 1987a, Vol. II, pp. 180–2).

Development of fortifications

Given the paucity of excavations, not much can be said at this stage of work on the development of fortifications. The typological difference between rectangular, circular and oval fortifications warrants explanation. Swanson (1968) has advanced the theory that rectangular fortifications were introduced by the missionaries, while the fortifications of the non-Christian forces were round. She argues that straight-sided defences were of use in gun warfare. However, the fortification of Mu'a, which is certainly pre-missionary, is rectangular. Although most, if not all other fortifications visible in Tonga today date to the last period of civil warfare (1799–1852), one fortification definitely is older, that of the former capital of Mu'a (see above). On the available evidence (it is the same or a later date than the fortification of Lapaha and predated the land reclamation), this defence system dates to the fourteenth or fifteenth century AD. It could be that other fortifications of the fifteenth century or earlier have been obliterated by the combined forces of erosion and continued gardening. Lapaha would be an exception because of the enormous size of its ditch, which is at 10-12 m wide and today up to 1.5 m deep.

The road network

The earliest map of the road system is provided by J. Wilson (1799, foldout), who mentions in the caption that the pattern of the small roads is schematic (Fig. 10). Even so, the general impression it conveys is most probably correct: a network of small roads branching off the major trunk road, which runs from the Kolovai/Kanokupolu peninsula via the Liahona area, Pea and Vaini to Heketa. Mu'a is not connected, but is indicated on the map as the area where the *langi* ('*affiatooka*') are. Wilson mentions in the caption to the map that the roads are between 1.8 and 3.6 m wide ('6 to 12 feet') and bordered on both sides with reed fences (for a general impression see the drawing made on Dumont d'Urville's voyage in 1826 reproduced as Figure 2). At intersections there were open, grass-covered spaces used for burials (Marra 1775, p. 61; Cook 1777, Vol. I, pp. 194, 213; Wilson 1799, foldout; Martin 1972; Bays 1831, p. 123; Waldegrave 1833, p. 187; West 1865, p. 44; Cook 1969, pp. 246, 252; Wales 1969, p. 812).

The archaeology of roads

Previous archaeologists visiting Tonga noted shallow ditches running for considerable distances, which were described by the Tongans as ancient roads (McKern 1929, p. 89; Davidson 1971, pp. 35–6). The term 'sunken road' was adopted to describe these features. In Tonga, archaeologically visible types of roads are very few owing to the general lack of easily accessible stone as paving material, in contrast to Samoa, for example, where many roads are either stone-paved or lined

with stone walls (Holmer 1980, pp. 16–17). On Tongatapu, only ‘sunken roads’ are visible to the archaeological eye, as they have been worn into the ground by the tramping of many feet over a long period of time. Unlike roads seen by McKern (1929, p. 89) on Vava’u and Ha’apai, none of the roads seen on Tongatapu had distinct embankments running parallel to the ditch, thus supporting the idea that they were not intentionally dug. By this argument, roads with less traffic would become less deeply entrenched and might soon become obliterated by gardening activities (particularly modern ploughing). Even frequently used roads in Nuku’alofa at the turn of the century are only visible as tracks where no grass is growing (old photographs in the Fiji Museum, Suva; for excavation of a road see Spennemann 1986a).

Using modern transport- and road-planning terminology (Lay 1982), a five-stage hierarchical system of roads can be set up, where all types of roads have different status in respect of traffic flow, and therefore different chances of survival in the archaeological record as a result not only of the amount of traffic but also the length of time they were in use (Table 4). On Tongatapu, stretches of sunken road were seen particularly in the Central and Hahake districts (see Fig. 11). They are between 4 and 7 m wide and between 0.5 and 1.5 m deep. They tend to run parallel to the modern road system. Sometimes the junctions, road forks or road branches are in an almost identical position to today. One good example is the modern road triangle at ‘Atele (Ha’ateiho township), where the road coming from Vaini/Veitongo (Taufa’ahau Road) branches off to Tokomololo (Loto Road) and to Nuku’alofa (still Taufa’ahau Road). This road fork has its earlier counterpart just 50 m to the south, where the sunken road divides (sites TO-At-29, TO-At-62, TO-At-63).

Reconstruction of the old system based on modern maps

Since the known stretches of the prehistoric road system (Fig. 11) closely resemble the pattern of the modern one, while one old road at least was in use during European times, it seems reasonable to base the reconstruction of the main prehistoric road system on the modern system. Indeed, there is evidence that the existing, serviceable road system was upgraded in 1909 (Fusitua & Rutherford 1977, p. 187) to allow for regular wheeled transport. Discounting all straight roads, which appear to have been designed on a drawing board, like those built by US forces during World War II, the system of major roads may have looked like that shown in Figure 12. Since this reconstruction represents the road system at the close of the nineteenth century and possibly also the pattern during the first half of that century, we can propose that it would tally with the distribution of the fortifications of that date. This is very likely since, already pointed out, many present-day villages have grown out of old fortifications. Network theory can be used to check whether this proposition is correct. Network analysis has frequently been utilised in the reconstruction of relationships between prehistoric populations as inferred from archaeological

sites (e.g. Irwin 1985; Hunt 1988). Any graph theoretical analysis assumes that the entity of sites is absolute, that is that all sites belonging to the network are known. This assumption may not hold true archaeologically, as not all sites may have been found.

Another problem inherent in the network analysis of archaeological data sets is whether the sites investigated are contemporary or not. In an island situation, of course, there is the additional factor of transport by water. Since the network analysis relates to the road system, however, it is posited that transport was conducted by land. It should be noted that graph theory at the level used in this modelling is confined to the major places (fortifications) as node points. The pattern that emerges will only represent the high-level road network, such as highways and arterial roads. Low-level roads, such as feeder and access roads, will not be included. A third proximal point analysis of the fortifications shows that they can be linked in four systems: a large system connecting most of the fortifications in the western part of Tongatapu; a system on the Nuku'alofa-Ma'ofanga peninsula; a system connecting sites at the eastern part of the lagoon; and a small system in the southeastern part of the island. Since in the model the three nearest places have been connected, major node points in the network are defined as those points which have four connections, central nodes as those which have more than four. On the assumption that it would run through the major and the central node points, the resulting major road connection, the 'Tongatapu highway', runs from Fo'ui (3: the numbers refer to Fig. 9) via Te'ekiu (4/5) and Hule (8) to Liahona (11) and then 'Utulau (13), and on, possibly via Ha'ateiho (16), to Vaini (21/22) and the fortification south of the Prison Farm (23), with possible connections to Mu'a (3) and Fua'amotu (24).

Following Kransky's (1963) exercise of reconstruction the evolution of the Sicilian railroad network, we can construct a road network using the minimum spanning tree (MST), which establishes the shortest path through the network with the least number of links. First, each node is connected with its nearest neighbour. The resulting subgraphs are then linked with their respective nearest neighbouring subgraphs, until all nodes are connected (Haggett, Cliff & Frey 1977, p. 80). The road network thus constructed has a basic resemblance to the previous system, with a central highway running west to east, and is astonishingly similar to a network drawn on a map of the 1840s (reprinted in Nicholson 1983, p. 197).

Both previous models are based on the proposition that all sites are equally important. In reality this is obviously not the case, as some places have a greater population than others. In addition, the social and societal rank of the chief of a given village or fortification needs to be taken into account. If we alter the weighting of the places, the network is changed, as short-path connections with the more important places are pre-eminent. If we assign a comparatively high weighting to the fortifications of Kolovai (2; numbers refer to Figure 9), Houma (9), Pea (14), Fatai (21/22), Mu'a (30) and Nuku'alofa.(31/32), given their importance during the Civil Wars,

then the minimum spanning tree model looks like Figure 12. The main new features are a southern road, running parallel to the *liku* coast from 'Utulau to Ha'utu and on to Fo'ui, and a northern road, running from Nuku'alofa to Nukunuku and then also to Fo'ui. On the whole, the picture from the weighted minimum spanning tree resembles the modern network.

The network analysis has shown that the present and, as far as we know, archaeologically recognisable road network can be predicted at the basis of the distribution of the fortifications. This discovery has a major implication. On the one hand, a road network is commonly constructed between population centres, with an emphasis on centres with the highest density or the greatest amount of items or people to be moved. On the other hand, population centres may well have developed secondarily in relation to the network, most advantageously at its node points. The question thus posed is whether the road network predates the fortifications or whether the latter are earlier; alternatively and most probably, both developed in conjunction with each other. Given the nature of Tongatapu, a central highway can be expected even if there are no villages. This is the situation depicted by Wilson in 1797 (Fig. 10).

Another implication from the network analysis is the establishment of a central node in the network. The adjacency connectivity arrays and the shortest-path connectivity arrays indicate that node 17, a fortification south of the Folaha peninsula, is the best located node point. Given the nature of Tongatapu, with a deeply indented inner lagoon, the land-transport network is necessarily largely linear and thus a node located in the middle of a linear array is favoured. This is even more emphasised by the fact that the central area of Tongatapu is very thin and that all traffic has to pass through a comparatively narrow strip of land. However, node 17 has never been a political centre of any standing, which clearly indicates that factors other than pure abstract network connectivity are involved.

The geopolitics of capital places

The network analysis carried out above identifies fortification 17 (TO-Fo-20, see Fig. 12) as the most central node. Even though this exercise is based on nineteenth century central places, it points to the importance of the narrow corridor of land south of the lagoon between Pea and Vaini for any land communication on Tongatapu. If the deep penetration of the lagoon thus affected communication by land, it also facilitated communication by water and focused it on the same general area. With the development by at latest AD 200 of the present narrow entrance to the lagoon as the only entrance, the locus of canoe traffic into the lagoon would have been its eastern rather than its western sector. The locational advantages of this area from the point of view of both land and water transport would be confirmed by the fact that the best soils and the least evapotranspiration are found there. Given a horticulturally based society by the end of the pottery

producing period in the fifth century AD, it is not surprising that Tongan oral traditions locate the first capital here, somewhere between Fua'amotu International Airport and Tupou College. The locational evidence shows that it was land- rather than sea-oriented. Its date would have been before AD 1200, based on genealogical dating (25 years per generation of Tu'i Tonga) of its successor, Heketa, founded by the tenth Tu'i Tonga, Momo.

Why the shift from Toloa to Heketa took place, and why Heketa was the site chosen, are impossible questions to answer on purely locational grounds. Heketa backs onto a rugged stretch of coast, difficult of access from the sea, with few and very small beaches in the vicinity. It is not the centre of a substantial agricultural region. As no fortifications exist, strategic considerations appear unlikely. It seems that purely political factors must have been at work, the desire of a now pre-eminent lineage to start with a 'clean slate', to found a miniature St. Petersburg, Washington or Canberra.

There are some things we can say about Heketa, however. Its plan is that of a recognisable chiefly compound, though on monumental scale. Its use of coral limestone and beachrock in construction seems to mark the first appearance of these as visible symbols of rank and power. Their existence, and particularly that of the Ha'amonga, estimated to have commanded the labour of at least 10 per cent of the able-bodied population of Tongatapu, testifies to the extent of the power which the Tu'i Tonga dynasty now wielded. Finally, the capital looks landward, its back to the sea, by the evidence of the monumental gateway of the Ha'amonga which looks south at the furthest point from the sea and the *langi* Heketa, which shows its largest stone slabs to the person approaching from the gate.

Within two generations, the twelfth Tu'i Tonga, Talatama, or his brother, Tala-'i-Ha'apepe the fourteenth, moved the capital to Mu'a, on the eastern shore of the lagoon, where it remained into the period of European context in the late eighteenth century. Unlike the apparently short-lived Heketa, Mu'a developed over time, so that it is impossible on present evidence to say what its original plan was like, particularly since it seems to have lacked the slab-faced dwelling platforms known at Heketa. The original settlement was Lapaha, in the early period defended by a ditch and inner bank, which terminated at the coast at both ends. Later, land reclamation in front of the fortification, which was thereby rendered ineffectual, if it had not already fallen into disuse, made ground for the residence of newly founded Ha'a Takalaua lineage. Later still, with the creation of the Tu'i Kanokupolu title, a further addition, Tatakamotonga, was added to the north.

The monuments consist almost without exception of slab-faced tombs of various ranking lineages. The important factor is the orientation of the display side of the major tombs towards the lagoon, with possibly an assembly ground (*mala'e*) in between. This lagoonward orientation is symbolic of a shift in focus of the ruling dynasty from Tongatapu to the world beyond, no more strikingly seen than in the harbour works associated with the land reclamation and no doubt

accounting for the move of the capital from Heketa. We have here the locational expression of what sometimes is called the Tongan Maritime Empire (e.g. Campbell 1983, p. 155). From the traditions, this is said to have extended as far as Samoa, Futuna, 'Uvea and Niue. It is better to be interpreted as a Tongan sphere of influence, in which we can distinguish three grades:

- 1) a core area, which was under the total control of the Tu'i Tonga, Tu'i Ha'atala or Tu'i Kanokupolu and was regarded as Tonga proper;
- 2) a zone of continuous influence, in which the Tongans exerted power over dependencies which had to provide goods and provisions to the Tu'i Tonga at the annual *'inasi* ceremony, as well as conscript labour (*fatongia*) as the need arose;
- 3) a zone of sporadic influence, in which the Tongans made their presence felt, for example, by the occasional raid, without exerting power continuously.

Besides the Tongan archipelago itself, the closest links were with Samoa and Fiji, with a regular exchange system operating (Couper 1968; Kaeppler 1973; Kirch 1984, pp. 238–41; Tippet 1984a; Tippet 1984b) with Tonga as the centre of a redistribution network. Mu'a was ideally placed to serve the role of capital of an island with overseas connections of this kind, its position at the eastern shore of the lagoon is reasonably near to the entrance and protected from adverse seas by the Nukuleka peninsula. By the end of the Civil Wars, power had been consolidated in the hands of Taufa'ahau Tupou I (King Siaosi Tupou I), who had no traditional power base at Mu'a, since he was neither of the Tu'i Tonga nor Tu'i Ha'atala lines. Nor did he stem immediately from the Tu'i Kanokupolu residing at Hihifo. Although he became the nineteenth Tu'i Kanokupolu, Tupou I had been born in Ha'apai, where, along with Vava'u, he had his own bases of power. Mu'a, moreover, had been the traditional home of one of his major opponents, the Tu'i Tonga Laufilitonga, as well as now being the stronghold of the Catholics, who had opposed him during the final flare-up of civil conflict. Finally, for Tupou I residence at Mu'a would have, to some extent, indicated his acknowledgment of the supremacy of the Tu'i Tonga, whom he had rendered politically impotent.

So, for Tupou, neither of the traditional Tongatapu power centres seemed appropriate for his own needs. A new capital, then, was the only solution. However, moving the capital to his own power bases in Ha'apai or Vava'u was out of the question, since Tongatapu was both the ancient traditional centre and 'source' of power and, even after the destruction caused by the extended civil strife, much more developed.

Most prominent amongst the forces who had backed Tupou's ascent to power were the Wesleyan missionaries. They had already formed a religious centre at Nuku'alofa, with their largest church, Saione Motu'a (Old Zion), atop the fortified hill known as Sia-ko-Veiongo. And Nuku'alofa was also the port of entry for European goods. To choose Nuku'alofa as his capital provided him with access to both overseas goods and political backing. The establishment of the

capital there also allowed the creation of a central place on Tongatapu, about half-way between the two previous centres of power, Mu'a and Kanokupolu, underlining the new start being made.

Implications for the world beyond

In times of unquestioned sacral and secular power, every member of society knew his or her place and acted accordingly. The settlement pattern thus presented the maximum utilisation of the land: densely settled, but very dispersed. Only the centre(s) of power, with the associated large number of retainers and craftspeople saw a semblance of urbanisation, the inhabitants concentrating on non-food producing activities.

Tongan history indicates that political assassinations of the rulers were not uncommon, but it appears that these were carried out by high ranking members of the chiefly family. While plot and counter-plot may have rocked the top levels of Tongan society, this did not directly affect the middle or lower tiers of society. Horticultural productivity (and hence power and prestige) was still sought after and the maximisation of land use was not affected. Discontent younger members of the royal family were sent overseas to conquer outlying islands, thus adding to the Tongan sphere of influence. Whilst still lower in rank and thus subordinate to the rulers of Tonga, these chiefs had ample space to quench any thirst for the expansion of their powers. Unlike these chiefs, however, the newly created title of Tu'i Kanokupolu, was associated with the relocation of a centre of power to a different part of Tongatapu. The resulting closeness of power centres on the same island allowed, over time, for the development of a clear competition for power with subsequent conflict over land, and thus retainers and followers. Rather than providing for a clean, albeit bloody transition, the ascendancy of the Tu'i Kanokupolu lineage was characterised by widespread civil war. The weakness of the Tu'i Tonga and Tu'i Ha'atakalua and their chiefs encouraged subordinate Kanokupolu chiefs from outlying islands (Vava'u) to attack Tongatapu.

During the following period of civil strife, a plethora of middle-tier chiefly lineages took centre stage, with changing alliances and allegiances with the Tu'i Tonga and Tu'i Ha'atakalua on the one hand and the Tu'i Kanokupolu on the other. The situation was more volatile than ever before and the dispersed population, by blood lineage closer related to the middle ranking chiefs, sought protection in small fortifications controlled by these chiefs. A congregated population, however, allowed for the exertion of more direct control over all willing or forced subordinates and thus in turn facilitated a more enterprising conduct of war and land acquisition.

In the Tongan case, fully centralised power resulted in the establishment of a succession of single administrative centres of ever more monumental proportions. Under a strong and pyramidal chiefly system, there was no need for any other centres. The utter fractionation of this power base,

however, led to widespread urbanisation, to the development of a plethora of small, non-monumental centres of small amounts of power.

The political realities at the end of the civil war were enshrined by the introduction of a European-style constitution in 1865. Before, middle ranking chiefly lineages could rise and fall in rank depending on their marriage politics played out against a background of overall horticultural productivity. After the constitution, the chiefly titles had become hereditary and the socio-political structure frozen.

It is mere speculation whether, given time, the settlement pattern would have reverted back to a dispersed one. There is evidence that the population reverted to the traditional style of living in peaceful times and the settlement pattern reverted back to a dispersed mode. Despite having subdued the other chiefs, the Tu'i Kanokupolu was still vulnerable to renewed events of civil strife. By enshrining the status quo and thus providing all chiefs with an assurance that they (and their offspring) would not lose any of the gains, the *raison d'être* for war was removed, thus, in turn, providing security for the Tu'i Kanokupolu .

Urbanisation in Tonga was the result of the need for the consolidation and exertion of direct power at a lower level. Although the need for defence had become obsolete by 1852, the villages created by 50 years of intermittent warfare were maintained. In such clustered settlements the new hereditary chiefs, mostly the winners of the civil wars, could more easily exert political control over formerly hostile groups of people.

This system too was favoured by the new political backers of these chiefs, the European missionaries, who sought to control the minds of the populace, and who were not too impressed with the 'self-indulgent' lifestyle facilitated by potential economic self-sufficiency. Moreover, the Christian faith, requiring daily or weekly attendance at services, created the need for clustered populations. Even though often at odds with the missionaries over issues such as alcohol and morals, an urbanised structure was also favoured by the European traders, who desired stable locations and ready markets for their retail operations, and a diversity of several not too powerful chiefs for the purchase of local produce for ships' provisions and cash crops for general export.

The previous study has implications for the general theory of urbanisation, as it represents a situation, where there is no economic need for wide-spread urbanisation. The land is very fertile, and all households would have been (almost) self sufficient with a food surplus to store or distribute. Apart from a few specialised crafts such as stone adze manufacture, all trades were directly related to chiefly items (canoes, kava bowls etc.) which were, on occasion, exchanged by the highest ranking chief to middle-level chiefs in return for food and services rendered. The needs of craft concentration were well met by a single political and administrative centre. Widespread urbanisation in Tonga is, however, not a result of craft specialisation and regional concentration of power, but of the fractionation of central power into small local units. It is somewhat ironic that

the need to control led to urbanisation and enshrined village life, but that total control had thrived for centuries without it.

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Table 1: The density of mounds and house-mound phases on Tongatapu.

Area	Area (km ²) ¹	No. of mounds	Mounds/km ²	No. of phases	Phases/km ²
Kolovai	2.2	34	15.46	159	72.27
Mataki'eua	4.2	39	9.29	174	41.43
Ha'ateiho/P ea	6.1	86	14.10	332	54.43
Beulah	0.6	23	38.33	110	183.33

Toloa ²	0.6	22	36.67	?	???
Fua'amotu ³	2.2	44	20.00	188	85.46
all areas	15.9	248	15.60	963 ⁴	62.94 ⁴

Notes: 1) Area given is only an approximation; 2) No height data are available for the Toloa area; 3) The area of Fua'amotu excludes the runway of the airport and the runway shoulder; 4) Excluding Toloa area.

Table 2. 'Principal towns, villages and population of Tongatapu with the names of their chiefs' Table presented by John Beveridge, captain of the ship St. Michael, in a letter to Rev. L. Erskine of Sydney dated November 1824. Beveridge's spelling and the modern equivalent are given.

	<i>Place</i>		<i>Chief</i>		
	Beveridge	Modern	Beveridge	Modern	Population
1	Eheefo	Hihifo	Ata	Ata	4000
2	Tagioo	Te'ekiu	Mootooa buaca	Motuapuaka	2000
3	Faheffa	Fahefa	Va halla		3000
4	Va dio	Ha'ateiho	Matta ili	Mata'ili	1000
5	Noogoo noogoo	Nukunuku	Tooi Vaca Noa	Tuivakano	2000
6	Hooro/Hoo na	???	Mafaina		2000
7	Homa	Houma	Vya. Phenow. Vaea		4000
8	Oodoolau	'Utulau	Valoo	Valu	2000
9	Bau	Pea (?)	Lavaea Taioufa	Havea Taiofa	4000
10	Nioucaloffa	Nuku'alofa	Laumooloo a	Laumulu'a	500
11	Vynei	Vaini	Mafuo	Ma'afu	1000
12	Olonga	Holonga	Caboo Cava	Kapukava	2000
13	Foua Motoo	Fua'amotu	Moholamoo	Mohulamu ¹	3000
14	Fooni	Fo'ui	Canagata	Kanagata	400

15	Noi	Hoi	Gnaho tonga		2000
16	Talafia	Talafo'ou		Lowage	2
17	Talagehapai	Talikiha'apa i	Tofooa	Tofua	2
18	Mafanga	Ma'ofanga	Fucca fonooa	Fakafanua	400
19	Takematonga	Tatakemotonga	Fatoo Missiou Hauu Matanget.		100
20	A Chine	Ha'asini	Cava lugoo	Kavaliku	100
21	Nuculaihi	Nukuleka	Tooi Fooua	Tu'ifua	100
22	Hule	Hule ³	Noogoo	Nuku	200
23	Colonga	Kolonga	Tooi tui fuo	Tu'ituifua	100
24	Namamoori	⁴	Tamanee	Tamale	100

Notes: 1) a title, not a name; 2) cannot be read, but not a figure; 3) no longer existing as a village; 4) cannot be identified; if the reading of Tamale for Tamanee is correct, then the village is Niutoa, in the northeast of Tongatapu.

Table 3. List of fortifications on Tongatapu.

Dimensions in m and area in m². Note that a fortification does not necessarily coincide with the village of the same name.

No.	Site no.	Name	Outline	Dimensions	Area	Type
1	TO-Ka-4	Ha'atafu (?)	rectangular	80 x 190	1520	DB1)
2	TO-Ko-4	Kolohau	rectangular	320 x 350	112,000	D
3	TO-Ko-5	Kolosi'i	rectangular	120 x 200	24,000	2BD2)
4	TO-Ko-2	Kolovai	circular	ø 220	38,100	2BD2)
5	TO-Ko-1	Te'ekiu	rectangular	275 x 310	85,250	2D2B
6	TO-Ma-1	Fahefa	circular	ø 250	49,150	DB

7	TO-Ma-8	Nukunuku	rectangular	150 x 150	22,500	DB
8	TO-Ma-9	Hule	rectangular	250 x 250	62,500	2DB
9	TO-Ha-1	Houma	circular	ø 300	70,800	DB
10	TO-La-1	Manahau	subrectangular	100 x 100	10,000	3D
11	TO-La-3	?	rectangular	150 x 150?	22,500	DB
12	TO-Ha-2	'Utulau 1	oval	190 x 230	c. 34,800	DB
13	TO-Ha-6	'Utulau 2	rectangular	100 x 150	15,000	DB
14	TO-Pe-7	Pea	semicircular	580 x 370	250,000	DB
15	TO-Pe-11	Ha'ateiho 1)	rectangular	400 x 400	160,000	DB
16	TO-At-30	Pouvalu	rectangular	190 x 150	28,500	DB
17	TO-Fo-20	?	rectangular	150 x 150?	22,500	DB
18	TO-Fo-5	Kolo Folaha	oval	?	?	D
19	TO-Fo-7	?	rectangular	?	?	D
20	TO-Fo-1	Longoteme (?)	oval	310	75,100	D
21	TO-Fo-3	Vaini 1	semicircular	360 x 220	45,500	DB
22	TO-Fo-4	Vaini 2	semicircular	300 x 320	81,900	DB
23	TO-Be-35	?	rectangular	??	?	DB
24	TO-Fu-89	Fua'amotu (?)	circular	ø 120	11,300	2DB
25	TO-Fu-41	Hamula (fort ?)	?	?	?	?

26	TO-Fu-39	Hamula (fort ?)	?	?	?	?
27	TO-Fu-13	Nakolo	oval	70 x 90	20,000	2D2B
28	TO-Mu-4	Lapaha	open rectangula r	400 x 550	220,000	DB
29	TO-Mu-5	Tatakamo tonga	irregular	?	?	DB
30	TO-Mu- 72	Kolotau	D-shaped	120 x 70	5700	DB
31	TO-Nu-6	Sia-ko- Veiong	o oval	?	?	?
32	TO-Nu- 41	Kolomotu 'a (?)	rectangula r	400 x 400	160,000	DB
33	TO-Nu-7	Ma'ofang a	rectangula r	??	?	?
34	TO-Nu-7	Ngele'ia	?	?	?	?

Abbreviations: open rect.: rectangular fortification, open to one side; semicircul.: semicircular fortification, open to one side. Type code: D: ditch; B: bank; 2D: double ditch; 2B: double bank etc. Notes: 1) bank on the enemy side of the ditch; 2) banks on both the inner and outer sides of the ditch.

Table 4. Systematics of a system of unpaved roads and its archaeological recognisability.

Category	Character	Archaeological visibility
I	Highway	'sunken road'
II	Arterial road	obliterated save for junctions with type I roads
III	Feeder road	obliterated
IV	Access road	obliterated
V	Driveway	ramps

Captions for illustrations

Fig. 1. Map of Tongatapu showing the location of principal places in the text. Former capital places are shown in capital letters.

Fig. 2. Compound ('api) bordered by roads. Note the pig-fence blocking the road, the protection of the tree against pigs and the stiles on the road and at the entrance to the compound. Note also that the houses are largely concealed by surrounding trees. (Drawing by L. de Sainson in 1826 on Dumont d'Urville's first voyage to Tonga; this figure is reproduced from the German edition; note that the figure is mirror-imaged compared with the French original).

Fig. 3. Map of Tongatapu showing the relative density of mounds per km².

Fig. 4. The Ha'amonga-'a-Masi as seen from the southwest.

Fig. 5. Location of map of the individual sites in the Ha'amonga monument complex, Tongatapu. Interpretation of lay-out.

Fig. 6. Location of map of the individual sites in the Mu'a monument complex, Tongatapu.

Mapping: Dirk H. R. Spennemann 1985.

Fig. 7. Map showing the population density at various locations in 1824 (Beveridge).

Fig. 8. Examples of Tongan fortifications (clockwise from top: TO-Fu-13, TO-Ma-9, TO-Pe-11, TO-Ma-1).

Fig. 9. Distribution of fortifications on Tongatapu. The numbers refer to Table 3. The continuous line indicates the approximate position of the Keli-'a-Pelehake.

Fig. 10. Schematic representation of the road network of Tongatapu in 1797. Chart of the island and harbour of Tongataboo (Wilson 1799).

Fig. 11. Reconstruction of the road system at the close of the nineteenth century (see text) and the distribution of archaeologically visible stretches of 'sunken' roads.

Fig. 12. Road networks as reconstructed by a linked weighted minimum spanning tree.